CRITICAL CARE PEARLS

By

Iqbal Ratnani, MD, FCCP
&
Salim Surani, MD, MPH, MSHM, FACP,
FAASM, FCCP

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Dedication

This book is dedicated to our patients and teachers who taught us what we know; to our students who with their intriguing questions have inspired us to look for the answers; and to our families without their love, support and sacrifices we would not be able to do the things we do.

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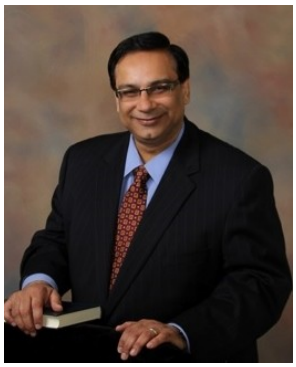
Author's Bio Data

Iqbal Ratnani M.D., FCCP

Dr. Iqbal Ratnani work as an Intensivist at Debakey Heart and Vascular Center, The Houston Methodist Hospital, Texas. He is faculty as an Assistant professor in Clinical Anesthesiology with Weill Cornell University. He did his Critical Care fellowship (Internal Medicine) from University of Medicine and Dentistry, Camden, NJ. He has special interest in developing critical care related Multiple Choice Questions (MCQs) for students, residents and fellows. He has been part of various question writing endeavours including MCCKAP questions committee and Adult Online Practice Exam Committee of SCCM. For last 10 years he is moderator for non-commercial educational Critical Care website www.icuroom.net, which posts pearl on critical care on daily basis with wide audience globally. He has been speaker to various conferences at national and international level, as well as director of critical care workshop and boot camps in third world countries. He is also part of the executive committee of the Texas chapter of SCCM.



Salim R Surani, MD, MPH, FACP, FAASM, FCCP

Dr Salim Surani currently works as the Medical Director of Intensivist program at Christus Spohn Hospital Memorial, Corpus Christi. He serves as Associate Professor of Pulmonary, Critical Care & Sleep Medicine department at Texas A&M University. He also serves as the program director for Pulmonary & Critical Care Fellowship Program at Bay Area Medical Center, Corpus Christi. He has done his fellowship in Pulmonary Medicine from Baylor College of Medicine, Houston Texas. Dr Surani has done his Masters in Public Health & Epidemiology from Yale University and Masters in Health Managemnt from University of Texas, Dallas. Dr Surani also currently serves as secretary of THE CHEST Foundation.

Dr Surani has authored more than 100 articles in the peer review journals, and has written several books and book chapters. He is involved in teaching residents for almost two decades. Dr Surani serves as an associate editor for current respiratory medicine review & critical care and shock. He also serves as ad hoc reviewer for more than 20 journals. He has served as a speaker in several regional, national and international scientific conferences. He has served in the editorial board and has been involved in writing the critical care pearls for icuroom.net. Dr Surani has also served in committee for several national organizations and has received several community and teaching awards. Dr Surani is also the founding president of *It's Your Life Foundation*, a community educational foundation.

Foreword

Stephanie M. Levine, MD, FCCP

Professor, University of Texas Health Science Center, San Antonio
Director, Pulmonary & Critical Care Fellowship Program, UTHSC San Antonio

It gives me a pleasure to write the foreword for this e-book written by Dr Iqbal Ratnani and Dr. Salim R. Surani. Dr. Iqbal Ratnani works as an Intensivist at Debakey Heart and Vascular Center, The Houston Methodist Hospital, Texas. He is on faculty as an Assistant Professor in Clinical Anesthesiology with Weill Cornell University. He has a special interest in developing critical care related Multiple Choice Questions (MCQs) for students, residents and fellows. He has been part of various question-writing endeavors including the multidisciplinary critical care knowledge assessment program (MCCKAP) questions committee and the Adult Online Practice Exam Committee of Society of Critical Care Medicine.

Dr Salim Surani is in practice in the fields of pulmonary, critical care and sleep medicine in Corpus Christi in South Texas. Dr. Surani is a Clinical Associate Professor at the University of North Texas and an Associate Professor at Texas A & M. He went to Yale University where he received a Masters in Public Health. He completed his Fellowship in Pulmonary Medicine from Baylor College of Medicine in Houston. He is the Director of the Pulmonary Fellowship Training Program in Corpus Christi, Texas. Dr. Surani has authored over 100 peer-reviewed articles and have ten published book chapters. He has lectured worldwide on various topics in pulmonary, sleep medicine and critical care. In his career he has held numerous professional appointments in the Christus Spohn Healthcare System and served on committees throughout. He has also conducted research and has served as the principal investigator on more than 30 research grants. He serves on numerous Editorial and Review Boards for Pulmonary and Sleep journals, and is an active member and Fellow in several pulmonary, critical care and sleep professional medical societies.

Dr. Surani is as impressive in his work and accomplishments outside of medicine as in the field. He is a true philanthropist as exemplified by the large foundation he has built

across South Texas. He is the founding president of "It's Your Life Foundation" with the mission and vision of providing tobacco education, substance abuse education and the promotion of healthy sleep to children and young adults. His work has resulted in education to thousands across South Texas and beyond. Nationally, Dr. Surani has continued his philanthropy as a member of the Board of Trustees, and by donating generously to the Chest Foundation: the philanthropic arm of CHEST (the America College of Chest Physicians, the largest clinical pulmonary/critical care organization worldwide). He also holds the office of Secretary of the Board of Trustees of the CHEST Foundation.

This e-book represents a collection of ten years of work by Dr. Surani and other extremely accomplished and dedicated physicians. The book contains ten chapters of clinical questions related to multiple areas in internal medicine, pulmonary medicine, medical and surgical critical care, and sleep medicine. Each chapter is also followed by a section of pearls in that area. Finally the book ends with a series of multiple choice questions.

Experience is a large component of how medicine is practiced and in this book the authors combine their experience with evidence and literature support and top it off with a touch of the art of medicine. The pearls contained in this e-book are true examples of both the art and science of practicing medicine. Each pearl is described with the addition of the authors' nuances and teaching points which will serve those that practice clinical medicine well at the bedside. I urge you to read the pearls contained in this book, and know they will have an impact on those patients under your care.

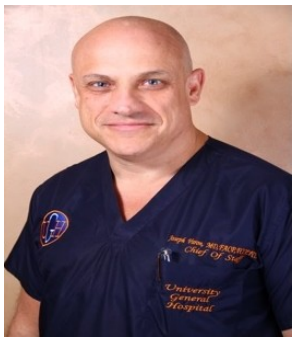
Suhail Raoof, MD, FCCP, MACP, FCCM

Chief, Pulmonary Medicine, Lenox Hill Hospital, 100 East 77th Street, New York, NY
Professor of Clinical Medicine, Weill Medical School of Cornell University, NY

This book addresses the pragmatic, day-to-day issues that come up during patient management and teaching rounds. Both Dr. Iqbal Ratnani and Dr. Salim Surani have more than three decades of experience in taking care of critically ill patients. I commend them for developing their website entitled, "icuroom.net" almost 10 years ago, where they have posted critical care pearls for the edification of the health care providers. They have condensed these pearls, converted them into a question-answer format and provided an easy to assimilate platform that is presented as chapters.

I applaud the authors for doing this educational Pro bono work to enhance the education of health care providers in the critical care arena.

Dr. Iqbal Ratnani serves as Assistant professor at Houston Methodist Weill Cornell University. Dr. Salim Surani serves as the Associate Professor of Texas A&M University and University of North Texas. The latter also serves as the director of intensivist program at Christus Spohn Hospital & Program Director for Pulmonary & Critical Care at Bay Area Medical Center Corpus Christi.



Joseph Varon, MD, FACP, FCCP, FCCM, FRSM

Chief of Critical Care Services, University General Hospital, Houston, Texas, USA

Why do we need another book on questions about critically ill patients? The field of *Critical Care Medicine* is relatively young. In the last few decades we have seen an enormous growth in the number of intensive care units (ICUs). In these ICUs, thousands of medical students, residents, fellows, attending physicians, critical care nurses, pharmacists, respiratory therapists and other health-care providers (irrespective of their ultimate field of practice), will spend countless hours of their professional lives, taking care of those patients who are critically ill. These clinicians must be able to understand the different variables that can affect the outcome of critically ill patients. A number of "question books" are available in the area, however, only few utilize a multi-disciplinary approach.

Drs. Ratnani and Surani have created their book, *Critical Care Peals,* for everyone engaged in the field of Critical Care Medicine. This book presents a series of questions that include a short answer and the rationale for such response. Basic and generally accepted concepts in the field of critical care are provided. The questions presented in the chapters of this book follow a random sequence within each system-oriented section. Each question has an answer that is considered to be up-to-date. Even though this book is not meant to define the standard of care in the field, it elicits simple answers to common conditions found in the ICU environment so that the clinician can both test their own knowledge, as well as to seek additional information on selected topics.
It is important for the reader of this book to understand that Critical Care Medicine is not a static field and changes occur every day. The authors wrote this book hoping that it will benefit thousands of critically ill patients, but more importantly that it will aid practicing clinicians to assume a multidisciplinary approach. One of the attributes of this book is that both authors care for patients every day. Their questions present real scenarios and the answers are evidence-based.

I applaud the efforts of Drs. Ratnani and Surani in their efforts to facilitate education in the area of critical care medicine in a concise and educational manner.

Messages

Kannan Ramar, MD, FCCP

Associate Professor of Medicine
Program Director, Pulmonary, Critical Care & Sleep Medicine, Mayo Clinic, Rochester Minnesota

I would like to congratulate Drs. Iqbal Ratnani and Salim Surani for their excellent work compiling ICU pearls into an online book format that will benefit all types of learners. I have followed their educational work at icuroom.net for a while. Icuroom.net was established 10 years ago to enhance educational learning by providing one critical care medicine pearl a day. After 10 years of their tireless voluntary educational service to the critical care medicine community, the authors have compiled more than 1000 selected teaching pearls and multiple-choice questions into an e-book format. Apart from being a valuable educational resource for health care providers, this e-book will serve well for those who are preparing for their critical care medicine boards.

Drs. Ratnani and Surani are well qualified to write this e-book based on their many years of service in taking care of patients in critical care and in providing teaching to residents, medical students, and fellows. Both physicians have also served in several regional and national committees and have given several lectures both nationally and internationally on critical care related topics.

This e-book has multiple choice questions organized based on the specialty areas, and addresses common challenges and questions that emerge during daily patient care and teaching rounds. It also addresses critical care management controversies and some forgotten facts.

Writing a book is a daunting task, especially when it is done as a pro-bono act. Drs. Ratnani's and Surani's un-parallel commitment is a source of inspiration. I wish them luck in their educational philanthropy journey. I am certain readers will enjoy and benefit from this e-book.

Acknowledgement

We will like to thank all the readers and physicians who have occasionally provided us with the clinical pearls but our special thanks to ***Mohammed A Aziz, MD, MBA, FACP, FCCP, FAASM***, Director of Critical Care Services, St. Catherine of Siena Medical Center, Smithtown New York for consistently contributing the critical care pearls to make this project a success over past several years.

We also would like to acknowledge the help of ***George Udeani*** and ***Christine Udeani*** for their help in editing and design of the book cover.

We also like to thank our professors and mentors for their mentorship and teaching.

PREFACE

Critical Care physicians take care of patients with critical illness and are challenged at times with patients who have multi-organ disease. The patients requires array of diagnostic, therapeutic and pharmacological interventions. The diagnostic intervention or therapeutic intervention on one hand may help one organ status, but can act as a double edge sword, which can compromise the other organ. Similarly, pharmacological therapy may help to fight the infection, but may have nephrotoxic, cardio toxic or renal side effect.

The critical care physicians deal with patient with multi-organ dysfunction or potential multi-organ dysfunction. They have to be familiar with several interventions and therapies, which sometimes may be overlooked. Critical care pearl book is the composition of approximately 1100 key pearls/questions which we have encountered or been asked by the residents and fellows. Sometimes those answers can be simple and sometimes it can be challenging, and sometimes we perform the task without really researching why? We have tried to educate the critical care health providers with one critical care pearls every day for past 10 years at www.icuroom.net. This book is composition of key pearl which has been published at our site for past 10 years, as our thanks to our readers/students/mentors/residents and fellows who helped us to seek the answers and keep ourselves current. We still continue to post daily pearl at www.icuroom.net that readers can access free. These pearls can also be helpful for critical care physicians preparing for the critical care boards. We hope the readers may enjoy reading this book and may help in their knowledge base.

Iqbal Ratnani, MD, FCCP
Assistant Professor, Weil Cornell University

Salim Surani, MD, MPH, FCCP
Associate Professor, Texas A&M University

Critical Care Pearls

CARDIOLOGY

QUESTION 1:

What level of cardiac index can be achieved, if Tandem Heart is functioning properly?

Answer:

Cardiac index of 2.62 L/min/m^2.

Rationale:

If Tandem heart is working properly, then it can provide the pump flow rate ranging from 1.5 to 3.5 L/min, which will result in an average cardiac index of 2.62 L/min/m^2. The flow rate for IABP is limited to approximately 1.5 L/min, whereas the Tandem Heart can provide up to 4 L/min. The support provided by Tandem Heart, results in better metabolic and hemodynamic parameters. This does not however, result in improved survival.

QUESTION 2:

A 52-year-old male presented to ED with chest pain radiating to back. Which one blood test may rule out aortic dissection?

Answer:

Negative D-dimer.

Rationale:

A D-dimer <0.1 µg/mL will rule out acute aortic dissection in all cases.

Reference(s):

D-dimer in ruling out acute aortic dissection: a systematic review and prospective cohort study - Eur Heart J (2007) 28 (24): 3067-3075.

QUESTION 3:

While administrating procainamide, what is the cutoff point to stop it based on EKG criteria?

Answer:

The QRS complex widens by 50% or more

Rationale:

Procainamide has a prolonged action on cardiac muscles, particularly due to its metabolite N-acetyl procainamide (NAPA). NAPA is also as equipotent as the parent drug, as an antiarrhythmic agent. The elimination half-life of NAPA is about twice that of procainamide.

Procainamide should be discontinued when:

a. Dysrhythmia is suppressed, or
b. Hypotension ensues, or

c. QRS complex widens by 50% or more, or
d. Maximum dose is achieved.

QUESTION 4:

Case:

A 74-year-old patient with previous history of CHF developed atrial fibrillation with rapid ventricular rate (RVR) pre-operatively which was controlled with IV Cardizem drip. Cardizem was continued. The patient then developed signs and symptoms of malignant hyperthermia during surgery. Intravenous dantrolene was administered. Thereafter the patient became hypotensive, developed ventricular tachycardia, collapsed and died. Why?

Answer:

Calcium channel blockers such as diltiazem (Cardizem) or verapamil may cause severe hemodynamic problems if concomitantly administrated with dantrolene. This could also lead to severe cardiovascular collapse, arrhythmias, myocardial depressions, and hyperkalemia.

QUESTION 5:

What is the best parameter to follow in amiodarone overdose?

Answer:

Follow serial QT duration

Rationale:

Surprisingly, overdose with amiodarone is usually benign as it is very poorly and variably absorbed. But all such patients should be admitted to ICU/CCU for close observation with serial EKGs. On the EKG, amiodarone leads to prolonged QT interval due to its blocking of repolarizing potassium channels. The QT duration is the best indicator of the extent of potassium channel blockade.

QUESTION 6:

Case:

A 39-year-old male was admitted with hypertensive emergency after he ran out of his prescriptions. "ED Doc" started the patient on IV Cardene (nicardipine) drip and resumed patient's home medication for BP, metoprolol extended release (Toprol XL) - first dose given in the ED. Upon review of the CXR you noticed some pulmonary edema and decide to switch to fenoldopam to get dual effect of lowering BP as well as dopaminergic effect to resolve pulmonary edema. The patient drops his BP precipitously and coded. What is the probable cause?

***Answer*:**

It is not advisable to start fenoldopam on patients with B-blocker or at least close caution should be maintained. Concomitant use of beta-blockers in conjunction with fenoldopam

may cause life-threatening hypotension from beta-blocker's inhibition of the sympathetic reflex response to fenoldopam.

QUESTION 7:

Case:

Patient is on intra-aortic balloon pump (IABP) with 1:1 ratio and rhythm is atrial fibrillation. Patient went into rapid ventricular rate (RVR) at 180 beats/min. What should be your adjustment for IABP?

Answer:

Decrease ratio to 1:2

Rationale:

IABP are incapable of inflation and deflation rapidly to accommodate heart rate beyond 150. Better augmentation can be obtained by decreasing the ratio to 1:2 till situation improves.

QUESTION 8:

What is Frog sign?

Answer:

In Paroxysmal Supra-Ventricular Tachycardia (PSVT) a rapid and regular bulging seen in the neck. These are actually prominent jugular venous "a" waves due to atrial contraction against the closed tricuspid valve, and termed as "frog sign".

Reference(s):

1. Brief report: the hemodynamic mechanism of pounding in the neck in atrioventricular nodal reentrant tachycardia - N Engl J Med. 1992 Sep 10; 327(11): 772-4.

2. Evaluation of Patients with Palpitations - NEJM, May, 1998, Volume 338:1369-1373

QUESTION 9:

What are 2 very commonly used medicines that physicians prescribe simultaneously and probably reflexly – that cancel each other effect. What are they?

Answer:

β-blockers and Dobutamine (while trying to control tachycardia of Dobutamine by β-blockers).

Rationale:

Dobutamine is a selective β1 adrenergic agonist and its effect gets neutralize by β-blockers.

Atenolol, Esmolol, Metoprolol are β1 blockers
Carvedilol, Labetalol and Nadolol are β1, β2 blockers

QUESTION 10:

Name at least one other condition, which can give rise to Osborn wave (electrocardiographic J wave usually associated with hypothermia)?

Answer:

Cocaine use.

Rationale:

Osborn waves are famous for their association with hypothermia but there are many other conditions, which can produce similar EKG 'j' wave findings under normothermia including cocaine use, haloperidol overdose, and left ventricular hypertrophy due to hypertension, after cardiac resuscitation and in severe hypercalcemia, cardiac ischemia and central nervous system injury.

The objective of this question is to understand that Osborn wave is not a diagnostic of hypothermia and other conditions should also be considered.

Reference(s):

The Osborn wave of hypothermia in normothermic patients - Clin Cardiol.1994 May; 17(5): 273-6

QUESTION 11:

What are the 3 major risk factors for Vasoplegic syndrome in post-CABG patients?

Answer:

1. The long initial Cardiopulmonary Bypass (CPB) time;
2. Angiotensin converting enzyme inhibitor; and
3. Beta-blocker

Reference(s):

Levin MA, Lin HM, Castillo JG, Adams DH, Reich DL, et al. (2009) Early on-cardiopulmonary bypass hypotension and other factors associated with Vasoplegic syndrome. Circulation 120: 1664-1671.

QUESTION 12:

Case:

A 52-year-old male is back from cardiac angioplasty with abciximab (ReoPro) infusion. Pre- catheterization laboratory data were normal. CBC was ordered per protocol after 4-hours of abciximab infusion the laboratory called with a critical platelet level of 62. Abciximab was stopped and hematology consulted. Hematology advised to restart abciximab. Why?

Answer:

Pseudo thrombocytopenia

Rationale:

Pseudo thrombocytopenia is a common phenomenon with patients on abciximab (ReoPro). It is a benign condition and is not a real thrombocytopenia as platelets actually clump in collecting tubes contains Ethylenediaminetetraacetic acid (EDTA). It is an important diagnosis to make as it may leave patient without an appropriate treatment. Reviewing peripheral blood film or drawing blood in citrated or heparinized tube can make diagnosis. It is not clear why abciximab causes more EDTA-induced platelet clumping. EDTA is a commonly used anticoagulant in sampling tubes for blood counts.

Reference(s):
1. Occurrence and clinical significance of pseudothrombocytopenia during Abciximab therapy J Am Coll Cardiol. 2000 Jul; 36(1): 75-83.
2. Abciximab-Associated Pseudothrombocytopenia - Circulation. 2000; 101:938
3. EDTA dependent pseudothrombocytopenia caused by antibodies against the cytoadhesive receptor of platelet gpIIB-IIIA - Journal of Clinical Pathology 1994; 47:625-630
4. Pseudothrombocytopenia Volume 329:1467 Nov. 11, 1993

QUESTION 13:

What is the mean level of Troponin I elevation in Subarachnoid Hemorrhage (SAH)?

Answer:
0.93

Rationale:
At least one study showed that the mean troponin level in subarachnoid hemorrhage was 0.93 (range, 0.01-25.8 ng/mL). But, Troponin I elevation after SAH was not found to be an independent predictor of in-hospital mortality.

Reference(s):
Gupte M, John S, Prabhakaran S, Lee VH. - Troponin elevation in subarachnoid hemorrhage does not impact in-hospital mortality. Neurocrit Care. 2013 Jun; 18(3): 368-73.

QUESTION 14:

Case:
A 24-year-old male presented with syncope. Patient has family history of sudden cardiac deaths in family and you strongly suspect Brugada syndrome. Which drug can be used to illicit specific EKG patterns for diagnosis of Brugada syndrome?

Answer:
Flecainide

Rationale:
The Brugada syndrome is a genetic disorder characterized by abnormality in Electrocardiographic findings associated with an increased risk of sudden cardiac death particularly in young men without known underlying cardiac disease.

Brugada syndrome can be detected by observing characteristic patterns on an EKG, which may be present all the time, or in clinical suspicion can be elicited by the

administration of Class IC antiarrhythmic drugs (like Flecainide) that blocks sodium channels and causing appearance of ECG abnormalities.

QUESTION 15:

Which condition may mimic pseudo-atrial flutter on EKG and on monitor?

Answer:

Parkinsonian tremor (first reported about 40 years ago, and later on confirmed by many other reports).

Rationale:

In literature, cases have been reported of pseudo atrial flutter with use of electronic devices by patients.

Reference(s):

1. *Muscle-tremor artifact due to Parkinson's syndrome. It stimulated atrial flutter and disappeared during sleep - postgrad med. 1965 Jun; 37:718-20.*
2. *Atrial flutter simulated by a portable CD player - mayo clinic proceedings - march 2006,82(3), Page 383 -pdf file*

QUESTION 16:

Is menstrual bleeding a contraindication to thrombolytic therapy in Acute MI or Stroke?

Answer:

No.

Rationale:

There may be a clinically significant increase in the risk of moderate bleeding during menstruation. Thrombolytic therapy should however not by withhold for active mensuration, in view of its benefits in the reduction of mortality for acute myocardial infarction. Patients receiving thrombolytic therapy should be advised that they might require transfusion for menorrhagia.

QUESTION 17:

The reentrant circuits in Atrial Fibrillation usually arise from? (Choose one).
(A) Right Atrium
(B) Left Atrium

Answer:

Left Atrium.

Rationale:

The SA node lies in right atrium, as a result, there is a general misconception that atrial fibrillation arises in right atrium but usually the abnormal foci are in left atrium near the

entrance of pulmonary veins. In Maze procedure, the ablation path surrounds the pulmonary veins.

QUESTION 18:

A 44-year-old male with CHF went into atrial fibrillation with Rapid Ventricular Rate (RVR) of 160 to 180 beats per minute. You ordered Digoxin 0.25 mg IV but after 15 minutes, there is no response. Why?

Answer:

Digoxin is effective in controlling heart rate in patients with atrial fibrillation with rapid ventricular rate (RVR) especially in the presence of congestive heart failure (CHF), and left ventricular systolic dysfunction. Digoxin on the other hand is not recommended for the treatment of very acute atrial fibrillation. Its onset of action is at 30 minutes and the peak effect is in 2-3 hours.

QUESTION 19:

A 24-year-old male with no past medical history presented to ED with Supraventricular Tachycardia (SVT). Heart rate is 210. The patient was given adenosine and went into ventricular fibrillation. CPR started and converted back to normal sinus rhythm (NSR) with cardioversion. What is your first thought?

Answer:

Wolff-Parkinson-White syndrome (WPW)

Rationale:

Patients with WPW have an accessory pathway (known as bundle of Kent), which connects the atria and the ventricles, in addition to the AV node. The bundle of Kent can conduct electrical activity at a significantly higher rate than the AV node particularly when it is blocked and may degenerate into ventricular fibrillation.
Adenosine and other AV node blockers should be avoided including calcium channel blockers and beta-blockers. Procainamide is the preferred therapy and cardioversion is the therapy of choice in patients with hemodynamic instability.

QUESTION 20:

Case:

A 79-year-old male was admitted with Non ST segment elevation acute myocardial infarction (MI). The patient is treated conservatively without any invasive intervention. Clinically patient stabilized and has no symptoms, the echocardiogram remains stable. Patient seems ready to go to telemetry floor on 4th day of admission but on review of labs, Troponin-I remains elevated around 18 ng per milliliter.

Answer:

Troponin, once secreted, remains elevated for 7-10 days.

Rationale:
Troponin I is not expressed in human skeletal muscle and is highly specific for myocardial tissue, and should not be detectable in the blood of healthy persons but remains elevated for 7 to 10 days after an episode of myocardial infarction.

Reference(s):
Cardiac-Specific Troponin I Levels to Predict the Risk of Mortality in Patients with Acute Coronary Syndromes - Volume 335:1342-1349, October 31, 1996, The New England Journal of Medicine

QUESTION 21:
What are 2 types of atrial flutter?

Answer:
Type I atrial flutters (tricuspid valve isthmus dependent): Catheter ablation is typically successful and recurrence after ablation therapy is less than 5%. Post procedure anticoagulation with warfarin is usually recommended for 4-6 weeks.

Type II atrial flutters (non-tricuspid valve isthmus dependent): These circuits are amenable to catheter ablation but require advanced mapping systems. Recurrences in these cases are more common and may require the use of antiarrhythmic agents for suppression.

QUESTION 22:
In which heart valvular condition is Intra-Aortic Balloon Pump (IABP) counterpulsation, contra-indicated for anginal symptoms?

Answer:
Severe Aortic valvular insufficiency (Aortic Regurgitation).

Rationale:
It worsens the diastolic augmentation of IABP and thus the magnitude of regurgitation.

QUESTION 23:
Case:
A 69-year-old male was admitted to the ICU for community acquired pneumonia and did well with treatment. Over last 24 hours received Thorazine for persistent hiccups. While reviewing morning EKG, you noticed prominent U waves.

Answer:
Phenothiazines induced EKG changes.

Rationale:
Phenothiazines related EKG changes are seen in approximately 50% of patients receiving "therapeutic" doses.

a. It can mimic hypokalemia
b. It shows prominent U waves
c. It has low amplitude T waves or T wave inversion
d. There is ST segment depression
e. There is prolonged QT interval

Phenothiazines include Chlorpromazine hydrochloride (Thorazine), Prochlorperazine (Compazine), Promethazine hydrochloride (Phenergan), Thioridazine hydrochloride (Mellaril), Trifluoperazine hydrochloride (Stelazine) and others.

QUESTION 24:

A 52-year-old female went into supraventricular tachycardia. While you call for Adenosine at bedside, clinical pharmacist informs you that patient is on chronic Aggrenox for her stroke?

Answer:
Aggrenox is the combination of Aspirin and extended release dipyridamole. It can potentiate the action of adenosine, so the lower doses (usually half) should be given. Give only half of recommended dose of adenosine.

QUESTION 25:

Case:
A 47-year-old male admitted from cardiac catheterization laboratory after insertion of pericardial catheter with drainage bag, patient is hemodynamically stable. Few hours later nurse reported that blood in pericardial bag appears 'darker' and more 'bloody'. Describe various methods to rule out ventricular puncture by pericardial catheter?

Answer:
There could be various laboratory and non-laboratory methods to rule out ventricular puncture by pericardial catheter.

1. Though not always true but pure pericardial fluid usually does not clot.
2. Decholin test - Inject 3 ml of Sodium dehydrocholate (Decholin) in pericardial catheter. If patient complains of bitter taste within few minutes - ventricular rupture is likely.
3. Fluorescein test - Inject Fluorescein in pericardial catheter and look for fluorescent 'flush' under ultraviolet light beneath the skin of the eyelid. If visible - ventricular rupture is likely.
4. Draw hematocrit from venous blood and compare with pericardial hematocrit. Same values of hematocrit make ventricular rupture highly likely.

5. Draw ABG from venous blood and compare with pericardial ABG. PO2 is usually lower and PCO2 is usually higher in pericardial fluid. Same values in ABGs make ventricular rupture likely.

QUESTION 26:

Case:

A 61-year-old male is admitted with Angina. Cardiac catheterization showed 3-vessel disease. Cardiac bypass surgery planned for next morning. Patient admitted back to CCU with protocolled post cardiac catheterization orders. Around 12 midnights, patient suddenly became hypotensive. Arriving at bedside you noticed tall v waves on pulmonary artery catheter tracings. You suspect flail Mitral valve (Mitral regurgitation - MR) with possible ruptured chordae tendinae. Cardiologist is also concerned about ventricular septal defect (VSD). Unfortunately, STAT echocardiogram is not available at 12 midnights. What would be the best way to differentiate between MR and VSD?

Answer:

VSD is very difficult to diagnose from MR on clinical grounds. VSD can be differentiated from MR by demonstrating a step-up in oxygen saturation in the right ventricle (by collecting blood from CVP, RV and PA/distal ports of PA catheter).
If oxygen saturation level in right ventricle is more than 5% from right atrium or 8% from pulmonary artery (due left-to-right shunt across the ventricular septum), it is diagnostic of VSD. In this era of technology, echocardiography is preferable, if available, due to its non-invasive and good diagnostic value.

Reference(s):

Hemodynamic complications of ventricular septal rupture after acute myocardial infarction - Catheterization and Cardiovascular Interventions, Volume 60, Issue 4, Pages 509 - 514, 2003

QUESTION 27:

Case:

An 88-year-old female is admitted to hospital after Non-Q wave MI. Patient required intubation during cardiac catheterization due to over sedation but pre-procedure ABG was normal. Patient continues to have refractory hypoxemia. Workup for PE is negative with essentially normal chest CT. No infiltrates noted either. CXR is essentially normal too. Cardiac index is 2.7. Hypoxemia gets worse as PEEP was increased to counter hypoxemia. There is no auto-PEEP detected. Lactic acid and other workup are normal. Cardiac enzymes are actually improving. Regular transthoracic echocardiogram is normal. In short, you have a patient with stable laboratory data and hemodynamics but with only refractory hypoxemia getting worse with increasing ventilator pressure.

Answer:

Patent foramen ovale causing right to left shunt and worsening due to high right-sided pressure from high PEEP. Patent foramen ovale is present in about 15% of the population. It gets worse with age, usually from a mean of 3.4 mm in the first decade to

5.8 mm in the 10th decade of life. Any increased pressure on right side of heart may make it worse. Diagnosis can be made by bubble study during echocardiogram.
Bubble (contrast) study: After getting the clear visualization of the atrial septum on echocardiography (transthoracic or transesophageal), agitated saline bolus is injected intravenously. Micro bubbles will appear first in the right atrium. If the bubbles appear in the left atrium within 3 cardiac cycles of their appearance in the right atrium, the test is considered to be positive.

Treatment is closure of PFO surgically or by device; or decreasing right-sided pressure by IV nitro, diuresis and decreasing ventilator pressure till permanent solution can be intervened.

QUESTION 28:

A 52-year-old female went into supraventricular tachycardia. While you call for adenosine at bedside, clinical pharmacist informs you that patient is on chronic Aggrenox for her stroke?

Answer:

Aggrenox is the combination of aspirin and extended release dipyridamole. Dipyridamole potentiates the action of adenosine, so the lower doses (usually half) should be given. Give only half of recommended dose of adenosine.

QUESTION 29:

What is the basic difference between monophasic and biphasic cardioversion?

Answer:

In monophasic cardioversion, the current travels only in one direction - from one paddle to the other.

In biphasic cardioversion, the current travels towards the positive paddle and then reverses and goes back; this happens several times delivering one cycle every 10 milliseconds.

QUESTION 30:

Fluoroquinolones are of considerable clinical importance because of their ability to cause prolongation of the QT interval and consequently causing Torsades de pointes (TdP). Which Fluoroquinolone is known to be the least and which Fluoroquinolone is known to be the worst offender?

Answer:

Among Quinolones, ciprofloxacin has the lowest risk for QT prolongation and the lowest incidence of TdP. Moxifloxacin carries the greatest risk of QT prolongation.

"Fluoroquinolones prolong the QT interval by blocking voltage-gated potassium channels".

Reference(s):
Briasoulis A1, Agarwal V, Pierce WJ. QT prolongation and torsade de pointes induced by Fluoroquinolones: infrequent side effects from commonly used medications - Cardiology. 2011; 120(2): 103-10

QUESTION 31:

What percentage of patients may require permanent pacemaker (PPM) after transcatheter aortic valve implantation (TAVI) (CorValve)?

Answer:
About one third.

Rationale:
One third of patients undergoing a (CoreValve) transcatheter aortic valve implantation procedure may require a PPM. Following factors may affect the need:

A. Periprocedural atrioventricular block
B. Balloon pre dilatation
C. Larger CoreValve prosthesis
D. Increased interventricular septum diameter
E. Prolonged QRS duration

Reference(s):
Permanent Pacemaker Insertion After CoreValve Transcatheter Aortic Valve Implantation Incidence and Contributing Factors (the UK CoreValve Collaborative) M.Z. Khawaja, MBBS; and co. - Circulation.2011; 123: 951-960

QUESTION 32:

What is the danger of synchronized cardioversion in the presence of hyperkalemia?

Answer:
Cardioversion in "synchronized" form reads the EKG so the shock occurs on an R wave. When you synchronize cardiovert a patient, it may take few seconds until the defibrillator senses an R wave and delivers the shock. Sometimes it takes 3 or 4 QRS complexes to do this.

If the patient has severe hyperkalemia, sometimes the defibrillator may sense tall, peaked T waves as QRS complexes. If you deliver a cardioversion shock that is synced on the T wave, you may induce ventricular fibrillation.

QUESTION 33:

In Hypothermia induced ventricular fibrillation, which cardiac medicine is preferred and which one may harm the patient?

Answer:
Bretylium (5 mg/kg initially) is recommended for any hypothermic patient manifesting significant new frank dysrhythmia. However, bretylium has a worldwide shortage and may not be available. Relying on Amiodarone or Lidocaine are the next choices. Procainamide may induce more ventricular fibrillation and should be avoided. Defibrillation should also be performed simultaneously. Defibrillate at 2 J/kg (or the biphasic equivalent) if patient remains in ventricular fibrillation or ventricular tachycardia.

Success rates of defibrillation are low if the core temperature is less than 32°C and should be performed with rise in body temperature. Given that many arrhythmias convert spontaneously upon rewarming, aggressive therapy of minor arrhythmias is not warranted. Transient ventricular arrhythmias should be ignored. This also is true of bradycardia or atrial arrhythmias.

The cornerstone of treatment is rewarming the patient.

QUESTION 34:
Serum alkalinization with intravenous sodium bicarbonate has been the mainstay of therapy in cyclic antidepressants (CA) such as Amitriptyline, Desipramine, Imipramine, Nortriptyline, Doxepin, Clomipramine, and Protriptyline overdose. What is the cutoff limit of QRS complex for use of intravenous sodium bicarbonate therapy?

Answer:
A QRS of 100 milliseconds or greater is generally use as the cut off for intravenous sodium bicarbonate. Besides alkalization, sodium loading may be the most important factor in the reversal of the symptoms of cyclic antidepressant toxicity. IV normal saline is indicated for CA-induced hypotension.

QUESTION 35:
Why is it called drug "eluting" stent?

Answer:
Drug "eluting" stents refers to metal stents that elute (slowly release from stent) a drug designed to limit the growth of neointimal scar tissue. It further reduces the likelihood of stent restenosis. Most commonly used drugs are sirolimus and paclitaxel. In last few years, everolimus has also gained popularity.

Rule of thumb for adjusting Amiodarone with Coumadin:

For Amiodarone 400 mg/day: One should reduce Warfarin dose by 40%
For Amiodarone 300 mg/day: One should reduce Warfarin dose by 35%

For Amiodarone 200 mg/day: One should reduce Warfarin dose by 30%
For Amiodarone 100 mg/day: One should reduce Warfarin dose by 25%

QUESTION 36:

Why Indomethacin is not advocated any more for the treatment of Dressler's Syndrome?

Answer:

Indomethacin inhibits new collagen deposition, and thus impairs the healing process for the infarcted myocardial region. NSAIDs in general are now less advocated in patients with ischemic heart disease.

Preferred treatment for Dressler's syndrome is now Colchicine.
Corticosteroids are still popular with many folks particularly after cardiac surgeries, but the frequency of relapse is high when corticosteroid therapy is discontinued.

QUESTION 37:

A 52-year-old male is admitted with unstable angina and going to the catheterization laboratory for probable coronary stenting. Cardiologist called you to replace Plavix (Clopidogrel) from protocol to Effient (Prasugrel). What would be the replaced dose?

Answer:

Loading dose of 60 mg of Prasugrel followed by 10 mg Prasugrel per day.

Rationale:

Effient (Prasugrel) is a new platelet inhibitor (like Plavix), developed for use in acute coronary syndromes planned for percutaneous coronary intervention (PCI).
It has been said (or claimed) that compared to Clopidogrel, 'Prasugrel' inhibits adenosine diphosphate–induced platelet aggregation consistently and rapidly, and to a greater extent than the standard and higher doses of Clopidogrel.

QUESTION 38:

How much Aorta should be optimally occupied while Intra-Aortic Balloon Pump (IABP) is inflated?

Answer:

Optimally 85% of aorta should be occluded.

Rationale:

With Intra-Aortic Balloon Pump (IABP) the more blood displaced during diastole, the better the augmentation but total occlusion of aorta should be avoided.

QUESTION 39:

Which position is best to perform pericardiocentesis?

Answer:

At 30 to 45 degree angle.

Rationale:

Semi recumbent position at a 30 to 45 degree angle brings the heart closer to the anterior chest wall. Some physicians recommend up to 60 degrees too.

QUESTION 40:

Which pressor is preferable to counteract vasodilatation (hypotension) induced by Milrinone during or immediate post-operative coronary bypass surgery? (Choose one).

A. Norepinephrine
B. Dopamine
C. Vasopressin
D. Phenylephrine

Answer:

C. Vasopressin

Rationale:

Phosphodiesterase inhibitor is used during coronary bypass surgery in management of decompensated heart failure because it increases contractility and decreases afterload of right ventricle. It also improves hemodynamics and increases blood flow of the grafted internal mammary arteries and middle cerebral arteries during coronary artery bypass surgery. It induces vasodilation however, and necessitates the use of vasoconstrictors.

In the patients undergoing CABG surgery, both norepinephrine and low dose vasopressin were effective in restoring Milrinone-induced decrease of SVR. Only low-dose vasopressin decreased the PVR/SVR ratio that was increased by Milrinone. Considering the importance of maintaining systemic perfusion pressure as well as reducing right heart afterload, Milrinone–Vasopressin may provide better hemodynamics than Milrinone–Norephinephrine during the management of right heart failure.

SVR = systemic vascular resistance
PVR = pulmonary vascular resistance

Reference(s):

Comparative hemodynamic effects of vasopressin and norepinephrine after Milrinone-induced hypotension in off-pump coronary artery bypass surgical patients – European Journal of Cardio-Thoracic Surgery, Volume 29, Issue 6, Pages 952-956 (June 2006)

QUESTION 41:

What amount of Coronary Air Embolism can be fatal?

Answer:
It may sound strange, but as low as 0.5 ml of air in coronary circulation can cause cardiac arrest.

QUESTION 42:
Which drug works best for ventricular fibrillation resulting from hypothermia?

Answer:
Bretylium.

Rationale:
Ventricular fibrillation in a hypothermic patient can be very frustrating. Defibrillation is usually ineffective. The recommendation is to attempt chemical conversion with intravenous bretylium times one accompanied by CPR until active rewarming can be done to perform successful defibrillation.

Reference(s):
1. *Murphy K, Nowak RM, Tomlanovich MC. Use of bretylium tosylate as prophylaxis and treatment in hypothermic ventricular fibrillation in the canine model. Ann Emerg Med. Oct 1986; 15(10): 1160-6.*
2. *Vachiery JL, Reuse C, Blecic S, Contempre B, Vincent JL. Bretylium tosylate versus Lidocaine in experimental cardiac arrest. Am J Emerg Med. Nov 1990;8(6): 492-5*
3. *Buckley JJ, Bosch OK, Bacaner MB. Prevention of ventricular fibrillation during hypothermia with bretylium tosylate. Anesth Analg. Jul-Aug 1971; 50(4): 587-93*

QUESTION 43:
Can digitalis even with therapeutic serum levels cause chromatopsia and photopsia? What is that?

Answer:
Chromatopsia is a condition in which the patient subjectively perceives colors other than their objective colors, especially in the yellow or green range.

A patient with photopsia on the other hand gets the subjective sensation of visualizing light, which is not present in the environment.

Visual abnormalities are the most common subjective symptoms of digitalis intoxication. "Digitalized “patients may also have other less common visual symptoms as snowy vision, blurred vision and decreased visual acuity. It is important to note that visual disturbances may be the sole clinical manifestation of digitalis intoxication. This can even happen at therapeutic or sub-therapeutic levels. The patients may not have any other symptoms of digitalis toxicity.

QUESTION 44:

What are the maximum joules you can use to cardiovert refractory atrial fibrillation?

Answer:

720 Joules.

Rationale:

For atrial fibrillation are 100-200 Joules initially and 360 Joules for subsequent shocks. For refractory atrial fibrillation, a study has shown good response to higher energy shocks of 720 Joules.

Reference(s):

Saliba W, Juratli N, Chung MK, Niebauer MJ, Erdogan O, Trohman R. Higher energy synchronized external direct current cardioversion for refractory atrial fibrillation. J Am Coll Cardiol. Dec 1999; 34(7): 2031-4

QUESTION 45:

Why Sotalol is preferred over other Beta-Blockers for prevention of ventricular tachycardia and ventricular fibrillation?

Answer:

Due to its dual action, as it prolongs PR and QT interval.

Rationale:

Sotalol is a non-selective β-blocker and works by inhibition of the potassium channels. It has class III antiarrhythmic properties. Because of this dual action, it prolongs the PR and QT intervals. Sotalol is often preferred over other β-blockers in the prevention and treatment of both ventricular fibrillation and ventricular tachycardia.

QUESTION 46:

A 48-year-old male is brought to ED after ventricular fibrillation cardiac arrest. Cardiology wants to take patient to the catheterization laboratory. What are the recommendations regarding therapeutic hypothermia?

Answer:

Therapeutic hypothermia should not be delayed particularly in clear-cut cases of ventricular fibrillation cardiac arrest; and should be initiated in the emergency department. Cardiology interventions can be done and patients should continue to be cooled during percutaneous coronary intervention (PCI). Necessary medications as aspirin, antiplatelet compounds or even thrombolytics should continue being used.

QUESTION 47:

Case:

A 62-year-old male with past medical history of diabetes mellitus, hyperlipidemia, atrial fibrillation, hypertension, and mild renal insufficiency is brought to the ED with severe

weakness, anuria and renal failure. The patient reports extremely dark urine for a few days prior to presentation. The patient was discharged 5 weeks ago from hospital with aspirin, coumadin, Lopressor, Amiodarone and simvastatin. Laboratory workup in ED showed creatine kinase (CK) in 80,000 U/L range. BUN 65 mg/dl, creatinine 4.6 mg/dl. Liver function test (LFT) are also moderately elevated. What could be the reason of this life threatening Rhabdomyolysis?

Answer:
Simvastatin-Amiodarone interaction.

Rationale:
Simvastatin is metabolized primarily by CYP3A4, and Amiodarone is an inhibitor of this enzyme. This drug interaction may cause severe life threatening Rhabdomyolysis. The risk is higher in patients, particularly when patient is taking greater than 20 mg of Simvastatin.

QUESTION 48:

While performing bubble echocardiography to diagnose hepatopulmonary syndrome - bubbles usually appear in left atrium within how many heartbeats?

Answer:
7 heart beats/minute.

Rationale:
Intravenous micro bubbles (from agitated normal saline) are normally obstructed by pulmonary capillaries. In hepatopulmonary syndrome they rapidly transit the dilated pulmonary vessels and appear in the left atrium usually within 7 heart beats.
In hepatopulmonary syndrome there is formation of microscopic intrapulmonary arteriovenous dilatations in patients with liver failure. The vascular dilatations can cause over perfusion relative to ventilation, which in turn leads to ventilation-perfusion mismatch and hypoxemia.

Reference(s):
Value of contrast echocardiography for the diagnosis of hepatopulmonary syndrome - European Journal of Echocardiography, Volume 8, Issue 5, Pp. 408-410.

QUESTION 49:

What are the therapeutic target levels of digoxin in congestive heart failure (CHF) and non-CHF patients?

Answer:
CHF patients = 0.5–0.9 mcg/L,
Non-CHF patients like for atrial fibrillation rate control, its 0.5–2 mcg/L

Reference(s):

Adams KF Jr., Gheorghiade M, Uretsky BF, et al. Clinical benefits of low serum digoxin concentrations in heart failure. J Am Coll Cardiol. 2002; 39:946–953.
Ahmed A, Rich MW, Love TE, et al. Digoxin and reduction in mortality and hospitalization in heart failure: a comprehensive post hoc analysis of the DIG trial. Eur Heart J. 2006; 27:178–186.
Rathore SS, Curtis JP, Wang Y, et al. Association of serum digoxin concentration and outcomes in patients with heart failure. JAMA. 2003; 289:871–878

QUESTION 50:

Which commonly used cardiovascular drip in ICU may prolong QT interval (and may cause Torsades de pointes)?

Answer:
Vasopressin.

QUESTION 51:

What is Jervell and Lange-Nielsen syndrome?

Answer:
The Jervell and Lange-Nielsen syndrome (JLNS) is an autosomal recessive form of Long QT Syndrome (LQTS) with associated congenital deafness.

Clinical significance: If undiagnosed or untreated, about 50% die by the age of 15-years due to ventricular arrhythmias.

QUESTION 52:

A 42-year-old female with no significant past medical history except for hypertension, presented to ED with dizziness and palpitations. Initial rhythm showed runs of ventricular tachycardia. Only significant description given in history is recent episode of urinary tract infection (UTI) for which an urgent care physician prescribed antibiotics. Which drug interaction is suspected?

Answer:
Bactrim (Trimethoprim-Sulfamethoxazole) and ACE-Inhibitor (ACE-I).

Rationale:
Among patients treated with ACEIs or ARBs, the use of Bactrim is associated with a life threatening hyperkalemia, in comparison to other antibiotics. Alternate antibiotic therapy should be considered in such situation.

QUESTION 53:

A 51-year-old male with previous history of asthma presented to ED with frequent episodes of supra-ventricular tachycardia (SVT). As you enter patient's room you are amused by the fact that though heart rate on monitor is 180/minutes patient is drinking a cup of coffee. You administered adenocard twice with maximum dose, but there is no

response. What could be the reason?

Answer:
Patient has history of asthma and could be on theophylline. Also, patient's intake of caffeine may be masking the effect of adenosine.

Rationale:
Theophylline/aminophylline antagonize actions of Adenocard. Another major culprit could be caffeine. By nature of caffeine's purine structure it binds to some of the same receptors as adenosine. The pharmacological effects of adenosine may therefore be blunted in individuals who are taking large quantities of Methylxanthines (e.g. caffeine, found in coffee and tea, or theobromine, as found in chocolate).

QUESTION 54:

A 58-year-old male with renal failure, but not yet on dialysis, is admitted with ST elevation MI and taken to the catheterization laboratory for PCI and stent placement. Patient is back in unit and is to be started on glycoprotein IIb/IIIa inhibitor.
What would be your choice?

Answer:
ReoPro Eptifibatide gets renal elimination and in such patients Abciximab (ReoPro) would be a better choice.
In case Integrilin has to be given, renal dosing should be provided.

QUESTION 55:

How many days does it usually take for Clopidogrel (Plavix) hypersensitivity to manifest?

Answer:
About one week

Rationale:
Interestingly, it takes a few days before Clopidogrel manifests its hypersensitivity. Usually, it presents as an erythematous, macular, morbilliform rash, which usually begins on the face, chest, or abdomen, and slowly spreads to the proximal and then distal extremities. It may even involve palms and soles. In rare cases, it can become pruritic. The median time from drug introduction to appearance of symptoms is between 5 and 10 days.

Hypersensitivity can be managed without discontinuation of drug.

Reference(s):
1. Cheema AN, Mohammad A, Hong T, et al. Characterization of Clopidogrel hypersensitivity reactions and management with oral steroids without Clopidogrel discontinuation. J Am Coll Cardiol 2011; 58:1445.

2. Von Tiehl KF, Price MJ, Valencia R, et al. Clopidogrel desensitization after drug-eluting stent placement. J Am Coll Cardiol 2007; 50:2039.
3. Campbell KL, Cohn JR, Fischman DL, et al. Management of Clopidogrel hypersensitivity without drug interruption. Am J Cardiol 2011; 107:812?

QUESTION 56:

Case:

A 48-year-old male patient is brought from OR to ICU after Coronary bypass (CABG). There were no perioperative complications and the whole procedure went smoothly. Intra Aortic Balloon Pump (IABP) was inserted during surgery. Upon arrival, the perfusionist informed you that augmentation is not good. Per anesthesia report augmentation was good during the case?

Answer:

In the OR the patient may be positioned with legs flexed for vein harvest. But when the legs are returned to neutral position, the IABP may well be pulled distally. It does not hurt to recheck the position of the IABP with TEE prior to transport to the ICU - or reposition with CXR in ICU.

QUESTION 57:

A 58-year-old male with renal failure and travelling from Europe is presented to your ED with Digitoxin (not digoxin) toxicity, shown by various blocks on EKG. Patient has been prescribed Digitoxin (not available in USA) due to its advantage of elimination via liver.

What is your option here?

Answer:

Digitoxin is mainly eliminated via the liver, and thus not affected by decrease in renal function like digoxin. Anti-digoxin antibody fragments, the specific antidote for digoxin toxicity however, is similarly effective in life-threatening digitoxin toxicity.

QUESTION 58:

Once patient receives digoxin Fragmented Antibody (DIGIFAB or Digibind), how frequently should the digoxin level be measured?

Answer:

Digoxin level, after giving Digibind will rise, and will remain distorted for about 7-days. This is due to the ability of Digibind to pull all of the digoxin into the blood stream. These are inactive fragments and not toxic. There is no need to follow digoxin level after administration of Digibind, as it will be erroneously high and misleading.

QUESTION 59:

Why should IV Digoxin be given slowly (over 5 minutes)?

Answer:
Rapid infusion of Digoxin may cause systemic and coronary arteriolar constriction, which may precipitate ischemia. Digoxin injection should be given over a period of 5 to 7 minutes.

QUESTION 60:

It is a common practice to give calcium to counteract arrhythmias. In what condition, may it not be a good move or even harmful to the patient?

Answer:
In a digitalized patient

Rationale:
Digoxin inhibits the Na^+/K^+ pump. ATPase exchanges 2 K^+ for 3Na^+ in the cardiac myocyte by competing with potassium. This exchange causes intracellular sodium concentration to increase. This lead to an accumulation of intracellular calcium by blocking the Na^+-Ca^{++} exchange system.
In patients on Digoxin, administration of calcium can lead to increase in intracellular calcium in mycocyte, which can lead to what has been described as cardiac tetany secondary to prolonged depolarization.

QUESTION 61:

What is the difference between Orthotopic and the Heterotopic heart transplant?

Answer:
In Orthotopic heart transplant, the patient's failing heart is removed and a donor heart is transplanted and attached to the recipient's remaining left vessel. The great vessels are then sutured in the appropriate position.

In Heterotopic heart transplant, the patient's own heart is retained before implanting the donor heart. The new heart is positioned in such a way that the vessels and the chambers of both hearts are connected to form what is effectively a 'double heart'. The procedure can help give a chance to the recipient heart to recover, moreover if the donor heart is rejected then it can be removed, allowing the recipient's original heart to start working again.

QUESTION 62:

Besides CSF drainage, what other modality of treatment has shown some beneficial effect in acute postoperative paraplegia complicating with emergency graft replacement of the ascending aorta for the Type A dissection?

Answer:

Hyperbaric Oxygen (HBO)

Rationale:
Usual dose of oxygen given to patient is to make them breathe 100% oxygen for one and half hour at a pressure of 2.4 atmospheres absolute.

Reference(s):
1. Puttaswamy V, Bennett M, Frawley JE. Hyperbaric oxygenation treatment of acute paraplegia after resection of thoracoabdominal aortic aneurysm. J Vasc Surg 1999; 30: 1158–61.
2. Gharagozloo F, Larson L, Dausmann MJ, Neville RF, Gomes MN. Spinal cord protection during surgical procedures on the descending thoracic and thoracoabdominal aorta. Chest 1996; 109: 799–809.
3. Fleck T, Hutschala D, Weissl M, Wolner E, Grabenwoger M, Austria V. Cerebrospinal fluid drainage as a useful treatment option to relieve paraplegia after stent-graft implantation for acute aortic dissection type B. J Thorac Cardiovasc Surg 2002; 123: 1003–5.
4. Narayana PA, Kudrle WA, Liu SJ, Charnov JH, Butler BD, Harris JH Jr. Magnetic resonance imaging of hyperbaric oxygen treatment rats with spinal cord injury: preliminary studies. Magn Reson Imaging 1991; 9:423-8.

QUESTION 63:
A 54-year-old male who is day 22 postoperative heart transplant, is found to have symptomatic bradycardia with heart rate of 24. Resident administered 3 mg of Atropine without any effect.
Why did that happen?

Answer:
Atropine is ineffective and should be avoided in heart transplant patients. The vagus nerve is not re-transplanted after transplant and so Atropine would be useless in symptomatic bradycardia.

The transplanted heart is able to function in the recipient patient via the intact, intrinsic nervous system. The heart's nervous system comprises of approximately 40,000 neurons, known as sensory neuritis. It helps in detecting the circulating hormones and neurochemicals levels and also helps in sensing the heart rate and pressure information. This information are then translated into neurological impulses by the cardiac nervous system and sent from the heart to the medulla in brain, via several afferent pathways. These signals have a regulatory role over many of the autonomic nervous system signals, which allows outflow of the brain to the heart, blood vessels and other organs.

Reference(s):
Murphy D A, Thompson G W, et al (2000), the heart reinnervates after transplantation. Annals of Thoracic Surgery; 69(6): 1769-1781.

QUESTION 64:
Case:
A 78-year-old DNR patient is in atrial fibrillation with Rapid Ventricular Rate (RVR) causing borderline hypotension. Patient did not respond to Digoxin and Amiodarone. Patient is on chronic coumadin therapy with INR of 2.8. Echo ruled out any thrombus. Patient refuses any sort of cardioversion but was acceptable to any drug treatment.

Cardiologist on consult informed you that he would be using ibutalide this afternoon, to see if that works.
To minimize the associated ventricular arrhythmia, what could be your preventive strategy?

Answer:
Administer Magnesium before ibutalide use.

Rationale:
The risk of developing torsade de pointes with ibutilide is about 4% but it can be reduced with intravenous infusion of high-dose magnesium sulfate and by having potassium level around 4.5 ranges.

Reference(s):
Patsilinakos S, Christou A, Kafkas N, et al. Effect of high doses of magnesium on converting ibutilide to a safe and more effective agent. Am J Cardiol 2010; 106: 673–6?

QUESTION 65:
Describe the significance of "Herald Bleeding" in Primary aortoenteric fistula (PAEF)?

Answer:
One of the known characteristic of PAEF is of a "herald" bleeding which is followed hours, days, or even weeks later by a catastrophic bleeding. The herald bleeding occurs as a result of a small fistula, which is tamponaded by the thrombus formation. If the fistula continues to expand or the occluding thrombus is removed or dislodged, massive hemorrhage can occur.
Clinical significance: This is probably the only window of opportunity to salvage the patient before massive bleed takes over. Emergency exploratory laparotomy should be done in those conditions as soon as the clinical diagnosis is made. Mortality without intervention is 100%.
Communications between the aorta and the intestine are referred to as primary aortoenteric fistulas. Causes include untreated aortic aneurysm, infectious aortitis, erosion of the intestine by prosthetic vascular grafts, esophageal cancer etc.

QUESTION 66:
What is the rule of thumb for Esmolol dose in heart rate (HR) control of atrial fibrillation?

Answer:
Following intravenous infusion of Esmolol for 30 minutes with dose of:

A. 50 mcg/kg per minute HR drops by 8%
B. 100 mcg/kg per minute HR drops by 11%
C. 150 mcg/kg per minute HR drops by 14%
D. 200 and above mcg/kg per minute HR drops by 15%

Reference(s):

QUESTION 67:

Is Digoxin a diuretic?

***Answer*:**

Yes it has direct diuretic properties.

Rationale:

Digoxin increases diuresis by at least 4 mechanisms

A. It causes direct vasodilation
B. It can cause increased CO improves renal hemodynamics
C. It causes inhibition of tubular reabsorption of sodium, of renal Na+ -K+-ATPase, and of concentrating and diluting ability
D. It causes increase in secretion of atrial natriuretic peptide

Reference(s):

Rahimtoola SH, Tak T. The use of digitalis in heart failure. Curr Probl Cardiol. 1996; 21: 781–756

QUESTION 68:

Which supplement intake may help in preventing Coronary artery vasospasm (Prinzmetal Angina)?

Answer:

Magnesium

Rationale:

Magnesium deficiency heightens sensitivity to acetylcholine and hyperventilation-induced coronary artery spasm. Magnesium supplementation may help as a useful therapy.

QUESTION 69:

What is Twiddler's syndrome?

Answer:

Twiddler's syndrome is a known complication of pacemakers. It occurs when a patient manipulates and rotates the pulse generator that it results in lead dislodgment, diaphragmatic stimulation and loss of capture. Its incidence is higher than as thought, around 0.07-7%. Possible causes include elderly age group, obesity, female gender, psychiatric illness, and the small size of the implanted device relative to its pocket. Most dramatic effect beside failure to pace is diaphragmatic contraction by phrenic nerve stimulation, vagus nerve, pectoral muscle, or brachial plexus stimulation resulting in rhythmic arm twitching.

Although originally described with pacemakers, the condition is also reported with implantable cardioverter-defibrillators.

Reference(s):
1. Fahraeus T, Hijer CJ. Early pacemaker Twiddler syndrome. Euro pace. 2003; 5:279–81.
2. Gupta R, Lin E. Twiddler syndrome. J Emerg Med. 2004; 26:119–20.
3. Castilo R, Cavusoglu E. Twiddler's syndrome: An interesting cause of pacemaker failure. Cardiology. 2006; 105:119–21.
4. Nicholson WJ, Tuohy KA, Tilkemeier P. Twiddler's syndrome. N Engl J Med. 2003; 348:1726–7.
5. Sharif M, Inbar S, Neckels B, Shook H. Twiddling to the extreme: Development of Twiddler syndrome in an implanted cardioverter-defibrillator. J Invasive Cardiol. 2005; 17:195–6.

QUESTION 70:

What are the 2 types of Amiodarone Induced Thyrotoxicosis (AIT)?

Answer:

Type 1 AIT: It affects patients with previously known or latent thyroid disorders. It is seen more commonly in areas where patients may have low intake of iodine. This condition is usually caused by iodine-induced excess thyroid hormone synthesis and release.

Type 2 AIT: It occurs in patients with a normal thyroid gland. It is caused by the destructive thyroiditis, which results in releasing of preformed thyroid hormones from the damaged thyroid follicular cells.

Clinical Significance: Type 2 thyrotoxicosis may respond to course of glucocorticoids, which has membrane-stabilizing and anti-inflammatory effects, as well as glucocorticoids reduce conversion of T4 to T3. Treatment is prednisone 30-40 mg/d as a starting dose and tapering over a couple of months until the levels of free T4 levels are within the reference range. Patient biochemically symptoms and clinical recovery happens within one week of start of the therapy.

Note: Some patients may have mixed forms of AIT.

QUESTION 71:

In Acute Aortic Dissection, why is it imperative to not only decrease the blood pressure, but also the heart rate?

Answer:

In aortic dissection and aortic aneurysm, propagation of aortic dissection depends on the velocity of left ventricular contractions in addition to the absolute blood pressure. A target heart rate between 55 and 65 per minute is recommended.

Reference(s):
Varon, J.; Marik, P.E. The diagnosis and management of hypertensive crises. Chest 2000, 118, 214-227.

QUESTION 72:
Why Vasotec (Enalapril) never got popular as an intravenous anti-hypertensive in ICUs?

Answer:
Vasotec (Enalapril) can be used as an anti-hypertensive in doses from 0.625 – 5 mg IV every 6 hours.

Though initial BP reduction occurs in 15 minutes but full response may not occur for up to 4-6 hours after first dose and in many instances may lead to cumulative effect of various doses, causing massive drop in BP.

QUESTION 73:
A 56-year-old male with established history of paroxysmal atrial fibrillation, on home medications of Digoxin and warfarin, is admitted to ICU with atrial fibrillation and Rapid Ventricular Response (RVR). Patient did not respond to Esmolol or Cardizem IV drips, but to IV bolus and maintenance drip of Amiodarone. What cautionary measure should be taken?

Answer:
Monitor digoxin level closely.

Rationale:
Amiodarone will increase the level or effect of digoxin by cationic drug competition for renal tubular clearance, which may cause life-threatening interaction.

QUESTION 74:
Coumadin (warfarin) is contraindicated in pregnancy, except in one condition. Which one?

Answer:
Prosthetic mechanical heart valves.

Rationale:
In pregnancy, warfarin can be continued after the first trimester in women with prosthetic heart valves.

"Current guidelines recommend that the decision whether to use heparin during the first trimester or to continue oral anticoagulation throughout pregnancy should be made after full discussion of the aforementioned facts with the patient". The 2008 ACC/AHA guidelines recommend that patients who elect to stop warfarin between weeks 6 and 12 of gestation, to decrease the risk of fetal defects, should receive continuous IV, or dose adjusted subcutaneous (SQ) UFH or dose-adjusted SQ LMWH.

Reference(s):
1. Chan WS, Anand S, Ginsberg JS. Anticoagulation of pregnant women with mechanical heart valves: a systematic

review of the literature. Arch Intern Med 2000;160:191–6.
2. Bonow RO, Carabello BA, Chatterjee K, et al. 2008 focused update incorporated into the ACC/AHA 2006 guidelines for the management of patients with valvular heart disease: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Writing Committee to revise the 1998 guidelines for the management of patients with valvular heart disease). Endorsed by the Society of Cardiovascular Anesthesiologists, Society for Cardiovascular Angiography and Interventions, and Society of Thoracic Surgeons. J Am Coll Cardiol 2008; 52:e1.

QUESTION 75:

What is Libman-Sacks endocarditis?

Answer:

Libman-Sacks endocarditis is the most characteristic cardiac manifestation of systemic lupus erythematous. The condition most commonly involves the mitral valve.
The vegetation is formed from strands of fibrin, neutrophils, lymphocytes, and histiocytes. It rarely produces significant valve dysfunction and rarely embolizes.
No specific therapy is required for Libman-Sacks endocarditis. In clinical manifestations, standard treatment is required.

QUESTION 76:

What is the dose of Methylene blue in Vasoplegic Syndrome?

Answer:

A single dose 2 mg/kg over 20-min of intravenous methylene blue. Continuous infusion of methylene blue may be an option for patients who do not respond to the single dose.

Reference(s):

Leyh RG, Kofidis T, Strüber M, Fischer S, Knobloch K, Wachsmann B, Hagl C, Simon AR, Haverich A. Methylene blue: the drug of choice for catecholamine-refractory vasoplegia after cardiopulmonary bypass. J Thorac Cardiovasc Surg 2003;125:1426-1431

QUESTION 77:

A 32-year-old male preparing for London 2012 summer Olympics in "Competitive Weightlifting" - complained of severe chest pain during training session, which was radiating to back. What should be your first concern?

Answer:

Aortic Dissection

Rationale:

There is increasing evidence that weight lifting related acute aortic dissection is a real phenomenon. Routine screening echocardiography is recommended in such competitive sports. Persons with known aortic dilatation should be advised against weight lifting.

Reference(s):

Weight lifting and aortic dissection: more evidence for a connection - Cardiology. 2007; 107(2): 103-6.

QUESTION 78:
What level of D-dimer along with clinical signs is predictive of Acute Aortic dissection?

Answer:
In acute aortic dissection, usually any level more than 500 ng/ml is significant. In most cases, in acute aortic dissection this level is reported to be more than 2000 ng/ml. D-dimer levels are useful in risk stratifying patients with suspected aortic dissection to rule out aortic dissection if used within the first 24-hours after of the patients have shown symptoms.

QUESTION 79:
Which 2 drugs are most effective in tachydysrhythmias from digoxin toxicity?

Answer:
Lidocaine and phenytoin
Atropine can be helpful in reversing symptomatic sinus bradycardia

QUESTION 80:
What are the effects of digoxin on EKG?

Answer:
The following could be the EKG effects secondary to digoxin, popularly known, as "Dig effect", one or more may be present.

1. Patient may have ST depression with a characteristic "sagging" appearance
2. There may be flattened, inverted, or biphasic T waves.
3. QT interval may be shortened
4. There is mild PR interval prolongation of up to 240 ms
5. U waves may be prominent
6. There is peaking of the terminal portion of the T waves
7. There may be J point depression

QUESTION 81:
What is the advantage of Fosinopril (Monopril) over other ACE-Inhibitors?

Answer:
The kidneys primarily excrete other ACE inhibitors. Fosinopril on the other hand is eliminated via both liver and kidney. This makes Fosinopril a drug of safer choice than other ACE inhibitors for heart failure patients with some kidney function impairment. Fosinopril is metabolized by the liver by de-esterified or by gastrointestinal mucosa where it is converted to its active form, fosinoprilat.

QUESTION 82:
Why are steroids not favored as a treatment choice in acute pericarditis?

Answer:
They increase the chance of recurrent pericarditis.

Reference(s):
1. Imazio M, Spodick DH, Brucato A, Trinchero R, Adler Y. Controversial issues in the management of pericardial diseases. Circulation. 2010; 121:916–928.
2. Farand P, Belley-Côté ÉP. Give a bigger place for colchicine and a smaller place for corticosteroids in the algorithm for the treatment of acute and recurring pericarditis. MedActuel. 2010; 10:1–5.

QUESTION 83:
What is the hazard of using sub-optimal dose of Atropine in bradycardia?

Answer:
Minimum dose of Atropine in Bradycardia is 0.5 mg (0.4mg precisely). Doses less than 0.5 mg (0.2 mg in pediatrics) may further decrease the rate. Though this paradoxical bradycardia has been questioned in some literature papers.

Various explanations have been proposed for that including stimulation of the vagus nerve causing bradycardia at low doses, as atropine may cross blood brain barrier. Another explanation given is, at low doses, atropine may have affinity for presynaptic auto receptors thus blocking the negative feedback loop of acetylcholine and increasing presynaptic output of acetylcholine into the synaptic junction. This will activate m2 receptors on the heart and lead to bradycardia. At higher doses the muscarinic blocking effects of atropine causes tachycardia.

QUESTION 84:
How was the name Esmolol derived?

Answer:
The answer lies in the name Es-Molol. Esmolol has ester-methyl side chain.
Clinical significance: Ester-methyl side chain allows for quick hydrolysis by plasma esterases, giving a short half-life of 9 minutes.

QUESTION 85:
How long does it take to see the maximum effect after IV administration of Labetalol?

Answer:
5 minutes

Rationale:
Labetalol bolus dose is about 0.25 mg/kg. It should be given by slow IV injection over a 2-minute period.

Additional doses in increment can be given with a total of 300 mg. The maximum effect usually occurs within 5 minutes of each injection.

QUESTION 86:

Why is the Nitro drip always supplied in a glass bottle with special tubing?

Answer:

Nitroglycerin binds to soft plastic bags and tubing's which commonly contain polyvinylchloride (PVC). According to pharmacy literature, about 80% of the drug can be lost by this absorption. Nitroglycerin should be given in glass and stiff polyethylene tubing. This could very well be the case if patient requires high dose for effective clinical response*, though nitrate tolerance is another major reason if causes for adsorption is eliminated.

* Some central venous catheters may be made out from PVC.

QUESTION 87:

What are the normal QTc intervals in hospitalized patients?

Answer:

According to a scientific statement from the American College of Cardiology (ACC) and the Heart Rhythm Society (HRS), the normal value for QTc in general population is as follows:

1. For men, it is below 450ms
2. For women, it is below 460ms

In a recent ACC consensus document however, an expert writing group suggested that in a hospital setting the upper limit could be raised to the 99th percentile of normal:

1. For men up to 470ms
2. For women up to 480ms

(In any case, QTc more than 500ms is considered highly abnormal).

Reference(s):

1. Rautaharju PM, Surawicz B, Gettes LS, Bailey JJ, Childers R, Deal BJ, Gorgels A, Hancock EW, Josephson M, Kligfield P, Kors JA, Macfarlane P, Mason JW, Mirvis DM, Okin P, Pahlm O, van Herpen G, Wagner GS, and Wellens H. AHA/ACCF/HRS recommendations for the standardization and interpretation of the electrocardiogram: part IV: the ST segment, T and U waves, and the QT interval: a scientific statement from the American Heart Association Electrocardiography and Arrhythmias Committee, Council on Clinical Cardiology; the American College of Cardiology Foundation; and the Heart Rhythm Society: endorsed by the International Society for Computerized Electrocardiology. Circulation 2009 Mar 17; 119(10) e241-50.

2. Drew BJ, Ackerman MJ, Funk M, Gibler WB, Kligfield P, Menon V, Philippides GJ, Roden DM, and Zareba W. Prevention of torsade de pointes in hospital settings: a scientific statement from the American Heart Association and the American College of Cardiology Foundation. J Am Coll Cardiol 2010 Mar 2; 55(9) 934-47.

QUESTION 88:
How much is usually the loading dose of Amiodarone?

Answer:
Approximately 10 grams

Rationale:
An oral loading dose of Amiodarone is around a total of 10 grams, divided over 10-14 days.

After the initial loading dose a maintenance dose of Amiodarone of 100 or 200 mg daily is usually suggested.

QUESTION 89:
If a patient requires long term Intra-Aortic Balloon Pulsation (IABP), which vessel is desirable to use?

Answer:
In patients with severe peripheral vascular disease or where femoral approach is not desirable like in patients awaiting heart transplantation the left axillary artery approach is a great alternative, preferably with Dacron graft interposition. Use of TEE should be utilized during insertion for proper catheter placement.

QUESTION 90:
What is the occurrence of PFO (patent foramen ovale) in general population, and what is it clinical significance?

Answer:
In general population, PFO is present in 10-20% of adults but usually remains asymptomatic. With advancement of clinical care, and the availability of ventilators, these PFOs may become symptomatic under positive pressure as *shunt* with refractory hypoxia.

Any patient under positive pressure ventilation, whose hypoxia remains, unexplained or whose hypoxia gets worse with an increase in PEEP - should be evaluated for PFO.

Reference(s):
Patent Foramen Ovale and Mechanical Ventilation - Rev Esp Cardiol. 2010; 63:877-8 - Vol. 63 Num.07 (http://www.revespcardiol.org/en/patent-foramen-ovale-and-mechanical/articulo/13154121/)

QUESTION 91:
What are pulmonary anatomical shunting and cardiac anatomical shunting?

Answer:

In *pulmonary anatomical shunting*, the bronchial circulation provides oxygenation to the lung and is not oxygenated before it returns to the left heart.

In *cardiac anatomical shunting*, some of the blood, which flows through some small cardiac, veins empty back into the left heart directly without oxygenation.

QUESTION 92:

How is alcohol septal ablation performed for hypertrophic cardiomyopathy (HCM)?

Answer:

Alcohol septal ablation is not very different in technique from regular coronary angioplasty except here, artificial occlusion is performed. After localizing the septal artery feeding the hypertrophied muscle, a small amount of absolute alcohol is infused into the artery to produce infarction. Resulting in chest pain, which can be treated with analgesics and sedatives. About 5-10% of patients may require a permanent pacemaker. Cardiologists should perform this procedure with specific training in the procedure. This procedure is also called *Sigwart procedure*, a British cardiologist, Ulrich Sigwart in 1994, first performed it.

QUESTION 93:

Nicardipine is a calcium channel blocker (CCB); how it is distinct from other CCBs?

Answer:

Nicardipine (cardene) is a highly vascular selective calcium channel blockade. It has strong cerebral and coronary vasodilatory effect. It has minimal to no significant effect on the left ventricular function and conduction. It is now a preferred drug of choice as IV infusion in hypertensive crisis.

For rapid blood pressure control, therapy is initiated at a loading dose of 5 mg/hr and titrated by 2.5 mg/hr every 5 minutes up to 15 mg/hr until the desired results are achieved. For gradual reduction in blood pressure, the infusion rate is increased every 15-minutes until desired blood pressure is reached.

CARDIOLOGY - PEARLS

1. **Cardiac Complications in Subarachnoid Hemorrhage (SAH)**
   Cardiac complications are not rare in SAH patients. ECG changes can be seen in ¾ of the patients; the varied symptoms include sinus brady/tachycardia, QT prolongation, heart blocks, ST elevation and depression, T-wave changes, and pathological Q-waves. Cardiac markers can also be raised. Echocardiogram often shows wall dysfunction and histopathological changes in the myocardium. These signs can mimic acute MI. Acute heart failure can lead to arterial hypotension, pulmonary edema, cardiac arrest, and sudden cardiac death. However, coronary angiography shows typically no evidence of coronary artery stenosis. Causes of the cardiac signs are excessive releases of epinephrine and norepinephrine, as well as imbalances in the parasympathetic nervous system.

2. **Conventional cardiopulmonary resuscitation (CPR) vs. compression-only CPR**
   It has been shown that bystanders performing chest-compression-only CPR instead of traditional CPR with mouth-to-mouth resuscitation (rescue breathing) save more lives. Researchers have shown that patients who receive bystander compression only CPR in the non-hospital setting were 60% more likely to survive when compared to the traditional CPR or no CPR till the emergency medical service people arrives. The survival benefit may occur as a result of not interrupting the chest compressions. Interrupting chest compressions even for the rescue breathing may compromise the patient's blood flow, and it may cause delay in blood flowing back during next chest compressions.

   References(s):
   Bobrow BJ, Spaite DW, Berg RA, et al. Chest compression-only CPR by lay rescuers and survival from out of- hospital cardiac arrest. JAMA 2010; 30(13): 1447-1454.

3. **Intractable ventricular tachycardia in ventricular aneurysm**
   If any one of the following clinical symptoms is present in left ventricular aneurysm, surgery is indicated.
   A. Angina
   B. CHF
   C. Systemic thrombosis
   D. Malignant Arrhythmias

   Intractable ventricular tachycardia in the post myocardial infarction patient should alert the physician for the presence of ventricular aneurysm. Establishment of circus movement between the aneurysmal and viable myocardium play a role. Ischemic dead and fibrosed tissue may help in establishing reentry phenomenon by creating an area of relative refractoriness and detrimental conduction. It can also act as an independently firing ectopic pacemaker site.

   References(s):
   1. Left ventricular reconstruction: The aim and the reality after twenty years, J. Thorac. Cardiovasc. Surg., July 1, 2004; 128(1): 17 - 20.

2. Recurrent Ventricular Tachycardia, Successfully Treated by Excision of Ventricular Aneurysm - CHEST, VOL. 62, NO. 4, OCTOBER, 1972

4. **Capnography in CPR**
   Capnography, which indirectly measures cardiac output, is a great tool during "codes" to measure effectiveness of CPR and also can be an early indication of return of spontaneous circulation (ROSC). Sudden increase in $ETCO^2$ may be the first indication of ROSC. Similarly, a sudden decline in $ETCO^2$ may indication of patient loosing pulse. This may prompt the providers to restart the CPR.

5. **Washout gradient of Troponin in myocardial reperfusion**
   Myocardial reperfusion, (spontaneous or via lytics or PCI), affect the overall kinetics of troponin elimination. Patients who achieve effective reperfusion after ST elevation myocardial infarction tends to have faster normalization of troponin. This has been referred as ‘‘wash-out phenomenon’’. The ratio between the concentrations at these two points can be used to discriminate between successful and unsuccessful reperfusion. In condition where the ratio is higher (at least 5), it is more likely that the reperfusion has occurred.

6. **KILLIP CLASSIFICATION**
   The Killip classification (designed about 40 years ago) is a system designed for risk- stratified individuals with an acute myocardial infarction (heart attack). Individuals with a lower Killip class are less likely to die within the first 30-days after their myocardial infarction, than are individuals with a high Killip class.

   Killip class ranked patients in the following manner:

   Killip class I: Patients with no clinical signs of heart failure
   Killip class II: Patients with rales or crackles in the lungs an S3 gallop. They also have an elevated jugular venous pressure.
   Killip class III: Patients have frank acute pulmonary edema.
   Killip class IV: Patients are in cardiogenic shock or hypotension (SBP lower than 90 mmHg), and evidence of peripheral vasoconstriction (oliguria, cyanosis or sweating).

   Mortality rate based on Killip classification
   Killip class I: In this class 81/250 patients; 32% (27 to 38%). Mortality rate was found to be at 6%.
   Killip class II: In this class, 96/250 patients; 38% (32 to 44%). Mortality rate was found to be at 17%.
   Killip class III: In this class, 26/250 patients; 10% (6.6 to 14%). Mortality rate was found to be at 38%.
   Killip class IV: In this class, 47/250 patients; 19% (14 to 24%). Mortality rate was found to be at 81%.

Reference(s):
Killip T, Kimball JT. Treatment of myocardial infarction in a coronary care unit: a two-year experience of 250 patients. Am J Cardiol 1967; 20: 457-464?

7. **The 'Rule of 20' in cardiac temponade**
   A. CVP more than 20 cm H2O
   B. HR increase more than 20 beats/minute
   C. Pulsus paradoxus more than 20
   D. SBP decrease more than 20 mmHg and
   E. Pulse pressure less than 20

8. **Implantable left ventricular assist device (LVAD)**
   A ventricular assist device (VAD) is a mechanical pump that helps failed heart pump blood throughout the body. It was designed to be used as a "bridge-to-transplant", but it is also used as a therapy for many patients who are not eligible for transplant. It was recently reported that LVAD might reverse the heart failure by prolonged unloading of the myocardium causing myocardial recovery.

   There are many commercially type pumps available in market that share the same basic idea, to help weak ventricles pump blood. They come in two basic designs, pulsatile and continuous (or Debakey, which is totally implanted inside the body).

   The pump parts consist of:

   1. A pump unit, implanted in the abdomen (very thin patients are not eligible).
   2. An inflow tube (or conduit), attached to the bottom of the apex of left ventricle.
   3. An outflow tube, attached to the aorta internal valves that allow for one-way blood flow through the system.
   4. Power leads that pass from the internal device through the skin.
   5. External controller and power base unit or battery pack that attaches to the power leads/cables.

   The controller is programmed to maintain a specific pump spread. It displays the status of the system and sounds alarms if any. The controller and batteries can be worn in a belted waist pack or a holster under the arm. Or, it may be connected to a power base unit and plugged into a wall outlet.

9. **A note on PPIs and Arrhythmias**
   At least one study so far, has suggested a link between Proton Pump Inhibitors (PPIs) and cardiac arrhythmias. Interestingly, study suggested a nearly four-fold increase in heart arrhythmias such as focal atrial tachycardia and right ventricular outflow tract (RVOT) tachycardia).

   Possible Mechanism of Action: Proton pump inhibitors (PPIs) have been proven to be potent inhibitors of the gastric H+/K+-adenosine triphosphatase (ATPase) pump. H+/K+-ATPase is usually expressed in myocardium. Animal and human

tissue studies have shown that PPIs have electrophysiologic effects, potentially by virtue of increasing intracellular calcium concentrations.

Reference(s):
Marcus, GM, Smith LM et al. (2010). "Proton Pump Inhibitors are Associated with Focal Arrhythmias". The Journal of Innovations in Cardiac Rhythm Management 1 (4): 85–89.

10. **4 criteria of Peripartum Cardiomyopathy (PPCM)**
    Peripartum cardiomyopathy is a deadly disease with mortality described up to 56%. Virchow & Porack first described the relationship of heart failure with pregnancy in medical literature about 135 years ago. In 1937 Gouley recognized it as distinct entity with dilated cardiomyopathy. 35 years ago Demakis and Rahimtoola defined PPCM on the basis of 4 criteria. It was modified by National Heart, Lung, and Blood Institute and Office of Rare Diseases (National Institutes of Health) Workshop in April 1997.
    1. Heart failure within the last month of pregnancy or 5 months postpartum.
    2. Absence of preexisting heart disease.
    3. No determinable etiology and;
    4. Strict echocardiographic criteria of left ventricular dysfunction: Ejection fraction less than 45%, or M-mode fractional shortening less than 30%, or both, and end-diastolic dimension more than 2.7 cm/m2 body surface area.

Reference(s):
1. Peripartum cardiomyopathy. Demakis JG, Rahimtoola SH. Circulation. 1971 Nov; 44(5): 964-8
2. Peripartum Cardiomyopathy - National Heart, Lung, and Blood Institute and Office of Rare Diseases (National Institutes of Health) Workshop Recommendations and Review -JAMA. 2000; 283:1183-1188. Full text available with free registration.
3. Peripartum Cardiomyopathy - Cardiology in Review. 14(1): 35-42, January/February 2006.

11. **"MAZE" Procedure - Simply explained!**
    The MAZE procedure disrupts the re-entrant circuits by creating a number of incisions in the atrium which cause scar tissue to form. The incisions are then sewn together, making it possible for the atrium to hold blood. The atrium can constrict to force blood into the ventricle, but due to the scar tissue, electrical impulses are unable to cross the incision. This process results in a maze where the electrical impulse can travel in only one single path, from the SA node to the AV node. Sinus rhythm (the normal rhythm of the heart) is restored since the atrium can no longer fibrillate.

12. **TIMI risk score for STEMI**
    Category = Points
    Age more than 75 yrs. = 3
    Age 65-74 yrs. = 2
    DM or HTN or Angina = 1
    SBP less than 100 mm hg = 3
    HR more than 100 bpm = 2
    Killip II-IV = 2

Weight less than 67 kg (150 lbs.) = 1
Anterior STE or LBBB = 1
Time to treatment more than 4hrs = 1
Total points (0-14)

TIMI risk score and 30-day mortality
0 = 0.8
1 = 1.6
2 = 2.2
3 = 4.4
4 = 7.3
5 = 12
6 = 16
7 = 23
8 = 27
>8 = 36

Reference(s):
Morrow et al., TIMI Risk Score for ST-Elevation Myocardial Infarction: A Convenient, Bedside, Clinical Score for Risk Assessment at Presentation, Circulation 2000; 102:2031-2037

13. **A note on the role of magnesium in Digoxin toxicity induced tachyarrhythmia**
Digi-Bind, a direct antidote in digoxin toxicity, is not always readily available from the hospital pharmacy. Moreover, for its effect to kick-in.

Magnesium is an excellent choice as a temporizing anti-arrhythmic agent, particularly in ventricular tachycardia or fibrillation. 2 grams of IV magnesium sulfate can be given over 5 minutes. It is very effective in terminating digoxin-induced arrhythmia. Treatment can be continued as an IV drip with 1-2 gram/hour with close monitoring to keep therapeutic level between 4 and 5 mEq/L.

Beside its role at intracellular level, magnesium has also been described as an indirect antagonist of digoxin.

As a side note, 2 other important aspects, which should not be ignored is
   A. Treatment of hypo or hyperkalemia.
   B. Avoidance of calcium especially in the presence of hyperkalemia as it can cause fatal ventricular tachycardia or fibrillation. This is due to the fact that intracellular calcium levels are already high in digoxin toxicity.

14. **What are the various types of "endoleaks" after aneurysm grafting?**
Total exclusion of the aneurysm sac is the main goal of the stent-graft treatment, and its clinical success is also defined by the total exclusion of the aneurysm. Sometimes, there is failure of the stent-graft to totally exclude blood flow to the aneurysm sac, leading to endoleak. For reasons mentioned, endoleak is one of the major complications and failures in endoluminal treatment of AAA.

15. **Treating cocaine induced hypertension**
    Cocaine induced hypertension is due to alpha-mediated vasoconstriction. It is suggested to avoid Beta-blockers in the setting of cocaine toxicity because it may result in unopposed alpha effects of cocaine and may further increase the blood pressure. There are also some reports of seizures with Beta-blocker in such situations.
    Calcium channel blockers on the other hand can dilate splanchnic vessels, thereby increasing absorption of ingested cocaine from the gastrointestinal tract, which may create a challenging situation in body packers. Nifedipine is also reported to increase the incidence of seizures and death after cocaine administration and should be avoided especially in the treatment of cocaine-induced hypertension.

    Benzodiazepines are the first line of treatment in cocaine-induced hypertension. If benzodiazepines fail to control hypertension, vasodilators, such as Nitroprusside and nitroglycerin should be use. If vasodilators do not work, alpha-blockers, such as phentolamine are the next choice.

16. **Adenosine and limbs numbness**
    Adenosine can make the patient's limbs feel numb for about 2–5 minutes after intravenous administration particularly when total administration is above 12 mg.

17. **Takotsubo Cardiomyopathy**
    Takotsubo cardiomyopathy, which is also known as "broken heart syndrome," affects women seven to nine times more than it does men.

    This is observed when sudden or prolonged stressful circumstances such as an emotional breakup or death causes overpowering heart failure or heart attack-like indicators, a nationwide study of this found. Typically patients recover without any lasting damage.

    A medical group from Japan first recognized this syndrome, in the 1990s and named it Takotsubo cardiomyopathy. Takotsubo are octopus traps which look like the unusual pot-like shape of the stricken heart.

    The syndrome was three times more common in women over 55 than in younger women. Women younger than 55 were 9.5 times more likely to suffer this, than men of the same age.

    One theory as to why this occurs is that hormones play a significant role. Another theory is that men have more adrenaline receptors on their hearts cells than women do, "so maybe men are able to handle stress better" and the chemical surge it releases, Deshmukh said.

    Approximately 1 percent of such cases are known to be fatal, the new study demonstrates. Approximately 10 percent of victims will have a second

occurrence sometime in their live time. While more heart attacks occur in winter, broken heart syndrome is also frequent in the summer.

18. **Hypertension management in perioperative period**
Patients undergoing surgical procedures especially cardiac surgery can experience hypertensive urgencies (i.e. severe blood pressure elevations without end organ dysfunction) or hypertensive emergencies (i.e. severe blood pressure elevations BP >180/110 mm Hg with impending or progressive end organ damage), before, during, or after the procedure.

The following are several continuous infusion options to control the hypertensive crisis:

A. Esmolol (ultra-short action cardio selective b blocker):
Preferred use: Acute myocardial ischemia, ideal choice when CO, HR, and BP are increased.

Dose: LD 500-1000 microgram/kg over 1 minute; Infusion starting at 50 microgram/kg/min, titrating up to max 300 microgram/kg/min as needed to maintain BP.

Rapid onset of 60 seconds, duration of action 10-20 minutes
Comment: Caution should be used in patients with COPD

B. Nicardipine (short-acting dihydropyridine CCB):
Preferred use: Acute myocardial ischemia, acute renal insufficiency, acute ischemic stroke/intracerebral bleed, eclampsia/preeclampsia, hypertensive encephalopathy, and sympathetic crisis/cocaine overdose.
Dose: 5 mg/hr. increasing by 2.5mg/hr. every 5 minutes to maximum 15mg/hr. until BP achieved. It has been seen that doses have been titrated up to 30-45 mg/hr.
Comment: Increases SV and coronary blood flow

C. Labetalol (a1 and non-selective b1 blocker):
Preferred use: Acute aortic dissection, acute myocardial ischemia, acute ischemic stroke/intracerebral bleed, eclampsia/preeclampsia hypertensive encephalopathy
Dose: May be given as bolus doses or continuous infusion, Bolus: LD 20mg IV, with incremental dose of 20-80mg every 10 minutes until BP achieved, Continuous IV: LD 20mg IV, infusion 1-2 mg/min titrated up until BP achieved, Max dose 300mg over 24 hours
Onset of action 2-5 minutes, duration of action 2-4 hours.

Comment: Reduces SVR without reducing total peripheral blood flow. Caution should be taken in patients with HF. Avoid in patients with severe sinus bradycardia, heart block greater than 1st degree, and asthma.

D. Nitroglycerin (direct vasodilator or peripheral capacitance and resistance vessels)

Dose: 5 microgram/min every 5 minutes to 20 microgram/min. If not response at 20 microgram/min then increase by 10 microgram/min to max dose of 200 microgram/min, Onset of action 2-5 minutes, duration 10-20 minutes

Comments: Reduces BP by reducing preload and CO. Should not be used in patients with cerebral compromised or renal insufficiency

E. Sodium nitroprusside (arterial and venous vasodilator)
Preferred use: hypertensive emergency without cerebral compromise or renal/hepatic insufficiency.

Dose: 0.5 microgram/kg/min titrated as tolerated, max 2 microgram/kg/min Onset of action is seconds, duration of action 1-2 minutes.
Disadvantages: not recommended for patients who have decreased cerebral blood flow, accumulation of cyanide and thiocyanate.

Comment: Duration of use should be limited to 72 hours due to the potential for toxicity.

Reference(s):
Varon J. Vascular Health and Risk Management. 2008; 4(3): 615.
Varon J. Drugs. 2008; 68(3): 283

19. **Taste disturbances with captopril**
Captopril though not much in use in USA is a well known and frequently used ACE inhibitor in many developing countries, due to its availability in generic form and cost effectiveness.
Taste disturbances which is infrequent with most ACE inhibitors, are more prevalent in captopril. This is attributed to its sulfhydryl moiety. Altered taste sensation may include loss of taste perception, persistent salt taste or persistent metallic taste.

20. **Tips on use of Atropine in AV conduction block**
Atropine is useful in treating second-degree heart block Morbitz Type 1 (Wenckebach block), and also third-degree heart block with a high Purkinje or AV-nodal escape rhythm.

It is usually not effective in second-degree heart block Mobitz type 2, and in third-degree heart block with a low Purkinje or ventricular escape rhythm. Atropine is contraindicated in ischemia-induced conduction block, because the drug increases oxygen demand of the AV nodal tissue, thereby aggravating ischemia and the resulting heart block.

21. **Fenoldopam and Beta-blocker**

Fenoldopam is an antihypertensive agent, which acts as a selective D1 receptor partial agonist. Fenoldopam's concomitant use with a beta-blocker should be avoided if possible. Fenoldopam's concomitant use with beta-blocker can lead to unexpected hypotension can result from beta-blocker inhibition of sympathetic mediated reflex tachycardia in response to Fenoldopam.

22. **Something basic - On Adenosine stress test**
Adenosine can trigger vasodilation of the small and medium sized arterioles (less than 100 μm in diameter). Adenosine administration may result in a coronary steal phenomenon, where vessels in healthy tissue dilate as much as in ischemic tissue, as a result more blood is shunted away from the ischemic tissue, which needs it, the most. Thus the principle behind adenosine stress testing. Adenosine is rapidly broken down by adenosine deaminase, known to be present in red cells and the vessel walls.

23. **Holiday Heart Syndrome**
Holiday Heart Syndrome was originally defined as "arrhythmias of the heart, sometimes apparent after a vacation or weekend away from work, following excessive alcohol consumption; usually transient". It has been reported with recreational use of marijuana. The most common rhythm disorder is atrial fibrillation, which usually converts to normal sinus rhythm within 24 hours. It occurs in patients without structural heart disease and its clinical course is usually benign. Even modest alcohol intake may trigger paroxysmal atrial fibrillation.

Most patients with no evidence of structural heart disease can be discharged without further treatment once arrhythmia has stabilized with advice against the excessive use of alcohol. Patients with sustained tachyarrhythmia require treatment if the ventricular rate is excessive. Patients with structural heart disease need further work-up.

24. **Characteristics of IV Antihypertensive agents**
The following medicines are described for five effects
1. Therapy class
2. Onset of Action
3. Duration of action
4. Preload
5. Afterload

A. Nicardipine is Dihydropyridine Calcium Channel Blocker with onset in 5-10 minute and duration of action 2-4 hours. It has No effect on Preload but decrease afterload.

B. Clevipidine Nicardipine is Dihydropyridine Calcium Channel Blocker with onset in 1 minute and duration of action 10 minutes. It has No effect on Preload but decrease afterload.

C. Esmolol is Dihydropyridine Beta Blocker with onset in 6-10 minutes and duration of action 20 minutes. It has No effect on Preload or afterload.

D. Fenoldopam is Dihydropyridine Dopamine-D1 like receptor agonist with onset in 10-15 minutes and duration of action 10-15 minutes. It has No effect on Preload but decrease afterload.

E. Hydralazine is Arterial Vasodilator with onset in 10 minutes and duration of action 2-6 hours. It has No effect on Preload but decrease afterload.

F. Labetalol is Selective alpha and non-selective beta-adrenergic receptor blocker with onset in 5-10 minutes and duration of action 2-6 hours. It has No effect on Preload but decrease afterload.

G. Nitroglycerine is vasodilator with onset in 2-5 minutes and duration of action 10-20 minutes. It has No effect on Preload and minimal effect on afterload.

H. Sodium nitroprusside is Nitro vasodilator with onset in few seconds and duration of action 1-2 minutes. It has decrease Preload and afterload.

25. **Hypotension from intravenous Amiodarone**

It would be of interest to know that hypotension from IV Amiodarone bolus is mostly not due to Amiodarone itself but due to its solubilized vehicle called polysorbate 80.

Polysorbate 80 they can decreases heart rate by depressing AV nodal conduction and has property of increasing atrial and ventricular myocardial refractory period but can cause hypotension due to histamine releasing effect.

Polysorbate 80 is also blamed for Acute Amiodarone-induced hepatitis however; there is not much literature to support this theory.

Reference(s):

1. Pharmacology and Toxicology of a New Aqueous Formulation of Intravenous Amiodarone (Amio-Aqueous) Compared with Cordarone IV. - American Journal of Therapeutics. 12(1): 9-16, January/February 2005.

2. Effects of Amiodarone with and without polysorbate 80 on myocardial oxygen consumption and coronary blood flow during treadmill exercise in the dog - J Cardiovasc Pharmacol. 1991 Jul; 18(1): 11-6.

3. Histamine-releasing properties of Polysorbate 80 in vitro and in vivo: correlation with its hypotensive action in the dog - Agents Actions, 1985 Sep; 16(6): 470-7.

4. I.V. Amiodarone: What Do We Really Know About It? Cardiac Electrophysiology Review, Volume 2, Number 1 / March 1998

5. Early acute hepatitis with parenteral Amiodarone: a toxic effect of the vehicle? - Gut, Vol 34, 565-566, 1993

26. **CHADS2 Score**

There are several risk factor assessment algorithms that have been developed to aid and benefit the clinician in making decisions in anticoagulation therapy during atrial fibrillation. CHADS2 index (Cardiac failure, Diabetes, Stroke [or S2 =

TIA]) is one of the most widely used of these algorithms. The CHADS2 index uses a point system to define yearly thromboembolic risk. Two points are given for a history of stroke or transient ischemic attack (TIA), and one point for age over 75 or history of hypertension, diabetes, or heart failure. High scores are associated with increased risk rate of stroke.
CHF History = +1
HTN History = +1
Age 75 or above = +1
Diabetes Mellitus History = +1
Stroke previously or TIA History = +2
Warfarin is recommended for score 2 and above

27. **Amiodarone induced Optic Neuritis!**
Amiodarone is one of the most commonly used medicines in ICU. In past, we have done many pearls related to IV Amiodarone. One of the other unusual and common presentations of Amiodarone toxicity is optic neuritis. Optic neuritis may occur at any time following initiation of therapy. If any symptoms of visual impairment appear, like change in visual acuity or decrease in peripheral vision, prompt ophthalmic consults is recommended.

Endocrinology and Metabolism

Question 1:

Which commonly used diuretic in ICU may affect cosyntropin test?

Answer:

Spironolactone

Rationale:

Spironolactone or drugs containing estrogen may exhibit abnormally high basal plasma cortisol levels. Also, women should ideally undergo testing during the first week of their menstrual cycle as aldosterone (and possibly cortisol) may be falsely elevated in the luteal cycle secondary to progesterone inhibition.

Question 2:

Case:

A 22-year-old male with multiple myeloma presented to ED with severe facial pain. He recently received a drug from his oncologist and was told it is good for bones; and patient informs you he actually recommend the same drug for patient's mom once a year! You examined the patient and call for maxillo-facial surgical consults.

Answer:

Zoledronate (Zometa)

Rationale:

Zoledronate (Zometa) is a bisphosphonate. Zometa helps to prevent skeletal fractures in patients with multiple myeloma, Paget's disease and other cancers. In addition it is also used for treating osteoporosis. For cancer patients Zoledronate infusion of 4 mg intravenously over 15 mins every 4 weeks has been approved. In addition, it has also been approved for use as a once-yearly 5 mg infusion for the treatment of osteoporosis! A rare complication is osteonecrosis of the jaw. The risk is higher if such patients require dental workup. Jawbone damage and death may occur as a result of reduced local blood supply (avascular osteonecrosis). Severe cases require surgical removal of the affected bone.

Question 3:

You have admitted a patient with thyroid storm. You wrote all orders including IVF, Tylenol (aspirin is relatively contraindicated for control of pyrexia in thyroid storm), propranolol, hydrocortisone, propyl thiouracil (PTU) and order for oral potassium iodide one hour after administration of PTU (Yes! you have to wait one hour to give iodide after PTU or Methimazole). You received call from pharmacy that patient has documented allergy to iodine in previous medical record. What is your next option instead of iodine?

Answer:
In patients allergic to iodine, you may use lithium carbonate to reduce secretion of pre-formed thyroid hormone. Start dose with 300 mg PO every 6 hours and follow level closely to keep at 1 meq/L.

Question 4:

How should intravenous (IV) DDAVP (Desmopressin) be given?

Answer:
DDAVP, short name of 1-deamino-8-D-arginine vasopressin and also known as Desmopressin is used for a variety of reasons in ICUs including uremic bleeding diasthesis, some platelet disorders, to boost the plasma level of factor VIII and von Willebrand factor (VWF) and in diabetes insipidus. It may be given as nasal spray or subcutaneous injection but in ICUs mostly get administrated via IV route. DDAVP should be diluted in 100 ml of normal saline and given by slow intravenous infusion over 30 minutes. The usual dose is 0.3 mcg/kg. Rapid infusion may result in tachycardia, flushing, tremor and abdominal discomfort. Also thrombosis and even myocardial infarction after an infusion of DDAVP has been reported and should be used with caution in patients with signs of arterial disease.

Question 5:
How long should you wait to administer iodide after giving anti-thyroid medication in the management of thyroid storm?

Answer:
At least one hour. Oral or rectal iodide compounds block release of thyroid hormones after starting anti-thyroid drug therapy. If given early in management (before anti thyroid medication becomes effective) however, it can get utilized in the synthesis of new thyroid hormones.

Question 6:
Case:
A 40-year-old non-diabetic female, reliable historian, admitted to ICU with life threatening and persistent hypoglycemia. Patient is not on any medication and past medical and surgical history is significant only with gastric bypass surgery 2 years ago. Surgical service decide to take patient to OR.

Answer:
As gastric bypass procedures are growing in number, Nesidioblastosis (hyperinsulinemic hypoglycemia) is now a documented complication of gastric bypass surgery particularly Roux-en-Y gastric bypass surgery. Patients may present with repeated episodes of profound hypoglycemia, which are actually postprandial neuroglycopenia associated with

endogenous hyperinsulinemic hypoglycemia. Diagnosis is confirmed by selective arterial calcium-stimulation testing and treatment is partial pancreatectomy. Peri and post-operatively diffuse beta-cell hypertrophy and hyperplasia have been demonstrated (and resected). The exact mechanism is not clear though various explanations have been suggested.

Question 7:

Which factors may give false positive higher HbA1C level?

Answer:

Higher than actual level of HbA1C can be seen in people with a longer red blood cell lifespan, such as with Vitamin B12 or folate deficiency.

Reference(s):

Kilpatrick ES, Bloomgarden ZT, Zimmet PZ (2009). "Is haemoglobin A1c a step forward for diagnosing diabetes?" BMJ 339: b4432.

Question 8:

Diabetic Ketoacidosis (DKA) may present along with upper GI bleeding. What is the usual cause of it?

Answer:

Erosion of esophagus

Rationale:

9% of hospitalized diabetic ketoacidosis patients have upper gastrointestinal complications. The most common abnormality is erosive esophagitis. GI Bleeding correlates with glucose level, admission to the ICU, duration of diabetes and the presence of diabetic complications.

Reference(s):

Faigel DO, Metz DC. - Prevalence, etiology, and prognostic significance of upper gastrointestinal hemorrhage in diabetic ketoacidosis. - Dig Dis Sci. 1996 Jan; 41(1): 1-8.

Question 9:

In which condition may almost a quarter (25%) of patients have falsely positive elevated lipase level?

Answer:

DKA (Diabetic Keto-acidosis)

Rationale:

In DKA nonspecific elevations of amylase and lipase can occur in up to 25% of cases.

1. In DKA amylase elevation is correlated with the pH and serum osmolality
2. Elevation of Lipase is correlated with serum osmolality alone.

Diagnosing acute pancreatitis based only on elevated amylase or lipase, even >3 times normal, is said to be not justifiable.

Reference(s):
Yadav D, Nair S, Norkus EP, Pitchumoni CS - Nonspecific hyperamylasemia and hyperlipasemia in diabetic ketoacidosis: incidence and correlation with biochemical abnormalities. - Am J Gastroenterol. 2000; 95(11): 3123.

Question 10:

How much is the average fluid deficit in Hyperosmolar hyperglycemic states (HHS), previously known as hyperosmolar hyperglycemic nonketotic coma (HHNK)?

Answer:
About 9 liters

Rationale:
According to the consensus statement published by the American Diabetes Association, diagnostic features of HHS may include

1. "Plasma glucose level of 600 mg/dL or greater
2. Effective serum osmolality of 320 mOsm/kg or greater
3. Profound dehydration, up to an average of 9L
4. Serum pH greater than 7.30
5. Bicarbonate concentration greater than 15 mEq/L
6. Small ketonuria and absent-to-low ketonemia
7. Some alteration in consciousness"

Reference(s):
Kitabchi AE, Umpierrez GE, Murphy MB, Kreisberg RA. Hyperglycemic crises in adult patients with diabetes: a consensus statement from the American Diabetes Association. Diabetes Care. Dec 2006; 29(12): 2739-48

Question 11:

Do you need arterial blood gas (ABG) in Diabetic Ketoacidosis (DKA)?

Answer:
An Interesting study recently published from the UK concluded that:
"A venous blood sample, analyzed on a blood gas machine, is sufficiently reliable to assess pH, bicarbonate and potassium concentrations in critically ill patients, suggesting that venous sampling alone is appropriate in the management of diabetic ketoacidosis."

Reference(s):
Herrington WG, Nye HJ, Hammersley MS, Watkinson PJ. Are arterial and venous samples clinically equivalent for the estimation of pH, serum bicarbonate and potassium concentration in critically ill patients? Diabet Med. Jan 2012; 29(1): 32-5.

Question 12:

Which diuretic can have anti mineralocorticoids effects?

Answer:
Spironolactone

Rationale:
Spironolactone decreases the effects of mineralocorticoids including aldosterone and corticosteroid by competing for intracellular mineralocorticoid receptors in the cortical collecting duct.

Question 13:

A 28-year-old female, admitted to ICU with Urosepsis. The patient's routine screening shows positive for pregnancy though the patient was unaware of it. Her list of medications includes Methimazole for her hyperthyroidism. What would be your next step?

Answer:
If pregnancy occurs while taking Methimazole, switching to propylthiouracil (PTU) is suggested, particularly in first trimester.
Both PTU and Methimazole are classified as Drug Class D in pregnancy. PTU is preferred over Methimazole in the first trimester of pregnancy. In the second and third trimester, Methimazole is preferred.

Reference(s):
1. Bahn RS, Burch HS, Cooper DS, et al. (July 2009). The Role of Propylthiouracil in the Management of Graves' Disease in Adults: report of a meeting jointly sponsored by the American Thyroid Association and the Food and Drug Administration. Thyroid 19 (7): 673–4.
2. Abalovich M, Amino N, Barbour LA, et al. (August 2007). Management of thyroid dysfunction during pregnancy and postpartum: an Endocrine Society Clinical Practice Guideline. J. Clin. Endocrinol. Metab. 92 (8 Suppl): S1–47

Question 14:

During clinical exam for adrenal insufficiency, in which 2 sites should you look for 'tanning'?

Answer:
Addison's disease (adrenal insufficiency) may present with tanning of the skin that may be patchy or even all over the body. 2 characteristic sites of tanning to look for are skin creases (as of the hands) and the inside of the cheek (buccal mucosa).

Question 15:

Thyrotoxic patients with atrial fibrillation

1. Require a lower maintenance dose of warfarin than euthyroid patients
   or
2. Require a higher maintenance dose of warfarin than euthyroid patients

Answer:

Patients with thyrotoxicosis may require a lower maintenance dose of warfarin than euthyroid patients in atrial fibrillation because of increased clearance of vitamin K–dependent-clotting factors.

Reference(s):
Fadel BM, Ellahham S, Ringel MD, et al. Hyperthyroid heart disease. Clin Cardiol 2000; 23: 402–8.

Question 16:

A 43-year-old malnourished patient is admitted with septic shock. You started an early goal directed therapy protocol. The patient's blood pressure remained low despite showing signs of clinical improvement. You suspected adrenal insufficiency and ordered cosyntropin test. The patient failed to respond. You started low dose hydrocortisone. Next day you received call from lab that they also performed 'free cortisol' response to cosyntropin and found it appropriate to label patient as responder?

Answer:
Severe hypoproteinemia (as in this malnourished patient) may give false results and responders may get wrongly labeled as non-responders. In blood, about 90% of cortisol is bound to proteins (20% of cortisol is loosely bound to albumin and 70% is tightly bound to cortisol-binding globulin). Only 10% of cortisol is in the free state. This is a major pitfall and deception to fall in, while prescribing steroids in septic and hypoproteinemic patient under presumption of 'nonresponder'.

An important study reported about 2 years ago from Cleveland looked into 66 critically ill patients with 36/66 had hypoproteinemia (albumin 2.5 g/dl or less) and 30/66 had near-normal serum albumin concentrations (above 2.5 g/dl). Baseline and cosyntropin stimulated serum total cortisol level as well as baseline and cosyntropin stimulated serum free cortisol level were measured. Study found that, nearly 40% of critically ill patients with hypoproteinemia had subnormal serum total cortisol levels, even though their adrenal function was normal as measured by free cortisol level.

Question 17:

A 37-year-old female was admitted into the ICU with hypotension, hyponatremia, hyperkalemia, metabolic acidosis, and hypoglycemia. Hypotensive shock is refractory to fluid resuscitation. You highly suspect adrenal crisis. You order all required workup. What changes do you expect to see in EKG with adrenal crisis?

Answer:
Adrenal crisis may cause T-wave changes from peaked T-waves secondary to hyperkalemia to deep negative T-waves. More importantly it causes prolongation of the QT interval, which should be considered serious as it may degenerate into ventricular arrhythmias.

Question 18:
What is the physiologic amount of cortisol secreted by adrenals per day?

Answer:
Adults secrete about 20 mg of cortisol daily.

Rationale:
Hydrocortisone 200-300 mg may be used as a stress dose to treat adreanl insufficiency. Although European countries may use this, usually with fludrocortisones as a continuous drip, in the United States however, it is prescribed in multiple doses.

The adrenal cortex in adults, physiologically, may secrete only 20 mg of cortisol per day. It does also secrete 2 mg of corticosterone, which has similar activity. Higher doses are used, under the presumption that, the body may require higher cortisol levels, due to stress related factors.

In pure adrenal insufficiency, the initial hydrocortisone dose should restore blood pressure and general improvement in the patient within 1 hour. It is recommended that the hydrocortisone dose be left at 20 mg / day and with improvement in hemodynamics and resolution of stress, be tapered.[1]

Reference(s):
The ICU Book: Paul L. Marino: 2nd edition: Page 770

Question 19:
Which one laboratory work can quickly differentiate between thyrotoxic periodic paralysis and spontaneous periodic paralysis?

Answer:
Phosphate level

Rationale:
In spontaneous periodic paralysis phosphorus levels are likely to be normal and thyrotoxic periodic paralysis is most likely to have hypophosphatemia.

Question 20:
What is the pitfall of converting insulin drip to long acting insulin Lantus (insulin glargine [rDNA origin] injection)?

Answer:
Lantus takes 72-120 hours to get effectively on board and provide insulin coverage. Also, it is alleged that pain at LANTUS injected site is higher compared to NPH injection site.

But in case if you decide to use Lantus, to convert insulin drip to non-intravenous insulin

coverage in ICU, the rule of thumb is to determine the total insulin required in the last 24 hours and give half as Lantus and the other half as short-acting insulin divided into 3 meals.

Conversion from NPH to Lantus: Determine the total insulin need of NPH in the last 24 hours and reduce it by 20%. For instance, if the total requirement were 100 NPH, the Lantus dose would be 80 units.

Question 21:

A 34-year-old male with no medical access in the past presented to the ED with severe hypertension. On laboratory workup, patient was found to have hypokalemia and metabolic alkalosis. What is your first diagnosis?
Hint: Triad of HTN, Hypokalemia and metabolic alkalosis

Answer:
Primary hyperaldosteronism

Rationale:
Aldosterone hypersecretion acts on the cortical collecting duct to stimulate potassium secretion into the tubular fluid, enhancing renal potassium wasting. The metabolic alkalosis is due to increased renal hydrogen ion loss mediated by hypokalemia and aldosterone.

Question 22:

While starting treatment for Diabetes Ketoacidosis (DKA) how much time should be allowed between initiation of IVF (hydration) and Insulin infusion?

***Answer*:**
About one hour

Rationale:
One hour after the initiation of intravenous fluid, replacement insulin should be started. This allows the time for checking electrolytes as potassium. Insulin therapy may be more dangerous and less effective before some fluid replacement has been achieved. Aggressive insulin administration without fluid administration can possibly cause life-threatening hypokalemia.

Question 23:

How is DKA categorized as per its level of severity?

Answer:
The DKA is categorized by American Diabetes Association in adults into one of three stages of severity according to blood PH, Bicarbonate level and mental status.

1. **Mild:** pH 7.25 and 7.30; serum bicarbonate 15–18 mmol/l; Patient is alert.
2. **Moderate:** pH 7.00–7.25, bicarbonate 10–15, Patient is mildly drowsy.
3. **Severe:** pH below 7.00, bicarbonate below 10, Patient is stuporous or comatose.

Question 24:
What is Diabetes innocence?

Answer:
Diabetes innocence is also known as renal glucosuria. It is a condition in which the simple sugar glucose is excreted in the urine, despite having normal or low blood sugar levels. This is due to improper functioning of the renal tubules. In most affected individuals, it is asymptomatic. This condition is thought to be inherited as an autosomal recessive trait.

Question 25:
A 37-year-old female admitted to ICU with hypotension, hyponatremia, hyperkalemia, metabolic acidosis, and hypoglycemia. Hypotensive shock is refractory to fluid resuscitation. If you highly suspect adrenal crisis, and have ordered all required workup, what changes do you expect to see in EKG with adrenal crisis?

Answer:
Adrenal crisis may cause T-wave changes from peaked T-waves secondary to hyperkalemia to deep negative T-waves. More importantly it causes prolongation of the QT intervals, which should be considered serious as it may degenerate into ventricular arrhythmias.

Question 26:
Progesterone is also an “anticonvulsant.” True or false?

Answer:
True

Rationale:
Catamenial epilepsy is defined as seizure exacerbation in women aligned with their menstrual cycle. It usually subsides in menopause and is thought to be related to estrogen. Progesterone is the mainstay of the treatment.

Question 27:
A 52-year-old female with previous history of CVA is now brought to the ICU with probable diagnosis of thyroid storm. Which one medicine you should look for and stop it till patient get stabilizes?

Answer:
Aspirin

Rationale:
Aspirin is a universal medicine on most patient's medication list particularly in patients with stroke, cardiac or vascular history. Aspirin should be held and avoided in thyroid storm to prevent decrease in protein binding which subsequently could result in increases in free T3 and T4 levels. Aspirin, as a matter of fact, is known to precipitate thyroid storm.

Question 28:

Beside central diabetes, nephrogenic and gestational diabetes insipidus - what is Dipsogenic Diabetes Insipidus (DI)?

Answer:
Dipsogenic DI is due to a defect or damage to the thirst mechanism, which is located in the hypothalamus. This defect results in an abnormal increase in thirst and fluid intake that suppresses ADH secretion and increases urine output.

Clinical significance: Desmopressin (or other drugs) should not be used to treat dipsogenic diabetes insipidus because they may decrease urine output but not thirst and fluid intake. This fluid "overload" can lead to water intoxication, leading to hyponatremia and also brain damage.

There is no effective treatment but some physicians may recommend small doses of DDAVP at bedtime to relieve nocturia.

Question 29:

A 28-year-old patient is admitted to the ICU after traumatic brain injury. While evaluating films with radiologist he shows concerns of ischemia to pituitary gland, hypothalamus and surrounding structures. Which treatments you need to be worried about if symptoms of Panhypopituitarism develop?

Answer:
Pituitary hormones of clinical significance include

a. Adrenocorticotropic hormone (ACTH),
b. Follicle-stimulating hormone (FSH),
c. Luteinizing hormone (LH),
d. Growth hormone (GH),
e. Prolactin,
f. Thyroid-stimulating hormone (TSH), and
g. Antidiuretic hormone (ADH)

The following are 4 essential treatments to keep in mind:

1. Desmopressin acetate (DDAVP) if Diabetes insipidus develops.
2. Hydrocortisone: Should be initiated even before workup is initiated.
3. Leo-thyroxine
4. Reproductive hormones (Estrogen or Testosterone)

Growth hormone is not routinely replaced in adults.

Question 30:

What is the PO to IV conversion of thyroxine?

Answer:

50% of patient's previous PO dose.

Rationale:

It may help to continue patient's baseline thyroxine replacement in ICU and if needed in IV form with 50% of PO dose 1. It gets more important if patient stay in ICU gets longer. Many times, it is the absence of baseline thyroxine replacement, which prevents recovery of hemodynamics. Cases have been reported in literature with serious consequences, which could potentially result from failure to provide adequate thyroid hormone therapy [2, 3].

Reference(s):

1. Levothyroxine sodium for injection - bedfordlabs.com
2. Severe Myxedema after Cardiopulmonary Bypass - Anesth Analg 2003; 96:62-64
3. Severe Hypothyroidism after Coronary Artery Bypass Grafting - Ann Thorac Surg 2005; 80:714-716

Question 31:

Which steroid is preferable during treatment of Thyroid storm?

Answer:

Dexamethasone (Decadron)

Rationale:

Dexamethasone (2 mg every 6 hours during first 24 hours) not only inhibits hormone production but also decreases peripheral conversion from T4 to T3. After acute episode subsides and there is an indication or suspicion of adrenal insufficiency Hydrocortisone (Solu-Cortef) 100 mg IV every 8 hours should be given.

Question 32:

Case: You admitted 38-year-old female with DKA. Looking at her record, you found that her latest "estimated average glucose," reported is 212. What is her estimated HbA1C?

Answer:

9

Rationale:
The HbA1c measures blood glucose control over the previous 90 days. It is expressed as the percentage of glucose, which is attached to the hemoglobin molecules. In Patients HbA1c of less than 7% is suggested. Study has found a simple mathematical formula that can "translate" HbA1c levels into an eAG level. It almost accurately converted HbA1c levels into average glucose levels.

An "estimated average glucose" or eAG is an accurate and easier way to understand glucose control, and probably will soon become the standard of reporting blood glucose control.

The manual way to do this formula follows:

28.7 x HbA1c - 46.7 = eAG (in mg/dl)
Or use following graph (HbA1C % is followed with both mg/dl and mmol/L values)
6 % = 126 mg/dl = 7.0 mmol/l
6.5% =140 mg/dl = 7.8 mmol/l
7 % = 154 mg/dl = 8.6 mmol/l
7.5 % = 169 mg/dl = 9.4 mmol/l
8 % = 183 mg/dl = 10.1 mmol/l
8.5% = 197 mg/dl = 10.9 mmol/l
9 % = 212 mg/dl = 11.8 mmol/l
9.5 % = 226 mg/dl = 12.6 mmol/l
10 % = 240 mg/dl = 13.4 mmol/l

Reference(s):
Translating the A1C Assay into Estimated Average Glucose Values - Publish Ahead of Print published online ahead of print June 7, 2008, findings will be printed in the August issue of Diabetes Care

ENDOCRINOLOGY AND METABOLISM - PEARLS

1. **One relatively unknown use of DDAVP (Desmopressin)**
   Desmopressin (DDAVP) can be used in the treatment of sleep apnea. Patients prescribed DDAVP are four and half times more likely to have disrupted sleep than with placebo. FDA has banned the treatment of sleep apnea with Desmopressin, particularly nasal sprays due to reported deaths, hyponatremia and seizures. Desmopressin tablets are still used for sleep apnea. Side effects are as described above, along with severe vomiting, diarrhea, fever and flu like symptoms.

2. **Gestational diabetes insipidus**
   Vasopressinase is produced by all women in placenta during pregnancy, which can break down antidiuretic hormone (ADH). Women with Gestational diabetes insipidus (DI) are thought to have excessive vasopressinase production. It can be treated as usual with Desmopressin. Before starting treatment, care should be taken first to rule out pregnancy induced Dipsogenic DI where Desmopressin is contraindicated.

   Clinical Significance: Gestational Diabetes insipidus may be a warning sign of some serious underlying pathophysiology including pre-eclampsia, hemolysis, elevated liver enzyme and low platelets (HELLP) syndrome or acute fatty liver of pregnancy. Delay in diagnosis and treatment may lead to maternal or perinatal mortality.

3. **Sympathetic Storming**
   Sympathetic storming after traumatic brain injury remains one of the most dramatic clinical scenes particularly in neurological units. It occurs due to uncontrolled sympathetic surge with a diminished or unmatched parasympathetic response. According to Baguley criteria 5 out of the 7 clinical features should be present.
   1. Tachycardia
   2. Tachypnea
   3. Hyperthermia
   4. Hypertension
   5. Dystonia
   6. Posturing
   7. Diaphoresis

   Various agents have been used for treatment (see review article below) but haloperidol may worsen the symptoms. Dr. Blackman and coll. coined the term paroxysmal autonomic instability with dystonia (PAID), in Archives of Neurology March 2004.

Reference(s):
1. *Sympathetic Storming from Denise M. Lemke, published in J Neurosci Nurs 36(1): 4-9, 2004. © 2004*
2. Dysautonomia after traumatic brain injury: a forgotten syndrome? - J Neurol Neurosurg Psychiatry 1999; 67:39-43 (July)
3. Paroxysmal autonomic instability with dystonia (PAID) - Arch Neurol. October 2004; 61:1625.
4. Paroxysmal Autonomic Instability with Dystonia After Brain Injury - Arch. Neurol. March 2004; 61:321-328

4. **Choice of IVF in thyroid storm**

   In thyroid storm, solutions that contain dextrose (some experts recommend up to 10% dextrose solution) should be given as IVF. The hepatic glycogen reserve is usually depleted in thyroid storm and dextrose will help with replenishing it, and with coping with continuously high metabolic demand. Naturally, electrolyte monitoring is recommended with dextrose solution infusion.

   Bonus Pearl: Aspirin is contraindicated for the control of pyrexia in thyroid storm and Tylenol is the preferred agent.

5. **Euthyroid Sick Syndrome**

   It is wise to avoid checking thyroid function test in ICUs as it takes only few hours for the patient to *abnormalize* thyroid function test under stress, but if clinically indicated, send full "Thyroid Function Test" including TSH, Total T3, Total T4, Free T4 and rT3 (reverse T3). There is no absolute trend, but the general rule of thumb is, as patient gets sicker and sicker "all fall but reverse rise" this means that, reverse T3 (rT3) will be elevated.

Reference(s):

1. Sick euthyroid syndrome - Jennifer Best M.D - Harborview Medical Center, Seattle, Washington - University of Washington, Div. of General Internal Medicine.

2. Euthyroid Sick Syndrome - Serhat Aytug, MD - (please register free at emedicine.com)

Fluid and Electrolyte

Question 1:

Which one electrolyte should be replaced with Thiamine infusion in Wernicke's encephalopathy?

Answer:

Magnesium

Rationale:

Magnesium is a co-factor in many thiamine dependent enzymes involved in carbohydrate metabolism. Thiamine may not work in the presence of low magnesium. This is clinically an extremely important point as alcoholics usually lack magnesium.

Question 2:

Which 2 common conditions in the ICU may give falsely elevated Pre-Albumin level?

Answer:

1. Alcohol intake
2. Steroid administration

Rationale:

In patients with acute alcohol intoxication, there is leakage of proteins from damaged liver cells, which may cause a rise in the level of prealbumin. Alcoholic patients may have elevated levels of prealbumin after binge drinking. It takes about 7-days for levels to return to baseline. Also, serum prealbumin levels may also rise during prednisone/steroid therapy.

Reference(s):

Staley MJ, Naidoo D, Pridmore SA. Concentrations of transthyretin (prealbumin) and retinol-binding protein in alcoholics during alcohol withdrawal [Letter]. Clin Chem. 1984; 30:1887.

Oppenheimer JH, Werner SC. Effect of prednisone on thyroxine-binding proteins. J Clin Endocrinol Metab. 1966; 26:715–21.

Question 3:

6 elderly patients have been brought from the nursing home in summer season due to heatstroke after the air-conditioner (AC) stops working in the nursing home facility. Nursing staff established IV (intravenous) lines quickly upon arrival. You ordered laboratory work and *cooling protocol* along with fluid resuscitation. Before IV fluid resuscitation starts, which IV infusion is recommended?

Answer:

Thiamine and Dextrose (D-50)

Rationale:

Hypoglycemia is very common in patients with heatstroke and actually may be a manifestation of underlying liver failure; therefore, infusion of dextrose 50% is

recommended in all patients with heatstroke.

Most of these patients are on malnutrition side and possibly thiamine deficient. Infusion of Dextrose may precipitate Wernicke's encephalopathy* in these patients, therefore it is always a good idea to administer Thiamine before D-50 or addition of D-5 in IV fluid resuscitation.

* Carl Wernicke, as a triad of acute mental confusion, ataxia, and opthalmoplegia, described this disorder 25-years ago

Question 4:

Which electrolyte imbalance may cause Osborn wave on EKG, which is usually the hallmark of hypothermia?

Answer:
Hypercalcemia

Rationale:
Osborn wave on EKG, which is usually a hallmark of hypothermia - and manifest around 32 C / 90 F - may also been seen in other conditions like Hypercalcemia or CVAs

Question 5:

Why potassium cannot be fixed if hypomagnesaemia remains uncorrected?

Answer:
Hypomagnesaemia causes kidney to continue to loose potassium, that is why hypokalemia cannot be fixed if hypomagnesaemia remains uncorrected. It can be confirmed with TTKG calculation.

Question 6:

Do you really need IV potassium replacement?

Answer:
This is important to know that PO (by mouth) potassium replacement is as effective as IV replacement and should be used if enteral route is available. Actually, correction of K levels could be faster with oral supplementation due to limitation of slow rate needed for IV potassium.
40 meq of PO KCl increases serum K by 0.5 - 0.7 meq/L in 1 - 2 hours, means K level may rise from 3 to 3.5 meq/L with one PO dose of 40 meq KCl elixir.

Question 7:

At what level of CPK, you should be vigilant in preventing Acute Renal Failure (ARF), mostly with IVF as mainstay of treatment?

Answer:

6,000 IU/L

Rationale:

Acute Renal Failure develops in almost 40% of patients with rhabdomyolysis. Acute renal failure can cause precipitation of myoglobin and uric acid crystals within renal tubules along with decreased glomerular perfusion may cause acute tubular necrosis (ATN). As low as CPK level around 6000 IU/L, ATN may strike the patient.

Reference(s):

Ward MM. – Factors predictive of acute renal failure in rhabdomyolysis. Arch Intern Med. Jul 1988; 148(7): 1553-7.

Question 8:

A 21-year-old male is admitted to ICU after burn. The patient is intubated in the ED and Intra-venous fluid (IVF) started. Nurse inserted foley catheter in ICU and it appears black in color. What should be your next step?

Answer:

Increase IVF and start treatment for myoglobinuria

Rationale:

Failure to clear myoglobinuria after 6 hrs. Indicates ongoing source, and demands aggressive therapies as compartment release, immediate debridement of necrotic muscle tissue, or in the worst-case scenario, even amputation. A physician with expertise in treatment of burn patients/plastics should be consulted.

Question 9:

Give at least 3 reasons of pseudo-hyponatremia?

Answer:

1. Severe Hypertriglyceridemia
2. Extreme elevation of immunoglobulin as in multiple myeloma, and
3. Severe hyperglycemia

Question 10:

Beside Renal failure, name at least 5 conditions, which may be risk factors for hyperkalemia with succinylcholine?

Answer:

Conditions beside renal failure having susceptibility to succinylcholine-induced hyperkalemia are:

1. Burns

2. Closed head injury and CVAs
3. Acidosis
4. Gillian–Bare syndrome
5. Drowning; and
6. Massive trauma

Question 11:

A nurse calls you with K+ level of 7.8 (lab confirmed - no hemolysis). You ordered 10 units of IV insulin with 2 ampules of D-50, 1 ampule of calcium gluconate and 2 ampules of sodium bicarbonate in series. RT was requested to give 2 nebulizer treatments of albuterol. PO Kayexalate/sorbitol follows the final order set ultimately. What is wrong with the above orders for the management of hyperkalemia?

Answer:

In the management of hyperkalemia, sodium bicarbonate should be given before calcium. Administrating bicarbonate after calcium will bind calcium and will render it ineffective. This is another reason, we do not prepare *bicarb drip* in Lactated Ringer's (LR) as it contains calcium, which will bind with bicarbonate and will make the whole management ineffective.

Question 12:

A 64-year-old male with significant past medical history of end stage congestive heart failure with ejection fraction of 10-15%, awaiting left ventricular assist device (LVAD), is admitted to the ICU with coma. Laboratory rechecked patient's workup and calls you with critical value of calcium level of 16.5 mg/dL. Upon examination, the patient is markedly in anasarca and fluid overload. What is your treatment option here?

Answer:

Hemodialysis

Rationale:

Hemodialysis with no calcium in the dialysis fluid is an effective therapy for hypercalcemia in patients where IV hydration is not an option and immediate management is required. Nephrology service should be consulted to tailor composition of dialysis solution.

Reference(s):

Koo WS, Jeon DS, Ahn SJ, et al. Calcium-free hemodialysis for the management of hypercalcemia. Nephron 1996; 72:424.

Question 13:

Although Lactated Ringers (LR) has a PH of 6.5, it is an alkalizing solution. How?

Answer:
Although LR has pH of 6.5, it is an alkalizing solution. The lactate in LR is metabolized into bicarbonate (HCO3-) by the liver. It is interesting that even though lactate itself contributes a strong anion, LR solution alkalinizes via the sodium cations, which it leaves behind. This in turn, increases the strong ion difference in the solution, which leads proton consumption and an overall alkalinizing effect.

Question 14:

Usually all new machines provide Base Excess/deficit automatically along with arterial blood gas (ABG). Supposedly you have a situation where ABG is not available and due to some reason (like severe coagulopathy), you are not willing to do arterial puncture, what is the formula to calculate Base Excess or Base Deficit?

***Answer*:**
Obtain HCO_3 and PH from venous blood and apply following formula
B.E. = 0.9287 (HCO3 - 24.4 + 14.83 (pH - 7.4))
Or to roundup
B.E. = (HCO_3 - 24 + 15 (PH - 7.4)
Base Excess is defined as the negative value of the concentration of titratable hydrogen ion in blood or plasma. The endpoint of titration is pH = 7.40. It also helps in determining the amount of bicarbonate immediately required for replacement with following formula
mEq of $NaHCO_3$ needed = 0.1 or 0.2 × (BW in Kg) × (BE)
1 amp of bicarb carries 50 mEq of NaHCO3

Question 15:

How accurate is the Potassium level via A-line?

Answer:
Potassium level via arterial line may not be as reliable as through peripheral venous puncture. A case report published in the British Journal of Anesthesia, where radial arterial line consistently showed K level of 7.4 - 9.3 mEq/L without any clinical signs. Simultaneous venous sample level was 4.4 mEq/L. When cannula was slightly withdrawn, arterial potassium level came back as 4.1 mEq/L (c/w venous sample).
It was postulated that the tip of the cannula could have impinged against the vessel wall so that during withdrawal of the sample a high shear rate could have caused hemolysis of red blood cells leading to an increase in potassium concentration in the blood samples.

Reference(s):
Apparent hyperkalaemia from blood sampled from an arterial cannula - British Journal of Anaesthesia 2004 93(3): 456-458

Question 16:

Which common blood test in ICU may be misleading if you use hetastarch (hespan) as volume resuscitation?

Answer:
Amylase

***Rationale*:**
Hetastrach gets attached to amylase and reduces its clearance by kidney and may cause significant elevated amylase level for about one week after infusion. It is a benign effect but may get misdiagnosed as pancreatitis. The differential can be confirmed by lipase level, which remains normal.

Question 17:
Why are Thiazide diuretics contraindicated in acute treatment of hypercalcemia?

Answer:
Thiazide diuretics increase the reabsorption of calcium. In acute treatment of hypercalcemia, a loop diuretic like furosemide is preferred to be used with hydration as it increases the calcium excretion.

Question 18:
How does Lactate Ringer's solution help in maintaining more stabilized PH in large volume resuscitation?

Answer:
The Lactate Ringer's (LR) solution contains 28 mmol/L of Lactate. The lactate is metabolized into bicarbonate by the liver, which helps in correcting metabolic acidosis.

Question 19:
Give at least 7 reasons of pseudo-hyperkalemia?

Answer:
1. Excessive vacuum of the blood draw (hemolysis)
2. A collection needle that is of too fine a gauge (hemolysis)
3. Excessive tourniquet time or fist clenching during phlebotomy, which leads to efflux of potassium from the muscle cells
4. A delay in the processing of the blood specimen
5. Thrombocytosis (Platelet count >500,000/mm^3)
6. Leukocytosis (WBC count > 70 000/mm^3)
7. Erythrocytosis (hematocrit > 55%)

Question 20:

Kayexalate (Sodium Polystyrene) is a cation exchange resin that enhances potassium clearance across the GI tract. What is the exchange ratio of Na and K?

Answer:
For each mEq of potassium removed, 2-3 mEq of sodium is added. It is therefore important to watch for hypernatremia. Lasix can be given to enhance removing both sodium and potassium via diuresis.

Question 21:

The nurse calls you with K+ level of 7.8 (lab confirmed - no hemolysis). You order 10 units of IV insulin with 2 ampules of D-50, 1 ampule of calcium gluconate and 2 ampules of sodium bicarbonate in series. RT was requested to give 2 nebulizer treatments of albuterol. The final order set is followed ultimately by PO Kayexalate/sorbitol. What is wrong in above orders for the management of hyperkalemia?

Answer:
In the management of hyperkalemia, sodium bicarbonate should be given before calcium. Administrating bicarbonate after calcium will bind calcium and will render it ineffective. This is another reason, we don't prepare *bicarb drip* in Lactated Ringer's (LR) as it contains calcium, which will bind bicarbonate and will make the whole management ineffective.

Question 22:

A 72-year-old female with no significant past medical history has been admitted from the ED to the ICU with progressive mental status change over last 3 days. The only significant finding in workup is Na+ of 123 mEq/liter. The only pertinent history is start of a new anti-depressant medication about 2 weeks ago. According to patient's son, there is no sign of drug over-dose?

Answer:
Anti-depressants' associated hyponatremia. One of the significant but less knows side effect of anti-depressants (mostly SSRIs) is hyponatremia. The exact mechanism is unknown, but it causes Syndrome of Inappropriate Antidiuretic Hormone (SIADH). It has also been reported with *atypical* anti-depressants (Venlafaxine, Trazodone, Maprotiline, Nefazodone, bupropion) as well as with *tricyclic* antidepressants (TCAs) and monoamine oxidase inhibitors (MAOIs). When prescribing antidepressants particularly to elderly patients, consideration of hyponatremia should be kept in mind. Patients who develop mental status change need prompt assessment of electrolytes' status. Patients already at risk of the SIADH (such as cancer) should be prescribed anti-depressant with caution and close follow-up.

Question 23:

Can Wernicke's Encephalopathy be iatrogenic in ICU?

***Answer*:**
Yes, it can be precipitated in any patient, who is thiamine deficient, by glucose administration (such as D-5, D-10 or D-50). It is not limited to alcoholics and can happen in any nutritionally deficient patient. It is always a good idea to add thiamine in glucose drips for patients who are at risk of Wernicke's Encephalopathy. Carl Wernicke was a triad of described disorder 25 years ago

1. Acute mental confusion
2. Ataxia
3. Opthalmoplegia

Question 24:
What is the basic objective of administrating D-5 dextrose solution peri and post operatively?

Answer:
The purpose of administering a 5% dextrose solution both peri and postoperatively, is to provide a balance between starvation reactions and hyperglycemia, which can be caused by sympathetic activation.

Question 25:
Why is calcium the first line of treatment in hyperkalemia rather than Insulin/Dextrose or Albuterol treatment?

Answer:

- Calcium takes immediate effect and last for 30-60 minutes
- Insulin/Dextrose peak effect occurs in 30-60 minutes
- Albuterol peak effect occurs in 90 minutes

Question 26:
What is the rate of removal of potassium via Kayexalate (Sodium Polystyrene) and hemodialysis?

Answer:
Kayexalate (Sodium Polystyrene) = 1 mEq/gram
Hemodialysis = 25 - 50 mEq per hour

Question 27:
When is IV calcium contraindicated in symptomatic hypocalcaemia?

Answer:

Hypocalcaemia induced by severe life threatening hypophosphatemia

Rationale:
The key component in the treatment of phosphate toxicity is improving urinary excretion of phosphate. In patients with normal renal function, the expansion of the extracellular space with saline solution has been shown to improve renal phosphate excretion. Aggressive hydration is the mainstay of the treatment, which is in turn guided by the urine output. Dialysis is usually not required, but should be considered, given the clinical situation as Hemodialysis helps in clearing of the phosphate at the faster rate.
IV calcium infusion in hypocalcaemia from severe hypophosphatemia can be dangerous due to the possibility of metastatic calcifications when the calcium-phosphate concentration product is >70 mg^2/dL^2.

Reference(s):
1. Orias M, Mahnensmith RL, Perazella M. Extreme hyperphosphatemia and acute renal failure after a phosphorus-containing bowel regimen. Am J Nephrol.1999; 19: 60– 63
2. Sutters M, Gaboury CL, Bennett WM. Severe hyperphosphatemia and hypocalcemia: a dilemma in patient management. J Am Soc Nephrol.1996; 7: 2056– 2061
3. Knobel B, Petchenko P. Hyperphosphatemic hypocalcemic coma caused by hypertonic sodium phosphate (Fleet) enema intoxication. J Clin Gastroenterol.1996; 23: 217– 219
4. Feig PU, Hirszel P, Galen MA, Rosenworcel E, Raisz LG. Hemodialysis in the treatment of life-threatening hyperphosphatemia. Clin Exp Dial Apheresis.1982; 6: 105– 111

Question 28:
Why it is not a good idea to add Sorbitol while administrating Kayexalate for Hyperkalemia?

Answer:
Concern for Bowel Necrosis

Rationale:
In 2010, the FDA issued a warning of increased risk for GI Necrosis.

Question 29:
Caspofungin may cause abnormality in which electrolyte?

Answer:
Hypokalemia

Rationale:
Beside increase liver enzymes, other rare but life threatening side effects reported so far include severe thrombophlebitis (require a greater dilution and infusion over an extended period) and severe hypokalemia, with serum potassium levels as low as 1.7 mg/dl.

Reference(s):
Experience with Caspofungin in the Treatment of Persistent Fungemia in Neonates - Journal of Perinatology (2005) 25, 770–777; published online 13 October 2005

Question 30:

A 52-year-old alcoholic male who is frequent flyer at your ED presents again with symptoms of Wernicke encephalopathy. Despite quick repletion of Thiamine up to 300 mg IV, symptoms persist. What could be the missing point?

Answer:

Hypomagnesaemia

Rationale:

Patients with Wernicke encephalopathy may not respond to parenteral thiamine in the presence of low magnesium levels. Following magnesium repletion, thiamine become effective; the blood transketolase activity will return to normal and clinical symptoms will resolve.

Please request pharmacy to provide fresh Thiamine solution, since old solutions quickly get inactive.

Question 31:

Case:

A 52-year-old male, following emergent exploratory laparotomy, is admitted to the ICU. Patient has Lactated Ringer's solution going at 125 cc/hr. 2 units of pRBC have been ordered. Why it is a bad idea to mix Lactated Ringer's solution and pRBC through same IV line?

Answer:

Lactated Ringer's solution contains calcium, which may bind to the citrate (use as anticoagulant) in blood products. This promotes clot formation in donor blood (bag).

Normal Saline contains the following (per liter):

1. 154 mEq/L of Na^+
2. 154 mEq/L of Cl^-

Lactate Ringer solution contains the following (per liter):

1. 130 mEq/L of Na^+ (but total cations of 137 mEq/L, so still is isotonic)
2. 109 mEq/L of Cl^-
3. 28 mEq/L of lactate
4. 4 mEq/L of potassium
5. 3 mEq/L of calcium

Lactate converts to bicarbonate in liver. Patients with lactic acidosis usually have inadequate liver metabolism of lactate; so conversion to HCO_3- from the infused lactate of LR is impaired and may give false readings of serial lactate measurements.

Question 32:

What is the ratio of Potassium and Phosphate, when you prescribe Potassium-Phosphate to Patient?

Answer:
10 mEq: 7.5 mmol

Rationale:
To be precise, 1 mmol of intravenous phosphate delivers 1.46 mEq of potassium in *K-phos* rider. To make it a round figure, 7.5 mmol of phosphate gets delivered with 10 mEq of potassium.

Question 33:

Case:
A 74-year-old male has been found to have arrhythmia with runs of wide complex ventricular tachycardia. The patient so far has remained hemodynamically stable. You request crash cart near bed, applied pads to chest, send STAT labs and start reviewing patient's chart. You notice 4 days ago digoxin level was 1.9; and since then his serum creatinine is steadily rising from 1.6 to 2.8.

You suspect *Dig. Toxicity* and call the laboratory to run STAT on *Dig. level*. Indeed *Dig. level* comes back at 3.4, and accompanying labs showed K+ level of 6.9. You ordered Digoxin Immune Fab (Digi-bind). Pharmacy informed you, "It will take time before Digi-bind gets to ICU". Interim you started treating hyperkalemia with IV insulin, D-50, IV bicarb, IV calcium and albuterol nebulizer treatments. Where did you go wrong?

Answer:
Calcium has been shown to make digoxin toxicity worse. It may be wiser to avoid calcium in management of hyperkalemia from digoxin toxicity. Some literature has shown the similar membrane stabilizing effect from magnesium and may be used instead of calcium.

Caution should be taken not to go very aggressively in treating hyperkalemia, or at least potassium should be followed very closely if *DigiFab* is planned. With administration of *DigiFab* (Digibind), potassium shifts back into the cell and life-threatening hypokalemia may develop rapidly. Digoxin causes a shift of potassium from inside to outside of the cell and may cause severe hyperkalemia but overall there is a whole body deficit of potassium. With the administration of Digibind, actual hypokalemia may manifest which could be equally life threatening.

Question 34:

While you prescribe 15 mmol of intravenous (IV) potassium phosphate to patient, what amount of potassium is received by patient?

***Answer*:**
About 20 mEq

Rationale:
To be precise, 1 mmol of intravenous phosphate delivers 1.46 mEq of potassium in *K-phos rider*. To make it a round figure, 7.5 mmol of phosphate is equal to about 10 mEq of potassium.

By mouth repletion of phosphate is preferable but if used, intravenous phosphate should be given very slowly. The usual recommended infusion rate is 5 mmol/hour. Rapid phosphate infusion may lead to precipitous fall in serum calcium, hypotension, and acute renal failure. Also, it may lead to hypomagnesemia, metastatic soft tissue calcifications, and hypernatremia and volume loss from osmotic diuresis.

Reference(s):
Intravenous phosphate repletion regimen for critically ill patients with moderate hypophosphatemia – Critical Care Medicine. 23(7): 1204-1210, July 1995.

Question 35:
What is the difference between giving 1 ampule of calcium gluconate and 1 ampule of calcium chloride to patient?

Answer:
Calcium chloride contains 3 times more elemental calcium in comparison to same dose of calcium gluconate. 1 gram of calcium gluconate contains 4.65 mEq of elemental calcium but 1 gram of calcium chloride contains 13.6 mEq of elemental calcium.

Question 36:
Fomepizole and ethanol are both use as treatment in Ethylene Glycol toxicity. What other medicines should be considered as adjuvant therapy in Ethylene Glycol toxicity?

Answer:
Pyridoxine and Thiamine Pyridoxine (Vitamin B6) and Thiamine are cofactors in ethylene glycol metabolism and may be administered parentally. On a side note, while preparing antidotes, early treatment with sodium bicarbonate should be initiated, this is essential to correct acidosis. It may require up to 500-1000 mmol of bicarbonate within the first hours, especially if antidotal therapy is delayed.

Question 37:
What is the ratio of albumin and an-ion gap drop?

Answer:
With 1 gm/dL drop in albumin, an-ion gap drop by 2.5-3 mmol/L. Albumin is a major unmeasured anion. Every gram decrease in albumin will decrease anion gap by 2.5 to 3 mmol. In the ICU you have to be very vigilant - where low albumin levels are very

common. One has to be careful in patients with hypoalbunemia as a high anion gap acidosis may appear as though it is a normal anion gap acidosis.

Question 38:

It normal to do electrolytes frequently in the ICUs. One of the essential electrolytes is calcium. Do you know what level of ionized calcium - High or Low - may relate to ICU mortality?

Answer:

In one study published a few years ago, the authors studied 177,578 ionized calcium measurements from 7024 patients, with a mean value of 1.11 mmol/L (ionized calcium measured every 4.5 hrs. on average).

Multivariate logistic regression analysis showed that patients with ionized calcium have less than 0.8 mmol/L or an ionized calcium more than 1.4 mmol/L were independently found to be associated with ICU and hospital mortality.

Reference(s):

Ionized calcium concentration and outcome in critical illness, Critical Care Medicine: February 2011 - Volume 39 - Issue 2 - pp 314-321

Question 39:

Case:

You have an 88-year-old male admitted with COPD exacerbation. Patient's code status is *Do Not Resuscitate* (DNR) but chemical intervention is granted. Patient went into atrial fibrillation and Rapid Ventricular Rate (RVR), with heart rate 150-170. Blood pressure is marginal and you want to avoid calcium channel blockers or β-blockers. Electrolytes drawn 4 hours ago were reported normal. You decide to manage the patient with ibutilide. Which other drug may you consider using prior to, or concomitantly with Ibutilide.

Answer:

Intravenous Magnesium

Rationale:

Ibutilide (Corvert) is indicated for the chemical conversion of atrial fibrillation. It prolongs the action potential duration in myocytes and causes an increase in both atrial and ventricular refractoriness. The dose is .01 mg/kg (Up to 1mg total) IV over 10 minutes. About 2% of patients may convert into polymorphic ventricular tachycardia (torsade de pointes) and therefore Ibutilide should not be used in patients receiving concomitant drugs, which prolong the QT interval. If time and clinical situation permits, some clinicians preload patients with intravenous magnesium (2-4 grams) prior to infusing ibutilide as a preventative measure for torsade de pointes (TdP).

Interestingly, one study also showed that prophylactic magnesium improved the antiarrhythmic efficacy of ibutilide manifested by an increase in the rate of successful chemical conversion. They also found a reduction in the need for the direct current cardioversion.

Reference(s):
1. Intravenous Magnesium Sulfate Enhances the Ability of Intravenous Ibutilide to Successfully Convert Atrial Fibrillation or Flutter – Pacing and Clinical Electrophysiology, Volume 30, Number 11, November 2007 , pp. 1331-1335(5)
2. Cost Effectiveness of Ibutilide with Prophylactic Magnesium in the Treatment of Atrial Fibrillation – PharmacoEconomics, Volume (Year): 22 (2004) Issue: 13, Pages: 877-883

Question 40:

A 54-year-old patient with CHF presented to the ED with dizziness. Patient is found to be in 3rd degree AV block. Digoxin level is 4.2 nmol/l. You decide to administer Digibind. 12 hours later nurse calls you with potassium level of 2.8 mEq/L?

Answer:

With administration of DigiFab (Digibind), serum potassium concentration should be followed very closely. Digibind shifts potassium inside the cell and can cause life threatening hypokalemia.

Actually, Digoxin causes a shift of potassium from inside to outside of the cell, and may causing a life-threatening hyperkalemia despite deficit of whole body potassium. With administration of DigiFab, actual hypokalemia may manifest, which could be equally life threatening.

Question 41:

Gastric fluid contains very little potassium (about 10 mEq/L), then why does vomiting induce hypokalemia?

Answer:

Vomiting induces volume depletion, which can cause hypokalemia by three systemic effects.

1. Volume depletion can lead to secondary hyperaldosteronism, which may result in enhanced cortical collecting tubule secretion of potassium, in response to enhanced sodium reabsorption.

2. In response to the sodium reabsorption, metabolic alkalosis increases collecting tubule potassium secretion this is caused by the decrease in availability of hydrogen ions for secretion

3. The entry of potassium into cells is directly enhanced by metabolic alkalosis.

Question 42:

A standard dose of nebulized albuterol reduces serum potassium by what level?

Answer:

A standard dose of nebulized albuterol reduces serum potassium by 0.2 to 0.4 mmol per liter (mEq/L).

Question 43:

Hyponatremia should be corrected slowly and extreme caution should be taken. Rapid correction of Na^+ may lead to central pontine myelinolysis (CPM), which is characterized by focal demyelination in the pons and extrapontine areas. The CPM is usually associated with serious neurologic sequel. Which four subgroups of patients are more prone to develop CPM and at higher risk?

Answer:

1. Hypokalemia,
2. Female gender,
3. History of alcoholism and
4. Liver transplant

Reference(s):

Murase T, Sugimura Y, Takefuji S, et al. Mechanisms and therapy of osmotic demyelination. Am J Med. Jul 2006; 119(7 Suppl 1): S69-73

Fluid and Electrolyte - PEARLS

1. **A note on Magnesium level and Hemolysis**
   Magnesium concentrates in erythrocytes are almost three times more than in serum. Hemolysis can increase plasma magnesium. Hypermagnesemia is seen only in massive hemolysis. The serum magnesim is expected to rise by 0.1 mEq/ L for every 250 mL of complete erythrocytes lysis. Due to this phenomenon, hypermagnesemia is seen only with massive hemolysis.

2. **THAM vs. Sodium Bicarbonate in Metabolic acidosis**
   a. In patients with metabolic acidosis, Sodium bicarbonate and THAM have a similar alkalinizing effect.
   b. Sodium bicarbonate has a longer lasting effect.
   c. Sodium bicarbonate decrease serum potassium, but THAM does not.
   d. THAM tends to decrease serum sodium (THAM may be the alkalinizing agent of choice especially in patients who have hypernatremia).
   e. THAM decreases $PaCO_2$ sodium bicarbonate increases $PaCO_2$.

3. **On "Beer Potomania" (Beer induced hyponatremia)**
   Severe hyponatremia associated with intake of large quantities of beer or after episode of binge beer drinking is called beer potomania. Patients usually present with mental status change deteriorating into seizure or coma.

   Pathophysiology: Hypoosmolality of the beer associated with poor nutrition leads to the inability to excrete sufficient amounts of free water.

   Clinical significance: This hyponatremia doesn't respond well to restriction of free water but treatment with isotonic saline results in the rapid clearance of the accumulated excess free water and clinical improvement

4. **Advantage of Tolvaptan (Samsca) over Conivaptan (Vaprisol) in treatment of hyponatremia?**
   Tolvaptan (Samsca) is a selective vasopressin V2 -receptor antagonist. It can be given orally. It is indicated for hypervolemia and euvolemic hyponatremia (i.e., serum sodium level less than 125 mEq/L) or less marked hyponatremia that is symptomatic and has resisted correction with fluid restriction. Dose is 15 mg PO daily initially; may increase at 24-hour intervals to 30 mg/d; but not to exceed 60 mg/d.

   Conivaptan (Vaprisol) is an Arginine vasopressin antagonist (V1A, V2) indicated for euvolemic (dilutional) and hypervolemic hyponatremia. It increases urine output of mostly free water, with little electrolyte loss. The dose is 20 mg IV loading dose (infuse over 30 min), followed by 20 mg via continuous IV infusion over 24 hours; continue treatment for additional 1-3 days as a 20-mg/d continuous IV infusion; may titrate up to 40 mg/d if necessary.

5. **Bedside precaution**

If patient is receiving Lactate Ringer's solution, than lactate level should not be drawn from the same infusion catheter to avoid erroneous high level of lactate. It should be drawn from catheter at any other site of body or peripherally. Though, once inside circulation lactate ringer does not have any clinically significant effect on serum lactate level.

Reference(s):

Effects of crystalloid solutions on circulating lactate concentrations: Part 1. Implications for the proper handling of blood specimens obtained from critically ill patients - Critical Care Medicine. 25(11): 1840-1846, November 1997

6. **Sotalol and electrolytes**

Calcium: When calcium is taking with sotalol, the absorption of the drug is dramatically reduced. Individuals who are taking calcium supplements should take sotalol one hour prior to, or two hours after they have taken the calcium supplement.

Magnesium: Sotalol has a side effect of Torsades de pointes. This side effect can be prevented by supplemental magnesium.

Potassium: Taking Sotalol with hypokalemia increases the risk of developing a serious heart arrhythmia. Therefore, special care should be taken when Sotalol is prescribed with potassium-depleting diuretics.

7. **Arterial and venous lactate level**

Arterial lactate level is preferable to venous lactate level but it is not always feasible to have arterial lactate level.

To estimate accurate arterial level, following formula can be used:
Arterial lactate in mmol/L = 0.889 (venous lactate in mmol/L) + 0.076
Please note this formula is in mmol/L. (In USA we use mg/dl). The unit conversion from mg to mmol is 1 mg/dl = 0.11 mmol/L.

Reference(s):

Lavery RF, Livingston DH, et al. The utility of venous lactate to triage injured patients in the trauma center. J Am Coll Surg. 2000; 190: 656-664.

8. **A quick way of differentiating non-gap metabolic acidosis**

Once you determine from serum chemistry that you have a non-gap metabolic acidosis,

a. Check the urine anion gap (UNa + UK – UCl)
b. If urine anion gap is positive, patient has a renal cause (e.g. RTA; in reality only validated for types I, IV)
c. If urine anion gap is negative, the patient has an extra-renal cause

A Mnemonic you can use to remember non-gap metabolic acidosis is:
HARD UP

Hyper alimentation

Acetazolamide
RTA (Renal)
Diarrhea
Ureterosigmoidostomy
Pancreatic fistula

9. **THAM**

Introduction: In patients with acute respiratory distress syndrome (ARDS), permissive hypercapnia is a strategy to decrease airway pressures to prevent ventilator-induced lung damage by lowering tidal volumes and tolerating higher arterial carbon dioxide tension. A pure respiratory acidosis generally does not require alkali therapy. Alkali therapy is indicated for either a metabolic acidosis or a mixed acidosis. The choice of a buffer is based on the type of acidosis, cardiorespiratory status, and lung mechanics.

Problem with $NaHCO_3$: Slow infusions of $NaHCO_3$ can be used to treat non-anion gap metabolic acidosis and some forms of increased anion gap acidosis. But using $NaHCO_3$ to treat type A (hypoxia-related) lactic acidosis can be hazardous, particularly under conditions of hypoxemia, inadequate circulation, and limited alveolar ventilation.

THAM: Under circumstances mentioned above, THAM is the preferable buffer because it does not increase $PaCO_2$ and is excreted by the kidneys. Tromethamine (THAM) is a sodium-free alkalinizing agent that acts as a hydrogen ion (proton) acceptor. It is a weak base that combines with hydrogen ions from carbonic acid to form bicarbonate and cationic buffer. Administration of tromethamine decreases hydrogen ion concentration, which results in a decrease in carbon dioxide concentrations and an increase in bicarbonate concentrations. The administration of Tham also increases urine output through osmotic diuresis. Excretion of electrolytes and CO_2 is also increased. Urine pH is raised along with the excretion of electrolytes.

Usual Dose: Dose in ml's of 0.3M THAM = (1.1) (Wt. in Kg) (normal HCO3 – Pt.'s HCO3) OR Dose in ml's of 0.3M THAM = body wt. in kg X base deficit in MEq/L x 1.1

Total dose should be administered over a period not less than 1 hour via central line. .3M THAM solutions are available as premix and are contra-indicated in renal failure, anuria and hyperkalemia. It may cause transient hypoglycemia and respiratory depression.

10. **Calcium infusion and thrombophlebitis**

One important factor to bear in mind while writing an order for IV calcium is of the availability of central line. If central line is not available, it is better to write an order for calcium gluconate instead of calcium chloride. Calcium infusion tends to cause thrombophlebitis and chances are higher with calcium chloride as it

contains 3 times more elemental calcium in comparison to same dose of calcium gluconate.

1 gram of Calcium gluconate contains 4.65 mEq of elemental Calcium; and
1 gram of Calcium chloride contains 13.6 mEq of elemental Calcium.

11. **Correcting anion-gap for albumin**
Patients who are critically ill and having shock commonly have hypoalbuminaemia. Failing to consider this component may be associated with a low or normal observed anion gap despite clinically significant amounts of lactate and other occult tissue anions. For critically ill patients with shock, albumin corrected anion gap should be used to assess the acid base status. Correcting the ANION-GAP for changes in albumin would be a better mortality predictor than an uncorrected ANION-GAP.

The measured ANION-GAP is corrected for changes (usually decreases) in albumin by using following simple formula

Adjusted AG = observed AG + 0.25 x ([normal albumin]-[observed albumin])
AG = Anion Gap

12. **Difference between Lactate Ringer's and Normal Saline solutions**
Lactated Ringer's Solution was invented about 125 years ago by a British physiologist Sydney Ringer and never lost a day in its popularity. Let see its difference from normal saline.
Normal Saline is the solution of 0.9% NaCl. It has a slightly higher degree of osmolality compared to blood. One liter of Normal Saline contains
154 mEq/L of Na+ and
154 mEq/L of Cl−
Lactated Ringer's (per liter) Solution contains:
130 mEq/L of Na+ but total cations of 137 mEq/L, so still is isotonic.
109 mEq/L of Cl−
28 mEq/L of lactate
4 mEq/L of potassium
3 mEq/L of calcium
Lactate converts to bicarbonate in liver.

Bonus Pearl: Patients with lactic acidosis usually have inadequate liver metabolism of lactate so conversion to HCO3- from the infused lactate of LR is impaired and may give false readings of serial lactate measurements but may be a better choice in regular situations where hyperchloremia restricts use of normal saline.

13. **FLUID FACTS**
When patients return from the OR, you can get fairly good estimate of the fluid replacement in OR and assess further requirements in the ICU. Evaluate if the

patient was under hydrated or over hydrated and make adjustments in fluid rates.

1. NPO Deficit: NPO deficit = number of hours NPO x maintenance fluid requirement.
2. Maintenance Fluid Requirements:

Adults: approximately 1.5 ml/kg/hr.

3. Replacement of Third Space Fluid Losses:
    a. In superficial surgical trauma: 1-2 ml/kg/hr.
    b. In minimal Surgical Trauma: 3-4 ml/kg/hr. (head and neck, hernia, knee surgery)
    c. In moderate Surgical Trauma: 5-6 ml/kg/hr. (hysterectomy, chest surgery)
    d. In severe surgical trauma: 8-10 ml/kg/hr. (or more) (AAA repair, nephrectomy)

4. Blood Loss:
    a. Administer 3 ml of crystalloid solution per ml of blood loss (crystalloid solutions typically leave intravascular space).
    b. Replace blood loss volume per volume, when using blood products or colloids.

<u>Example:</u>
A 62-year-old male patient who weighs 80 kg, scheduled for a 3-hour hemicolectomy procedure, is NPO after 2200 hrs, has surgery at 0800 hrs, with a 500 ml blood loss.

What are his estimated intraoperative fluid requirements?

Fluid deficit: 1.5 ml/kg/hr. x 10 hrs. = 1200 ml = 1200 ml total deficit: (Replace 1/2 first hr., 1/4 2nd hr., 1/4 3rd hour).
Maintenance: 1.5 ml/kg/hr. x 3hrs = 360 ml
Third Space Losses: 6 ml/kg/hr. x 3 hrs. =1440 ml
Blood Loss: 500ml x 3 = 1500ml
Total = 1200+360+1440+1500=4500ml

FORMULA

Question 1:

What is the formula for Lactic acid Clearance?

Answer:

Lactic acid clearance = the initial lactate - subsequent lactate/initial lactate × 100
It is estimated that an 11% decrease in mortality for each 10% decrease in lactate clearance.

Reference(s):

1. Arnold RC, Shapiro NI, Jones AE, et al; Emergency Medicine Shock Research Network (EMShockNet) Investigators. Multicenter study of early lactate clearance as a determinant of survival in patients with presumed sepsis. Shock 2009; 32(1): 35–39

2. Nguyen HB, Rivers EP, Knoblich BP, et al. early lactate clearance is associated with improved outcome in severe sepsis and septic shock. Crit Care Med 2004; 32(8): 1637–1642

Question 2:

What is Oxygenation Index?

Answer:

The Oxygenation Index (OI) is defined as the reciprocal of PF times MAP (Mean Airway Pressure)
OI = (FiO2 × mean airway pressure)/PaO_2.

It is proposed that OI is a better representative of oxygenation dysfunction as it takes in account mean airway pressure from ventilator. A lower oxygenation index is better. As patient oxygenation improves, they are able to achieve a higher PaO_2 at a lower FiO_2

Question 3:

Body Surface Area (BSA) is used for various reasons in ICU, including cardiac output calculation, Chemotherapy doses and others. There are various formulae available to calculate Body surface area. If you don't have luxury of time or technology to access BSA - what is the rule of thumb?

Answer:

$$BSA = \sqrt{W \times H}/60$$

Where: W= weight in kg, H = Height in cm

Question 4:

Formula for Mean Arterial Pressure (MAP) is
MAP = [(2 x diastolic) + systolic] / 3

What is the logic behind it?

Answer:
Diastole counts two times more than systole because 2/3 of the cardiac cycle is spent in diastole. (Something very simple but essential to know!)

Question 5:
What is the formula to convert S/F ratio to P/F ratio?
- PaO_2/FiO_2 and SpO_2/FiO_2 ratio

Answer:
S/F = 64 + 0.84*(P/F)

Rationale:
An S/F value of 235 corresponded with P/F ratio of 200 while S/F value of 315 corresponded with P/F ratio of 300. Study shows that validation database from 2031 measurements produced a linear relationship.

Question 6:
What is the easy way to calculate loading dose of Esmolol? (and drip rate)

Answer:
Divide patient's body weight in kg by 2
(e.g., 70 kg/2 = 35 mg)
multiply loading dose by 0.1 to get the mg/kg/min drip rate
(0.1 X 35 = 3.5 mg)

Question 7:
In human body for measurement, each 1 g/dL decrease of albumin will raise the serum Calcium by what level?

Answer:
Each 1 g/dL decrease of albumin raises the serum calcium (Ca) level by 0.8 mg/dL in human body. Remember the formula for calcium correction from internship days?
Corrected calcium (mg/dL) = measured total Ca (mg/dL) + 0.8 (4.0 - serum albumin [g/dL])

Question 8:
How to calculate Iron Dextran infusion dose in Anemia?

Answer:
Intravenous injections of iron dextran are indicated for treatment of patients with documented iron deficiency in whom oral administration is unsatisfactory or impossible.

Dose (mL) = 0.0442 (Desired Hb - Observed Hb) x LBW + (0.26 x LBW)
LBW = Lean body weight in kg.
For males: LBW = 50 kg + 2.3 kg for each inch of patient's height over 5 feet.
For females: LBW = 45.5 kg + 2.3 kg for each inch of patient's height over 5 feet.
After administration of iron dextran complex, evidence of a therapeutic response can be seen in a few days as an increase in the reticulocyte count.

Question 9:

Which patient is more hypoxemic?
Patient A: PaO2 85 mm Hg, SaO2 95%, Hb 7 gm%
Patient B: PaO2 55 mm Hg, SaO2 85%, Hb 15 gm%

Answer:
Calculate arterial oxygen content (CaO2) (SaO2 x Hb x 1.34) assuming PaO2 is constant

Patient A
CaO2 = .95 x 7 x 1.34 = 8.9 ml O2/dl

Patient B
CaO2 = .85 x 15 x 1.34 = 17.1 ml O2/dl
Patient A, with the higher PaO2, is more hypoxemic

Full formula: Ca02 = (Hgb) (1.34) (Sa02) + (0.0031) (Pa02)

FORMULA - PEARLS

1. **How much extra phenytoin**
   The formula to decide, how much extra phenytoin should be prescribed to get level therapeutic is

   Extra phenytoin needed = [0.7 x IBW x (15 - current level)] / 0.92
   Where IBW = Ideal body weight (note - this is 'ideal' body weight)

   e.g. If patient with ideal body weight of 62 kg has Dilantin level of 7.4, the extra required dose would be [0.7 x 62 x (15 - 7.4)] / .92 = 330 mg or to be practical about 300 mg.

   Remember this formula is for patient with normal albumin and conserve renal function. Please see pearl from yesterday for phenytoin adjustment with low albumin and low CrCl.

   Reference(s):
   Phenytoin dosing guidelines by D.McAuley, GlobalRPh Inc.

2. **Visiting Basics - Age adjustment for A-a Gradient**
   As we are encountering more and more geriatric population with pulmonary symptoms, it is advisable to remind house staff to first adjust normal A-a Gradient value per age before jumping to calculate PAO2. Normal Gradient of 80 years old patient may not be consider acceptable for 20 years old.

   Two quick formulae for age adjustment are:

   Normal A-a Gradient = Age/4 + 4
   (For 80 years old is 24 but for 20 years old is 9)

   Normal A-a gradient = (Age+10) / 4
   (For 80 years old is 22.5 but for 20 years old is 7.5)
   (A-a Gradient = Alveolar-arterial Gradient)

Gastro Intestinal Tract

Question 1:

What is the cutoff point for the thickening of the gallbladder in acalculous cholecystitis on ultrasound?

Answer:

3 to 3.5 mm

Rationale:

Ultrasound is preferable in patients suspected of having acalculous cholecystitis as it is noninvasive, can be done at the bedside, and has good sensitivity and specificity. Thickening of the gallbladder wall is the most reliable feature seen in patients with acalculous cholecystitis. Using a cutoff of 3.5 mm, ultrasonography has a sensitivity of 80 percent and a specificity of 99 percent for detecting acalculous cholecystitis. If a cutoff of 3 mm is used, the sensitivity is 100 percent with a specificity of 90 percent.

Question 2:

What is Accordion sign on CT scan?

Answer:

Accordion sign refers to the similarity between the thickened edematous walls of pseudomembranous colitis to that of an accordion. It occurs as oral contrast is trapped between edematous haustral folds and pseudomembranes, which are formed on the surface of the colon. Besides Clostridium difficile related colitis, it has been described in other forms of colitis.

Question 3:

What are the few clues (pieces of puzzle) to diagnose D-Lactic Acidosis?

Answer:

This D-lactic acidosis can occur in patients with short-bowel syndrome, jejunoileal bypasses or small bowel resections. Bacteria in the gut are responsible for metabolizing glucose and carbohydrate to D-lactic acid, which is then gets absorbed systematically. D-lactate metabolized by human subjects slowly. Clues to the diagnosis are

1. Patients with history of a short bowel or any other cause of malabsorption,
2. Patients who have acidosis with a wide unexplained anion gap
3. Patient having encephalopathy or neurologic symptoms
4. Patient who may have above symptoms and normal lactate
5. Patients have negative Acetest,
6. Patients who have ingested
7. Patients who have diminished colonic motility, which can allow time for nutrients in the colon to undergo bacterial fermentation

Treatment of D-lactic acidosis consists of fluid resuscitation, restriction of simple sugars, sodium bicarbonate administration and judicious use of antibiotics (such as metronidazole). The use of antibiotics does require caution and stewardship as antibiotics can precipitate the syndrome by permitting lactobacilli overgrowth.

Question 4:

What is a Curling Ulcer?

Answer:

A Curling ulcer is an acute peptic ulcer, which results as a complication of severe burns. It occurs when reduced plasma volume leads to sloughing off of the gastric mucosa. They appear to be more prevalent in pediatric patients with burns compared with adults.

Question 5:

Why Continuous Proton Pump Inhibitor (PPI) drip is recommended in active GI bleed?

Answer:

In active GI bleed, sustained high pH is required to help clot stabilization. Continuous PPI infusion (infusion at 8 mg/h) reliably achieves high target PH, especially when preceded by an 80 mg bolus IV push. Target pH goal is more than 6 in patients with active GI bleed.

PPIs inhibit the stimulated parietal cells with active proton pumps and rapid administration of intravenous PPI bolus can rapidly and successfully achieve this. Continuous infusion after the bolus helps in providing the steady state of the drug to inactivate any newly synthesized proton pumps, as well as any newly recruited proton pumps on parietal cells, which can continued to be stimulated by gastrin, histamine or food.

Question 6:

A 53-year-old male in ICU is complaining of acidity. One of the veteran nurses asks you to try “Green Goddess”. As you look confuse to him, he further explained it as “Green Lizard”?

Answer:

The “Green Goddess,” or “Green Lizard” is slang for GI (gastrointestinal) cocktail - consisting of:

1. 10-30 ml of Mylanta,
2. 10 ml of Donnatal
3. 10 ml of viscous Lidocaine

Anecdotally, this mixture is said to be most effective for the treatment of dyspepsia.

Question 7:

What is the treatment of unresolved hepatic encephalopathy following transjugular intrahepatic portosystemic shunt (TIPS)?

Answer:

Insertion of ePTFE stent-graft inside the original shunt

In usual cases, post-TIPS encephalopathy symptoms get better with the use of Rifaximin or lactulose. In profound or unresolved Post-TIPS Hepatic Encephalopathy, placement of an hourglass-shaped balloon-expandable polytetrafluoroethylene (ePTFE) stent-graft inside the original shunt resolves the symptoms within a day.

Reference(s):

Fanelli F, Salvatori FM, Rabuffi P, et al. Management of refractory hepatic encephalopathy after insertion of TIPS: long-term results of shunt reduction with hourglass-shaped balloon-expandable stent-graft. AJR Am J Roentgenol. Dec 2009; 193(6): 1696-702

Question 8:

Which commonly used drug for GI prophylaxis in Critical Care Units may decrease the efficacy of Plavix (Clopidogrel)?

Answer:

Omeprazole (Prilosec)

Rationale:

Out of all PPIs (Proton Pump Inhibitors), Omeprazole is said to have most evidence of decreasing the efficacy of Plavix - which may lead to clinically evident cardiovascular events.

PPIs inhibit the enzyme CYP2C19 - the main enzyme that converts Plavix (prodrug) to its active metabolite.

Reference(s):

1. Risk of Adverse Outcomes Associated With Concomitant Use of Clopidogrel and Proton Pump Inhibitors Following Acute Coronary Syndrome JAMA. 2009; 301(9): 937-944.
2. Influence of Omeprazole on the Antiplatelet Action of Clopidogrel Associated With Aspirin- J Am Coll Cardiol, 2008; 51:256-260

Question 9:

The chances of survival with medical management in acute liver failure are 26%. How much difference liver transplant can make?

Answer:

It goes up to 90%.

Question 10:

Which electrolyte abnormality may prevent Neostigmine from resolving Oglivie's syndrome (Acute colonic pseudo-obstruction)?

Answer:
Potassium

Rationale:
Acute colonic pseudo-obstruction or Ogilvie syndrome is an acute large bowel obstruction with no evidence of mechanical colonic obstruction. It is secondary to invasion and destruction of the splanchnic nerves, superior mesenteric ganglion, and celiac nerve plexus. Neostigmine is an acetyl cholinesterase inhibitor, which increases the acetylcholine concentrations of the enteric neuromuscular junctions in the nervous system, which helps smooth muscle to contract. Neostigmine is given as intravenous, 2 mg over 5 minutes. A repeat dosage may be given if necessary. Side effects of neostigmine include excessive sweating, salivation, bradycardia, bronchospasm, and hypotension. Due to possible bradycardia, atropine should be available at bedside. The neostigmine is eliminated by kidney and should be use with caution in renal failure. An anecdotal report indicates that patients with hypokalemia may not respond to neostigmine.

Reference(s):
Acute colonic pseudo-obstruction (Ogilvie's syndrome) in critical care unit - Year: 2004, Volume: 8, Issue: 1, Page: 43-44

Question 11:
What are the added risk factors for pressure ulcer in ICU patients in addition to other hospitalized adult patients?

Answer:
1. Age
2. Length of ICU stay
3. Norepinephrine administration
4. Cardiovascular disease state

Reference(s):
Cox J., - Predictors of pressure ulcers in adult critical care patients. - Am J Crit Care. 2011 Sep; 20(5): 364-75.

Question 12:
What is the salvage treatment for severe pruritis in cirrhotic patient if all conventional and non-conventional treatment fails?

Answer:
Plasmapheresis

Reference(s):
1. Plasmapheresis in the treatment of cholestasis-induced pruritus Ugeskr Laeger. 2006 Feb 20; 168(8): 779-81.

2. Role of plasmapheresis in the treatment of severe pruritus in pregnant patients with primary biliary cirrhosis: case reports - Can J Gastroenterol. 2008 May; 22(5): 505-7.
3. Plasmapheresis for the treatment of intrahepatic cholestasis of pregnancy refractory to medical treatment - American Journal of Obstetrics and Gynecology, Volume 192, Issue 6, Pages 2088-2089

Question 13:

A 48-year-old male developed spontaneous hemoperitoneum 2 hours after uneventful procedure of Paracentesis. What happened?

Answer:

Patient developed spontaneous hemoperitoneum is a rare but life threatening complication after large volume Paracentesis (usually if beyond 4 liters). It occurs due to mesenteric variceal bleed.

Question 14:

What is Modified Rankin Scale?

Answer:

The modified Rankin Scale, also written as mRS is a commonly used scale for measuring the degree of disability or dependence in the daily activities of people who have suffered a stroke. Rankin originally introduced it in 1957. It was modified in 1988.
SCORE
0 = No symptoms at all
1 = No significant disability despite symptoms; able to carry out all usual duties and activities
2 = Slight disability; unable to carry out all previous activities, but able to look after own affairs without assistance
3 = Moderate disability; requiring some help, but able to walk without assistance
4 = Moderately severe disability; unable to walk without assistance and unable to attend to own bodily needs without assistance
5 = Severe disability; bedridden, incontinent and requiring constant nursing care and attention
6 = Dead

Reference(s):

Rankin J. "Cerebral vascular accidents in patients over the age of 60." Scott Med J 1957; 2:200-15.
Bonita R, Beaglehole R. "Modification of Rankin Scale: Recovery of motor function after stroke." Stroke 1988 Dec; 19(12): 1497-1500

Question 15:

Which vaptan is contraindicated in liver failure during treatment of hyponatremia?

Answer:

Conivaptan

Question 16:

Your nerdy ER doc called you to admit a 54-year-old male with Mackler's triad. (Hint) Patient has previous history of alcohol abuse and perforated duodenal ulcer. What is Mackler's triad?

Answer:

Mackler's triad includes

1. Lower chest pain,
2. Vomiting, and
3. Subcutaneous emphysema

It is a classic presentation of esophageal rupture (Boerhaave's syndrome) but present only in few patients (14%).
To note, the triad has been reported without esophageal perforation too.
Tachypnea and abdominal rigidity are usually present along with tachycardia, diaphoresis, fever, and hypotension. Unusual clues include hoarseness caused by involvement of the recurrent laryngeal nerve, tracheal shift, cervical vein distention, and proptosis.

Question 17:

A 54-year-old male with end stage liver disease may require large volume paracentesis. Patient is labeled as allergic to Albumin. What is your alternative to prevent circulatory dysfunction after large-volume paracentesis?

Answer:

Use of Terlipressin

Rationale*:*

The removal of 5 liters of fluid or more is considered large-volume paracentesis. The AASLD (American Association for the Study of Liver Diseases) suggests that post paracentesis albumin infusion may not be necessary after a single paracentesis of less than 5 liters; however, for large-volume paracentesis of greater than 5 liters consider an albumin infusion of 8-10 g/liter of fluid removed.
Another alternative is to use Terlipressin (1 mg every 4 hours for 48 hours) rather than albumin for prevention of circulatory dysfunction after patient undergoing large-volume paracentesis. Studies have shown Terlipressin to be as effective as albumin.

Reference(s):

1. The efficacy of Terlipressin in comparison with albumin in the prevention of circulatory changes after the paracentesis of tense ascites --a randomized multicentric study. Hepatogastroenterology. Oct-Nov 2007; 54(79): 1930-3.
2. Terlipressin versus albumin in paracentesis-induced circulatory dysfunction in cirrhosis: a randomized study. J Gastroenterol Hepatol. Jan 2006; 21(1 pt 2): 303-7.

Question 18:

How much blood is needed to turn guaiac-based fecal occult blood test positive?

Answer:
About 10 ml over 24 hours

Rationale:
Normally, there is only about 1-2 ml of blood a day that escapes blood vessels into the stool per day. The common, traditional guaiac-based fecal occult blood test usually picks up a daily blood loss of about 10 ml

Question 19:

A 42-year-old male with well-known history of cirrhosis is admitted with shortness of breath. Clinical exam showed ascites and CXR showed hydrothorax. Paracentesis is performed in ER with some relief. ER resident plans chest tube. Why it would be a bad idea to insert - particularly a large bore chest tube in a patient with hydrothorax?

Answer:
Insertion of chest tube in hydrothorax is a bad idea as it usually results in uncontrollable fluid loss and has a high mortality secondary to hypovolemic shock. Therapeutic thoracocentesis with albumin replacement may provide temporary relief but may refill again. Thoracocentesis combined with pleurodesis; LeVeen or Denver shunt or surgical repairs are other options. Management of underlying cause is warranted like placement of TIPS.

Question 20:

Case:
A 34-year-old female with history of recurrent DVT now on chronic Coumadin therapy, presented with black tarry stool and probable GI bleed. There was on change on her usual Coumadin dose of 5 mg/day on which she had therapeutic INR of 2.8 since last 2 years. Today her INR is 7.8. One week ago, she has a bout of severe UTI (urinary tract infection) and started on antibiotics by her primary care physician?

Answer:
Quinolone (Ciprofloxacin/levofloxacin) - Coumadin interaction

Rationale:
Coumadin-Quinolone interactions are among the top ten drug-drug interactions. The actual mechanism of quinolone-warfarin drug interaction is unknown. There is indication that reduction of intestinal flora, responsible for *vitamin K* production by antibiotics, is responsible, in addition to decreased warfarin metabolism and clearance. It can notoriously increase effects of warfarin, with potential for life threatening bleeding. Best approach is to avoid quinolone in Coumadin dependent patient but if required, INR should be monitored daily during concurrent of warfarin with a quinolone.

Question 21:

Which procedure can be use both as diagnostic as well as therapeutic in acute colonic pseudo-obstruction (Ogilvie syndrome)?

Answer:

Gastrografin enema

Rationale:

Gastrografin is a contrast medium, which is water-soluble but has a high osmolarity and so causes a fluid shift into the colon and subsequently increases colonic motility. A Gastrografin enema can be of diagnostic and therapeutic use in these conditions. Medical treatment of acute colonic pseudo-obstruction (Ogilvie syndrome) is 2 mg IV Neostigmine but if diagnosis is suspected on KUB and further workup is underway Gastrografin enema is a good choice. It may relieve pseudo-obstruction without the need of Neostigmine.

Question 22:

Asterixis is a hallmark of hepatic failure. What other conditions may also carry this clinical sign?

Answer:

Asterixis can also be observed in

1. Renal failure and azotemia,
2. Hyperbaric respiratory failure
3. After IV phenytoin infusion
4. Patients addicted to narcotics

Question 23:

What are the 3 mechanisms by which lactulose improve hepatic encephalopathy?

Answer:

1. The conversion of Lactulose to lactic acid results in acidification of the gut lumen. This favors conversion of NH4 + to NH3 and the passage of NH3 from tissues into the lumen.
2. Gut acidification inhibits ammoniagenic coliform bacteria, leading to increased levels of nonammoniagenic lactobacilli.
3. Lactulose also works as a cathartic, reducing colonic bacterial load.

Question 24:

Case:

A 67-year-old male admitted with acute GI bleed secondary to Coumadin (warfarin) overdose with INR more than 7. You ordered, pRBC, FFP (fresh frozen plasma) and IV

vitamin K. But you are afraid that patient may not survive before all the infusions are available. What could be your choice in such desperation?

Answer:
Recombinant FVIIa (Novo seven) in many anecdotal reports (see references), novo seven has showed very quick reversal of PT / INR.

Reference(s):
1. Recombinant factor VIIa corrects prothrombin time in cirrhotic patients: A preliminary study: Gastroenterology 113:1930-1937, 1997
2. Recombinant factor VIIa (rFVIIa) successfully and rapidly corrects the excessively high international normalized ratios (INR) and prothrombin times induced by warfarin. Blood 96 (11 Part 1): 638a, 2000
3. Reversal of Warfarin-Induced Excessive Anticoagulation with Recombinant Human Factor VIIa Concentrate. Ann Inter Med. 137:884-888, 2002

Question 25:
What is the advantage of intraduodenal feeding beside less chances of aspiration pneumonia?

Answer:
Intraduodenal feeding causes

1. GI response is stronger in intraduodenal feeding than intragastric feeding
2. It stimulates gallbladder contractions,
3. It accelerates small bowel transit time
4. It causes increase in cholecystokinin and pancreatic polypeptide release

(In contrast, jejunal feeding does not stimulate pancreatic secretion, as seen in patients receiving intragastric or intraduodenal feeding)

Reference(s):
1. Ledeboer M, Masclee AA, Biemond I, Lamers CB. Effect of intragastric or intraduodenal administration of a polymeric diet on gallbladder motility, small-bowel transit time, and hormone release. Am J Gastroenterol. 1998; 93:2089–2096
2. Ragins H, Levenson SM, Signer R, Stamford W, Seifter E. Intrajejunal administration of an elemental diet at neutral pH avoids pancreatic stimulation. Studies in dog and man. Am J Surg. 1973; 126:606–614

Question 26:
Which cardiac medication may lead to mesenteric ischemia?

Answer:
Digitalis

Rationale:
Digitalis has been found to cause vasoconstriction of both arterial and venous smooth muscle cells in the mesenteric vasculature. Acute intestinal ischemia could be the most deceiving clinical condition and requires very high index of suspicion. Acute mesenteric ischemia is a deadly disease, difficult to diagnose in a timely fashion and delayed intervention frequently results in fatal outcomes.

Clinical Findings:
There generally are minimal clinical, laboratory and radiologic findings. Fever, abdominal pain that may be severe, nausea, vomiting, are common. Although non-specific, marked increase in serum lactate is common as well.

Causes:
Acute occlusion of superior mesenteric artery, atherosclerosis, thrombosis, venous thrombosis.

Treatment:
Early diagnosis and resection of dead bowel. Generally diagnosed at laparotomy.

Prognosis:
Rapidly leads to multi-organ dysfunction syndrome with very high mortality rate.

Reference(s):
Nonocclusive mesenteric ischemia induced by digitalis - International Journal of Colorectal Disease, Volume 19, Number 3, May 2004, pp. 277-280(4)

Question 27:
What medication may transiently reverse hepatic encephalopathy?

Answer:
Flumazenil

Rationale:
The gastrointestinal tract produces gamma-aminobutyric acid (GABA), which is a neuro-inhibitory substance. GABA is the key cerebral nerve endings component. As much as 24-45% of the cerebral nerve endings are GABAergic. Cirrhotic patients have increased GABAergic tone, which is felt to be related to the decrease of GABA metabolism by the liver.

In cirrhotic patients, when GABA crosses the extra permeable blood-brain barrier, it interacts with supersensitive postsynaptic GABA receptors. The chloride ionophore is regulated by GABA receptor, in conjunction with receptors for benzodiazepines and barbiturates. Binding of GABA to its receptor permits an influx of chloride ions into the postsynaptic neuron, which leads to the generation of an inhibitory postsynaptic potential. In patients with cirrhosis, the administration of Benzodiazepines and barbiturates increases GABAergic tone, which results in a higher susceptibility to encephalopathy and depressed consciousness. There idea behind the GABA theory is that, clinically it has been observed that flumazenil, which is a benzodiazepine antagonist may ephemerally reverse hepatic encephalopathy in patients with cirrhosis.

Question 28:

How do you confirm the cause of pleural effusion (mostly right-sided) in a cirrhotic patient, as being hepatic hydrothorax?

Answer:
By radioisotope imaging (nuclear medicine).

Rationale:
Hepatic hydrothorax in cirrhotic patients may result from the migration of ascitic fluid across defects in the diaphragm. Indirect information of hepatic hydrothorax is provided by biochemical analysis of ascitic and pleural fluid. Direct transdiaphragmatic movement of ascitic fluid into the pleural space can be demonstrated by intraperitoneal injection of the radiotracer (99m Tc sulfur colloid scintigraphy), which is usually observed within two hours. Radionuclide scintigraphy is a non-invasive, simple and safe method to confirm passage of ascitic fluid across the diaphragm.

Question 29:
What is the rapid method of diagnosing pancreatitis secondary to alcohol intake?

Answer:
Lipase/amylase ratio.
A lipase/amylase ratio of greater than 2 is suggestive of alcoholic pancreatitis.
Note: Many sources question the reliability of this ratio.

Question 30:
A patient reports allergy to albumin, the patient is also a Jehovah's Witness, but requires large volume Paracentesis. What is your other option?

Answer:
Terlipressin in a dose of 1 mg every 4 hours for 48 hours can be used as an alternative to albumin for the prevention of circulatory collapse after large volume paracentesis. Terlipressin is said to be as effective as albumin for this purpose.

Question 31:
A 52-year-old male patient post-MI is started on cholesterol lowering drug Zetia (ezetimibe). The patient develops severe diarrhea. How is this related to the drug's mechanism of action?

Answer:
Ezetimibe localizes at the brush border of the small intestine, where it inhibits the absorption of cholesterol from the intestine. Specifically, it appears to bind to a critical mediator of cholesterol absorption, the Niemann-Pick C1-Like 1 (NPC1L1) protein on the gastrointestinal tract epithelial cells. Diarrhea occurs in 4.1% of patients.

Question 32:
What is V sign of Naclerio?

Answer:
The V-sign of Naclerio

Rationale:
The V-sign of Naclerio is present in about one fourth of patients with esophageal perforation. These are radiolucent streaks of air, which dissects the facial planes behind the heart to create the shape of the letter V. When seen, it is considered as fairly specific radiographic sign of esophageal perforation.

Question 33:
Why are non-selective β-blockers preferred in portal hypertension instead of selective β-blockers?

Answer:
The non-selective beta-blockers (propranolol, timolol and nadolol) are preferred because they cause decrease in both cardiac output via beta-1 blockade action and splanchnic blood flow, by blocking vasodilating beta-2 receptors at splanchnic vasculature.

Reference(s):
Talwalkar JA, Kamath PS (2004). "An evidence-based medicine approach to beta-blocker therapy in patients with cirrhosis". Am J Med 116 (11): 759–766

Question 34:
What is the ratio of lipase to amylase in acute pancreatitis from alcohol?

Answer:
2.5:1

Rationale:
If lipase level is about 2.5 to 3 times that of amylase, it is a strong indication of alcoholic pancreatitis.

Reference(s):
Gumaste V, Dave P, Weissman D, Messer J (1991) - "Lipase/amylase ratio. A new index that distinguishes acute episodes of alcoholic from nonalcoholic acute pancreatitis". Gastroenterology 101 (5): 1361–6.

Question 35:
In which condition is the pantoprazole (Protonix) dose 80 mg IV q12h used?

Answer:
Zollinger-Ellison Syndrome

Rationale:
Pantoprazole 80 mg administered intravenously q12h, is used in patients with hypersecretory conditions associated with Zollinger-Ellison Syndrome or other neoplastic conditions. The dosing frequency can be adjusted according to individual patient needs, based on acid output measurements. In some patients, doses as high as 80 mg q8h may be needed to maintain the acid output below 10 mEq/h.

Question 36:
What is the rule of thumb for intravenous resuscitation in GI bleed?

Answer:
Replace each milliliter of blood loss with 3 mL of crystalloid fluid.

Question 37:
Assuming a patient has normal renal function, what is a laboratory method to determine that gastrointestinal bleed is likely to be upper gastrointestinal bleed?

Answer:
If the ratio of BUN/Cr is greater than 30, the source of gastrointestinal bleed is more likely from the upper tract.

Reference(s):
Srygley FD, Gerardo CJ, Tran T, Fisher DA (March 2012). "Does this patient have a severe upper gastrointestinal bleed?" JAMA 307 (10): 1072–9

Question 38:
What is the disadvantage of using steroids in acute pericarditis?

Answer:
Steroids increase the chance of recurrent pericarditis. Colchicine on the other hand, is a very effective treatment. If Aspirin and NSAIDs are not sufficient, colchicine should be added to the regimen.

Reference(s):
Corticosteroids for Recurrent Pericarditis High versus Low Doses: A Nonrandomized Observation - Circulation. 2008; 118: 667-671Published online before print July 21, 2008

Question 39:
A 54-year-old male patient with cirrhosis is stabilized and now ready to be transferred out of the ICU. What is the preferred dose ratio of spironolactone and furosemide in the treatment of ascites to maintain eukalemia?

Answer:
100:40

Rationale:
In patients with cirrhotic ascites the first line diuretic therapy is the combined use of spironolactone and furosemide. Both drugs can be titrated up as needed. To avoid electrolyte imbalance, the use of the 100:40 mg ratio of spironolactone to furosemide is generally recommended. For spironolactone and furosemide, the accepted dosage range is 400 and 160 mg/day of spironolactone and furosemide, respectively.

Question 40:
What is the equipotent dose of propranolol to nadolol in portal hypertension?

Answer:
Decrease the dose to half and give once a day.

Rationale:
In portal hypertension treatment, beta-blockers are noncardioselective agents, which use the following two methods to reduce collateral blood flow as well as portal:

They cause reduction in cardiac output (via blockade of beta1-adrenoreceptors).
They cause splanchnic vasoconstriction (via blockade of vasodilatory adrenoreceptors in splanchnic circulation).

Propranolol and nadolol are among the most frequently used noncardioselective beta-blockers. Propranolol is administered as 20 mg every 12 hours, then increased or reduced every three to four days, until a 25% reduction in the resting heart rate is achieved, or the patient becomes bradycardic, with a heart rate of 55 beats per minute (bpm). The average dose of propranolol is 40 mg, administered twice daily.
Nadolol is administered once daily, and its dose is half that of propranolol.

Question 41:
What is Chilaiditi sign and syndrome?

Answer:
Chilaiditi sign is a condition where transposition of the loop of the large intestine (usually the transverse colon) occurs in-between the diaphragm and the liver, and on X-ray raises the suspicion of perforated viscus. If it causes clinical symptoms, it is called a syndrome. Causes include dolichocolon, emphysema, cirrhosis, absence or laxity of the ligament suspending the transverse colon or of the falciform ligament, atrophy of the medial segment of the left lobe of the liver. It is usually a benign condition but may cause pain or torsion of the bowel.

Question 42:

A 60-year-old male with End Stage Renal Disease (ESRD), and a history of atrial fibrillation, is recently started on dabigatran (Pradaxa). The patient presented with acute lower gastrointestinal bleeding. The patient took the last dose of dabigatran about 12 hours earlier. Knowing that there is no effective reversal for dabigatran, what could be your option here?

Answer:
Hemodialysis (HD)

Rationale:
Although hemodialysis may not be fully effective, up to 60% of dabigatran can be removed via hemodialysis and may provide some relief. Patients with already available access for HD, have an advantage, however they should be monitored closely, with adequate volume replacement. In patients with creatinine clearance (CrCl) more than 30 mL/min, the recommended dose of dabigatran is 150 mg twice daily. In patients with severe renal impairment (CrCl 15-30 mL/min), the recommended dose of PRADAXA is 75 mg twice daily.

Question 43:

Which antipsychotic drug has shown efficacy in preventing severe nausea vomiting?

Answer:
Olanzapine (Zyprexa)

Rationale:
Olanzapine (Zyprexa) has been used off-label as an antiemetic, particularly for the control of chemotherapy-induced nausea and vomiting. It is said to be very effective if used in conjunction with palonosetron and dexamethasone.

Question 44:

What is the mechanism of action of beta-blockers in reducing portal hypertension, which ultimately helps in reducing variceal bleeding?

Answer:
Nonselective beta-blockers such as propranolol and nadolol reduce portal pressure, through both local and systemic effects by 9% to 31%.

Local: In the splanchnic circulation, blockade of the vasodilator beta-2 adrenoreceptors results in unrestricted alpha-adrenergic activity, splanchnic arteriolar vasoconstriction, and decreased portal inflow.
Systemic: Blockade of the cardiac beta-1 receptors decreases the heart rate and cardiac output and secondarily decreases portal inflow.

Question 45:
What is Tension Gastro Thorax?

Answer:
Patients with diaphragmatic injury or defect who are self-ventilating (negative pressure ventilation) sometimes may have abdominal content; mostly stomach herniate (pull) into the chest. It may appear as pneumothorax on chest X-ray (CXR).
Acute management includes placement of nasogastric tubes or positive pressure ventilation. Also needle decompression has been described as a treatment modality.

Question 46:
The Model for End-Stage Liver Disease (MELD), is a scoring system used for assessing the severity of chronic liver disease. The formula for determining MELD score is MELD = 3.78[Ln serum bilirubin (mg/dL)] + 11.2[Ln INR] + 9.57[Ln serum creatinine (mg/dL)] + 6.43. If a patient is already on Dialysis, what creatinine value is automatically substituted?

Answer:
4

In interpreting MELD Score in hospitalized patients, the 3-month mortality is:
40 or more — 71.3% mortality
30–39 — 52.6% mortality
20–29 — 19.6% mortality
10–19 — 6.0% mortality
<9 — 1.9% mortality

Question 47:
How would you distinguish between traumatic bloody ascitic tap and non-traumatic bloody ascitic fluid?

Answer:
Bloody ascitic fluid from a traumatic tap will be heterogeneously bloody, and tend to clot. Nontraumatic bloody fluid is usually homogeneously red and does not clot because the blood has already been lysed after clotting within the sac.
For ascetic fluid to appear pink, a minimum of 10,000 red blood cells/μL is required and more than 20,000 red blood cells/μL to produce a distinct blood-tinged fluid.

Question 48:
What is the treatment for D-Lactic acidosis?

Answer:

D-lactate is a by-product of bacterial metabolism, which accumulates in patients with short-gut syndrome, and is a common finding in patients with a history of gastric bypass or small-bowel resection. Bacteria metabolized glucose and carbohydrate to D-lactic acid, is then systemically absorbed. D-lactate is only slowly metabolized by human subjects, and accumulates in patients with short guts. Usually it is clinically a benign condition.

Treatment consists of:
Restriction of simple sugars
Hydration
Bicarbonate administration, if clinically indicated

Use of metronidazole has been described as a treatment approach however, it is controversial as antibiotics can make the syndrome worse by permitting overgrowth of lactobacilli.

Reference(s):
1. Uribarri J, Oh MS, Carroll HJ: D-Lactic acidosis. Medicine 77:73 -82, 1998
2. Coronado BE, Opal SM, Yoburn DC: Antibiotic-induced D-lactic acidosis. Ann Intern Med 122:839 -842, 1995

Question 49:

What is the clinical importance of Mayo-Robson point?

Answer:

A point just above and to the right of the umbilicus is called Mayo-Robson's point. At this point the tail of the pancreas is projected on the abdominal wall. Here tenderness on pressure exists in diseases of the pancreas; and it is one clinical sign seen in acute pancreatitis.

Question 50:

One of the most deceiving signs in Diabetic ketoacidosis (DKA) is acute abdomen. Which factors are commonly associated with acute abdomen in DKA?

Answer:

Severity of Metabolic Acidosis
History of Cocaine abuse
History of alcohol abuse

Interestingly severity of dehydration and hyperglycemia is not found to be an associated factor in this type of presentation.

Reference(s):
Umpierrez G, Freire AX. - Abdominal pain in patients with hyperglycemic crises. J Crit Care. 2002 Mar; 17(1): 63-7

Question 51:

A patient developed lower GI bleeds in ICU. GI service post endoscopy diagnosed anal fissure and prescribed diltiazem (Cardizem). Is this a mistake?

Answer:
No

Rationale:
Diltiazem (Cardizem) is frequently used in the treatment of anal fissures - either via oral route or can be applied topically. It has a very good short-term success rate and provides temporary relief until surgical intervention is done, if required. Local application of diltiazem relaxes the sphincter muscle, and allows the healing to proceed.

Question 52:
What is the dose of erythromycin used in hospitalized patients to treat gastroparesis?

Answer:
3-mg/kg q8h (by IV infusion over 45y minutes, to avoid sclerosing veins) of erythromycin lactobionate has been shown to be effective in hospitalized diabetics with gastroparesis.

Reference(s):
Guidelines for Management of Gastroparesis - American College of Gastroenterology - Am J Gastroenterol 2013; 108:18–37

Question 53:
Which one added step is recommended to decrease the trauma complication from Paracentesis?

Answer:
Either request patient to urinate before the procedure; or insert a foley catheter to empty the bladder.

Question 54:
How much ascitic fluid can the abdomen hold?

Answer:
25 liters.

The abdomen can hold up to 25 liters of ascitic fluid but care should be taken to avoid large volume paracentesis

Question 55:
What is Boas' sign?

Answer:
Boas's sign is hyperesthesia below the right scapula in acute cholecystitis. It has also been described as 'point tenderness' in the region to the right of the 10^{th} to 12^{th} thoracic vertebrae. Boas' sign can also be present in stomach and duodenal disease.

Please note that clinical signs in acute cholecystitis can be very tricky and no single clinical finding (like the famous Murphy's sign) carry sufficient weight to establish or exclude acute cholecystitis without further testing.

Question 56:
What does types A, B and C stand for in hepatic encephalopathy?

Answer:
Hepatic encephalopathy is subdivided into type A, B and C depending on the underlying cause.

Type A (or acute) encephalopathy is hepatic encephalopathy associated with acute liver failure.

Type B (or bypass) encephalopathy occurs as a result of portal-systemic shunting without patient having any associated intrinsic liver disease.

Type C (or cirrhosis) encephalopathy occurs in patients with cirrhosis of the liver.

Question 57:
A 52-year-old male with end stage liver disease, presented with shortness of breath. The patient is found to have a massive right-sided hydrothorax. Which one procedure should be avoided?

Answer:
Inserting chest tube

Rationale:
Chest tubes should almost never be inserted in hydrothorax unless there is evidence of pyothorax or pneumothorax. The treatment option to be considered in clinically significant hydrothorax is Transjugular Intrahepatic Portosystemic Shunt (TIPS), although it may transiently worsen hepatic encephalopathy. The ultimate treatment is a liver transplant.

Question 58:
What are the 2 methods of diagnosing Chylous ascites?

Answer:

Chylous ascites is diagnosed when the ascites triglyceride level is greater than 110 mg/dL. Another finding, is elevated ascites: plasma triglyceride ratio (somewhere between 2:1 and 8:1). Also, color of the ascetic fluid usually is white or milky. Chylous ascites may occur due to various reasons, such as abdominal surgery, blunt abdominal trauma, malignant neoplasms, and spontaneous bacterial peritonitis, occasionally in cirrhosis, pelvic irradiation, peritoneal dialysis, abdominal tuberculosis and carcinoid syndrome.

Question 59:

What is the clinical significance of rising AST and ALT after initiation of Heparin?

Answer:
None

Rationale:
Elevation of serum aminotransferase levels is very common and reported in as many as 80% of patients receiving heparin. To note, this abnormality is not associated with liver dysfunction, and it disappears after the drug is discontinued.

Question 60:

Inverted sleep-wake pattern (i.e. sleeping by day and being awake at night), is the hallmark (or at least a sign) of which form of encephalopathy?

Answer:
Hepatic encephelopathy

Rationale:
Mild to moderate hepatic encephalopathy is characterized by forgetfulness, confusion, irritability, inverted sleep-wake pattern, irritability, and tremors.

Question 61:

In ascites, if a patient requires both spironolactone and furosemide - what combination minimizes the danger of hypokalemia?

Answer:
Generally, patients with ascites respond well to spironolactone. For nonresponders, a loop diuretic may also be added. The ratio of 100 mg : 40 mg reduces risks of hypokalemia.

Question 62:

A 23-year-old male is admitted to ICU after severe abdominal pain. The CT scan reports foreign body obstruction. The GI service performed upper and lower GI endoscopy and

advised surgical consult. Their diagnosis was Rapunzel syndrome?

Answer:
Rapunzel syndrome is a rare intestinal disorder resulting from a condition called trichophagia (eating hair).

Trichophagia is a severe form of this condition called Trichotillomania (also known as "trichotillosis"). It is the compulsive urge to pull out one's own hair, which leads to noticeable hair loss. In trichophagia, people with trichotillomania may also ingest the hair that they pull; which can lead to a hairball formation in the GI tract called trichobezoar, and may cause GI obstruction.

Rapunzel syndrome is an extreme form of trichobezoar in which the "tail" of the hairball extends into the intestines, and can be fatal if misdiagnosed. Because the human gastrointestinal tract is unable to digest human hair, trichobezoar may require surgical treatment. This syndrome is named after the longhaired girl Rapunzel, in a fairy tale story.

Question 63:
What are Maddrey's modified Discriminant Function (mDF) and its clinical implication?

Answer:
The American College of Gastroenterology defines severity of alcoholic hepatitis as a modified Discriminant Function (mDF). If this score is greater than or equal to 32 and/or hepatic encephalopathy is present, it identifies cutoff for severity.

mDF is calculated as follows:
mDF = 4.6 (Patient–Control)+ serum bilirubin (µmol/l)/17.

mDF of greater than or equal to 32 and/or hepatic encephalopathy was associated with a 65% 28-day survival in patients treatment under the placebo. Patients having a score of less than 32 had the survival rate of 93%.

Question 64:
In severe nausea which drug may provide good synergism with ondansetron (Zofran)?

Answer:
Dexamethasone (Decadron)

Rationale:
Dexamethasone and ondansetron (Zofran) may be more effective than ondansetron alone in preventing postoperative nausea and vomiting.

Reference(s):
Song (2011). "The effect of combining dexamethasone with ondansetron for nausea and vomiting associated with fentanyl-based intravenous patient-controlled analgesia." Anaesthesia 66 (4): 263–7

Gastro Intestinal Tract - PEARLS

1. **Hepatorenal Syndrome**

Hepatorenal syndrome is commonly seen among cirrhotic patients, especially hospitalized patients. It is found among 10% of cirrhotic patients who have ascites and are hospitalized. It is characterized by:

a. Oliguria
b. Azotemia

Increase urine-plasma osmolality ratio (U: P) in the absence of urinary sediment
Low urinary sodium excretion of 10 mEq per liter or less

Patients with hepatorenal syndrome have normal renal tissue on histology. It occurs in patients who have pre-existing liver parenchymal disease. It is usually precipitated by events such as GI Bleed, surgery or hypotensive episodes. Its mechanism is not completely understood, but it is thought to involve vasodilatation, which results in decreased effective arterial volume which in turn causes further reduction of glomerular filtration by the renin angiotensin-aldosterone system.

Hepatorenal syndrome can progress over days to weeks after the precipitating event. In the initial phase it is responsive to volume expansion, but ultimately it is refractory to all interventions except liver transplantation.

Reference(s):
Rroyo, V, Guevara M, Gin`es P, et al. (2002) Hepatorenal syndrome in cirrhosis: pathogenesis and treatment.Gastroenterology 122 (6), 1658–76.
Mulholland MW, Lillemoe KD, Doherty G et al. (2010) Greenfield's Surgery: Scientific Principles and Practice, Lippincott Williams & Wilkins, Philadelphia, PA.

2. **Mnemonic for Ranson criteria of Acute Pancreatitis**

Ranson criteria are clinical prediction severity rules of acute pancreatitis.

At admission: "GA LAW"
Glucose; more than 200 mg/dL
AST: more than 250 IU/L
LDH: more than 350 IU/L
Age: more than 55 years
WBC: more than 16000 cells/mm3

At 48 hours: "C Hobbs"
Calcium: less than 8.0 mg/dL
Hematocrit falls more than 10%
Oxygen: PO_2 less than 60 mmHg
BUN increased by 1.5 or more mg/dL after IV fluid hydration
Base deficit: more than 4 mEq/L
Sequestration of fluids: more than 6 L
Score 0 to 2: Patient has 2% mortality

Score 3 to 4: Patient has 15% mortality
Score 5 to 6: Patient has 40% mortality
Score 7 to 8: Patient has100% mortality

3. **Neostigmine drip and critical illness induced intestinal Pseudo-obstruction**
   IV Neostigmine has been used successfully in acute colonic pseudo-obstruction with quick colonic decompression after a bolus infusion. But it carries significant risk of adverse effects of cholinesterase inhibition including bronchospasm, salivation, vomiting, life threatening bradycardia and hypotension. Atropine should be available at the bedside during administration of neostigmine.

   To counteract this life threatening bradycardia a slow infusion may be used, which may carry a lower risk of bradycardia. This could also be extremely useful in patients with critical illness-related intestinal ileus unresponsive to other standard measures. The recommended dose of neostigmine for continuous infusion is 0.4-0.8 mg/h over 24 hours.

4. **Colonic Necrosis - unusual complication of Kayexalate-Sorbitol**
   We have used sodium polystyrene sulfonate (SPS or Kayexalate) over the last 45 years with great confidence. It is common practice to add sorbitol to dissolve Kayexalate mainly to avoid fecal impaction or possible bowel obstruction. Kayexalate binds intraluminal calcium and may cause constipation, fecal impaction or bowel obstruction.

   One of the relatively unknown complications of Kayexalate-sorbitol combination is colonic necrosis, although this has been reported in earlier literature. The exact reason for colonic necrosis is not clear but the diagnosis can be made via pathologic examination of post-operative specimen or material from endoscopic biopsy and may require specialized expertise and special stains. The sorbitol component is taught to be responsible for the complication. Intensivists need to be wary of the possible complication of acute abdomen after administration of Kayexalate-sorbitol in approximately 1% of cases, particularly within the first 24-36 hours.

5. **A note on importance of high vigilance for Boerhaave's syndrome**
   Diagnosis of Boerhaave's syndrome is difficult since approximately one third of all cases of Boerhaave's syndrome are clinically atypical. Even with clinical signs, Boerhaave's syndrome is usually misdiagnosed as acute myocardial infarction, pancreatitis, pleuritis, pericarditis, aortic dissection or pneumothorax. Radiographic studies should be promptly obtained.

   Overall mortality is estimated to be around 35%, which makes it the most lethal perforation of the GI tract. Those patients who are diagnosed and treated early have the best outcomes. If intervention is delayed for more than 24 hours, the mortality rate rises to higher than 50% and the mortality is approximately 90% if the patient undergoes treatment after 48 hours. Mortality is as high as 100%, in untreated patients.

6. **TIPS**

Transjugular Intrahepatic Porto Systemic Shunts (TIPS) involve creation of a low-resistance channel between the hepatic vein and the intrahepatic portion of the portal vein using the interventional angiographic techniques.
Indications for TIPS include:

Bleeding refractory to endoscopic and medical management
Refractory ascites
Budd–Chiari syndrome
Hepatorenal syndromes.

In TIPS the stent is expanded to a diameter, which effectively reduces the porto-systemic gradient to less than 12 mm Hg.

Complications of TIPS include 25% post-procedure encephalopathy. It is worse in patients with renal insufficiency.

The long-term complications of TIPS include stenosis of the shunt, which happens in as many as two thirds of patients. Most centers advocate an aggressive Doppler ultrasound-monitoring program to identify the stenosis early, and prompt balloon dilation in patients with stent stenosis.

Reference(s):
1. Boyer TD, Haskal ZJ, American Association for the Study of Liver Diseases (2010) The role of transjugular intrahepatic portosystemp shunt (TIPS) in the management of portal hypertension: update 2009. Hepatology 51, 306.
2. Mulholland MW, Lillemoe KD, Doherty G et al. (2010) Greenfield's Surgery: Scientific Principles and Practice, Lippincott Williams & Wilkins, Philadelphia, PA.

7. **SRMD and PUD**

We commonly use terms Stress ulcer (Stress Related Mucosal Disease (SRMD)) and Peptic ulcer disease (PUD) interchangeably in the ICU when discussing "GI prophylaxis". Both are two different conditions. Probably what we are worried about in our "unit" patients is mostly SRMD.

SRMD is multiple superficial erosions occurring in proximal gastric bulb involving superficial capillaries secondary to mucosal hypoperfusion and perforations are rare. PUD is associated with a few deep erosions occurring usually in the duodenum involving one vessel secondary to other reasons (drugs, H. Pylori, and hypersecretory states) and perforation is common.

8. **Diagnostic Criteria for Portopulmonary Hypertension (POPH)**

The European Respiratory Society Task Force on Pulmonary-Hepatic Vascular Disorders has proposed specific diagnostic criteria for POPH obtained by right heart catheterization
Presence of portal hypertension (clinical diagnosis), A diagnosis with or without cirrhosis
Patient with mean pulmonary artery pressure (mPAP) > 25 mm Hg

Patients having pulmonary vascular resistance (PVR) > 240 dynes sec/cm-5
Patient have transpulmonary gradient* > 12 mm Hg
*Transpulmonary gradient = mean pulmonary artery pressure - pulmonary artery occlusion pressure (mPAP - PAOP).

9. GET SMASHED

The mnemonic GETSMASHED is used for common causes of Pancreatitis:
G - Gall stones
E - Ethanol
T- Trauma
S - Steroids
M - Mumps
A - Autoimmune
S - Scorpion sting
H - Hyperlipidemia, Hypothermia, Hyperparathyroidism
E - ERCP
D - Drugs

10. False positive or false negative stool guaiac test

False positive:
Iron supplements,
Bismuth containing products
Red meat (the blood it contains can turn the test positive),
Many vegetables particularly if raw (cucumber, cauliflower and horseradish), which contain a chemical with peroxidase properties that can turn the test positive.

False negative:
This is seen in patients taking vitamin C and citrus fruits (which can give false negative results)

Reference(s):
1. *Beg M, et al. (2002). "Occult Gastrointestinal Bleeding: Detection, Interpretation, and Evaluation"JIACM 3 (2): 153–8.*
2. Jaffe RM, Kasten B, Young DS, MacLowry JD (December 1975). "False-negative stool occult blood tests caused by ingestion of ascorbic acid (vitamin C)". Ann. Intern. Med. 83 (6): 824–6.
3. Anderson GD, Yuellig TR, Krone RE (May 1990). "An investigation into the effects of oral iron supplementation on in vivo Hemoccult stool testing". Am. J. Gastroenterol. 85 (5): 558–61.
4.Wells HJ, Pagano JF (1977). "Hemoccult test — reversal of false-negative results due to storage". Gastroenterology 72: 1148.

11. Gastrointestinal Beriberi: A Previously Unrecognized Syndrome
"In the 1940s, several separate experiments induced thiamine deficiency in humans; almost all participants reported nausea, vomiting, and abdominal pain. These early observations were not translated into a clinical syndrome and have essentially been forgotten. A case series documented the occurrence of "fulminant beriberi" in intensive care unit patients who were deprived of thiamine during administration of total parenteral nutrition. Eleven patients in that series had undergone laparotomy for

abdominal pain; surgical findings were negative. All patients given intravenous thiamine recovered. The current report of 2 cases is the first to recognize a primary gastrointestinal syndrome secondary to thiamine deficiency. Both patients were critically ill and recovered rapidly after receiving thiamine as the only therapeutic intervention. In-patient 1, the abdominal pain was severe enough to warrant an operation. Both patients also displayed severe venous hyperoxia (central venous oximetry 93%), which indicates a mitochondrial defect in oxygen utilization consistent with thiamine deficiency. The rapid recovery from such profound venous hyperoxia and lactic acidosis (in the absence of other treated causes) can be explained only by thiamine repletion. Thiamine deficiency may lead to a gastrointestinal syndrome of nausea, vomiting, abdominal pain, and lactic acidosis. Further delineation of this potential syndrome is of paramount importance—failure to recognize and treat it may lead to unnecessary morbidity and death. Thiamine administration should be considered for all inadequately nourished patients who present with gastrointestinal symptoms and lactic acidosis"[1].

Reference(s):
1. Gastrointestinal Beriberi: A Previously Unrecognized Syndrome - 7 December 2004 Volume 141 Issue 11 Pages 898-899
2. Observations on induced thiamine deficiency in man. Arch Intern Med. 1940;66:785-99
3. TPN-induced fulminant beriberi: a report on our experience and a review of the literature. Surg Today. 1996; 26:769-76

12. Fan Score (Hong-Kong criteria or 20/200 Score)

Why we not hear about the easiest ways to assess the severity of acute pancreatitis, with only 2 parameters:

Azotemia - BUN more than 20 mg/dL (7.4 mmol/L)
and/or
Glycemia - more than 200 mg/dL (11 mmol/L)

Reason: These criteria failed to gain ground, due to conflicting reports in the literature. Originally, Fan and colleagues reported the sensitivity of 76% and specificity of 75% but later 2 studies failed to confirm the high sensitivity (only 33%, reference # 4 and 52%, reference # 3 respectively). The study in reference # 3 also found that best prediction to severity of acute pancreatitis was provided by the APACHE II score 24 hours post admission with sensitivity of 79% and specificity of 82%. The famous Ranson criteria in the same study showed sensitivity of 79% but specificity was only 56%

Reference(s):
1. Assessment of severity of acute pancreatitis: a comparison between old and most recent modalities used to evaluate this perennial problem - World J Gastroenterol 1999; August 5(4): 283-285
2. Fan ST, Choi TK, Lai ECS, Wong J. Prediction of severity of acute pancreatitis: an alternative approach. - Gut, 1989; 30:1591-1595
3. Failure of the Hong Kong criteria to predict the severity of acute pancreatitis - Int J Pancreatol. 1997 Dec; 22(3): 201-6.
4. The Hong Kong criteria and severity prediction in acute pancreatitis - Int J Pancreatol. 1994 Jun; 15(3): 179-85.

13. Glasgow criteria for acute pancreatitis

Glasgow criteria for acute pancreatitis can be remembered as mnemonic PANCREAS:

P PO_2 Oxygen < 60mmHg
A Age > 55
N (Neutrophilia) White blood cells > 15
C Calcium < 2 mmol/L
R Renal Urea > 16 mmol/L
E Enzymes: Lactate Dehydrogenase (LDH) > 600iu/L Aspartate Transaminase (AST) > 200iu/L
Albumin < 32g/L
S Sugar Glucose > 10 mmol/L

14. Fidaxomicin - A new kid on the block to treat Clostridium difficile

Fidaxomicin is a narrow spectrum macrocyclic non-systemic antibiotic drug. It is bactericidal, and causes selective eradication of pathogenic Clostridium difficile with minimal disruption of the other bacteria that make up the normal, healthy intestinal flora. It is evident that the maintenance of normal physiological conditions in the colon is the best defense against the probability of Clostridium difficile infection recurrence.

Dose is 200 mg tablet every 12 hours for the duration of 10 days.

15. Two (2) less appreciated factors in Variceal bleed beside obstruction

Obstruction of portal venous flow, whatever the etiology, results in a rise in portal venous pressure. This is a well know documented etiology. But there are 2 other factors, which may play part in, increase portal pressure and variceal bleed.

a. Increase Endothelin-1 (ET-1), which is a powerful vasoconstrictor, synthesized by sinusoidal endothelial cells and causes increased hepatic vascular resistance of cirrhosis and the development of liver fibrosis.
b. Nitric Oxide (NO) is a known vasodilator substance that is synthesized by sinusoidal endothelial cells. In the cirrhotic liver, the production of NO is decreased.

Reference(s):

Gupta TK, Toruner M, Chung MK, Groszmann RJ. Endothelial dysfunction and decreased production of nitric oxide in the intrahepatic microcirculation of cirrhotic rats. Hepatology. Oct 1998; 28(4): 926-31.

16. A note on Portal Hypertension and development of varices

Portal pressure in normal person is about 9 mmHg and a normal inferior vena cava pressure is about 2-6 mmHg. This helps creates a normal pressure gradient of 3-7 mmHg. If the portal pressure rises above 12 mmHg, the gradient rises to more than 5 mm Hg. A gradient observed to be greater than 5 mmHg is defined as portal hypertension. Once the gradient rises to greater than 10 mmHg, blood flowing via the hepatic portal system gets redirected from the liver into areas with lower venous pressures. This creates collateral circulation within the lower esophagus, stomach, abdominal wall, as well as the rectum.

17. MELD Score: What is it?

MELD stands for Model for End-Stage Liver Disease, initially designed and validated for predicting survival in patients with portal hypertension undergoing Transjugular Intrahepatic Portosystemic Shunt (TIPS). Three parameters used in calculating the predicting models are:

1. INR (international normalized ratio)
2. Serum creatinine
3. Serum Bilirubin

It is calculated as:

MELD = 9.57 x $\log_e$ (creatinine) + 3.78 $\log_e$ (total bilirubin) + 11.2 $\log_e$ (INR) =6.43

MELD has played an important role in predicting the mortality in liver disease, and has significantly decreased the liver transplantation time. Patient with MELD scores of less than 16 have a good rate of survival, while those with scores of more than 24 have a poor survival rate. It also removes favoritism and subjective bias out of transplant preference.

Reference(s):

Kamath PS, Kim WR. The model for end stage liver disease (MELD). Hepatology 2007; 45(3): 797-805

18. Cameron lesions

Cameron lesions are linear gastric erosions positioned at the diaphragmatic impression, in patients with large hiatus hernia. It is a distinct entity from other erosions and was described the first time about 20 years ago by AJ Cameron.

Clinical significance: In up to one third of cases, Cameron lesions can present as acute upper GI bleed which may become life-threatening. Despite treatment, 33% develop recurrence of the lesions with possible acute event requiring immediate surgery. The lesions can also cause iron deficiency anemia and chronic GI bleed.

Reference(s):

1. Linear gastric erosion. A lesion associated with large diaphragmatic hernia and chronic blood loss anemia. - Gastroenterology. 1986 Aug; 91(2): 338-42.
2. Hiatal hernia with Cameron ulcers and erosions. - Gastrointest Endosc Clin N Am. 1996 Oct; 6(4): 671-9.
3. Cameron lesion and its laparoscopic management - Indian J Gastroenterol 2005; 24:163-163

19. Stool Osmolal Gap

About one third of patients on enteral feeding develops diarrhea in ICU. One easy way to confirm diarrhea secondary to enteral feed is to calculate Stool Osmolal Gap.

The formula of Stool Osmolal Gap follows:

Stool Osmolal Gap = Measured stool osmolality - 2 (stool Na - stool K)

A stool Osmolal Gap of more than 160 mOsm/kg H_2O is most probably related to enteral feeding in the ICU or may be due to medications. Other causes of higher stool

osmolal gap are pancreatic insufficiency, celiac sprue, and lactose intolerance, but they are relatively uncommon.

Note: In the ICU if stool osmolal gap is less than 50 mOsm/kg H2O, secretory diarrhea from C.diff. colitis should be ruled out first.

Serum-Ascites Albumin Gradient (SAAG)

A serum-ascites albumin gradient (SAAG) is a useful test for differential diagnosis of ascites. Both should be drawn/measured at same time.

High gradients (≥ 1.1 g/dL) is seen in patients with:

Cirrhosis
Cardiac ascites
Mixed ascites
Alcoholic hepatitis
Budd-Chiari Syndrome
Fulminant liver failure
Fatty liver in pregnancy
Veno-occlusive disease
Portal vein thrombosis

Low gradient < 1.1 g/dL is seen in:

Tuberculosis peritonitis
Pancreatic ascites
Biliary ascites
Nephrotic syndrome
Peritoneal carcinomatosis

Hematology / Oncology

Question 1:

Name 3 conditions where PT, PTT and platelet count is not affected - but only the bleeding time increases?

Answer:

1. ASA
2. Uremia
3. Glanzmann's Thromboasthenia

Question 2:

How long does it take for transfused platelet to show apparent effect?

Answer:

About one hour.

Rationale:

Each unit of platelet transfusion is expected to increase platelet count by 5 - 10,000 / uL, and platelet transfusion is usually given as 6 or 10 units together.

Question 3:

Case:

A 52-year-old male after emergent exploratory laparotomy is admitted to ICU. The patient has Lactated Ringer's solution infusing at 125 ml /hr. Two units of PRBC have been ordered. Why is it a bad idea to mix Lactated Ringer's solution and PRBC through the same IV line?

Answer:

Lactated Ringer's solution contains calcium, which may bind to the citrate (used as anticoagulant) in blood products. This promotes clot formation in donor blood (bag).

Rationale:

Normal Saline contains (per liter)

154 mEq/L of Na^+ and
154 mEq/L of Cl^-

Lactate Ringer contains (per liter)

130 mEq/L of Na^+ (but total cations of 137 mEq/L, so still is isotonic)
109 mEq/L of Cl^-
28 mEq/L of lactate
4 mEq/L of potassium
3 mEq/L of calcium

Lactate converts to bicarbonate in liver. Patients with lactic acidosis usually have inadequate liver metabolism of lactate so conversion to HCO_3 from the infused lactate of LR is impaired and may give false readings of serial lactate measurements.

Question 4:

One unit of Fresh Frozen Plasma (FFP) is the plasma taken from a unit of whole blood. How quickly, should it be frozen after collection?

Answer:

It should be frozen within eight hours of collection.

Rationale:

Each unit of FFP contains approximately 225-250 ml of plasma, which is derived from a single unit of whole blood. It is stored at -18° C or less to preserve all coagulation factors. When FFP is requested it is thawed in a 37° C (water bath) for 20-30 minutes; and it can then be stored after thawing for up to 24 hours at 1-6°C. FFP does not require cross matching.

Question 5:

You just diagnosed a patient with thrombotic thrombocytopenic purpura (TTP) but the nursing supervisor informed you that plasma exchange with fresh frozen plasma is not available at the hospital due to technical reasons and it will take time before the patient can be transferred to a facility where the said services are available. What would be your alternate plan to bridge that time gap?

Answer:

High-dose plasma infusion at a rate of 25-30 mL/kg per day. When immediate plasma exchange with fresh frozen plasma is not available, simple plasma infusion can be performed until transfer to a higher facility is available. There is always a substantial risk of fluid overload with such high plasma infusion and you have to weigh risks and benefits of the clinical decision or to watch patient closely while plasma is infusing.

Reference(s):

High-dose plasma infusion versus plasma exchange as early treatment of thrombotic thrombocytopenic purpura/hemolytic-uremic syndrome - Medicine. 82(1): 27-38, January 2003.

Question 6:

Case:

A 28-year-old male with history of sickle cell crisis presented with priapism. After six hours and despite adequate hydration and analgesia, there is no relief! What is your next option?

Answer:

In case of priapism, you have 2 options. Either call an urologist for aspiration of corpus cavernosum or consult a hematologist for exchange blood transfusion.
Exchange blood transfusion in sickle cell crisis should be consider in the following situations:

1. Where there is no relief in crisis, despite adequate hydration and analgesia
2. Where there is any sign of a stroke
3. If patient is pregnant
4. In the event of prophylactic exchange transfusion prior to major surgery. A single exchange transfusion reduces the risk of complications from the general anesthetic and surgery
5. Where there is complain of vision loss in one eye or visual symptoms
6. Where there is unresolved painful erection of the penis (priapism)

Reference(s):
Anemia, Sickle Cell, emedicine.com

Question 7:

Is high fibrinogen level indicative of DIC?

Answer:
No

Rationale:
Normal fibrinogen level can occur in over 57% of DIC cases. It can be elevated due to the underlying inflammatory condition. On the other hand a high plasma fibrinogen level is associated with poor clinical outcome in DIC patients. A low level, however, is more consistent with the consumptive process of DIC.

Reference(s):
Wada H1, Mori Y, Okabayashi K, Gabazza EC, Kushiya F, Watanabe M, Nishikawa M, Shiku H. - High plasma fibrinogen level is associated with poor clinical outcome in DIC patients. Am J Hematol. 2003 Jan; 72(1): 1-7.

Question 8:

How many units of platelets are required to avoid possible bleeding due to 300 mg dose of Plavix (Clopidogrel)?

Answer:
10 units

Rationale:
In a study published in the *Journal of Thrombosis*, pre-operative transfusion of 10 units of platelets concentrate after a 300-mg clopidogrel loading or 12.5 units after a 600 mg loading may adequately reverse clopidogrel-induced platelet disaggregation and helped in facilitating postoperative hemostasis. If 2.5 units more are given, this can completely

normalize the platelet function. Approximately each unit of platelet increases the platelet count by 10,000 / uL.

Editor's note: Limitation of study - The study was performed under *in vitro* conditions and there is a lack of information regarding the correlation with *in vivo* clinical outcomes, which is acknowledged by the authors.

Reference(s):

Normalization of platelet reactivity in Clopidogrel-treated subjects - Journal of Thrombosis and Haemostasis, 5: 82–90

Question 9:

What is cryoprecipitate?

***Answer*:**

The name explains everything. Cryoprecipitate means "cold precipitate". When FFP is thawed slowly at 4° C, a white precipitate forms at the bottom of the bag, which can then be separated from the supernatant plasma. This precipitate is rich in fibrinogen, factor VIII, von Willebrand factor, factor XIII, and fibronectin, called cryoprecipitate. One unit of cryoprecipitate is derived from fresh frozen plasma (FFP) prepared from a unit of whole blood and it is only a little precipitate at the bottom of the bag, 1 unit of cryoprecipitate comprised only a volume of 10-20 mL.

Contents:

1. 80-100 units of factor VIII, which consists of both the procoagulant activity and the von Willebrand factor,
2. 150-250 mg of fibrinogen,
3. 50-100 units of factor XIII, and
4. 50-60 mg of fibronectin.

The half-life is about one year if stored at -18° C. When ordered (generally given as 6 units at a time), cryoprecipitate is thawed back to 37° C. Once thawed it must be kept at room temperature and has an expiration time of 4-6 hours.

Question 10:

Which two commonly used drugs in the ICU may cause non-infectious leucocytosis beside steroids?

Answer:

1. Lithium
2. Beta agonists

Question 11:

Case:

A 52-year-old male is back from cardiac angioplasty with Abciximab (ReoPro) infusion. Pre-catheterization laboratory values were normal. CBC was sent for per protocol 4 hours after Abciximab infusion and the laboratory called with critical platelet level of 62,000 / uL. Abciximab was stopped and hematology consulted. Hematology advised to restart Abciximab!

Answer:
Pseudothrombocytopenia

Rationale:
Pseudothrombocytopenia is a common phenomenon with patients on Abciximab (ReoPro). It is a benign condition and is not a real thrombocytopenia as platelets actually clump into collecting tubes containing EDTA. It is an important diagnosis to make. Reviewing peripheral blood film or drawing blood in citrated or heparinized tubes can make the diagnosis. It is not clear why Abciximab causes more EDTA-induced platelet clumping. * EDTA (Ethylenediaminetetraacetic acid) is a commonly used anticoagulant in sampling tubes for blood counts.

Reference(s):
1. Occurrence and clinical significance of pseudothrombocytopenia during Abciximab therapy J Am Coll Cardiol. 2000 Jul; 36(1): 75-83.
2. Abciximab-Associated Pseudothrombocytopenia - Circulation. 2000; 101:938
3. EDTA dependent pseudothrombocytopenia caused by antibodies against the cytoadhesive receptor of platelet gpIIB-IIIA - Journal of Clinical Pathology 1994;
47:625-6304. Pseudothrombocytopenia Volume 329:1467 Nov. 11, 1993

Question 12:
What is cell saver?

Answer:
"Cell saver" is a machine, which suctions, washes, and filters blood so that it can be given back to the patient, instead of being thrown in other words, the patient receives his or her own blood back. Newer machines now have the flexibility of even salvaging more blood, reducing blood-loss to 70 cc.

The cell saver is a viable choice for patients with Jehovah's Witness beliefs. There is some controversy in the literature regarding the cost effectiveness and efficacy however, in surgery with higher estimated blood loss (EBL), it definitely is a valuable technology.

Question 13:
Which order should you add while writing orders for pRBC transfusion beside rate?

Answer:

"Please insert 18 gauge IV catheter if possible for pRBC transfusion".

Rationale:
In adult patients, if available, pRBC should be transfused preferably through at least an 18-gauge catheter. This is not a guideline or a necessity but an 18-G catheter provides good flow rates for cellular components.

On the flip side, drawing blood from smaller catheter can produce hemolysis and lead to over-diagnosis of hyperkalemia and possible patient safety issues. As the catheter gets smaller, hemolysis goes up by1.

24 gauge (100% chance of hemolysis)
22 gauge (25% chance of hemolysis)
20 gauge (15% chance of hemolysis)
18 gauge (10% chance of hemolysis)
14 -16 gauge (0% chances of hemolysis).

Reference(s):
A comparison of hemolysis rates using intravenous catheters versus venipuncture tubes for obtaining blood samples - J Emerg Nurs.1996 Dec; 22(6): 566-9

Question 14:
What options are available, in the event that a patient develops life-threatening bleeding as a complication of fibrinolytic therapy?

Answer:
If a patient receiving fibrinolytic therapy develops serious bleeding; the first step is to stop the fibrinolytic agent and any anticoagulants. Hemodynamic stability with volume and pressors as supportive therapy is vital.

Aminocaproic acid: Aminocaproic acid is a specific antidote to fibrinolytic agents. The loading dose of aminocaproic acid is 4-5 grams over one hour, followed by a continuous infusion at the rate of 1 g / hour. Infusion of aminocaproic acid is continued for about eight hours or until the bleeding is controlled. Aminocaproic acid should only be given for life-threatening hemorrhage, because it inhibits intrinsic fibrinolytic activity.

Blood products: FFP, cryoprecipitate, or both may be used to replenish fibrin and clotting factors.

Question 15:
Although thrombocytosis seems to cause more thrombotic symptoms, why is GI bleed then one of the most common presenting symptoms?

Answer:
It is true that thrombosis is the basis of most symptoms, particularly with a platelet count

greater than 1 million/mL. Thrombosis of large veins and arteries is common and may result in occlusion of the leg, coronary, and renal arteries. Other arteries may also be involved. Symptoms from venous thrombosis of the splenic, hepatic, or leg and pelvic veins may develop. Priapism is another known complication. Pulmonary hypertension may result from pulmonary vasculature occlusion.

The gastrointestinal tract is the common site of bleeding complications due to duodenal arcade thrombosis, resulting in sloughing of the duodenal mucosa and thus bleeding. Similarly sloughing of mucosa at other sites may cause bleeding as well, such as the eyes, gums, and urinary tract and possibly brain.

Another cause of bleeding could be an acquired von Willebrand's deficiency particularly with extreme thrombocytosis (i.e., more than 1.5 million platelets/µL).

Question 16:

Why is *Warfarin Bridging* recommended?

Answer:

For the first 48 to 72 hours of initiation of warfarin, the levels of protein C and protein S, which are also anticoagulation proteins, drop faster than pro-coagulation proteins such as factor II, VII, IX and X. As a result, bridging therapies with anticoagulants (such as heparin) are recommended to be used during the period of this temporary hypercoagulable state.

Question 17:

In which 3 clinical conditions can Anti-XA Assay be misleading?

Answer:

1. Hemolysis
2. Hyperbilirubinemia
3. High lipids

Question 18:

Fresh Frozen Plasma (FFP) can be stored / preserved for a maximum of what time period?

Answer:

3 years

Rationale:

One study showed that an extended storage for up to 3 years at - 40 °C should be possible without clinically relevant loss of efficacy.

Fresh Frozen Plasma is the fluid portion of one unit of human blood that has been centrifuged, separated, and frozen solid usually at −18 °C within 8 hours of collection.

Reference(s):
Long-Term Storage of Fresh Frozen Plasma at -40 °C. A Multicenter Study on the Stability of Labile Coagulation Factors over a Period of 3 Years - Infusion Therapy and Transfusion Medicine 2001;28:189-194

Question 19:
By how much is one unit of platelet transfusion expected to increase platelet count?

Answer:
Each unit of platelet transfusion is expected to increase platelet count by 7 - 10,000 / uL.
Platelet transfusion is usually given as 6 or 10 units together.

Question 19:
How long does it take for transfused platelet to show apparent effect?

Answer:
About one hour.

Rationale:
Each unit of platelet transfusion is expected to increase platelet count by 5 - 10,000/uL, and platelet transfusion is usually given as 6 or 10 units together.

Question 20:
What is the formula to calculate fibrinogen to be infused via cryoprecipitate to a patient?

Answer:
Number of bags = 0.2 x weight (kg) to provide about 100mg/dL fibrinogen.
Usually, a pack of 10 units is given together.
Fibrinogen levels should be monitored to adjust dosing.

Question 21:
Case:
A 52-year-old male is back from cardiac angioplasty with Abciximab (ReoPro) infusion. Pre-catheterization laboratory values were normal. CBC was sent per protocol after 4 hours of Abciximab infusion, following which the laboratory calls with critical platelet level of 62. Abciximab was stopped and hematology consulted. Hematology made a trip to laboratory and advised to restart Abciximab!!

Question 22:

Thrombotic thrombocytopenic purpura (TTP) is an occasional but serious side effect of PLAVIX® (Clopidogrel bisulfate). Why is it important to quickly recognize this side effect?

Answer:

It's very important to recognize Clopidogrel associated TTP. It usually occurs within 2 weeks of starting treatment. Beside discontinuation of drug, total plasma exchange (TPE) should be initiated as soon as possible.

Persons who receive plasma exchange within three days of TTP onset were more likely to survive than those in whom plasma exchange was initiated after three days (survival rate was 100% versus 27.3%).

Reference(s):

Clopidogrel-Associated TTP - Stroke. 2004; 35:533.

Question 23:

A critically ill patient in ICU is requiring frequent platelet transfusions. The family of the patients wants to know how frequent a family member can donate platelets.

Answer:

The body replenishes platelets immediately. Technically, this enables a donor to donate as frequently as every 72 hours. However per guidelines donors may not donate platelets more than 12 times a year.

Question 24:

A 52-year-old male is admitted to ICU as "Pre-op" CABG patient. Previous admission record shows the patient had a diagnosis of HIT (Heparin Induced Thrombocytopenia) 2 years ago. You rechecked HIT test and OD (optimal density) for HIT is reported as 0.2. What would be your advice on the use of heparin?

Answer:

Patients with previous history of HIT but now with negative antibodies can have heparin during CBP; but it should be avoided pre or post-surgery.

Reference(s):

1. Follis F, Schmidt CA. Cardiopulmonary bypass in patients with heparin-induced thrombocytopenia and thrombosis. Ann Thorac Surg. 2000; 70:2173-2181.
2. Warkentein TE. Heparin-induced thrombocytopenia: pathogenesis, frequency, avoidance and management. Drug Safety. 1997; 17:325-341.

Question 25:

What is the most common cause of "false-negative" D-Dimer test?

Answer:
Inappropriate collection of specimen

Rationale:
D-Dimer test may give a "false-negative" result, if the specimen collection tube is not adequately filled (under-filled). This is secondary to the dilution effect of the anticoagulant. The blood in the specimen tube should be collected in a 9:1 blood to anticoagulant ratio.

Question 26:
What is May-Thurner syndrome?

Answer:
It is the condition in which the left iliac vein is compressed by the right iliac artery. It is a major risk factor for severe DVT. May-Thurner syndrome is an anatomical variant, and may require stent as a treatment.

Question 27:
Why is Heparin added to Prothrombin Complex Concentrates (PCC)?

Answer:
Ion-exchange chromatography from the cryoprecipitate supernatant of large plasma pools produces PCC. It may contain a combination of either three-factor (i.e., factors II, IX and X) or four-factor (i.e., factors II, VII, IX and X) concentrates with a final overall clotting factor concentration approximately 25 times higher than in normal plasma. To prevent activation of these coagulation factors, most PCC contain heparin.

Reference(s):
1. Hellstern P. Production and composition of prothrombin complex concentrates: correlation between composition and therapeutic efficiency. Thromb Res. 1999; 95:S7–12.
2. Schulman S, Bijsterveld NR. Anticoagulants and their reversal. Transfus Med Rev. 2007; 21:37–48.

Question 28:
At what level of WBC, Platelet and Hematocrit count is pseudo hyperkalemia expected?

Answer:
Pseudo hyperkalemia is usually a laboratory artifact rather than a real biological abnormality.

Beside common causes of pseudo hyperkalemia like hemolysis, excessive tourniquet time or a delay in the processing of the blood specimen, it can also occur in patients with abnormally high numbers of the following:

1. Platelets count (>500,000/mm³)
2. Patient with leukocytes (> 70 000/mm³)
3. Patient with increase erythrocytes (hematocrit > 55%)

Question 29:

The average life span of a platelet in the blood is 10 days but what is the average life span of transfused Platelets?

Answer:

The average life span of a platelet in the blood is 10 days but transfused platelets have a short life span of 3-4 days.

Question 30:

What causes Transfusion-Related Acute Lung Injury (TRALI) via pRBC transfusion?

Answer:

TRALI is mostly associated with plasma components, platelets and Fresh Frozen Plasma. TRALI due to packed red blood cells occurs as a result of residual plasma in the packed cells. It is the presence of leukocyte antibodies in transfused plasma, which is thought to lead to TRALI. Leukoagglutination and pooling of granulocytes in the recipient's lungs then causes release of the contents of leukocyte granules. This results in injury to cellular membranes, endothelial surfaces, and potentially to lung parenchyma.

Question 31:

Steroids and diuretics are indicated in treatment of Transfusion-related acute lung injury (TRALI)

A) True

B) False

Answer:

B) False

Rationale:

So far there is no evidence that steroids are helpful in TRALI. Another mistake would be to administer diuretics. TRALI is associated with microvascular damage and not fluid overload, so diuretics are not really helpful and actually not recommended. Since the pulmonary edema in TRALI is not related to fluid overload or cardiac dysfunction, it is logical that maintenance of adequate circulating volume is more beneficial, so it may even require IV fluid. Ventilatory assistance and circulatory support are the mainstays of treatment of TRALI. Diuretic use may be detrimental and could lead to hypotension. TRALI is essentially a clinical diagnosis but one laboratory finding may include sudden fall in serum albumin.

Question 32:

A 43-year-old female is transferred to the ICU with a diagnosis of thrombocytopenic purpura (TTP). Looking at her previous record you found similar episode 4 years ago. It is also mentioned that the patient did not respond to regular plasma exchange and required cryo-poor plasma exchange. What is cryo-poor plasma?

Answer:

Cryo-poor plasma or cryosupernatant refers to plasma from which the cryoprecipitate has been removed. The resulting plasma has reduced levels of Factor VIII, von Willebrand factor, Factor XIII, fibronectin and fibrinogen.

Cryo-poor plasma is used for the treatment of relapsing TTP for which regular plasma exchange is not effective. The rationale for using cryo-poor plasma in these refractory patients is that no additional von Willebrand factor will be administered to these patients who already have too much von Willebrand factor activity due to the presence of extra-large multimers of vWf.

Caution: It is not a component regularly stocked in the blood bank. Usually it will require special preparation, requiring advance notice.

Question 33:

What could support laboratory findings in transfusion-related acute lung injury (TRALI)?

Answer:

Laboratory findings may include unexpected haemoconcentration and a sudden fall in serum albumin. As in other causes of acute alveolar capillary leak, the pulmonary exudate in TRALI has high albumin content. Peripheral blood neutropenia has been reported but neutrophilia is more common.

Reference(s):

The pathology of transfusion-related acute lung injury. Am J Clin Pathol 1999; 112: 216–21

Question 34:

What is Upshaw-Schülman syndrome (USS)?

Answer:

A hereditary form of thrombotic thrombocytopenic purpura (TTP) is called the Upshaw-Schülman syndrome. Patients with this condition develop TTP in clinical situations with increased in von Willebrand factor levels, such as in patients having infections. About 5-10% of all TTP cases are due to Upshaw-Schülman syndrome.

Patients with Upshaw-Schulman syndrome (USS) have recurrent episodes of thrombocytopenia and microangiopathic hemolytic anemia, which usually responds to

transfusion of fresh frozen plasma. USS has autosomal recessive inheritance, because two siblings from asymptomatic parents are affected.

Question 35:

A 58-year-old male is in the ICU after cardiac surgery. The patient is showing significant post-operative bleeding. The patient continues to bleed despite correction of all coagulation profiles via blood products. The Surgeon wants to try using more conservative measures before taking the patient back to OR due to high-risk and associated morbidities. While going through the chart you find that the patient has history of anaphylaxis with use of bovine meat. Which one intervention is out of question?

Answer:

Use of Factor VII

Rationale:

Factor VII is contraindicated in patients with known hypersensitivity to mouse, hamster, or bovine proteins. NovoSeven contains amounts of proteins derived from the manufacturing and purification processes such as mouse IgG (maximum of 1. 2 ng/mg), bovine IgG (maximum of 30 ng/mg), and protein from BHK-cells and media (maximum of 19ng/mg).

Question 36:

Case:

A 38-year-old female with cervical cancer and undergoing chemotherapy is admitted with dehydration secondary to chemotherapy-induced nausea and vomiting (CINV). According to patient standard anti-nausea medications including Zofran (Ondansetron), Compazine (Prochlorperazine) or Phenergan do not work on her. Which 'trick' or cocktail usually works in such resistant nausea?

Answer:

ABH Cocktail

Rationale:

ABH (Ativan, Benadryl and Haldol) cocktail is effective in resistant nausea particularly in chemotherapy-induced nausea and vomiting (CINV). It is available in capsule, suppository as well as in transdermal gel form. If needed, it may be given in IV mixes over 15 minutes. Extended form is called "ABHR" with addition of Reglan (metoclopramide).

The usual IV dose is as follows:

1. Ativan (lorazepam) = 0.5 mg,
2. Benadryl (diphenhydramine) = 12.5 mg,
3. Haldol (haloperidol) = 0.5 mg and
4. Reglan (metoclopramide)= 5-10 mg

Doses can be escalated in oral and gel form if needed up to lorazepam 4 mg/ diphenhydramine 100 mg/haloperidol 4 mg/metoclopramide 80 mg per ml.

Question 37:

What is the clinical utility of doing free plasma Hemoglobin?

Answer:

Plasma normally contains no free hemoglobin. Significant amount of hemoglobin is seen in plasma following hemolysis either from a transfusion reaction or any mechanical fragmentation of red blood cells.

Caution should be taken not to perform test on serum, as hemoglobin gets liberated from red blood cells during clotting. Moreover, elevated bilirubin levels interfere with the quantitation of the total plasma hemoglobin.

Reference(s):

Fairbanks VF, Ziesmer SC, O'Brien PC: Methods for measuring plasma hemoglobin in micromolar concentration compared. Clin Chem 1992; 38:132-140

Question 38:

Case:

A 54-year-old female is admitted to the ICU with pulmonary embolism. Patient is started on heparin and has been switched to Coumadin (warfarin). The patient's platelet count remained low and further workup confirmed HIT (Heparin induced thrombocytopenia). What should be administrated to patient along with initiation of either argatroban or lepirudin?

Answer:

Vitamin K (10 mg po or 5 to 10 mg IV)

Rationale:

Warfarin should be postponed until substantial platelet recovery. If warfarin has already been started, vitamin K should be given to reverse the effect of warfarin. Warfarin should be avoided in acute HIT. Warfarin has been associated with worsening venous thrombosis, venous limb gangrene, and/or skin necrosis when used alone or in combination with ancrod in acute HIT. Warfarin is appropriate for longer-term anticoagulation however, in patients with HIT and thrombosis. Warfarin should be delayed until there is substantial resolution of the thrombocytopenia.

Reference(s):

Treatment and Prevention of Heparin-Induced Thrombocytopenia – American College of Chest Physicians Evidence-Based Clinical Practice Guidelines (8th Edition) – CHEST June 2008 vol. 133 no. 6 suppl 340S-380S

Question 39:

A 22-year-old male in the ICU is admitted for unrelated reason. The patient continues to show prolonged PTT but normal PT, Bleeding Time and Platelet count. Which disease process only prolongs PTT but shows all other normal basic coagulation profile?

Answer:
Factor X11 deficiency

Rationale:
Factor X11 deficiency is also known as Hageman factor deficiency. It is very rare with evidence of about 1 in 1 million. Fortunately it is a benign process, does not cause bleeding and normally does not need treatment. Even with major surgery, bleeding manifestations are extremely rare. Usually, it is diagnosed accidently by a prolonged activated partial thromboplastin time (aPTT) test.

Question 40:
Which blood test can be used to monitor the progress or improvement of Thrombotic thrombocytopenic purpura (TTP) while on plasmapharesis?

Answer:
Lactate dehydrogenase levels (LDH)

Rationale:
LDHs are generally used to monitor TTP activity. Plasmapheresis may need to be continued till patients cease to consume platelets. Research protocols have used improvement or normalization of LDH as a measure for ending plasmapheresis.

Question 41:
Each 15 mL unit of Cryoprecipitate typically contains how much of fibrinogen?

Answer:
Each 15 mL unit of Cryoprecipitate typically contains 250 mg of fibrinogen.
It also contains 100 IU of factor VIII, von Willebrand factor (vWF) and factor XIII.
FDA standards requires that the product must have an average of 150 mg or more of fibrinogen and 80 IU of factor VIII.

Question 42:
How does Desmopressin (DDAVP) help in coagulation?

Answer:
Desmopressin (DDAVP) helps in coagulation via 2 mechanisms:

1. Desmopressin stimulates release of factor VIII and von Willebrand factor (vWF) from endothelial cells due to stimulation of the V1a receptor.

2. Desmopressin is shown to be effective even in bleeding disorders that do not involve a deficiency or dysfunction of factor VIII or vWF, including congenital and acquired defects of platelet function as those associated with chronic kidney and liver diseases.

Reference(s):
How do you treat bleeding disorders with desmopressin? - Postgrad Med J 2007; 83:159-163

Question 43:
What is Post transfusion purpura (PTP)?

Answer:
Post-transfusion purpura (PTP) is a transfusion reaction that occurs when the body produces alloantibodies to the transfused platelets' antigens. It typically occurs 7-10 days after a transfusion. It can be induced by platelet transfusion, or a small amount of platelets contaminating packed RBC transfusion, or following the transfusion of FFP.

PTP is most common in women with multiple pregnancies, and men with the history of previous transfusions. The thrombocytopenia responds to intravenous immunoglobulin (IVIG).

Question 44:
How quickly does IV Vitamin K start working?

Answer:
IN approximately 2-6 hours.

IV Vitamin K should be given very slowly over 20-30 minutes. It may cause hypersensitivity reaction. Hypersensitivity reaction symptoms may include facial flushing, chest pain, hypotension, diaphoresis, dyspnea, cardiac arrest and even death. A very low dose of 1-2 mg is mostly enough.

Question 45:
What is Gray platelet syndrome?

Answer:
Gray platelet syndrome is a congenital bleeding disorder caused by a reduction or absence of alpha-granules in blood platelets. Not only does it cause thrombocytopenia but also it releases proteins normally contained in these granules into the marrow, which in turn causes myelofibrosis. It poses a risk of increased bleeding, which can be life threatening.

Grey Platelet Syndrome received its name because of the greyish appearance of these platelets when viewed under a microscope.

Question 46:

A 28-year-old male has repeated history of ED presentation with acute abdomen, requiring narcotics analgesics. Record shows complete negative workup on each visit to ED. While evaluating the patient this time, your medical student suggests acute intermittent porphyria. Which test should you order?

Answer:
Urine Porphobilinogen

Rationale:
Urine Porphobilinogen is a porphyrin precursor. This may not be included in hospital's standard urine porphyrin screen test and must be ordered specially. Acute intermittent porphyria patients have elevated porphobilinogen even between attacks, though in some patients with long gaps between attacks, porphobilinogen may return to the normal range.

Question 47:

Which patient population is at highest risk of developing Heparin Induced Thrombocytopenia (HIT)?

Answer:
Female Gender receiving heparin after a recent surgical procedure, particularly cardiothoracic surgery.

Question 48:

A 54-year-old male developed life threatening GI bleeding after Fondaparinux (Arixtra) administration post orthopedic surgery. FFP and pRBC is ordered and volume resuscitation started. What else can be done to counter the effect of Fondaparinux (Arixtra)?

Answer:
Recombinant Factor VIIa (rFVIIa)

Rationale:
Low-molecular-weight heparins are inhibitors of factor Xa, but have small therapeutic window and has the risk of bleeding. Fondaparinux has a long elimination half-life. rFVIIa overcome the inhibition of thrombin generation and normalize the Fondaparinux-induced prolongation of aPTT and PT. Sensitive thrombin-generation assays demonstrated the efficacy of rFVIIa in restoring impaired thrombin formation after

Fondaparinux administration. rFVIIa reverses not only the anticoagulant effect of Fondaparinux but also the profibrinolytic effects of this agent, probably through activation of thrombin-activatable fibrinolysis inhibitor (TAFI).

Reference(s):
Ability of Recombinant Factor VIIa to Reverse the Anticoagulant Effect of the Pentasaccharide Fondaparinux in Healthy Volunteers - Circulation. 2002; 106: 2550

Question 49:

Patient's platelet count suddenly dropped from 283 k/uL to 25 k/uL. Patient is clinically stable and you expect pseudothrombocytopenia. What would be your instruction to nursing staff while repeating lab?

Answer:
Send second blood sample with *blue top*.

Rationale:
Most pseudothrombocytopenia has been reported in association with the use of ethylenediaminetetraacetic acid (EDTA) as an anticoagulant. A second sample run with a different anticoagulant such as citrate (*blue top* tube) usually helps to rule out the error.

Question 50:

What is the rule of thumb of dosing Argatroban in patients with significant liver dysfunction?

Answer:
Decrease Dose by 75%
The dose should be adjusted by aPTT with a target of 1.5-3 times the baseline.

Question 51:

A 32-year-old male with sickle cell disease presented to ER with a severe episode of priapism. What should be considered?

Answer:
For priapism in sickle cell disease, early exchange transfusion is indicated; meanwhile pain can be controlled with epidural analgesia. Exchange transfusions may be required to achieve a hemoglobin concentration to higher than 10% and decrease hemoglobin S level to less than 30%, before any intervention urology consult should be obtained for possible use of terbutaline and pseudoephedrine.

5-10 mg of terbutaline followed by another 5-10 mg 15 minutes later, if required, produces resolution in about one third of patients. Oral pseudoephedrine, 60-120 mg

orally has also been used as a potential therapy due to its alpha-agonist effect. The true efficacy of these medications is unknown.

Question 52:

Combination of Argatroban and warfarin can give falsely very high INR. What would be the best method to know that INR would be in therapeutic range if Argatroban were discontinued?

Answer:

Measurement of chromogenic factor X level

Rationale:

The combination of Argatroban and warfarin may raise the INR falsely to a value higher than 5.0. Measuring chromogenic factor X level may be helpful in smooth transition. Once level of chromogenic factor X is lower than 40-45%, it typically indicates that the INR will be therapeutic (between 2-3) when the Argatroban is discontinued.

Reference(s):

Hursting MJ, Lewis BE, Macfarlane DE. (2005). "Transitioning from argatroban to warfarin therapy in patients with heparin-induced thrombocytopenia." Clin Appl Thromb Hemost 11 (3): 279–87.

Question 53:

To avoid falsely low Anti-XA assay for Heparin/LMWH anticoagulation effect, what is the most optimum time in a laboratory to separate plasma from cellular components?

Answer:

To avoid falsely low Anti-XA assay for Heparin/LMWH anticoagulation effect, Plasma must be separated from cellular components within 1 hour. Platelet factor IV, released by platelets, neutralizes the effect of heparin.

Reference(s):

Weitz JI. Antithrombotic Drugs. In: Hoffman F, Benz EJ, Shattil SJ, eds. Hematology: Basic Principles and Practice. 5th ed. Philadelpha, PA: Churchill Livingstone; 2009: Chapter 137.

Question 54:

After how long can PTT be checked if Protamine is given for Heparin reversal?

Answer:

About 5-15 minutes

It is recommended to check PTT in 6 hours again due to possibility of Heparin rebound phenomenon.

Question 55:
What is shelf life of Platelet pheresis?

Answer:
5 days

Rationale:
Platelets can be stored at room temperature for up to 5 days, but requires gentle agitation. So, Platelets are not supposed to be in the cooler at bedside while awaiting transfusion. Apheresis platelets are collected from an individual donor. The procedure takes approximately 2-3 hours and contains approximately 3 x 1011 platelets (which is equivalent of 6-8 units of platelet concentrate; a therapeutic dose for an adult).

Question 56:
Name 3 conditions each of which may make fibrinogen level to go up or down?

Answer:
Conditions/drugs, which may cause decrease fibrinogen levels:

1. Anabolic steroids,
2. Phenobarbital and
3. Valproic acid

Conditions/drugs, which may cause increase fibrinogen levels:

1. Pregnancy,
2. Cigarette smoking, and
3. Estrogen

Question 57:
Which laboratory is most reliable in following the effect of plasmapheresis in resolution of TTP (Thrombotic thrombocytopenic purpura)?

Answer:
LDH

Rationale:
Declining LDH level is a pretty good indicator that plasma exchange is working to treat TTP.

Question 58:
A 44-year-old female is admitted to the ICU with hypovolemia after chemotherapy session and continues to have severe nausea and bouts of vomiting. All conventional anti-emetics failed to control her symptoms. Can you use Propofol as an anti-emetic without getting patient to intubate?

Answer:
Yes

Rationale:
Propofol has a good anti-emetic effect at low dose (sub hypnotic dose) when other anti-emetics fail in severe nausea and vomiting after surgery or chemotherapy sessions. It can be given as a continuous infusion of 1 mg /kg/hr. or as single dose of 10 mg (1 cc) which provides relief for about 30 minutes. Propofol acts directly on the chemoreceptor trigger zone, vagal nuclei, and other centers implicated in nausea and vomiting.

Reference(s):
1. Subhypnotic doses of propofol possess direct antiemetic properties. Anesth Analg. 1992 Apr;74(4):539-41.
2. When Nothing Helps: Propofol as Sedative and Antiemetic in Palliative Cancer Care - Journal of Pain and Symptom Management Volume 30, Issue 6, December 2005, Pages 570-577
3. Prevention of postoperative nausea and vomiting by continuous infusion of subhypnotic propofol in female patients receiving intravenous patient controlled analgesia - Br. J. Anaesth. (2000) 85 (6): 898-900.

Question 59:
In Hemolytic Anemia, does haptoglobin increase or decrease?

Answer:
Decrease

Rationale:
Haptoglobin is the protein in the blood plasma. It binds free hemoglobin released from erythrocytes with higher affinity. The reticuloendothelial system, mainly spleen then removes the haptoglobin-hemoglobin complex.

In intravascular hemolysis, free hemoglobin is released into circulation and haptoglobin then binds the hemoglobin. This results in decline in the haptoglobin levels.

Question 60:
What are the 3 parameters, which can be followed to see the progression/resolution/remission in treatment of Thrombotic thrombocytopenic purpura (TTP)?

Answer:
Measurements of
1. LDH,
2. Platelets, and
3. Schistocytes

Question 61:
What is the rule to remember if blood type compatibility is done for plasma products?

Answer:
Compatibility testing is not strictly necessary for plasma products like FFP or cryo-precipitate, but if possible, is given as ABO compatible. Rule to remember is - compatibility is reversed for plasma products, means O type is the universal plasma recipient and AB type is the universal plasma donor.

Question 62:

How does the female gender effect Transfusion related acute lung injury (TRALI)?

Answer:
Female donor's plasma is associated with an increased risk of TRALI, whereas female donors RBCs are not associated with TRALI.

Reference(s):
Middelburg RA, Van Stein D, Zupanska B, Uhrynowska M, Gajic O, Muñiz-Diaz E, Galvez NN, Silliman CC, Krusius T, Wallis JP, Vandenbroucke JP, Briët E, Van Der Bom JG. - Female donors and transfusion-related acute lung injury: A case-referent study from the International TRALI Unisex Research Group. Transfusion. 2010 Nov; 50(11): 2447-54.

Question 63:

A 52-year-old male with established diagnosis of *Hereditary Angioedema* is admitted to ICU for an unrelated reason. Which one group of anti-hypertensives should be avoided?

Answer:
ACE-Inhibitors

Rationale:
Hereditary Angioedema is an autosomal dominantly inherited blood disorder, which causes episodic attacks leading to facial swelling, swelling of extremities, genitals, gastrointestinal tract and upper airways. Hereditary angioedema occurs as a result of C1 esterase inhibitor deficiency, a protein of the complement system.

Treatment with ACE inhibitors is contraindicated in this condition, as it can lead to bradykinin accumulation, which can precipitate the disease.

Question 64:

Case:
A 28-year-old male with history of sickle cell crisis presented with priapism. After 6 hours has past and despite adequate hydration and analgesia, there is no relief! What is your next option?

Answer:
In case of priapism, you have 2 options. Either call an urologist for aspiration of corpus cavernosum or consult a hematologist for exchange blood transfusion.

Exchange blood transfusion in sickle cell crisis should be considered in following situations:

1. No relief in crisis despite adequate hydration and analgesia
2. Any sign of stroke
3. Pregnancy
4. Prophylactic exchange transfusion prior to major surgery. A single exchange transfusion reduces the risk of complications from the general anesthetic and surgery.
5. C/O loss of vision in one eye or visual symptoms
6. Unresolved painful erection of the penis (priapism)

Question 65:

Are Activated Coagulation Time (ACT) and Partial Thromboplastin Time (PTT) interchangeable during Heparin infusion - Yes or No?

Answer:

No

Rationale:

During Heparin infusion, ACT and PTT monitoring are not interchangeable. They have very poor correlation. ACT and PTT results should be followed independently. It is better to determine patient's heparin anticoagulant requirement, stabilize him/her, and follow one monitoring tool.

The ACT is measured in seconds - the longer the time blood takes to clot, the higher the degree of clotting inhibition.

PTT performs in a more complex way - The blood is spun in a centrifuge, which separates plasma from the cells. Calcium and activating substances are added to the plasma, which starts the intrinsic pathway of the coagulation cascade. PTT is the time it takes for a clot to form, and is measured in seconds.

Question 66:

A 44-year-obese male admitted with PE is now on Heparin and transitioning to warfarin therapy. On the 9th day of treatment, patient is diagnosed with Heparin induced Thrombocytopenia (HIT) with platelet count of 72. INR is reported to be 2.9. What would be your next step besides stopping Heparin?

Answer:

Stop Warfarin and reverse the warfarin effect with Vitamin K.

Rationale:

The risk of warfarin necrosis is high in people with HIT who have low platelet counts. Warfarin should not be used in patients with HIT until the platelet count is above 150 x

10^9/L. Warfarin necrosis is marked by skin gangrenes. If the patient was receiving warfarin at the time when HIT is diagnosed, the patient should be given vitamin K to reverse the activity of warfarin.

Another important decision to make is the need to use of *direct thrombin inhibitors*.

Question 67:

You have been called to evaluate a patient who developed red-urine. At the patient's bedside, you noticed pRBC transfusion in progress. What would be your first few immediate responses?

Answer:

The first thing you need to determine is whether it is a transfusion reaction (hemolysis) or a pure hematuria. Send Urine or blood for centrifuge.

The onset of red urine during or shortly after a blood transfusion may represent hemoglobinuria from acute hemolytic reaction. To distinguish it from hematuria, if freshly collected urine is centrifuged, the urine sample remains clear red. If its pure hematuria, red blood cells settle at the bottom of the tube, leaving a clear yellow urine supernatant. Similarly patient's blood with centrifuge will turn free serum as a pink color from free hemoglobin in a clotted centrifuged specimen otherwise serum will be yellow if no transfusion reaction.

Other actions to consider:

1. Halt the transfusion.
2. Send donor blood and patient's blood quickly to blood bank to make sure that right blood was transfused (repeat cross match and type) and for antibody screen, and direct and indirect Coombs tests. If transfusion reaction is highly suspected then;
3. Administer IV Benadryl, IV steroid, IV saline followed with IV Lasix or with low dose dopamine to improve renal blood flow. Symptomatic treatment with acetaminophen.
4. Airway protection and if seems to be anaphylactic reaction, administer epinephrine (nebulizer treatment, SQ or IV drip depending on severity). Oxygen to keep saturation up.
5. Send complete laboratory work-up including electrolytes, renal function (BUN/Cr), serum bilirubin level (peaks in 3-6 hours), Haptoglobin (binds to hemoglobin), urine for hemoglobinuria, a repeat CBC (fails to show the rise in hematocrit because of intravascular or extravascular hemolysis) and DIC panel.
6. Hematology consults.
   Management is largely supportive.

Question 68:

What is the difference between Filgrastim (Neupogen) and pegfilgrastim (Neulasta)?

Answer:
Filgrastim (Neupogen): is a granulocyte colony-stimulating factor (G-CSF) analog used to stimulate the differentiation and proliferation of granulocytes in neutropenic patients. It can be given subcutaneously or intravenously. Usual dose is 5 mcg/kg daily.

Pegfilgrastim (Neulasta): Pegfilgrastim has an added polyethylene glycol molecule, which is absent in Filgrastim, thus reducing the renal clearance and prolonging persistence in vivo (half-life range: 46-62 hours). Pegfilgrastim can be given on the first day of chemotherapy. The effect of single dose of pegfilgrastim lasts for fourteen days. It can only be given subcutaneously and not intravenously. The recommended dosage is a single subcutaneous injection of 6 mg administered once per chemotherapy cycle.

Question 69:
Why is initiation of warfarin always recommended with Heparin/LMW Heparins, particularly at higher doses?

Answer:
Warfarinization (start of warfarin) initially and temporarily may cause clotting. This is because warfarin causes a drop in protein C levels during the initial 36 hours, and since the level of protein C and protein S are also dependent on vitamin K activity, lowered levels of S can lead to a lower rate of activity in protein C, for which it is the co-factor. This leads to a prothrombotic state. For this very reason, when warfarin is given at a dose greater than 5 mg/day, it is advisable to co-administer heparin.

Reference(s):
Wittkowsky AK (2005). "Why warfarin and heparin need to overlap when treating acute venous thromboembolism". Dis Mon 51 (2–3): 112–5.

Question 70:
What are the guidelines on new oral anticoagulants (NOACs) on holding, before surgical procedures?

Answer:
Warfarin remained the lone oral anti-coagulant for almost 40 years. The new anticoagulants (NOACs) are:

1. Dabigatran - a direct thrombin inhibitor
2. Rivaroxaban - a direct factor Xa inhibitor
3. Apixaban - a direct factor Xa inhibitor

They have a relatively short half-life, and dissipate rapidly within 12-24 hours after dosage. In patients with normal renal function, the NOACs should be held for ≥24 hours before an elective surgical procedure associated with a minor bleeding risk, and for ≥48 hours before surgical procedures associated with a major bleeding risk.

Question 71:
What could be the supported laboratory findings in Transfusion-related acute lung injury (TRALI)?

Answer:
Laboratory findings may include unexpected haemoconcentration and a sudden fall in serum albumin.

Question 72:
Hematology service ordered IV Iron for an anemic patient who is Jehovah witness by faith. The nurse asks you about the test dose?

Answer:
As studies indicate that allergic reactions may still occur in patients who have not reacted to a test dose, a test dose is no longer recommended.

Every caution should be exercised with every dose of intravenous iron that is given, even if previous administrations have shown no signs of reaction.

Reference(s):
Press release from The European Medicines Agency's Committee for Medicinal Products for Human Use (CHMP) on 28/06/2013 - New recommendations to manage risk of allergic reactions with intravenous iron-containing medicines.

Question 73:
Which one disease process in ICU may prolong Activated Clotting Time (ACT)?

Answer:
Lupus anticoagulant (LA)

Rationale:
In patients with Lupus anticoagulant, other tests should be considered. ACT becomes unreliable in patients with LA. Presence of a lupus anticoagulant has been shown to interfere with and prolong the ACT in some patients, but in other cases the ACT may be relatively unaffected.

Question 74:
Which commonly used drugs in ICU may cause resistance to heparin therapy (failure of monitoring tests to change or higher than expected doses)?

Answer:

Antithrombin III deficiency is one of the most important and apparent causes of resistance to heparin therapy. Replacement of antithrombin III in those patients may restore heparin efficacy.

Also, it is important to know that following commonly used medicines may cause resistance to heparin therapy.

1. Intravenous nitroglycerin
2. Digitalis,
3. Nicotine (smoking),
4. Tetracycline
5. Some antihistamines

Reference(s):

Bick RL. Disorders of Thrombosis & Hemostasis. Clinical and Laboratory Practice. 1992. ASCP Press. (Figure 1-29 page 20; Table 14-7, page 305).

Question 75:

What is Ecarin clotting time (ECT)?

Answer:

Clinically this process is not much in use, but ECT is the most precise way to measure and monitor the activity of Direct Thrombin Inhibitors (DTIs). Though most of the literature is available with experience to hirudin, but are likely to be useful to other DTIs, in particular to new oral direct thrombin inhibitors.

Ecarin, the primary reagent in this assay, is derived from the venom of the saw-scaled viper, Echis carinatus.

This is an important test to be aware of in the ICU, as both Activated Clotting Time (ACT) and PTT have no particular linear correlation between the plasma DTIs levels and their activities, particularly at a higher level.

Reference(s):

1. Di Nisio M, Middeldorp S, Büller H (2005). "Direct thrombin inhibitors." N Engl J Med 353 (10): 1028–40
2. Use of Ecarin Clotting Time (ECT) with Lepirudin Therapy in Heparin-Induced Thrombocytopenia and Cardiopulmonary Bypass. JECT 33:117–125.
3. Lange U, Nowak G, Bucha E. Ecarin chromogenic assay—a new method for quantitative determination of direct thrombin inhibitors like hirudin. Pathophysiol Haemost Thromb. 2003 Jul-2004 Aug; 33(4): 184-91.
4. Pathophysiol. Haemost. Thromb. 33 (4): 173–83.

Question 76:

A 28-year-old male is admitted to hospital with shortness of breath. The Laboratory work-up showed elevation of alkaline phosphatase. Further laboratory inquiry for specific isozyme showed it to be of the placental type. What is the diagnosis?

Answer:

Seminoma

Rationale:
In humans, alkaline phosphatase is present in all tissues but is particularly concentrated in the intestine, liver, bone and the placenta. The Following are the alkaline phosphatase isozymes:

1. ALPI – intestinal
2. ALPL – liver/bone/kidney
3. ALPP – placental

Placental alkaline phosphatase is elevated in seminomas and is an active form of Rickets.

Question 77:

In *catheter-directed thrombolysis* for *acute limb ischemia*, what is the threshold to transfuse fresh frozen plasma (FFP) for low fibrinogen level, to avoid bleeding complications?

Answer:
100 mg/dL

Rationale*:*
Some vascular services monitor fibrinogen levels during catheter-directed thrombolysis for acute limb ischemia, and may halt thrombolysis or give fresh frozen plasma if the value drops below 100 mg/dL. There is no strong evidence that it may decrease bleeding risk, so many other vascular services do not monitor fibrinogen. Also, accumulation of fragment X, which is one of several fibrin degradation products, can cause the fibrinogen level to be artificially high or normal in patients with rtPA infusion.

Reference(s):
1. Catheter-Directed Thrombolysis for Acute Limb Ischemia - Semin Intervent Radiol. 2006 September; 23(3): 258–269.
2. The STILE Investigators Results of a prospective randomized trial evaluating surgery versus thrombolysis for ischemia of the lower extremity. The STILE trial. Ann Surg. 1994; 220:251–268.

Question 78:

What are Prothrombin complex concentrates (PCC)?

Answer:
Prothrombin complex concentrates (PCC) are derived from human plasma and it contains vitamin K dependent coagulation factors II, VII, IX, and X in varying concentrations. Several international guidelines as well as American College of Chest Physicians, now recommends PCC for warfarin reversal in patients with serious bleeding. The use of PCC in the United States (US) is still limited.

Reference(s):

Question 79:

What is the right time to check Anti-factor Xa levels in renally impaired patients who are on q24 dosing?

Answer:

Anti-Xa levels should be checked at their peak at 4 hours in all patients irrespective of dosing variations (both q12 and q24).

Question 80:

A 37-year-old female is in the ICU for suspected DVT. There is a concern for Heparin induced Thrombocytopenia (HIT). The patient is clinically stable. The therapeutic decision to stop Heparin and start Argatroban, is made. How long should you wait before initiating Argatroban?

Answer:

About 3 hours

Rationale:

For Enoxaparin it is recommended to wait about 8 hours. All relevant labs should be checked before starting Argatroban.

HEMATOLOGY / ONCOLOGY - PEARLS

1. **Reversal of INR – Guidelines**
   The American College of Chest Physicians (ACCP) updated their recommendations on the use of vitamin K in June of 2008.
   a. Oral vitamin K is preferred to subcutaneous (SC) for patients with elevated INRs in the absence of major bleeding.
   b. INR ≥5.0 and <9.0 – may give oral vitamin K 1 to 2.5 mg if the patient is at an increased risk for bleeding; up to 5 mg oral vitamin K may be given if more rapid reversal is required. Additional doses may be required.
   c. INR ≥9.0 – give vitamin K 2.5 to 5 mg orally; additional doses may be required.
   d. If the patient is experiencing serious or life threatening bleeding, intravenous vitamin K 10 mg along with blood products should be administered.

2. **A note on Factor 7 (rVIIa) and thrombocytopenia**
   Factor 7 (rVIIa - Novo seven) is now significantly used as off label in uncontrolled bleeding. It may not be effective in the presence of severe thrombocytopenia and should be corrected prior to its administration. Although there are case reports of the successful use of rVIIa in severe thrombocytopenia, a low platelet count is likely to predict a poor or partial response to rVIIa therapy.
   Its hemostatic effects are mediated by the thrombin it generates by both tissue factor (TF) dependent and independent mechanisms. The TF independent mechanism requires platelets for the direct activation of Factor X on their surface by rVIIa.

3. **A simple way to diagnose Iron-deficiency anemia**
   Decrease FHM
   Increase TTR
   F = Ferritin
   H = Hemoglobin
   M= MCV (Mean Corpuscular Volume)
   T = TIBC (Total Iron Binding Capacity)
   T = Transferrin
   R = RDW (red cell distribution width)

4. **Nomogram for Enoxaparin Treatment**
   Anti Factor Xa level: Less than 0.35 u/ml
   Hold Next Dose? No
   Dose Change?: Increase by 25%
   Repeat Anti Factor Xa level?: 4 hours post next dose

   Anti Factor Xa level: 0.35 to 0.69 u/ml
   Hold Next Dose?: No
   Dose Change?: Increase by 15%
   Repeat Anti Factor Xa level?: 4 hours post next dose

Anti Factor Xa level: 0.7 to 1.1 u/ml
Hold Next Dose: No
Dose Change: 0
Repeat Anti Factor Xa level: 1 x per week at 4 hours post dose

Anti Factor Xa level: 1.1 to 1.5 u/ml
Hold Next Dose: No
Dose Change: Decrease by 20%
Repeat Anti Factor Xa level: 4 hours post next dose

Anti Factor Xa level: 1.6 to 2.0 u/ml
Hold next dose: No
Dose Change: Decrease by 30%
Repeat Anti Factor Xa level: 4 hours post next dose

Anti Factor Xa level: More than 2.0 u/ml
For these patients, all further doses should be held, and the anti-factor Xa level measured q 12 hours until the anti-factor Xa level is less than 0.5 u/ml. Enoxaparin can then be restarted at a dose 40% less than was originally prescribed.

The above nomogram assumes that there is no bleeding.

5. **Diagnostic criteria of Retinoic acid Syndrome:**
Retinoic acid syndrome is the major side effect of tretinoin therapy ATRA (all-trans retinoic acid) in patients with acute promyelocytic leukemia (APL). It occurs in about quarter of patients with treatment. It has been suggested that 3 out of the following 7 signs and symptoms should be present to label patients as having Retinoic acid syndrome while getting ATRA and in the absence of other causes like sepsis.

    1. Fever
    2. Weight Gain
    3. Respiratory distress
    4. Pulmonary infiltrates
    5. Pleural or pericardial effusion
    6. Hypotension
    7. Renal failure

Bonus Pearl: Acute colonic pseudo-obstruction (Ogilvie's syndrome) is one of the other complications, which may happen during induction treatment with chemotherapy and all-trans-retinoic acid for acute promyelocytic leukemia[3].

Reference(s):
1. Incidence, Clinical Features, and Outcome of All Trans-Retinoic Acid Syndrome in 413 Cases of Newly Diagnosed Acute Promyelocytic Leukemia - Blood, Vol. 92 No. 8 (October 15), 1998: pp. 2712-2718
2. The "retinoic acid syndrome" in acute promyelocytic leukemia - Ann Intern Med. 1992 Aug 15; 117(4): 292-6.
3. Acute colonic pseudo-obstruction (Ogilvie's syndrome) during induction treatment with chemotherapy and all-trans-retinoic acid for acute promyelocytic leukemia - Am J Hematol.1995 May; 49(1): 97-8.

6. **Triad of HELLP Syndrome**
   HELLP syndrome is a unique variant of preeclampsia and may manifest even before clinical signs of preeclampsia. Triad or criteria and term "HELLP" syndrome was first designated by Louis Weinstein, M.D. in 1982 in American Journal of Obstet. Gynecol. 1, and is as follows:
   1. Hemolysis: Abnormal blood smear - Elevated Bilirubin >1.2 mg/dl
   2. Elevated liver enzymes - with SGOT >72 UI / L (but has been mentioned as low as 40) and LDH >600 UI/L
   3. Low Platelets: Less than 100. Please note that platelet's cutoff of 100 is debatable and another classification for this syndrome called Mississippi Classification used level less than 150. Read reference # 2 which may need subscription.

7. **Classifying risk of hemorrhage with warfarin**
   Anemia (3 points),
   Severe renal disease–defined as glomerular filtration rate less than 30 ml/min or on dialysis (3 points),
   Age more than/= 75 years (2 points),
   Prior bleeding (1 point), and
   Hypertension (1 point)
   Cumulative point score was associated with major hemorrhage rates ranging from 0.4% (at 0 points) to 17.3% (at 10 points).

   Three categories of risk
   Low risk 0-3 points;
   Intermediate risk 4 points;
   high risk 5-10 points

8. **How much Fresh Frozen Plasma (FFP)?**
   Dr. Sam Schulman from Karolinska Hospital, Stockholm, Sweden wrote an excellent review on "Care of Patients Receiving Long-Term Anticoagulant Therapy" in August 14, 2003 issue of NEJM. Part of article suggested a formula for amount of FFP to correct INR up to desired level in a bleeding patient from over-anticoagulation.
   Amount of FFP needed (ml) = (target level as percentage - present level as percentage) x Wt. (kg)
   The "percentage" is prothrombin complex, expressed as a percentage of normal plasma, corresponds to the mean level of the vitamin K–dependent coagulation factors. It can be compute easily with following table:
   INR 1 = 100 (%)
   INR 1.4 - 1.6 = 40
   INR 1.7 - 1.8 = 30
   INR 1.9 - 2.1 = 25
   INR 2.2 - 2.5 = 20
   INR 2.6 - 3.2 = 15

INR 4.0 - 4.9 = 10
INR > 5 = 5 (%)

Example: In a 70 kg patient bleeding with INR of 7.5 and if our target is to bring INR down to 1.4, using the table above:

Total FFP needed = (40 - 5) x 70 = 2450 ml
(One unit FFP usually contains 200-250 ml of FFP)

Reference(s):
Care of Patients Receiving Long-Term Anticoagulant Therapy - NEJM - Volume 349:675-683, August 14, 2003

9. **Epogen and Iron**

Erythropoetin (Epogen/Procrit) will not work if patient's iron level is low. The following are important points to remember:

a. Simply checking Fe level may not provide reliable answer to Fe storage 1.
b. Erythropoetin, by stimulating erythropoiesis to greater than physiologic level, may itself induce iatrogenic functional iron deficiency.
c. Oral iron may take longer and may not satisfy the requirement and extra dose of IV iron may be needed. IV loading dose followed by intermittent maintenance doses may be required.

Use the following simple formula to see if a supplemental iron is required:
Transferrin saturation less than 25% *
or/and Ferritin less than 100 g/dl
* Some recommend 30%

Reference(s):
1. Diagnosis and management of iron-related anemias in critical illness. Critical Care Medicine. 34(7): 1898-1905, July 2006
2. Optimization of Epoetin Therapy with Intravenous Iron Therapy in Hemodialysis Patients - Am Soc Nephrol 11:530-538, 2000

10. **Is fresh blood better?**

Results of one study span over 10 years including 12,264 patients (total median transfusion of 4 pRBC units), done at Mayo Clinic, Rochester, MN - found that

a. Adjusted in-hospital mortality was 5% if pRBC was stored for less than 7 days
b. Adjusted in-hospital mortality was 8% if pRBC was stored for 7-14 days
c. Adjusted in-hospital mortality was 13% if pRBC was stored for more than 14 days

This corresponds to a reduction in the risk of in-hospital mortality of 62% for patients receiving pRBC stored for less than 7 days.

Reference(s)*:*
ATS 2007 poster presentations: The 2007 International Conference Abstracts of the American Thoracic Society (ATS) are published in the American Journal of Respiratory and Critical Care Medicine, Volume 175, Abstracts Issue, April 2007.

11. **Platelet-rich plasmapheresis**

    Platelet-rich plasmapheresis is a technique used mostly in cardiac surgery that involves a patient's own blood. The platelet-rich plasma is withdrawn into a plasmapheresis device. This can be either be performed pre-operatively (within 24 hours of surgery) or intra-operatively. The platelet rich plasma is returned to the patient at the end of the surgery (usually after protamine infusion). The transfusion of the patients with a highly concentrated and platelet-rich product derived from their own blood reduces the need for transfusion of blood. The technique is however, expensive and time-consuming, and not widely used.

Lines / Sepsis / Hemodynamics / Arrest

Question 1:

A 45-year-old female with established diagnosis of pheochromocytoma and on maintenance dose of phenoxybenzamine, presented with septic shock. Which pressors may not work on her?

Answer:

Epinephrine and Norepinephrine

Rationale:

Phenoxybenzamine forms a permanent covalent bond with adrenergic receptors. Phenooxybenzamine remains permanently bound to the receptor, which prevents adrenaline and noradrenaline from binding. This antagonistic effect at the alpha-1 adrenoceptor leads to vasodilatation.

Question 2:

Which 2 factors may increase the risk of Vasoplegia after Coronary Artery Bypass Graft (CABG)?

Answer:

1. On-pump CABG, and
2. Hypothermia during surgery

Reference(s):

1. Sun X, Zhang L, Hill PC, et al. (October 2008). "Is incidence of postoperative vasoplegic syndrome different between off-pump and on-pump coronary artery bypass grafting surgery?". Eur J Cardiothorac Surg 34 (4): 820-5.
2. Xu J, Long C, Qi R, Xie L, Shi S, Zhang Y (January 2002). "[Study of mechanism of vasoplegic syndrome for open heart surgery]". Zhonghua Yi Xue Za Zhi (in Chinese) 82 (2): 127–30.

Question 3:

One purpose of administrating local anesthesia (Lidocaine) during Arterial line placement is to relieve pain for the patient. What other purpose does it serve?

Answer:

A subcutaneous infiltration of anesthetic around the puncture site also helps in reducing vessel spasm besides providing pain relief to a patient.

Question 4:

What percentage of patients may develop complications secondary to brachial artery cannulation?

Answer:

Up to 42%

Rationale:
Mortensen established almost 40 years ago that brachial artery cannulation is not an ideal location. The lack of collateral circulation at the elbow level may predispose to forearm and hand ischemic complications.

Reference(s):
1. Case report & review: Compartment Syndrome of the Forearm and Hand After Brachial Artery Cannulation (pdf) - Anesth Analg 1995; 81: 1092-4
2. Mortensen JD. Clinical sequelae from arterial needle puncture, cannulation, and incision. Circulation 1967; 35:1118-23.

Question 5:
Why is Decadron (Dexamethasone) not a good choice for a steroid to be used in the event of septic shock?

Answer:
Reasons, which render dexamethasone a poor choice in sepsis:

a. It has very minimal (almost negligible) mineralocorticoid activity. Advantage of performing ACTH stimulation test, while on Decadron is there but again it's no more recommended to perform in septic shock per updated guidelines of Surviving Sepsis Campaign. It is suggested to give IV hydrocortisone to adult septic shock patients if blood pressure remains poorly responsive to fluid resuscitation and vasopressor therapy (grade 2C) - without ACTH stimulation test. Potency of Hydrocortisone and Dexamethasone is 20:1 - means 1 mg of dexamethasone is equal to 20 mg of hydrocortisone.

b. It has prolog half-life of 36-54 hours. In updated guidelines of Surviving Sepsis Campaign, it is Grade 2B recommendation that patients with septic shock should not receive dexamethasone if hydrocortisone is available. As dexamethasone has no mineralocorticoid activity, in case if used, should be use with florinef (fludrocortisone).

c. Dexamethasone can lead to immediate and prolonged suppression of the hypothalamic-pituitary-adrenal axis after administration 2.

Reference(s):
1. Surviving Sepsis Campaign: International guidelines for management of severe sepsis and septic shock: 2008 - Critical Care Medicine: Volume 36(1) January 2008pp 296-327
2. The hypothalamic-pituitary-adrenal axis in critical illness: Response to dexamethasone and corticotropin-releasing hormone. J Clin Endocrinol Metab 1993; 77:151-156

Question 6:
During or immediately following CPR and in hemodynamic shock, which PH is more worthwhile to follow?

Answer:

Venous PH

Rationale:
During shock state, venous blood is a more accurate reflection of metabolism in tissues. It may be of benefit to follow the trend in venous PH to measure the improvement of shock following CPR and hemodynamic instability.

Reference(s):
Difference in acid-base state between venous and arterial blood during cardiopulmonary resuscitation, NEJM, Number 3, Volume 315:153-156, July 17, 1986

Question 7:
What is the basic physiology that allows Pulmonary Artery Catheter (PAC) (Swan-Ganz catheter) to measure left atrial pressure while the catheter is still in the pulmonary artery?

Answer:
It is the large compliance of the pulmonary circulation, which allows an indirect measurement of the left atrial pressure, while catheter is still in pulmonary artery. When balloon is inflated (wedged) in pulmonary artery, it occludes the branch of the pulmonary artery. When this occurs, the pressure in the distal port of PAC rapidly falls, and after several seconds, reaches a stable lower value that is very similar to left atrial pressure (normally about 8-10 mmHg). One needs to understand that valvular abnormality; abnormal intrathoracic compliance and pressure are few things, which may affect the measurement.

Question 8:
How much is the pressure usually inflated in the arterial line pressure bag?

Answer:
300 mmHg

Rationale:
In arterial line monitoring, keeping pressure bag inflated to 300 mm Hg, keeps line patent and infuses saline 3-5ml /hr, which prevents dampening of traces and prevents clot formations. Deflation of bag will result in retrograde blood flow.

Question 9:
What is Dopamine dysregulation syndrome?

Answer:
It is an interesting syndrome, which may be seen on people on long term Dopamine replacement therapy (DRT) like Levodopa in Parkinson's disease. It is characterized by addiction to DRT medication (taking extra doses), gambling, hyper sexuality, shopping, eating disorder, euphoria, psychosis etc., and is marked by periods in between of

dysphoria, sadness, psychomotor slowing, fatigue, apathy and so on, resulting from DRT withdrawal. One interesting symptom during euphoria phase is repetition of complex motor behaviors such as collecting or arranging objects.

Management is drug dose stratification.

Question 10:

Which artery is called "mother of all end arteries"?

Answer:

Brachial artery

Rationale:

Due to its designation of sole supplier around elbow for downward areas, brachial artery is called "mother of all end arteries". Before advent of ultrasound, arterial line insertion was highly discouraged in brachial artery, due to possible hematoma and nerve injury. Still the radial and femoral arteries are preferable over brachial artery for A-line insertion.

Question 11:

What is "wedged blood PO_2" and what is the clinical implication?

Answer:

"Wedged blood PO2" is the level of PO_2 while Pulmonary artery catheter balloon is inflated (wedging).
Wedge blood PO_2 should be at least 20 mm Hg higher than arterial PO_2 (ABG) to confirm that you are measuring Pulmonary artery occlusion pressure at right level/spot.

Reference(s):

Paul L. Marino - The little ICU book of facts and Formulas, 2009 - Page 119

Question 12:

What is the rule of thumb in selecting a size of Intra-Aortic Balloon Pump (IABP)?

Answer:

The size of the IAB is dependent on the patient's height to prevent occlusion of subclavian or renal arteries.
Less than 160 cm height: Use 34 cc
between 160 – 182 cm height: Use 40 cc
More than 182 cm height: Use 50 cc

Question 13:

Case:

You have been called to *code blue* with patient in pulseless electrical activity (PEA). You tried rounds of epinephrine and atropine beside IVF wide open, without any success. While in that chaos you heard 2 suggestions - one for *soda-bicarb* and the other for *calcium chloride*. You decide to try both. What would be the advice you will give with order?

Answer:
First of all calcium is not recommended in PEA unless there is a specific indication like evidence or suspicion of hyperkalemia (as in renal failure patients) or hypocalcemia or calcium channel-blocker overdose. It may have potential serious complications.
Also, routine administration of sodium bicarbonate is discouraged because it worsens intracellular and intracerebral acidosis and failed to show any improvement in mortality rate. It should be reserved for patients with severe systemic acidosis, hyperkalemia, or a tricyclic antidepressant overdose.

Bedside tip! In case, for above reasons, if you decide to use both sodium bicarbonate and calcium - Give order with advice - Use different lines for both. It is a simple chemistry. $NaHCO_3$ and CaCl in the same line will form together CaCO3. Also, it is advisable to give soda-bicarb before calcium to avoid above reaction and to avail the benefit of soda-bicarb and once utilized, give calcium.

Question 14:

Case:
While performing femoral vein cannulation, you obtained good blood return but after advancing wire you felt resistance so you decide to come out. Wire is bend laterally! What could be the reason?

Answer:
You may have cannulated upper part of great saphenous vein just before it enters femoral vein. As wire may bend while entering the junction and may obstruct free flow of wire. Get new wire and attempt again with little up and lateral with continuous palpation of femoral artery to avoid arterial puncture! (or utilize the bedside ultrasound if available).

Question 15:

Why vasopressin is preferable over epinephrine in cardio-pulmonary arrest due to cocaine overdose?

Answer:
Epinephrine like cocaine has alpha-adrenergic effects. Because of this similarity in both having similar adrenergic cardiovascular effect, the administration of epinephrine to a patient who arrests in a hyperadrenergic state has been like "pouring gasoline over fire." Moreover, cocaine also prevents the reuptake of exogenously administered epinephrine. Therefore, if epinephrine is used, American Heart Association Guidelines recommends that high-dose epinephrine should be avoided and that the interval for its administration be increased (q 5-10min).

Vasopressin on the other hand offers considerable advantages over epinephrine in cardiac arrest secondary to cocaine toxicity. The hyperadrenergic state caused by cocaine increases myocardial oxygen demand and vasopressin increases coronary blood flow, and thereby myocardial oxygen availability. Also, cocaine toxicity causes acidosis and epinephrine loses much of its effectiveness in an acidotic environment, whereas vasopressin have demonstrated good efficacy in an environment with severe acidosis.

Question 16:

What is the approximate half-life of infusing epinephrine in septic shock patient?

Answer:

About 3.5 minutes

Rationale:

Pharmacokinetics of epinephrine is linear in septic shock patients, without any saturation at high doses. Basal neurohormonal status has no influence on epinephrine pharmacokinetics.

Reference(s):

Pharmacokinetics of epinephrine in patients with septic shock: modelization and interaction with endogenous neurohormonal status - Published July 21, 2009 - Critical Care 2009

Question 17:

What's the danger of being very close to inguinal ligament while putting femoral venous or arterial central line?

Answer:

Possible development of retroperitoneal hematoma and decreased ability to compress the bleeding site. Retroperitoneal hematoma is a serious and potentially very fatal complication after femoral cannulation. High femoral puncture (particularly if accompanied by coagulopathy) increases the risk of hematoma formation. It is always wise to stay well below inguinal ligament (at least 3-4 cm) so developing hematoma is visible and can be compressed.

Question 18:

Case:

A 68-year-old patient is admitted with CHF. Now with diuresis, the patient is stabilized and clinically stable to transfer to floor. The patient's last CVP noted was 12, and the patient's bed is raised to perform portable chest x-ray. Which of the following will happen with the elevation of patient's bed (choose one)?

1. Fall
2. Rise

3. No change

Answer:
Will rise

Rationale:
CVP transducer and intravascular volume at “zero point” acts as a balance set of fluids. If transducer goes down below zero point (as with the elevation of bed) CVP will rise.

Question 19:

What does it mean when you say, “7 French catheter”?

Answer:
"French" is the size of catheters in outside diameter.
1 French = 0.33 mm
and so,
2 French = 0.66 mm,
3 French = 0.99 mm
7 French = 7 x 0.33 = 2.31 mm in outside diameter

Question 20:

Case:
The nurse calls you, as radial artery "A-line" continues to have problems. You decide to change it over wire. Despite changing it over wire, it does not produce satisfactory waveform on monitor. What should be your next thought?

Answer:
Probable radial artery occlusion

Rationale:
Radial artery occlusion can be encountered in up to 30% of patients and incidence is higher than expected. It is of legal importance to document Allen's test prior to radial artery insertion and assessment of flow with ultrasound is desirable. 20-gauge cannulae are the safest. Radial artery occlusion is relatively more common in females. Other factors include insertion techniques (causing hematoma), low cardiac output, anticoagulation (prone to cause hematoma), duration of cannulation, vasopressors, previous surgical history and so on. Heparinized solution has no advantage over regular saline flushes.

In case of suspected ischemia, catheter should be removed and the hand should be monitored closely. It is not advisable to apply warm wrap as it may make ischemia worse. Arterial duplex Doppler sonography should be ordered to rule out arterial spasm, delineate areas of occlusion, thrombus formation and flow through the artery. If arterial duplex suspects spasm, a sympathetic block can be performed at bedside to induce

vasodilatation. In such cases, vascular consult is recommended. If required angiography should be performed to evaluate the need of operative intervention for clot removal, repair of lacerated radial artery, or to perform a graft procedure. Intravenous heparin can be used if no contraindication and local thrombolytic therapy can also be applied. Beside above treatment modalities, nursing interventions include close monitoring, splinting of arm and demarcation of ischemic area.

Reference(s):
1. Cannulation Injury of the Radial Artery: Diagnosis and Treatment Algorithm Am. J. Crit. Care. July 1, 2004; 13(4): 315 - 319.
2. RADIAL ARTERY CANNULATION - British Journal of Anaesthesia, 1980, Vol. 52, No. 1 41-47
3. Cannulation Injuries of the Radial Artery Am. J. Crit. Care. July 1, 2004; 13(4): 314 - 315.
4. Severe ischemia of the hand following radial artery catheterization. Surgery. 1976; 80:449–457
5. Ischaemia of the hand after radial artery monitoring. Cardiovasc Surg. 1996; 4:456–458
6. Complications during and following radial artery cannulation: a prospective study. Intensive Care Med. 1986; 12:424–428
7. Radial artery cannulation in 1000 patients: precautions and complications. J Hand Surg [Am]. 1977; 2:482–485.
8. On the safety of radial artery cannulation. Anesthesiology. 1983; 59:42–47.

Question 21:

What does “by Cryptic Shock” mean?

Answer:

The term "cryptic shock" is used for patients who seem to have normal hemodynamic parameters, yet have high morbidity and mortality as a result of global ischemia with increased lactate blood level. It is also called normotensive shock. Patients with pheochromoctoma having hypertensive crisis with evidence of tissue hypoxia, also may have high lactate blood level.

Question 22:

Why is D-5 a poor choice of resuscitation at cellular level in septic shocks?

Answer:

At cellular level, in hypoperfused patients, most D-5 gets diverted to lactate production-making acidosis worse. Also, as we know - at vascular level - it has no resuscitation effect.

Question 23:

Is Milrinone a venodilator or an arterial dilator?

Answer:

Milrinone has minimal venodilation effect.
In reality, it’s a pure arterial dilator.

Question 24:

How does Methylene blue work in Nor-epinephrine refractory vasoplegia?

Answer:
Via inhibition of guanylate cyclase

Rationale:
Refractory vasoplegia reflects a dysregulation of nitric oxide synthesis and vascular smooth muscle cell guanylate cyclase activation. Release of proinflammatory mediators may act through the induction of the final common pathway of nitric oxide, which is the activation of the guanylate cyclase, leading to vasodilation. Hyporesponsiveness to norepinephrine is due to the activation of the soluble guanylate cyclase.

Dose is 2 mg/kg administered intravenously over 20 minutes one time use.

Question 25:
Describe three contraindications for application of Lithium based Cardiac output?

Answer:
Measurement of cardiac output by lithium dilution is based on the same principles as the thermodilution techniques. Isotonic lithium chloride is injected as a bolus. It mixes with the venous blood as it travels through the right heart, pulmonary circulation, left heart, and the aorta. The concentration-time curve of the indicator is, in contrast to the thermodilution methods, routinely generated in a peripheral artery (A-line) by the use of an ion-selective electrode.
It is contra-indicated in the following:

1. Patients receiving lithium therapy
2. Patients who are less than 40 kg in weight
3. Patients in the first trimester of pregnancy

Question 26:
What is the normal stroke volume in a normal healthy 70 Kg man?

Answer:
About 70 ml

The difference between end-diastolic volume (EDV) and end-systolic volumes (ESV) is the stroke volume, which is the volume of blood ejected with each heartbeat.

Question 27:
Case:
While floating a pulmonary artery catheter, you have a hard time measuring "wedge" (pulmonary artery occlusion pressure). After few attempts you noticed couple of blood drops in the pulmonary artery catheter syringe. What does it mean and what should be you next step?

Answer:
This means the pulmonary artery catheter balloon is ruptured. When the pulmonary artery catheter balloon is ruptured, there could be two scenarios, either there is usually no resistance to balloon inflation or you may notice blood in the balloon port's tubing (syringe).

If there is suspicion of balloon rupture or blood in the balloon tubing, do the following:

1. IMMEDIATELY clamp off the port
2. Do not perform any PAOP/wedge measurement anymore
3. Lock the port
4. Tape over the port/syringe with a note "Balloon Busted".

Attempt to inject further air or to clear the blood may cause a potentially life-threatening air or blood clot emboli

Question 28:

Case:
You are performing *code blue* on a patient. You do not have an arterial line. What would be the best way to determine the efficacy of resuscitation?

Answer:
Venous Blood Gas (VBG)

Rationale:
Arterial blood gas (ABG) analysis provides useful information on the critically ill patients; however, it comes with its pains and arterial line may not be available or needed in many. The Venous blood gas is a quicker, easier and safer way to obtain such information with less pain for the patient. In a *code* situation it would be easier for the physician to replace VBG with ABG for analysis of base excess (acidosis). If VBG results are normal, then usually there is no need for ABG. If abnormal, VBG level predicts abnormal ABG value. A venous pH of 7 or lower, for example, predicts an arterial pH of 7.2 or lower.

In cardiac arrest victims, the disparity between arterial and venous values is even greater. During cardiac arrest, tissue hypoxia is all but a certainty and is reflected by the lower pH and higher PCO2 on the venous side.

Question 29:

Case:
A 42-year-old female presented with weakness, ataxia, nausea, slurred speech, dehydration, and severe lethargy. Laboratory reports showed high anion gap metabolic acidosis. The patient was made NPO and was resuscitated with IVF and empiric antibiotics. The patient stabilized within 24 hours. Review of old records showed similar

multiple episodes with no clear diagnosis before each discharge except for one unrelated admission 12 years ago for uneventful gastric bypass surgery.
The patient bounced back to the ICU after 2 days with similar clinical presentation. Due to clerical error D-Lactic acid was marked instead of L-Lactic acid on lab slip and indeed it is reported high and patient was diagnosed with D-Lactic acidosis. What is D-Lactic Acidosis?

Answer:
There are 2 kinds of Lactic Acidosis:

1. L-lactate: It is the only form produced in human metabolism, and its excess represents an increase in anaerobic metabolism secondary to tissue hypoperfusion.
2. D-lactate: It is a by-product of bacterial metabolism and it accumulates in patients with short-gut syndrome or in patients with a history of gastric bypass or small-bowel resection.

Development of *D-Lactic acidosis* occurs due to carbohydrate malabsorption with ingestion of large amounts of carbohydrate, and colonic bacterial flora of a type that produces D-lactic acid. It gets worse due to diminished colonic motility, allowing time for nutrients in the colon to undergo bacterial fermentation.

Reference(s):
D-lactic acidosis. A review of clinical presentation, biochemical features, and pathophysiologic mechanisms - Medicine (Baltimore) 1998 Mar; 77(2): 73-82

Question 30:
How much improvement in renal perfusion is expected when using a properly inserted IABP?

Answer:
About 25%

Rationale:
Kidney blood flow can increase up to 25% due to increase in cardiac output. After insertion of IABP, if there is a decrease in urine output it should raise the suspicion of juxta-renal balloon positioning.

Question 31:
Can a patient with pulmonary artery catheter (PAC) have an MRI?

Answer:
Preferably not.

Rationale:
MRI should not be ideally performed in patients with pulmonary artery catheters. It is

recommended for these patients that the pulmonary artery catheter is temporarily removed before the MRI. PACs contain an electrical thermistor that allow for thermodilution measurements. Any electrical conductor, such as this, in the presence of alternating magnetic fields, generates electrical current, which not only can melt parts of the catheter but also may induce arrhythmias.

Question 32:

Which commonly used ICU vasopressor is also used as a treatment to abort low flow priapism?

Answer:
Phenylephrine

Rationale:
Phenylephrine is also used to abort priapism. It is diluted and injected directly into the corpora cavernosa. It works via causing constriction of the blood vessels entering into the penile region, thus breaking the cycle that continues the priapism.

Dose: Use mixture of 1 ampule of phenylephrine (1 mL: 1000 mcg), and dilute it with a 9 mL of normal saline. Use a 29-gauge needle, inject 0.3-0.5 mL into the corpora cavernosa, wait 10-15 minutes before repeating the dose.

Other pressor, which can also be used, is epinephrine. Methylene blue is also been suggested for the same purpose.

Question 33:

A 53-year-old patient is admitted to the ICU for septic shock secondary to diabetic foot. Surgical service decides to perform above knee amputation. What one thing do you need to be careful about while interpreting data from Pulmonary artery catheter?

Answer:
Cardiac Index

Rationale:
Patient's status post Body Surface Area (BSA) is now changed due to loss of leg (above knee amputation). Remember Cardiac Index is a calculated value (CO/BSA). It is very important to change the patient's weight on monitor. It may sound simple but may be an often forgotten value.

Question 34:

Where should ICP monitoring be leveled (zeroed)?

Answer:

The transducer is supposed to be leveled at the location of the patient's face that corresponds to the Foramen of Monro. A Few external points describe are:

1. The outer canthus of the eye.
2. Halfway between the outer canthus of the eye and the tragus of the ear.
3. Patient's external auditory meatus.
4. If the patient is lateral, between the eyebrows.

(Laser pointing device is recommended by many).

Question 35:

What is the easy way to estimate the distance from the right subclavian vein to the junction of the superior vena cava and right atrium?

Answer:

For R- SC vein: (Height in cm)/10 – 2 cm
For R- IJ vein: (Height in cm)/10
For L-IJ vein: (Height in cm)/10 + 4 cm

Question 36:

While at patient's bedside you noticed Dopamine drip is yellow in color. What does it mean?

Answer:

Bag should be changed.

Rationale:

Any dark color discoloration of solutions containing dopamine indicates decomposition of the drug. Any solutions that is darker than slightly yellow should not be used. Dopamine is sensitive to, and should be protected from light.

Question 37:

Is Pregnancy contraindication (exclusion criteria) for Hypothermia Protocol?

Answer:

Yes

Rationale:

Standard exclusions for Hypothermia protocol:

a. Reason for comatose e.g. convulsive status epilepticus
b. Pregnancy
c. Where the patient has a known terminal illness, preceding the arrest
d. Patient with known severe pre-existing coagulopathy or active bleeding (relative exclusion, especially for patients on warfarin)

e. No limit on duration of resuscitation effort; however *down time* of less than 1 hour most desirable
f. Pre-existing conditions as DO NOT INTUBATE code status and patient not intubated as part of resuscitation efforts

Question 38:

What is the maximum length of guide-wire that is recommended for insertion (advance) during subclavian or internal jugular venous catheterization?

Answer:

About 18 cm (maybe little less in right IJ)

Rationale:

Beside not to lose control of guide-wire, it is appropriate to know the markings on guide wire in CVC kit. The patient's height is less reliable in predicting a safe wire length. 18 cm should be considered the upper limit of guide-wire introduced during central catheter placement in adults.

Reference(s):

How much guide wire is too much? Direct measurement of the distance from subclavian and internal jugular vein access sites to the superior vena cava-atrial junction during central venous catheter placement - Critical Care Medicine. 28(1): 138-142, January 2000

Lines / Sepsis / Hemodynamics / Arrest - PEARLS

1. **How is intraabdominal pressure monitored?**
   Intraabdominal pressure can be measured by transducing the pressure in the urinary bladder via a Foley catheter.

   20-50 mL saline solutions are instilled into the urinary bladder to ensure a continuous column of fluid. A needle (connected to a pressure transducer) is aseptically placed into the sampling port of the drainage tubing, which is clamped downstream from the port. The pubic symphysis is used as a zero reference. Alternatively, the drainage tubing itself can be used as a manometer.

   Because urinary specific gravity is approximately 1, the height of the fluid column in centimeters needs to be multiplied by 0.74 to convert to millimeters of mercury. Respiratory variation should be observed in the measured pressure to confirm that pressure is being transduced in the abdomen.

   A sustained intraabdominal pressure above 20 mm Hg with end-organ dysfunction (renal dysfunction, ventilator failure, or intestinal ischemia) is defined as 'Abdominal Compartment Syndrome.

2. **Cardiopulmonary Arrest in Pregnancy**
   Cardiac arrest is uncommon event during the pregnancy with frequency of one in every 30,000 late pregnancies. When it happens, the patient rarely survives. During intubation, the cricoid pressure should be applied to prevent aspiration due to high risk of regurgitation and pulmonary aspiration of gastric contents in late pregnancy.

   During pregnancy there is an increase in oxygen requirements. The decreased chest wall compliance makes ventilation more difficult. The decreased compliance is secondary to rib flaring and splinting of the diaphragm by the abdominal contents.

   A pregnant patient requiring chest compressions should have a Cardiff Wedge or other device achieving approximately a 30° tilt placed under her back. This allows the patient to have adequate support of the torso for cardiopulmonary resuscitation (CPR) but also minimizes compression of the inferior vena cava (IVC). It can be substituted with a backboard with rolled up towels or pillows under one side.

   A pregnant patient can safely undergo both synchronized and unsynchronized direct cardioversion. Amiodarone is contraindicated as it can cause abnormality in fetal thyroid development. Other cardiac drugs such as Lidocaine, procainamide, adenosine, and quinidine can be safely used in the gravid patient. It is possible for an emergent cesarean section to be performed during CPR.
   Expiratory holding approach in measuring end-expiratory pulmonary artery wedge pressure for mechanically ventilated patients.

   Reference(s):

Yang W, Zhao X, Feng Q, An Y, Wei K, Wang W, Li C, Cheng X - "Expiratory holding" approach in measuring end-expiratory pulmonary artery wedge pressure for mechanically ventilated patients. - Patient Prefer Adherence. - 2013 Oct 8; 7:1041-5. doi: 10.2147/PPA.S52122.

3. Recommended Cuff Sizes for Accurate Measurement of Blood Pressure

It is calculated as:

Arm circumference: 22 to 26 cm	Cuff size: 12 × 22 cm (small adult)
Arm Circumference: 27 to 34 cm	1Cuff size: 6 × 30 cm (adult)
Arm circumference: 35 to 44 cm	Cuff size: 16 × 36 cm (large adult)
Arm circumference: 45 to 52 cm	Cuff size: 16 × 42 cm (adult thigh)

(For ease of use, adult cuffs for BP monitoring can be characterized into 4 sizes - *Small*, *Medium*, and *Large* arm cuffs; and *Thigh* cuffs)

Objective of above pearl is to emphasis that ideally arm cuffs cannot be applied to the thigh, which is a common practice.

Reference(s):

Pickering TG, Hall JE, Appel LJ, Falkner BE, Graves J, Hill MN, et al.; Subcommittee of Professional and Public Education of the American Heart Association Council on High Blood Pressure Research. Recommendations for blood pressure measurement in humans and experimental animals. Part 1: blood pressure measurement in humans. Hypertension 2005; 45:142–61

4. Ultrasound for subclavian central lines (CVC)

Ultrasound guided Internal Jugular CVC is now pretty much standard for internal jugular (IJ) approach. For subclavian vein cannulation this study published in CCM Journal shed some light. 463 mechanically ventilated patients were compared - the ultrasound-guided subclavian vein cannulation (200 patients) vs. the landmark method (201 patients) using an infraclavicular approach. Patients were stratified based on body mass index, age and sex.

Results:

1. No significant differences were seen as related to risk factors for difficult cannulation among groups.
2. Success rate for subclavian vein cannulation was 100% when compared to a landmark method, which had the success rate of 87.5% ($p < .05$).
3. Use of ultrasound significantly decreased the average access time and number of attempts ($p < .05$).
4. The procedure related complication rate was higher in the landmark group when compared to the ultrasound group ($p < .05$).
5. No differences were seen in the rate of catheter misplacements among groups.

Conclusions: Ultrasound guided placement of subclavian vein cannulation was superior to the landmark method.

Reference(s):

Real-time ultrasound-guided subclavian vein cannulation versus the landmark method in critical care patients: A prospective randomized study - Critical Care Medicine. 39(7): 1607-1612, July 2011.

5. Quick and Dirty on Vasopressors and Inotropes

Vasopressor activities on the following receptors are agonistic:

a. Alpha 1 receptors-- peripheral arteries-- peripheral vasoconstriction
b. Beta 1 receptors-- coronary smooth muscle-- increased heart rate and contractility
c. Beta 2 receptors—smooth muscle—increases force of contractility in the heart
d. DA1 receptors-- renal, mesenteric, and coronary beds-- vasodilation and increase urine output.
e. V1, receptors-- vascular smooth muscle--vasopressor;
f. V2 receptors-- renal collecting duct system--natural diuretic

Vasopressors:

a. Dopamine: receptor action is dependent on dose… DA1 1-5 microgram/kg/min + HR; b1 5-10 microgram/kg/min, ++ HR, + MAP, + CO; a1 > 10 microgram/kg/min + SVR, + MAP, + HR, +CO
b. Epinephrine: b1 >> a1 1-20 microgram/min ++ SVR, +MAP, +HR, +CO
c. Norepinephrine: a1 > b1 1-80 microgram/min, ++ SVR, ++MAP, +HR,? +CO
d. Phenylephrine: a1 2-200 micrograms/min; ++SVR, +MAP, ?+HR, ?+ CO
e. Vasopressin: V1 V2 0.04 units/min ++SVR, +MAP,? +HR, ? +CO

Inotropes:

a. Dobutamine: b1, b2 2-20 microgram/kg/min
b. Milrinone: PDE inhibitor in vascular and cardiac smooth muscle, which improves calcium handling causing dilation. In cardiac muscle, the inhibition of

phosphodiesterase results in increased levels of cAMP, resulting in increased chronotropic and inotropic effects.

Reference(s):
Dellinger RP. Crit Care Med 2008; 36(1): 296

6. 2 ways of CVP measurement

Central Venous Pressure can be measured in 2 units - cm H_2O and mm Hg, depending on which system is used. CVP in ICUs is usually measured in mmHg via electronic monitor.

The conversion formula of CVP in cm H_2O to mm Hg is:
10 mm H_20 = 7.5 mm Hg
or to be precise
1 mm Hg = 1.36 cm H_2O

Normal CVP is 2-8 mmHg and 5 - 10 cmH_2O

7. Significance of venous blood gas

Venous blood gasses is easy to obtain, but very much under-utilized in ICUs.
In the ICU setting where hypotension and hypoperfusion are very common, it is very important to know that although information about arterial blood gases is important to assess pulmonary gas exchange, but conditions where there is presence of severe hypoperfusion, the hypercapnia and acidemia at the level of the tissues, venous blood gas detects them better and those correlate better with the central venous blood.

Reference(s):
1. Assessing acid-base status in circulatory failure. Differences between arterial and central venous blood - Volume 320:1312-1316, May 18. 1989
2. Comparison of Blood Gas and Acid-Base Measurements in Arterial and Venous Blood Samples in Patients with Uremic Acidosis and Diabetic Ketoacidosis in the Emergency Room - American Journal of Nephrology 2000; 20:319-323
3. Agreement between arterial and central venous values for pH, bicarbonate, base excess, and lactate. Emerg. Med. J. 23: 622-624

8. Altered zinc homeostasis in septic shock

Zinc homeostasis is of significant importance for the normal function of the immune system, oxidative stress responses, neurocognitive function, and growth and development.

Metallothioneins are cysteine-rich; metal-binding proteins which are involved in the homeostasis of zinc. Transcription is strongly down regulated in zinc deficiency, but is up regulated with inflammation, metals, and administration of exogenous glucocorticoids. Plasma zinc concentrations are low in critically ill children.
It is postulated that that enhanced metallothionein expression earlier in acute stress associated with the decline in plasma zinc contributes to the inflammatory response

and the risk of organ failure in critically ill patients.

***Reference(s)**:*
1. Genome-level expression profiles in pediatric septic shock indicate a role for altered zinc homeostasis in poor outcome - Physiol. Genomics 30: 146-155, 2007. First published March 20, 2007
2. Zinc homeostasis in pediatric critical illness- Pediatric Critical Care Medicine. 10(1): 29-34, January 2009

9. Ports of PICC

Do you know that, PICC lines have no distal or proximal port? They run side by side. This is because PICC lined need to be trimmed from top depending on length per patient height. As PICC lines need to be trimmed, it is a good practice to document in chart the length of PICC at removal with length at insertion time. Obviously, they should be same.

Length of PICC on removal _____ cm = Length of PICC on insertion _____ cm

Infectious Diseases

Question 1:

Treatment of which infection has been shown to improve Idiopathic thrombocytopenic purpura (ITP)?

Answer:

Helicobacter pylori

Rationale:

Interestingly, for mechanisms not fully understood, particularly in adults who live in areas with a high prevalence of Helicobacter pylori, diagnosis and treatment of Helicobacter pylori infection has been shown to improve the platelet counts in many patients.

Reference(s):

Stasi R, Sarpatwari A, Segal JB, Osborn J, Evangelista ML, Cooper N, Provan D, Newland A, Amadori S, Bussel JB (2009). "Effects of eradication of Helicobacter pylori infection in patients with immune thrombocytopenic purpura: a systematic review". Blood 113 (6): 1231–40.

Question 2:

Which one group of antibiotics (other than Vancomycin) has been shown to increase the risk of vancomycin-resistant Enterococcus (VRE)?

Answer:

Cephalosporin

Rationale:

Use of Cephalosporin has been found to increase the risk for colonization and infection by VRE. Restriction of cephalosporin usage has been shown to be associated with decreased in VRE infection and transmission among hospitalized patients.

Reference(s):

Chavers, LS. Moser, SA.; Benjamin, WH.; Banks, SE.; Steinhauer, JR.; Smith, AM.; Johnson, CN.; Funkhouser, E. et al. (Mar 2003). "Vancomycin-resistant enterococci: 15 years and counting". J Hosp Infect 53 (3): 159–71.

Question 3:

Methylene Blue can be used as a treatment in which infectious disease?

Answer:

Malaria

Rationale:

Actually Methylene Blue has been used as an anti-malarial for almost a century. It has been shown to play a role in malarial treatment with increasing the resistance of Plasmodium falciparum to front line treatments.

Mechanism of action: Methylene Blue, which is a specific inhibitor of Plasmodium falciparum glutathione reductase, has the potential to reverse Chloroquine resistance and it prevents the polymerization of haem into haemozoin similar to 4-amino-quinoline anti-malarials.

Dose: 36-72mg/kg is given over three days.

Reference(s):
Meissner Peter E, Germain Mandi, Boubacar Coulibaly, et al. – Methylene blue for malaria in Africa: results from a dose-finding study in combination with chloroquine. Malaria Journal. 2006; 5:84.

Question 4:

A 52 year old male, who returned from Zambia 8 weeks ago, is admitted to ICU with fever, malaise, hypotension, generalized urticarial and pruritic rash. Blood work up showed marked eosinophilia. Infectious Disease service is consulted and they strongly suspect Schistosomiasis. While urine and fecal microbiology as well as PCR are waiting, what is the treatment of Schistosomiasis?

Answer:
Praziquantel

Rationale:
Cure rates of 6o-90% is described after a single treatment with praziquantel, but maturing schistosomes are less susceptible to therapy than adult worms, a second course of treatment may be required after few weeks.

Question 5:

In Dengue virus shock syndrome, what should trigger the blood transfusion?

Answer:
In contrast to other clinical situations, Blood transfusion should be initiated early in hemodynamically unstable patients suffering from Dengue virus shock syndrome, in the face of a decreasing hematocrit, rather than following hemoglobin concentration.

Reference(s):
WHO (2009). Dengue Guidelines for Diagnosis, Treatment, Prevention and Control: Geneva: World Health Organization.

Question 6:

What does the bacteria Escherichia coli (E. coli) have to do with Filgrastim (Neupogen)?

Answer:

Filgrastim (Neupogen) is produced by the recombinant DNA technology. It is a granulocyte colony-stimulating factor (G-CSF) analog, which is used to stimulate the proliferation and differentiation of granulocytes.
It is produced by inserting the gene for human granulocyte colony-stimulating factor into the genetic material of Escherichia coli. The G-CSF then produced by E. coli is different from G-CSF produced in humans.

Question 7:

Case:

You have been called to the ED to evaluate a 21-year-old male with hypotension, dehydration, severe diarrhea and abdominal tenderness, which is more pronounced in the right upper quadrant. Upon examination you noticed hepatomegaly. The history is remarkable with visit to rural parts of South Africa recently. You send septic workup along with stool examination and asked for STAT abdominal ultrasound at bedside with focus on right upper quadrant. The ultrasound technician at patient's bedside showed you a solitary abscess located in the right hepatic lobe. Based on travel history and ultrasound finding, what is the probable diagnosis?

***Answer*:**

Amoebic liver abscess

Rationale:

In comparison to pyogenic liver abscesses, amoebic abscess tend to be a solitary abscess. The preponderance of amoebic liver abscess in the right lobe may be explained by streaming of blood in the portal vein. Amebiasis most frequently affects the right side of the colon. Flow from the superior mesenteric vein, which drains the right side of the colon and goes to the right hepatic lobe, whereas flow from the inferior mesenteric and splenic veins go to the left lobe.

Question 8:

Case:

A patient was transferred to the Critical Care Unit in septic shock. 4 out of 4 blood cultures were positive for Staphylococcus epidermidis and Eschericia coli. Patient moved from Mexico to the United States approximately six months ago for the treatment of HTLV-1 associated Lymphoma and has been on chemotherapy. What is the most likely cause of sepsis?

Answer

Strongyloidiasis.

Rationale:

Strongyloides stercoralis is endemic in many areas of the world and is associated with HTLV-1. There is increased risk of disseminated Strongyloides in immunocompromised individuals, and can result in polymicrobial bacteremia.

Question 9:

What is the risk of acid suppression medication in developing Clostridium Difficle Colitis (C. Diff. Colitis)?

Answer:

Acid suppression medications increase the risk of Clostridium Difficle Colitis. H2-receptor antagonists increased the risk by .5-fold, and Proton pump inhibitors increase the risk by 1.7 with once-daily use and 2.4 folds with usage more than once a day.

Reference(s):

1. Howell, MD; Novack, V; Grgurich, P; Soulliard, D; Novack, L; Pencina, M; Talmor, D (May 2010). "Iatrogenic gastric acid suppression and the risk of nosocomial Clostridium difficile infection". Archives of Internal Medicine 170 (9): 784–90.

2. Deshpande, A; Pant, C; Pasupuleti, V; Rolston, DD; Jain, A; Deshpande, N; Thota, P; Sferra, TJ et al. (March 2012). "Association between proton pump inhibitor therapy and Clostridium difficile infection in a meta-analysis". Clinical Gastroenterology and Hepatology 10 (3): 225–33.

Question 10:

What length of catheter should be cut distally to send the catheter tip for culture?

Answer:

Preferably about 2 inches (5 cm)

Question 11:

A 32-year-old male who recently migrated from Africa, presented with hypotension, left flank pain and "Milky Urine". What are the treatment options beside resuscitation?

Answer:

Chyluria (Milky Urine) is not uncommon in many parts of the world. Wuchereria Bancrofti, which is the main agent of filariasis, is endemic in Africa. It occurs, on average, five to ten years after the worm has died, and so there may be no evidence of active filariasis.

Therapeutic trial with diethylcarbamazine is considered before undertaking surgical intervention for lymphatic urinary fistula.

Reference(s):

Filarial chyluria: Long-term experience of a university hospital in India – International Journal of Urology, Volume 11 Issue 4, Pages 193 – 198, Published Online: 16 Mar 2004

Question 12:

Which disease do "Crushed ping pong balls" remind you of?

Answer:
PCP (Pneumocystis pneumonia/ PJP)

Rationale:
The diagnosis of PCP can be confirmed by identification of the PCP (PJP) organism in sputum or bronchio-alveolar lavage (BAL). Special staining will show the characteristic cysts. The cysts when viewed under microscope, resembles crushed Ping-Pong balls and are usually present in an aggregates of two to eight. In contrast, fungal agents as Histoplasma or Cryptococcus typically do not form aggregates of spores or cells.

Question 13:
Why have steroids remained the mainstay of treatment in Neurocysticercosis?

Answer:
Albendazole and Praziquantel are both effective in treatment of Neurocysticercosis. They are given under cover of steroids. Steroids are essentially needed, as inflammatory reactions to the dying parasite could be life threatening with mental status changes and convulsions.

Also, Albendazole when co administered with a steroid (to treat inflammation) results in increased absorption of Albendazole.
Both Albendazole and Praziquantel are recommended to give with fatty meal.

Question 14:
What is the advantage of "oily Chloramphenicol"?

Answer:
Oily chloramphenicol is the oil-based solution of chloramphenicol. It is a long-acting preparation of chloramphenicol.
Oily chloramphenicol is recommended by the World Health Organization (WHO) as the first line treatment of meningitis in low-income countries. It has the great advantage of requiring only a single injection.

Though not very much in use in the USA due to its bone marrow toxicity it is essential for the intensivist to be aware of the advantage of this drug. It has excellent blood brain barrier penetration with activity against a wide variety of Gram-positive, Gram-negative bacteria and anaerobic organisms.

Question 15:
A 35-year-old male developed severe diarrhea, fever and abdominal pain after blood transfusion. Symptoms progressed very rapidly. CT scan of abdomen showed hepatic and splenic abscesses. Surgery back up is called and infectious diseases (ID) consult is

obtained. Meanwhile blood bank confirmed contamination of stored blood. ID service started patient on Ciprofloxacin. Which 'bug' are they suspecting?

Answer:
Yersinia Enterocolitica

Rationale:
Yersinia Enterocolitica is a gram-negative bacillus and is a siderophilic (iron-loving) bacteria. Those with hereditary hemochromatosis are more susceptible to infection with Yersinia - and the most common contaminant of stored blood is Y. Enterocolitica. Yersinia Enterocolitica multiplies rapidly in whole blood or red blood cells stored at 4-8°C.

Other sources of infection are contaminated pork, milk, water, and tofu consumption. Infected individuals may shed Yersinia Enterocolitica in stools for 90-days after the resolution of symptoms.

Question 16:
A 48-year-old female who has been on Cipro for the last 5 days, due to severe urinary tract infection (UTI) is now complaining of diplopia. What is your concern?

Answer:
Damage may be permanent

Rationale:
Ciprofloxacin has been reported to cause diplopia, which may be permanent. It may also cause complete loss of vision and impaired color vision but those are usually reversible.

Question 17:
Case:
Why is the use of gloves more important than soap and water in the prevention of the spread of C. difficile-associated diarrhea (CDAD)?

Answer:
Early data suggested that, despite using soap and water, it is difficult to remove the C. difficile spores. Usage of gloves in addition to hand washing still remains the corner stone. (cdc.gov).

Question 18:
Give 7 risk factors for the development of Zygomycosis?

Answer:
Zygomycosis or Mucormycosis is a fungal infection, which is found mostly in diabetic patients. It is found to be associated with some interesting risks factors

1. Acidosis
2. Renal insufficiency
3. Diarrhea
4. Aspirin intake
5. Glucocorticoids intake
6. Desferoxamine intake
7. Splenectomy

Zygomycosis is also referred to as an infection caused by bread mold fungi and includes Mucormycosis, phycomycosis and basidiobolomycosis. "Mucormycosis" and "Zygomycosis" are used interchangeably.

Question 19:

What is the difference between Indium Scan and Gallium scan in localizing infection?

Answer:

The indium scan is a procedure in which WBCs (neutrophils) are removed from the patient, tagged with the radioisotope Indium-111, and then injected back into the patient. The tagged leukocytes subsequently enhance areas of relatively new infection, where live neutrophils are still rapidly and actively localizing.

Gallium scan has advantage over the indium scan because gallium binds to neutrophil membranes, even after neutrophil death. This makes gallium more broadly sensitive, localizing to other sources of fever, such as chronic infections and tumors.

Question 20:

A 54-year-old male with HIV was admitted to the ICU with respiratory failure. The initial work-up showed LDH level of 1200 IU/L. What is your probable diagnosis?

Answer:

Histoplasmosis

Rationale:

Based on the study by Butt and colleague, LDH level of more than 450 IU/L is 9.33 times more likely to be associated with a diagnosis of Histoplasmosis than with PCP. An LDH level of 450 IU/L or greater had a sensitivity and specificity of 70% and 80%, respectively; whereas LDH level of 600 IU/L or greater had sensitivity and specificity of 50% and 89%.

Thus, serum LDH levels of 600 IU/L or greater are highly suggestive of Histoplasmosis rather than PCP in appropriate clinical settings.

Reference(s):

Butt AA, Michaels S, Greer D, Clark R, Kissinger P, Martin DH (July 2002). "Serum LDH level as a clue to the diagnosis of histoplasmosis". AIDS Read 12 (7): 317–21.

Question 21:

What are the less well-known risk factors for Clostridium Difficle Colitis in ICU beside previous antibiotics usage, age and severity of illness?

Answer:

1. Antacid therapy
2. Stool softeners
3. Nasogastric or oro-gastric tubes
4. Enteral feeds
5. Cathartics

Reference(s):

1. Poutanen SM, Simor AE: Clostridium difficile–associated diarrhea in adults. CMAJ 2004; 171:51-58

2. Thielman NM, Wilson KH: Antibiotic-associated colitis - Mandell GL, Bennett JE, Dolin R (eds): Principles and Practice of Infectious Diseases, 6th ed, vol 1. Philadelphia: Elsevier, 2005, pp 1249-1262.

Question 22:

A 35 year-old-patient presented to hospital with complaint of 3 days history of diplopia and muscular weakness. Muscular weakness was found to be symmetrical and descending. Patient had no fever or chills. Patient has a history of recent facial injury. His symptoms are progressively getting worse. Patient blood pressure was stable but has significant bradycardia. Patient vital capacity was low. He was admitted in intensive care unit.

Answer:

Botulism

Rationale

Differential diagnosis: In this condition differential diagnosis can be multiple as Myasthenia Gravis, Lambert-Eaton syndrome, Guillain-Barre's syndrome, poliolmyelitis, Ticks paralysis, heavy metal intoxication.

The differentiating feature is that botulism has an acute onset with bilateral cranial neuropathies and symmetric descending weakness.

The key features include:

a. Patient has no fever
b. Neurological deficit are symmetrical
c. Patient is awake and responsive
d. Patient had bradycardia and normal BP
e. There is no sensory deficit
f. Patient complains of diplopia and blurred vision

Treatment:

a. Patient is given equine serum botulism antitoxin

b. Antibiotic therapy with Penicillin G intravenously 3 grams every 4 hours is also given.

Question 23:

Why have steroids remained the mainstay in the treatment of Neurocysticercosis?

Answer:

Albendazole and Praziquantel are both effective in treatment of Neurocysticercosis. They are given under cover of steroids. Steroids are essentially needed, as inflammatory reactions to the dying parasite could be life threatening with mental status changes and convulsions. Also, Albendazole when co-administered with a steroid (to treat inflammation) results in increased absorption of Albendazole.
Both Albendazole and Praziquantel are both recommended to be given with a fatty meal.

Question 24:

What is the treatment of Q fever in Pregnancy?

Answer:

Co-trimoxazole

Rationale:

Q fever is caused by infection with Coxiella burnetii. This organism is found in cats, dogs, cattle, sheep, goats and other domestic mammals. This infection results from inhalation of endospores, and from contact with the milk, urine, and feces or body fluid of infected animals. Q fever can be treated with antibiotics - doxycycline, tetracycline, chloramphenicol, ciprofloxacin, ofloxacin, and hydroxychloroquine.

Q fever in pregnancy may cause abortions particularly in the first trimester. Co-trimoxazole is the preferred therapy during pregnancy as doxycycline and ciprofloxacin are contraindicated in pregnancy.

Reference(s):

Q fever during pregnancy: diagnosis, treatment, and follow-up - Arch Intern Med. 2002 Mar 25; 162(6): 701-4.

Question 25:

Which one other chemical is added in IV preparation of Primaxin, which may affect acid base balance?

Answer:

Sodium Bicarbonate

Rationale:

IV Primaxin is actually a combination of imipenem, cilastatin sodium and sodium bicarbonate, which is added as a buffer.
Likelihood of having any clinical effect is low though.

Question 26:

Which has more risk of transmission via needle stick injuries - HIV or Hepatitis C (HCV)?

Answer:
Hepatitis C

Rationale:
HIV = 0.3%
HCV = 1.8%

Question 27:

Which commonly used Antibiotic in ICU may cause black discoloration of tongue?

Answer:
Linezolid, fortunately it's not very common and it is reversible!

Reference(s):
Black tongue associated with linezolid – Am J Ther. 2010 Jul-Aug; 17(4): e115-7

Question 28:

A 17-year-old male is admitted with bloody diarrhea and vomiting. Patient visited petting zoo 3 days ago with his friend. Now patient is hypotensive, no urine output and altered mental status. Probable diagnosis?

Answer:
HUS

Rationale:
Hemolytic Uremic syndrome (HUS) should be high on list with bloody diarrhea after visit to petting zoo. Other risk factors include contamination via hamburger or contact to infected person. The GI symptoms usually start after 4-6 days. Diarrhea typically become hemorrhagic and may quickly set into septic shock.

Antibiotics are usually not required, actually discouraged. Minor cases can be treated with supportive treatment but in cases like above plasma exchange (plasmapheresis combined with fresh-frozen plasma replacement) is currently the treatment of choice.

Question 29:

A 36-year-old female is in ICU with septic shock and diagnosed with Strongyloidiasis. She also has severe GI ileus and was made NPO. She is on ivermectin. What is your option to administer her essential treatment?

Answer:
Rectal or SC administration of Ivermectin

Rationale:
Ivermectin is the drug of choice for Strongyloidiasis. It is usually given as PO with empty stomach but if PO route is note feasible, it can be given rectally or even as SC administration.

Reference(s):
Fusco DN, Downs JA, Satlin MJ, Pahuja M, Ramos L, Barie PS, et al. Non-oral treatment with ivermectin for disseminated strongyloidiasis. Am J Trop Med Hyg. Oct 2010; 83(4): 879-83

Question 30:
What is "botulinum cook"?

Answer:
Proper thorough cooking destroys botulinum toxin but the temperatures at normal boiling do not kill the spore itself. Spores may grow again when conditions are right. All commercially canned goods are required to undergo a "botulinum cook" in a pressure cooker at 121 °C (250 °F) for 3 minutes, which most likely will kill spores.
Clinically most important thing to remember besides history taking is - paralysis usually goes in a descending fashion, starting from cranial nerves downward, towards arms and legs. It also may affect respiratory muscles. Initial symptoms are double vision, drooping of both eyelids, and loss of facial expression, swallowing and speech problems. The weakness then spreads, starting in the shoulders and proceeding to the forearms, and again, from the thighs down to the feet.

Question 31:
A 28-year-old male, who just returned from Bangladesh 2 days ago presented to ED with vomiting, painless but profuse "rice water" type diarrhea - almost 20 liters/day! The diarrhea smells like fish. Upon examination, patient's skin seems turning a bluish-gray hue. What should your concern be?

Answer:
Cholera

Rationale:
The hallmark of cholera is profuse, painless diarrhea and vomiting of clear fluid. Clinical symptoms start from a few hours up to five days after ingestion of the bacteria. The diarrhea is classically described as "rice water" with fishy odor. The patient may produce 10-20 liters of diarrhea per day. Cholera has also been nicknamed as the "blue death" due to a patient's skin turning a bluish-gray hue from massive dehydration.

Doxycycline is the first line of agent for treatment, followed by cotrimoxazole, erythromycin, tetracycline, chloramphenicol, and furazolidone. Fluoroquinolones, such as norfloxacin, also may be used.

Question 32:

ID service advises you to consider Octreotide for a patient with Aids related diarrhea. What is the dosing?

Answer:

100- 500 mcg SC tid

Rationale:

Though evidence is weak but Octreotide has been used in AIDS related refractory chronic diarrhea. Octreotide is a candidate drug for the treatment of these patients as it inhibits gastrointestinal motility and increases the transit time.

Question 33:

Is Verapamil an anti-malarial drug?

Answer:

Sort of.

Rationale:

Verapamil has shown potential use in the treatment of malaria as an adjuvant treatment with chloroquine particularly in resistance. Resistance to chloroquine is caused by the parasite cell's ability to expel the drug outside of its digestive vacuole. Verapamil, will render a parasitic cell more susceptible to death, when used in combination with Chloroquine. It achieves this by increasing the accumulation of Chloroquine within the cell's digestive vacuole, preventing the cell from detoxifying itself. Resistance to the anti-malarial drug Chloroquine has impeded the treatment of malaria in Southeast Asia, South America and Africa. Adjuvant use of verapamil may be useful in such circumstances.

Reference(s):

Martin, S.; Oduola, A.; Milhous, W. (1987). "Reversal of Chloroquine resistance in Plasmodium falciparum by verapamil". Science235 (4791): 899–901

Question 34:

House staff injured a patient while performing central line with a needle stick. The patient is known to be Hepatitis C positive. What are his chances of contracting a disease?

Answer:

1.5 - 2.0 %
As expected chances are high if puncture wound is deep.

Question 35:

A 72-year-old NHR female is admitted into the ICU with Urosepsis. Patient's record shows previous cultures growing MDR Klebsiella, which is resistant to most antibiotics. The pharmacy suggested Tigecycline?

Answer:

Tigecycline is one of the very few antibiotics, which are highly active against multidrug-resistant (MDR) Klebsiella pneumonia and MDR Acinetobacter braumannii (MDR KP/AB) but may require high dosing for maximal therapeutic effectiveness. In such cases use an initial dose of 200 mg IV followed by 100 mg IV daily. If patient does not respond to this dose, an even higher dose can be use with initial dose of 400 mg IV followed by 200 mg IV daily.

Caution: Tigecycline should be given slowly in 250 - 500 ml bag to avoid GI symptoms.

Reference(s):

Pharmacokinetic Considerations regarding Tigecycline for Multidrug-Resistant (MDR) Klebsiella pneumonia or MDR Acinetobacter Baumannii Urosepsis - Journal of Clinical Microbiology, May 2009, p. 1613, Vol. 47, No. 5

Question 36:

Case:

A 47-year-old male of Indian sub-continent origin is admitted into the ICU with status epilepticus. The patient has recently been started on TB prophylaxis medicine at his new work place. What is your probable diagnosis and what would be the treatment?

Answer:

Isoniazid (INH) induced seizures.

Rationale:

Isoniazid (INH) induced seizures is unique in the sense that it is usually refractory to standard anticonvulsant therapy. Even doses as low as 1.5 g can be neurologically toxic. INH induced seizure requires administration of a specific antidote, pyridoxine (B-6), with dose of 5 gram in IV form. Dose can be repeated 2 to 3 times if needed.

Question 37:

A 78-year-old male resident of assisted living facility presented to ED with severe pain going from "loin to groin". You suspect urosepsis. Indeed a urine analysis (UA) showed WBC, and nitrites. Urine PH is reported at 8. What would be your consideration in selecting antibiotics?

Answer:

Cover Proteus, Pseudomonas, or Klebsiella.

Rationale:
Urea-splitting organism such as Proteus, Pseudomonas, or Klebsiella are likely to cause urine pH greater than 8.0 - and should be covered with antibiotics while cultures are pending.

Question 38:
What are ESKAPE pathogens?

Answer:
The ESKAPE pathogens are six bad bugs on the loose!

Enterococcus faecium
Staphylococcus Aureus
Klebsiella species
Acinetobacter Baumannii
Pseudomonas Aeruginosa
Enterobacter species

These are biggest infectious threats in view of their rising resistance and no new novel antibiotics in the pipeline!

Question 39:
Should highly active antiretroviral therapy be prescribed in critically ill HIV-infected patients during the ICU stay?

Answer:
Yes

Rationale:
At least one study looked into this question and found decreased mortality rate over 6 months in critically ill HIV-infected patients taking HAART during intensive care unit stay.

Reference(s):
Agnes Meybeck, Lydie Lecomte, Michel Valette, Nicolas Van Grunderbeeck, Nicolas Boussekey, Arnaud Chiche, Hugues Georges, Yazdan Yazdanpanah and Olivier Leroy - Should highly active antiretroviral therapy be prescribed in critically ill HIV-infected patients during the ICU stay? A retrospective cohort study - AIDS Research and Therapy 2012, 9:27

Infectious Diseases - PEARLS

1. **Daptomycin and Eosinophilic pneumonia**

   Daptomycin may cause eosinophilic pneumonia, somewhere between 2 to 4 weeks after initiation of Daptomycin therapy. In 2010 seven confirmed cases were reported and 36 were suspicious of it. Symptoms resolved when Daptomycin was discontinued but recurred in two patients when the drug was restarted.

   Eosinophilic pneumonia should be suspected in patients receiving Daptomycin who develop new or worsening fever, cough or dyspnea. Peripheral eosinophilia may or may not be present, but BAL eosinophil counts are usually elevated.

   The primary treatment is discontinuation of Daptomycin, along with respiratory support and, +/-, steroids.

2. **Four generations of Quinolones**

   The classification of the Fluoroquinolones on the basis of generations (imitating from cephalosporins) is not officially standardized, but it is now commonly use to classify them by their spectrum of action.

   1st generation: Gram-negative coverage but not pseudomonas (example: Nalidixic acid).

   2nd generation: Gram-negative coverage with pseudomonas and some gram-positive coverage including Staphylococcus Aureus but not strep pneumonia (example: Ciprofloxacin, Ofloxacin, Norfloxacin).

   3rd generation: Gram-negative coverage with pseudomonas. More gram-positive coverage including penicillin sensitive and resistant s. pneumonia (example: Levofloxacin, Sparfloxacin, Gatifloxacin (Tequin), Moxifloxacin (Avelox)). Avelox has been said to be the most effective in this generation.

   4th generation: Same as 3rd generation but with anaerobic coverage (example: Trovafloxacin (Trovan).

   Reference(s):

   Comprehensive review on Quinolones (Source: Am Fam Physician 2002; 65:455-64, authors: CATHERINE M. OLIPHANT, PHARM.D. University of Wyoming School of Pharmacy and GARY M. GREEN, M.D., Kaiser Permanente, California)

3. **Cryptococcosis meningitis**

   5 tips for differentially diagnose cryptococcosis meningitis:

   1. Neck stiffness is uncommon rather non-specific signs may be present ranging anything from headache to coma including personality change.
   2. CT scan or MRI should be performed prior to Lumbar puncture (LP) and may present with specific findings of leptomeningeal enhancement and enlarged Virchow-Robin spaces. CT scan and MRI may be normal but if scan shows mass lesion (cryptococcomas), avoid LP and consult a neurosurgeon.

3. High opening pressure on LP (greater than 200 mm H_2O) is common and may have trio of low glucose, high protein and more lymphocytes but CSF may be normal. The cryptococcal organism is surrounded by a polysaccharide capsule, which may protect it from the host inflammatory response.
4. Make sure to send CSF for India ink.
5. Eye exam is essential to r/o optic neuritis, endophthalmitis or compressive optic neuropathy from high intracranial pressure. Quick treatment can salvage patient's vision and emergent ophthalmology and neurosurgical consults are indicated.

Reference(s):

1. Overwhelming CNS cryptococcus in AIDS - Neurology 2001 57: 1560
2. Central Nervous System Cryptococcal Invasion - hivinsite.ucsf.edu
3. Cryptococcal Meningitis Resulting in Irreversible Visual Impairment in AIDS Patients - A Report of Two Cases - SINGAPORE MEDICAL JOURNAL
4. Cryptococcosis - emedicine.com
5. CNS Infections Laboratory - ratsteachmicro.com

Airway / Mechanical Ventilation

Question 1:

How much Oxygen is recommended in emergent Angiocath Trans-tracheal Jet Ventilation (TTJV)?

Answer:

50 psi

Rationale:

A regular ventilation bag may not work with emergent Angiocath TTJV. You will need special equipment to connect to angiocath trans-tracheal jet to the oxygen source and provide Oxygen with 50 psi

Question 2:

A 32-year-old female is admitted to the ICU after cardio-pulmonary collapse secondary to Hanta Virus infection. What is the treatment of Hanta Virus Cardio-Pulmonary syndrome (HCPS)?

Answer:

Supportive - Probable ECMO insertion

Rationale:

Though ribavirin has been suggested in HCPS but has not shown any survival benefit. Research literature is available on the use of neutralizing antibodies (passive immunotherapy) for HCPS; but so far has not been used much in clinical practice. Supportive treatment is recommended until the symptoms are resolved.

Reference(s):

1. Mertz GJ, Miedzinski L, Goade D, et al. Placebo-controlled, double-blind trial of intravenous ribavirin for the treatment of hantavirus cardiopulmonary syndrome in North America. Clin Infect Dis. Nov 1 2004; 39(9): 1307-13.
2. Bharadwaj M, Nofchissey R, Goade D, Koster F, Hjelle B. Humoral immune responses in the hantavirus cardiopulmonary syndrome. J Infect Dis. Jul 2000; 182(1): 43-8.

Question 3:

What is the bedside trick to facilitate left lung intubation, assuming no other tools are available?

Answer:

Given the circumstances, the best way to facilitate left lung intubation, is to place the patient in right lateral decubitus and curving the tube to the left.

Question 4:

What is the right length of endotracheal tube (ETT) for oral intubation?

Answer:
As a golden standard the only way to make sure that tips of ETT is at least 2 cm away from carina (or at appropriate place) is via chest X-ray. But there are many bedsides quick tricks/formulae described in literature.

One such formula 1 which also found to have good clinical correlation, follows:
ETT length (incisors to midpoint of trachea, cm) = patient's height (cm)/10+5
Like, if patient's height is 170 cm, ETT should be taped at
170/10 + 5 = 22 cm

Another trick is to have ETT's cuff palpable at sternal notch, a technique described about 40 years ago.

Reference(s):
1. Anaesthesia Intensive Care 1992; 20:156;
2. Anesthesiology 1964; 25:169

Question 5:
What is the advantage of the Miller blade over the Macintosh blade?

Answer:
Traditionally, Macintosh has remained the blade of choice when intubating patients; as the curvature of the blade allows the tip to fall naturally into position in the vallecula of the patient; and the wide flange assists in holding the tongue safely aside during intubation. On the other hand, in a situation where vocal cords are not easily visible or in coagulopathic patients where concern of trauma and bleed is high, the Miller blade may provide some advantage. The narrower flange is designed to reduce trauma and the curved tip facilitates easy anterior lifting of the epiglottis. This allows greater exposure of the larynx.

It is a good practice to keep the Miller blade as a backup for the Macintosh blade, if vocal cord is hard to reach or hard to see even after appropriate alignment of 3 axes.

Question 6:
Are equal breath sounds a reliable indicator of proper placement of endotracheal tube?

Answer:
No

Rationale:
Equal breath sounds can be heard in up to 60% of right main stem intubations; nevertheless, a chest radiograph should always be done to confirm proper placement of ETT in ICUs. An end-tidal CO_2 monitoring just tells that you are in the right track. Fiberoptic bronchoscopy is a more reliable means of confirming ETT position. Recently, hand held ultrasound is suggested as a quick mean to confirm proper placement of ETT.

Reference(s):
1. Assessment of routine chest roentgenograms and the physical examination to confirm endotracheal tube position. - Chest1989; 96:1043-1045.
2. Anaesthesia Intensive Care 1992; 20:156
3. Where's the Tube? Evaluation of Hand-held Ultrasound in Confirming Endotracheal Tube Placement - Prehosp Disast Med 2004; 19(4): 366–369.

Question 7:

What is the basic difference between 2 major modes of bilevel ventilation - Biphasic and Airway pressure Release Ventilation (APRV)?

Answer:

"Bilevel" is relatively a newer mode of ventilation which allows the patient to breath normally at any level of PEEP. It is a pressure control (PC) mode of ventilation that allows both spontaneous and mandatory breaths. It has 2 levels of PEEP as follows:

1. High PEEP (PEEPH)
2. Low PEEP (PEEPL)

Biphasic: allows patient to breath at any level of PEEP.
APRV: allows patient to breath only at high PEEP. APRV has established Time High (TH) to breath on higher PEEP and smaller Time Low (TL) to relieve pressure.

Question 8:

A patient with CSF rhinorrhea and mandibular fractures for fixation. Neither oral nor nasal intubation preferred. Retromolar space not adequate. Tracheostomy is not indicated, planned to extubate immediately after surgery.

Answer:

Submental Orotracheal Intubation.

Rationale:

Incision is made anterior to facial artery (not the midline submental area which is conventionally the site of incision, on the surgeons request), blunt dissection with artery forceps till you get into the oral cavity, the tube is disconnected from its catheter, pilot balloon is deflated and grabbed with the artery forceps; and then delivered through the incision. Artery forceps is reintroduced, the tube is grabbed and delivered, and pilot balloon reinflated, then the tube is sutured into place. After surgery, sutures are cut, the tube is deflated and delivered through the incision, which is then closed.

Question 9:

What is the rule of thumb while applying tie to Tracheostomy tube?

Answer:

"Tight enough to slip one finger beneath the tie."

Rationale:
The tie around tracheostomy tube must be tight enough to secure the tube but should be loose enough to avoid skin breakdown and vascular obstruction.

Question 10:
How may PEEP contribute to induce pulmonary edema?

Answer:
PEEP may increase pulmonary edema by the following 2 factors:

1. Increasing intrathoracic pressure
2. Decreasing outflow of lymph

Question 11:
What is an appropriate way of estimating upper airway edema before extubation (cuff leak)?

Answer:
Exhaled tidal volume less than 10-12% of delivered tidal volume after deflating the cuff implies probable upper airway edema. The average difference between inspiratory and expiratory volume after cuff deflation should be recorded for at least six consecutive breaths.

Reference(s):
Tracheal extubation - Contin Educ Anaesth Crit Care Pain (2008) 8 (6): 214-220.

Question 12:
Case:
You intubated a 53-year-old short female without any complications. CXR showed ETT in right main stem. You instructed Respiratory Therapist (RT) to pull ETT by 3 cm. After adjustment, patient develops significant SQ emphysema along with periorbital swelling.

Answer:
Tracheal tear due to repositioning of the tube without cuff deflation.

Rationale:
Tracheobronchial laceration is a potentially serious complication of endotracheal intubation. It can occur following uneventful intubation. Most injuries are in the lower third of the trachea.

Most common causes include:

1. Over inflation of the cuff, resulting in necrosis of the mucosa after prolonged intubation

2. Repositioning of the tube without cuff deflation
3. Patient movement
4. Sudden increase in the intratracheal pressure caused by strong cough in the presence of the endotracheal tube
5. Inappropriate tube size
6. COPD
7. Conditions associated with a weakness of the membranous trachea (e.g., elderly patient, steroid therapy)
8. Patient suffering mucosal erosion or perforation of the anterior cartilaginous tracheal wall from the tip of the tube or the stylet

Reference(s):
A 63-Year-Old Woman with Subcutaneous Emphysema Following Endotracheal Intubation - Chest. 2005; 128:434-438

Question 13:

You decide to extubate a morbidly obese patient but weaning parameters are borderline. There is a good air cuff leak. Earlier notes indicate *difficult intubation* with non-visualization of vocal cords. What could be your option?

***Answer*:**
To extubate over exchange catheter and leave catheter inside respiratory tract till success of extubation is assured.

One study showed maintenance of airway up to 72 hours.
Make patient sit at 45-60 degrees in bed. Explain the discomfort. Preoxygenate with 100% oxygen for about 10 minutes. Check for cuff leak. Pass exchange catheter in ETT as much as can be tolerated gently, and extubate. Leave exchange catheter taped to patient's forehead. Another advantage is ventilation with catheter till ETT can be reinserted if required.

Reference(s):
1. The use of an endotracheal ventilation catheter in the management of difficult extubations - Canadian Journal of Anesthesia, Vol 43, 90-93,
2. Airway Management in Critical Illness - Chest. 2007; 131:608-620
3. Extubation of the Patient after a Difficult Intubation - Ann Thorac Surg 1998; 65:1778-1780

Question 14:

Concurrent use of which medications may exacerbate risk of adrenal insufficiency from Etomidate?

Answer:
Opioids or benzodiazepines

Rationale:
At least 2 studies showed that concurrent use of Etomidate with opioids and/or benzodiazepines might to exacerbate Etomidate related adrenal insufficiency. However,

solid evidence is lacking.

Reference(s):
1. Daniell, Harry (2008). "Opioid and benzodiazepine contributions to etomidate-associated adrenal insufficiency". Intensive Care Medicine 34: 2117–8.
2. Daniell, HW (2008). "Opioid contribution to decreased cortisol levels in critical care patients." Arch Surg 143 (12): 1147-1148.

Question 15:

What percentage of patients may experience post extubation stridor (PES)?

Answer:
About 15%

Rationale:
A low cuff-leak volume (less than 130 ml or 12%) around the endotracheal tube prior to extubation is helpful in identifying patients at risk for post-extubation stridor.
Racemic Epinephrine, Heliox and Decadron have been used as treatment for PES. It may require re-intubation in severe cases.

Question 16:

What is the desirable/optimum temperature for delivering humidification at trachea during mechanical ventilation?

Answer:
33 ± 2°C

Rationale:
Humidification during mechanical ventilation is necessary to prevent hypothermia, inspissation of airway secretions, destruction of airway epithelium, and atelectasis, when the upper airway is bypassed,. This may be achieved via either a heated humidifier or heat and moisture exchanger (HME). The apparatus should supply a minimum of 30 mg H2O/L of delivered gas at 33 ± 2°C.

Low temperature alarm should be set no lower than 30°C and high temperature alarm limit should not be set higher then 37°C.

Question 17:

Why is it that Etomidate may not be a good choice in neurological and neuro-surgical patients?

Answer:
It may decrease the seizure threshold.

Rationale:

Etomidate has fallen out of favor in medical ICUs for intubation due to its transient effect of causing adrenal insufficiency, which makes it undesirable in septic patients. Another less known side effect is its ability to decrease the threshold for seizure. Despite its effect on above 2 groups of patients, it is still a very valuable drug to use during intubation (at least in other patients) due to its quality of having minimal effect on hemodynamic changes, faster effect (15 sec) and quick recovery (3-7 mins). Adrenocortical suppression after single dose is transient which last for 12-36 hours.

Question 18:

Size of ET Tube (Endotracheal Tube) represents what? (Choose one).

A) Internal diameter of ETT
B) External diameter of ETT

Answer:

A: Internal diameter of ETT

Rationale:

The "size" of an ET tube refers to its internal diameter. Therefore a "size 7 " ET tube, means one with an internal diameter of 7 mm. ET tubes are usually labeled as ID (internal diameter) and OD (outside diameter).

Question 19:

Etomidate has its peak effect within how many minutes?

Answer:

One minute

Rationale:

Etomidate causes loss of consciousness after one arm-brain circulation time and has its peak effect around one minute.

Question 20:

What does this single or double mark near cuff of ETT means if present?

Answer:

Endotracheal tube should be placed in such a way that the vocal cords should be at the black mark (single mark) or if the ET tube has two marks then keep the vocal cords between the two marks. These markings help to provide a rough estimate. ET tube position depth should always be confirmed by other means as chest x-ray or bronchoscopy.

Question 21:

Name at least 3 general conditions beside genetic increased plasma cholinesterase activity, which may prolong succinylcholine action?

Answer:

1. Metoclopramide (Reglan) - which may prolong succinylcholine action due to effects on pseudocholinesterase.
2. Obesity - may cause resistance to succinylcholine due to more plasma cholinesterase activity.
3. In myasthenia gravis - due to reduced number of nicotinic, neuromuscular junctional receptors, which is the target for the drug succinylcholine. Movement of endotracheal tube (ETT) with neck

Question 22:

Extension of neck (Chin up) will cause ETT to migrate (up or down)?
Flexion of neck (Chin down) will cause ETT to migrate (up or down)?

Answer:

Extension of neck (Chin up) will cause ETT to migrate up. Flexion of neck (Chin down) will cause ETT to migrate down.

Remember:
Chin up - ETT up
Chin down - ETT down

Question 23:

Case:

You have been called to psychiatric floor to intubate a patient, who was found unconscious on floor. You felt thready pulse. You successfully intubated the patient and confirmed endotracheal tube placement by listening to bilateral chest and bright color change on CO_2 detector. While respiratory therapist (RT) was applying ET-holder you noticed that the Color change on CO_2 detector stopped and remained purple. What is your next step?

A. Change CO_2 detector and watch for color change.
B. You are probably in GI tract - so remove ET tube and reintubate.
C. Check for pulse and if no pulse is palpable, start CPR
D. Hook ET-tube to ventilator and watch for exhaled tidal volume
E. Ask nurse to check blood pressure with cuff

Answer:

C: Check for pulse and if no pulse is palpable, start CPR

Rationale:

Always remember, CO_2 detector may not change color if there is cardio-respiratory

collapse. The visible color change of carbon dioxide detection devices depends on a minimum concentration of the gas reaching the CO_2 detector. Pulmonary gas exchange (which is blood flow and delivery of CO_2 to the lungs is low) may be inadequate to deliver the required concentration of CO_2 to the detector device in cardio-respiratory collapse.

False-negative readings (failure to detect CO_2 despite tube placement in the trachea) have also been reported in association with patient suffering from pulmonary embolus because pulmonary blood flow and carbon dioxide delivery to the lungs are reduced. Additionally, CO_2 elimination and detection can be considerably reduced post intravenous epinephrine injection in patients with severe airway obstruction, such as status asthmaticus and pulmonary edema.

Another interesting scenario is that the CO_2 detector may show a consistent color rather than the breath-to-breath color change. This occurs, when the detector is contaminated with gastric contents or acidic drugs, such as endotracheally administered epinephrine.

In the event that patient appears hemodynamically intact, but CO_2 color change is not detected, a second method should be used to confirm endotracheal tube placement, such as direct visualization or the esophageal detector device.

Reference(s):
[Advanced Cardiovascular Life Support] Part 7.1: Adjuncts for Airway Control and VentilationCirculation: Volume 112(24) Supplement13 December 2005pp IV-51-IV-57

Question 24:

All of the following drugs can be given as epidural except?

A) Morphine,
B) Ketamine,
C) Clonidine
D) Lidocaine
E) Propofol

Answer: E (Propofol)

Propofol is obviously can't be given due to risk of sedation and has never been tried! Morphine, Ketamine and Lidocaine are well known to get used as epidurals. Objective of above question is to bring to attention the use of Clonidine as an epidural.

Rationale:
It is well established that clonidine is an effective analgesic, and this is attributable to its α2-agonist activity. A tremendous amount of modulation of incoming pain signals occurs in the dorsal horn of the spinal cord prior to being sent to higher centers in the CNS. Messages are either strengthened or attenuated by release of various neurotransmitters by primary afferent Aδ or C fibers, interneurons, and descending bulbospinal fibers.

Nociceptive stimuli will promote release of excitatory transmitters from primary afferents in the dorsal horn. To compensate, there is simultaneous release of norepinephrine from descending inhibitory bulbospinal neurons, which binds to α2-receptors in the dorsal horn to diminish afferent pain transmission, thereby producing analgesia.

Question 25:

What level of extrinsic PEEP should be applied to counteract (intrinsic) auto-PEEP?

Answer:
75 - 85% of auto-PEEP.

Rationale:
Keeping extrinsic PEEP lower than auto-PEEP not only helps in counteracting the auto-PEEP but also counters any circulatory depression or lung hyperinflation, which might have, happened at auto-PEEP.

Question 26:

A 52-year-old male with Grade 0 hepatic encephalopathy is intubated due to pneumonia. Is it good or bad to keep PH on alkalotic side? (Choose one).
A) Good
B) Bad

Answer:
B: Bad

Rationale:
Alkalosis may facilitate the conversion of Ammonium to Ammonia (NH4 + to NH3). Increased Ammonia level will make hepatic encephalopathy worse. There are 4 grades of hepatic encephalopathy but various factors may make it worse or better.

Grade 0 -Minimal hepatic encephalopathy (subclinical). Lack of detectable changes.
Grade 1 -Trivial lack of awareness. Shortened attention span. Impaired addition or subtraction. Hypersomnia, insomnia, or inversion of sleep pattern. Irritability. Mild confusion. Slowing of ability to perform mental tasks.
Grade 2 - Lethargy. Disorientation. Inappropriate behavior. Slurred speech. Obvious asterixis.
Grade 3 - Somnolent but can be aroused.
Grade 4 - Coma with or without response to painful stimuli.

Question 27:

Which liquid is used in Liquid Ventilation?

Answer:

Liquid ventilation is achieved via a liquid, perfluorocarbon (PFC). Perflubron has several unique features, which make it very efficient in ventilation and oxygenation.

1. Perflubron is an outstanding medium to help carry respiratory gases. PFC at one atmosphere of pressure can carry 20 times more oxygen than saline.
2. It is also used as a surfactant in premature infants, patients with ARDS or lung injury. In an ARDS, lung surface tension is noted to range between 67 and 75 dynes/cm. The surface tension in a lung with perflubron is only 18 dynes/cm, which helps prevent alveolar collapse as well as decreases alveolar opening pressures.
3. It spreads uniformly and quickly throughout the lungs when used for the management of ARDS or as a surfactant.
4. PFC is approximately twice as dense as water. It circulates in dependent areas as well as those areas where gas exchange is almost diminished. This feature is useful, in pulmonary edema.
5. Various components PFC are typically not taken up by the body but are evaporated by the lungs. Continuous administration is essential in order to adequate concentrations. This is possible, because it does not break down into toxic metabolites as is the case with high concentrations of gaseous oxygen.

Question 28:

Case:

You intubated a patient during cardiac arrest but Easy cap (CO2 detector) failed to change color. Should you re-intubate the patient?

Answer:

NO

Rationale:

During cardiac arrest, cardiac output is dependent on CPR and exhaled CO2 level is insufficient to produce color change despite endotracheal tube is in right position. In cardiac arrest, CO2 detector is not a reliable mean of confirming tracheal intubation.

Question 29:

Temperature around stored oxygen tanks in hospital / ICU should not exceed to what degree

Answer:

125ºF (52ºC)

When the oxygen tank is not in use valves should be kept close and oxygen tanks should be stored below 125°F (52ºC).

Airway / Mechanical Ventilation - PEARLS

1. **Bispectral Index (BIS) monitoring**
   BIS monitoring is an underutilize tool in ICUs particularly in patients on paralytics. Experts are still debating its full value.

   General guide regarding BIS monitoring level, if used:
   100 - 80: Awake or sedation is light.
   60 - 80: Respond to command but may not recall the event.
   40 - 60: Probably sedation is optimum.
   Less than 40: Deep sedation.
   0: No EEG like in barbiturate coma or deep hypothermia.

   Key is to monitor BIS sedation scale with hemodynamics together as BIS does not provide any measurement of analgesia, which may be needed simultaneously with sedation

   Reference(s):

   1. BIS Monitoring to Prevent Awareness during General Anesthesia - Anesthesiology: Volume 94(3) March 2001 pp 520-522
   2. BIS monitoring in ICU: advantages of the new XP generation - Critical Care 2002, 6(Suppl 1): P68
   3. Potential Benefits of Bispectral Index Monitoring in Critical Care: A Case Study - Crit Care Nurse 2003 Aug; 23(4): 45-52
   4. Use of BIS Monitoring Was Not Associated with a Reduced Incidence of Awareness - Anesth Analg.2005; 100: 1221

2. **CO-OXIMETRY**
   Interpretation of ABG can be divided into measured and calculated values. The PH, PaO_2 and $PaCO_2$ are the measured values and HCO_3 and SaO_2 are calculated values. As the SaO_2 is a calculated value, it does not reflect Methemoglobin and Carboxyhemoglobin levels and can misguide the management.

   The most accurate method of tracking the Methemoglobin and Carboxyhemoglobin is the Co-oximetry. The principle of operation is related to the Beer-Lambert law, which states that the amount of light absorbed by a substance is directly related to the concentration of the substance. The co-oximeter uses various wavelengths of light to measure the concentration of oxyhemoglobin, reduced hemoglobin, Methemoglobin and Carboxyhemoglobin.

3. **Ventilation during CPR - Dangers of 'over-bagging'**
   Per new ACLS guidelines, the rescuer should deliver a tidal volume sufficient to produce chest rise (approximately 6 to 7 mL/kg or 500 to 600 mL) over 1 second with 8-10 breaths per minute.

   The standard ventilation bag used in adult ICUs has a capacity of 1600 ml and over enthusiastic bagging can lead to further deterioration of cardio-pulmonary status, particularly when ETT is already in place, where all tidal volume gets

directly delivered to lungs. It may cause further decrease in cardiac output. In case of facemask ventilation, unrealized effect is over gastric inflation leading to regurgitation and aspiration. Moreover, gastric inflation elevates the diaphragm, restrict lung movement and decrease respiratory system compliance.

Sometimes it is preferable to do one handbag ventilation rather than two-hand ventilation to avoid 'over bagging'. Depending on hand size, grip strength, height and weight, tidal volumes delivered by two hands is significantly greater than those delivered by one hand.

Reference(s):
1. 2005 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care, Part 7.1: Adjuncts for Airway Control and Ventilation - Circulation. 2005; 112:IV-51 – IV-57
2. Comparison of tidal volumes obtained by one-handed and two-handed ventilation techniques, American Journal of Critical Care, Vol 2, Issue 6, 467-473

4. Barotrauma vs. Volutrauma

Barotrauma: It results in patients from -

A. High mean airway pressure
B. Presentation is usually sudden and dramatic
C. Is usually associated with mean airway pressure >35 mm hg
D. It can cause pneumothorax, pneumomediastinum or gas embolism.

Volutrauma: It occurs in patients due to -

A. Large fluctuations in the airway volume, creating alveolar distension
B. It is usually insidious and subclinical
C. Mostly happen in patients with tidal volume > 8ml/kg
D. It causes increase in atelectasis and pulmonary edema

5. Ventilation in Prone Position:

Study by Lee and colleagues showed that prone position has significantly reduced overall mortality in patients with severe acute respiratory distress syndrome. Longer duration of prone positioning was significantly associated with a reduction in overall mortality. Complications of prone position included pressure ulcer, tube displacement and major airway problems.

Reference(s):
Lee, Joo Myng MD, MPH; Bae, Won MD; Lee, Yeon Joo MD; Cho, Young-Jae MD, MPH - The Efficacy and Safety of Prone Positional Ventilation in Acute Respiratory Distress Syndrome: Updated Study-Level Meta-Analysis of 11 Randomized Controlled Trials - Critical Care Medicine: May 2014 - Volume 42 - Issue 5 - p 1252-1262

6. Mechanical Ventilation in Pregnancy

The indications for intubation of a pregnant patient are no different than the non-pregnant patient.

The guiding principle of ventilating the pregnant patient is ensuring adequate oxygen delivery. The goal is a PaO_2 of >90 mmHg.
Positive end-expiratory pressure (PEEP) should be applied to keep the FiO_2 <60%, but the patient should be kept in the left lateral decubitus position to minimize the effect of PEEP on venous return.

Permissive hypercapnia, a strategy used in acute lung injury, may lead to fetal distress. If higher $PaCO_2$ levels are being sustained in the pregnant patient, then continuous fetal monitoring is required.
Sedation with Propofol and opioid drugs are safe, though the fetus may need to be intubated on delivery as these drugs cross the placenta.

Benzodiazepines should be avoided as they have been shown to increase the incidence of cleft palate.
Higher than normal peak and plateau airway pressures can be expected on the ventilator: compression of the diaphragm by the gravid uterus will increase respiratory system elastance.

Fetal viability can be maintained while a patient is on mechanical ventilation, even during maternal brain death. Delivery or termination of pregnancy does not seem to improve the respiratory status of the mother, and therefore is not recommended.

7. **Rocuronium versus succinylcholine for rapid sequence induction intubation Cochrane Review**
Certain patients in emergency situations require a general anesthetic with an endotracheal tube (tube to assist them breathe). Fast acting medications are essential here, to allow physicians rapidly and safely complete this procedure. The muscle relaxant succinylcholine, is often used to achieve this. This agent is fast acting and lasts for only a few minutes which is ideal in this setting however, some patients cannot tolerate this medication, because it causes serious salt imbalances or reactions, thus an equally effective medication without such side effects is desirable. A meta-analysis compared one possible alternative, rocuronium, for quality of intubation conditions (ease with which physicians can rapidly and safely pass the endotracheal tube). This analysis of 37 studies, with a total of 2690 patients, compared the effects of succinylcholine with rocuronium on intubation conditions. Rocuronium was found to be less effective than succinylcholine in creating an excellent intubation environment. Thus rocuronium should be used as an alternative to succinylcholine.

8. **Use of Capnography in Assessment of CPR Adequacy**
Myocardial blood flow is determined by the difference between aortic diastolic and right atrial pressures. Because both aorta and atrium experience the same intrathoracic pressure change during cardiopulmonary resuscitation (CPR), myocardial blood flow is very poor during cardiac resuscitation. Even high compression forces that may generate acceptable systemic and pulmonary artery

pressures yield only small coronary perfusion pressures.
The arterial blood gas values during CPR manifest complex abnormalities. The reduction in cardiac output, and thus tissue perfusion, promotes anaerobic metabolism and lactic acidosis. However, arterial blood samples reflect either a normal or low PCO_2 during CPR, while venous blood gases manifest both a respiratory and metabolic acidosis.

When perfusion is absent in the presence of ventilation, the primary influence on arterial acid-base status is alveolar ventilation. Venous acidosis develops as tissue beds drain CO_2 and lactate is produced by anaerobic metabolism. The PCO_2 in pulmonary veins increases due to reduced pulmonary blood flow and a resulting decrease in CO_2 excretion.

With effective CPR or return of spontaneous circulation, pulmonary blood flow is improved and arterial pH decreases as more of the venous acid load (CO_2 and lactate) reaches the arterial side. Aerobic and anaerobic metabolism produce carbon dioxide that is transported in venous blood to the lung and eliminated from the lung by minute ventilation. End-tidal CO_2 is a measure of the partial pressure of carbon dioxide at the airway opening at the end of expiration.

During cardiac arrest, the abrupt decrease in cardiac output results in reduction of carbon dioxide transport from the tissues to lung and, hence, decreased carbon dioxide. More recently, capnography has been used to determine the adequacy of cardiopulmonary resuscitation.

9. Cuff leak test - to anticipate post-extubation stridor

There are at least 3 common ways to do a cuff leak test to anticipate post extubation stridor but none has been really tested in a big scientific randomized trial. And literature is full of conflicting studies.

1. Bedside crude method: Deflate the cuff, +/- occlude the ETT and put your hand at mouth to feel exhaled air (Is it not brutal?).
2. Record the difference between the inspiratory tidal volume and the expiratory tidal volume while the cuff around the endotracheal tube was deflated. (Average of any three values on six consecutive breathes). Cuff leak less than 110 mL is more associated with post extubation stridor.
3. Record the difference in exhaled tidal volume from before to after endotracheal tube cuff deflation. Divide this number by the exhaled tidal volume before cuff deflation. Your answer is 'percent cuff leak'. Patients with a cuff leak of less than 10% are at risk for stridor or reintubation.

   Some other methods like laryngeal ultrasound have also been described in literature. Also, experts recommend testing the ability to expel secretions with an effective cough. Be aware, a low value for cuff leak may actually be due to encrusted secretions around the tube rather than to a narrowed upper airway. Reintubation equipment (including tracheostomy

equipment) should be readily available during extubation and immediate post extubation period.

10. Law of LaPlace, PEEP and surfactant

Law of LaPlace tells us "Pressure is always greater in smaller radius".
$P = 2T/r$
where P = pressure, T = tension and r = radius

So in lungs, smaller alveoli will have greater resistance for air to flow during inspiration because of higher pressure. We use PEEP to keep alveoli open during expiration (prevent derecruitment), as the name says, positive end-expiratory pressure. High tidal volume cause more shear force damage to smaller alveoli with each breath to overcome this pressure. That is why our present approach to ventilator management in ARDS is low tidal volume and optimum PEEP (See ARDSnet).

11. Lower Tidal Volume/ Higher PEEP Reference Card

Looking at same formula, another approach is to decrease tension, by nature's method of applying a surfactant. One study published in August 2004 looked into 'Effect of Recombinant Surfactant Protein C–Based Surfactant on the Acute Respiratory Distress Syndrome' and found no significant difference in terms of 28-days mortality or the need for mechanical ventilation but also showed that Patients receiving surfactant had a significant greater improvement in blood oxygenation during the first 24 hours of treatment than patients receiving standard therapy. Actually literature suggests that, "Sufficient levels of PEEP will also help to prevent further loss of surfactant in still 'healthy' alveoli…"

Reference(s):
1.Effect of Recombinant Surfactant Protein C–Based Surfactant on the Acute Respiratory Distress Syndrome - Volume 351:884-892, Number 9, NEJM Aug. 26, 2004
2. Higher versus Lower Positive End-Expiratory Pressures in Patients with the Acute Respiratory Distress Syndrome - The National Heart, Lung, and Blood Institute ARDS Clinical Trials Network, Volume 351:327-336, Number 4, NEJM, July 22, 2004

12. The Bohr Effect and Permissive Hypercapnia

One of the physiologic basis of permissive hypercapnia is to increase unload of oxygen to tissues under decrease PH, call the *Bohr effect*. The *Bohr effect* is an adaptation to release oxygen to the starved tissues in conditions where respiratory carbon dioxide lowers blood pH. When blood pH decreases, the ability of hemoglobin to bind to oxygen decreases, classically said "shifting of oxygen dissociation curve to the right", although the SaO_2 may be relatively low. This leads many experts to ask the question, "Is permissive hypoxemia really bad?"

In depth, there are many other implications of permissive hypercapnia including suppressive effects on inflammatory mechanisms that may contribute to lung protection with therapeutic hypercapnia.

Reference(s):
1. Respiratory Function of Hemoglobin - Volume 338:239-248, January 22, 1998
2. Permissive Hypoxemia: Is It Time To Change Our Approach? Abdelsalam Chest.2006; 129: 210-211

13. Revisiting Rapid Sequence Induction (RSI) protocol

RSI protocol is aimed at quick, safe and organized emergent endotracheal intubation by using several medications. Very important consideration to remember is, unlike planned intubation for anesthesia, we should presume that patient's stomach might be full and complication like aspiration can happen.

Medications fall into three categories:

1. Pretreatment agents:
   A. Oxygen, use 100% with reservoir mask, avoids positive pressure ventilation.
   B. Fentanyl (3mcg/kg)
   C. Lidocaine may suppress the cough reflex (1.5 mg/kg)
   D. Atropine may decrease the bradycardia

2. Induction agents:
   A. Pentothal (4 mg/kg)
   B. Etomidate (0.3 mg/kg) (may induce adrenocortical dysfunction)
   C. Ketamine (1-2 mg/kg)
   D. Midazolam (0.25 mg/kg)
   E. Propofol

3. Paralyzing agents:
   A. Succinylcholine (2mg/kg) - may induce hyperkalemia
   B. Vecuronium (0.15 mg/kg),
   C. Rocuronium (0.8 mg/kg)

Reference(s)
Airway Management of the Critically Ill Patient Rapid-Sequence Intubation, Chest. 2005; 127:1397-1412
Rapid Sequence Induction (emdicine.com)

14. Does heated humidifier reduces the risk of Ventilator-Associated Pneumonia (VAP)?

Most of the VAP bundle guidelines do not include the type of humidifier to reduce the risk of VAP, although that is the first therapy in direct contact with respiratory tract.

In a paper published in Critical Care, authors studied 104 patients, who required mechanical ventilation more than 5 days. Patients were assigned either to heat and moisture exchangers (HME) (n = 53) or heated humidifiers (HH) (n = 51) VAP was found in 8 of 51 (15.69 %) patients in the HH group and in 21 of 53 (39.62 %) in the HME group. The median time free of VAP was 20-days for

HH and 42-days for HME group.

Study concluded that the patients who were mechanically ventilated for more than 5 days developed a lower incidence of VAP with a heated humidifier than heat and moisture exchanger.
* HH: In the active humidifiers, called heated humidifiers (HH): the inspired gas passes across or over a heated water bath. In this study HH was provided at 37º C and 100 % relative humidity to the proximal airway (containing approximately 44 mg of water/L of gas).

HME: Passive humidifier, called heat and moisture exchanger (HME), trap heat and humidity from the patient's exhaled gas and returns some of that to the patient on the subsequent inhalation.

Reference(s):
Ventilator-associated pneumonia using a heated humidifier or a heat and moisture exchanger- a randomized controlled trial - Critical Care 2006, 10:R116

15. Basics of High Frequency Oscillatory Ventilation (HFOV)

Editor's Note: Setup and management of HFOV should be done under experienced physician. Following are just basics to understand the dials and simple maneuvers for the beginners. Other details can be found in literature somewhere else.

HFOV is not an initial form of mechanical ventilation. It always gets transit from conventional mechanical ventilation.

Indications:
Patients with severe ARDS having Pplat more than 30 - 35 cm H_2O along with high FiO_2 and worsening acidosis and all conventional mode of ventilation is exhausted.

Check for the following things before initiating HFOV:

1. Need of suction. Bronchoscope should be done in conventional mode before switching to HFOV.
2. Good sedation, analgesia, and possible need of neuromuscular blockade.
3. Ensure euvolemia. Initial phase of HFOV may drop BP in hypovolemia. Initial Settings (RTs usually do the rest but you have to provide MAP, frequency and amplitude).

A) TO IMPROVE OXYGENATION

Mean Airway Pressure (MAP): Initiated at 5 cm H_20 higher than the MAP during conventional ventilation. The MAP should be raised only in 2-3 cm H_2O increments at 30 - 60 minute intervals to improve oxygenation. Ideal is not to

exceed beyond 35 cm H_2O.
FiO_2: Start at 1.00 and wean slowly towards .4
IT or I: E ratio: Set IT to 33% (can go up to max of 50% if difficulty with oxygenation)
Flow: Start at 15 LPM but increase if oxygenation remains issue.

B) **TO CORRECT HYPERCAPNIA**
Amplitude of oscillation (P): The amplitude is initiated at either a value where vibration can be seen down to mid-thigh. Amplitude is increased by 10 - 20 cm H_2O (value runs from 0-100 cm H_2O). You may start arbitrarily somewhere between 70 - 90 cm H_20.

Frequency:
It can be set arbitrarily at 5 Hz. Some experts prefer initial setting at 7 and target to go up, as oxygenation gets better (Value runs from 3-15 Hz).

The most important trick to remember is:
Increasing the amplitude and decreasing the frequency (Hz) will lower the $PaCO_2$. Conversely, decreasing amplitude and increasing frequency (Hz) will increase $PaCO_2$. If $PaCO_2$ worsens, increase amplitude in 10 cmH_2O increments every 30 minutes. After maximum amplitude is achieved, and oxygenation remains poor, decrease Hz to the minimum setting of 3 Hz.

Weaning:
Wean FiO_2 first.
Second wean MAP slowly 2-3 cm H_2O at a time till reach at least 24 cm H_2O.
Switch to conventional ventilator once patient is stable.

Complications:
ETT obstruction - suction
HYPOTENSION - IVF boluses or pressor as clinically indicated
PNEUMOTHORAX - Watch for chest vibration (stethoscope does not work due to noise) or quickly rising PCO2 or desaturation. Confirm PTX with CXR.

16. Differences Between Venoarterial and Venovenous Extracorporeal Membrane Oxygenation
Venoarterial ECMO

1. Higher PaO_2 is achieved
2. Lower perfusion rates are needed.
3. Bypasses pulmonary circulation
4. Decreases pulmonary artery pressures
5. Provides cardiac support to assist systemic circulation
6. Requires arterial cannulation

Venovenous ECMO

1. Lower PaO_2 is achieved.

2. Higher perfusion rates are needed.
3. Maintains pulmonary blood flow
4. Elevates mixed venous PO_2
5. Does not provide cardiac support to assist systemic circulation

17. A note on hyperkalemic response after succinylcholine administration

Not all patients have an exaggerated hyperkalemic response after succinylcholine administration. However, patients with conditions involving central and peripheral motor neurons, such as encephalitis, stroke, intracranial tumors, cerebral aneurysms, head trauma, spinal cord injuries, Guillain-Barre syndrome, and myopathies, may develop severe hyperkalemia after succinylcholine administration. Hyperkalemia has also been observed during the prolonged immobility of patients with burns or intraabdominal infections and in patients receiving other nondepolarizing neuromuscular blocking agents. Also, preexisting hyperkalemia may be exacerbated in patients with chronic renal insufficiency.

18. Esophageal Pressure Measurements and compliance

At bedside compliance is measured as
Cs = Vt / Ppl - (PEEP + auto PEEP)
Where Cs = compliance of static thorax, Vt = tidal volume, Ppl = plateau pressure and PEEP is positive-end-expiratory pressure
or in more precise terms
C stat = Vt / (Pao end'inhalation - Pao end'exhalation)
Where Pao = pressure at the airway opening. Pao end'inhalation is same as Ppl. and Pao end'exhalation is same as Total PEEP.
This compliance measures the whole thorax including chest wall and lungs. Normal Cs is ideally 100 ml/cm H_2O or practically 50 to 80 ml/cm H_2O is acceptable.

Placement of esophageal catheter can give lung compliance (CL) and chest wall compliance (Ccw) separately. Formulae are
CL = Vt / (Pao - Pes) end'inhalation - (Pao - Pes) end'exhalation
and
Ccw = Vt / (Pes - Patm) end'inhalation - (Pes - Patm) end ‘exhalation
or practically done simply as Ccw = Vt / Pes end ‘inhalation
Where Pes = Esophageal pressure and P atm = Atmospheric pressure
Normal CL and Ccw is 200 ml/cm H_2O.

19. Cricoid Pressure - Avoiding the pitfall

There is a tendency to apply cricoid pressure on every patient during intubation however, in difficult intubation; use of cricoid pressure is debatable. It is recommended only with deep sedation to avoid laryngospasm, and known to be ineffective and potentially dangerous in a patient who still has some reflexes. Rapid sequence intubation is to be used with cricoid pressure to minimize the risk of regurgitation and aspiration.

20. Preventing sympathetic surge during head injured patient's intubation

Orotracheal intubation cause sympathetic surges resulting in increase ICP (intracranial pressure). Despite no definite answer, endeavors continue to minimize iatrogenic expansion of hematoma. 3 drugs have shown some neuroprotective benefit during intubation of spontaneous or traumatic brain injury although they remained controversial and their benefit never get purely established.

1. ***Lidocaine:*** One study 25-years ago (but later studies were negative) showed that about 100 mg of Lidocaine (1.5 mg/kg), blunt ICP by approximately 15 mm Hg with tracheal suctioning 1.Mechanism of action is not entirely clear but probably Lidocaine decreases cough reflex and dysrhythmias. No studies document any harmful effects of prophylactic Lidocaine 2.

2. ***Fentanyl:*** Idea is to achieve sympatholysis and block hypertension and tachycardia. Dose of 2.5-3 μg/kg has been found to be without risk of hypotension.

3. ***Esmolol:*** Here again, goal is to achieve sympatholysis. Esmolol with dose of 100-200 mg has effect said to be superior to fentanyl and markedly superior to Lidocaine 3, 4.

   Combinations of above drugs have been described to have synergistic and better effect than using them alone, either Esmolol and fentanyl or fentanyl and Lidocaine.

Reference(s):

1. Intravenously administered lidocaine prevents intracranial hypertension during endotracheal suctioning. Anesthesiology 1980; 52:516-8

2. Prophylactic lidocaine use preintubation: a review - J Emerg Med. 1994 Jul-Aug; 12(4): 499-506.

3. Attenuation of hemodynamic responses to rapid sequence induction and intubation in healthy patients with a single bolus of Esmolol. J Clin Anesth 1990; 2:343-52.

MEDICATIONS

Question 1:
How frequent tubing for Propofol infusion should be changed?

Answer:
12 hours

Rationale:
Recommended time period to change tubing for prolonged Propofol infusion is about 12 hours. This is due to Propofol's lack of preservatives and its ability to support the growth of microorganisms.

Question 2:
What is the conversion equivalence of Bumex to Lasix?

Answer:
1 mg of Bumex is equal to 40 mg of Lasix.

Question 3:
Which medicine may cause "bluish" discoloration of skin, known as "The blue man syndrome"?

Hint: It is a heart medicine and may cause brownish hyperpigmentation of skin as well.

Answer:
Amiodarone

Rationale:
About 5% (some literature described up to 26%) of patients develop skin pigmentation from photosensitivity while on Amiodarone treatment depending on dose and length of treatment. It is suggested that that ultra violet light exposure induces vasodilatation and causes increase in diffusion of Amiodarone and its metabolite desethylamiodarone in perivascular tissue, which results in chronic accumulation of the drug. On histology, lipofuscin-laden macrophages are seen.

Question 4:
Case:
You admitted a patient in ICU with COPD exacerbation, requiring mechanical intubation. You started patient on cocktail of nebulizer treatments, IV steroid, antibiotic coverage, standard ICU prophylaxes and Propofol for short term sedation as you expected recovery and extubation within 48-72 hours. Next day, nurse noticed ST elevation in V2 lead. You ordered EKG (ECG) and indeed new ST elevations noted in leads V1 to V3 changes along with Right-Bundle-Branch-Block (RBBB). You acquired cardiology consult and

cardiologist was excited to report you that this is a Brugada syndrome. As far as you remember, Brugada syndrome is a hereditary and a genetic disease. And you are wondering - isn't the EKG was normal on admission?

Answer:
Propofol induced EKG findings look like Brugada syndrome.

Rationale:
The Brugada syndrome is a genetic syndrome said to be autosomal dominant associated with SCN5A gene. Clinically, it appears as EKG findings of right bundle branch block and ST segment elevation in V1 to V3 (J point elevation) with a structurally normal heart. It goes unnoticed and cause either syncopal episodes or sudden death. Mean age of death is 40 years but can happen at any point in lifetime. It is very common in Asian people and acquired different names as Lai Tai (death during sleep) in Thailand, Bangungut (scream followed by sudden death during sleep) in Philippines and Pokkuri (unexpected sudden death at night) in Japan.
Recently, it has been reported in Heart Rhythm that Brugada syndrome like EKG findings may be the earliest finding of Propofol infusion syndrome (PRIS) and early recognition with discontinuation of Propofol may save lives as mortality of PRIS is more than 80%.

Reference(s):
Electrocardiographic changes predicting sudden death in propofol-related infusion syndrome- HeartRhythmVolume 3, Issue 2, Pages 131-137 (February 2006)

Question 5:
Which 3 major clinical signs may help in differentiate Propofol infusion syndrome (PRIS) from other conditions particularly septic shock?

Answer:
In the presence of Propofol infusion, if following triad is present, its Propofol infusion syndrome - proved otherwise.
Bradycardia
Hyperlipidemia
Rhabdomyolysis

Question 6:
What is the time limit on use, once the vial is broken on Propofol bottle?

Answer:
When Propofol is used as an anesthetic from a vial as in intubations or cardioversion, the infusion be completed within 6 hours after the vial is opened. Any unused portion of Propofol must be discarded at the end of the procedure or at 6 hours, whichever occurs sooner. In the ICU, if Propofol is administered directly from its original container, the

tubing and any unused portion must be discarded after 12 hours (some places allow up to 24 hours). The infections appear to be a risk factor in prolonged unused Propofol.

Question 7:

Which very commonly used drug in ICU may increase the level of Fenoldopam by 30-70% when administered concurrently?

Answer:

Acetaminophen (Tylenol or Paracetamol)

Rationale:

Fenoldopam is a short-acting dopamine agonist (DA1), which is used in the management of severe hypertension. It increases the renal blood flow and sodium excretion. It is 10 times more potent than dopamine as renal vasodilator. Initial dose is 0.1-0.3 mcg/kg/min IV and should be increased cautiously to avoid reflex tachycardia in increments of 0.05-0.1 mcg/kg/min IV q15 min until target blood pressure achieved.

Fenoldopam is relatively contraindicated or should be used with caution in patients with glaucoma and angina. It may cause hypokalemia due to diuresis. Acetaminophen may increase levels by 30-70% when administered concurrently. Also concurrent use of beta-blockers may increases the risk of hypotension.

Question 8:

Why is taking Demerol PO not a good idea?

Answer:

Overall, Demerol (meperidine) is falling out of favor and has been referred by many as *demon* due to neurotoxicity of its metabolite normeperidine. Fortunately PO (by mouth) Demerol is not as popular as IV but it should be avoided at all. PO Demerol is way more dangerous than IV Demerol. 50% of PO Demerol get metabolized first pass via liver and give high level of normeperidine in blood which has long half life of 15-30 hours even with normal kidney function and may accumulate to cause tremors, myoclonus, hallucinations and seizure. Hemodialysis has been described to help in normeperidine toxicity.

Question 9:

Once patient receive Digoxin Fragmented Antibody (DIGIFAB or Digibind), how frequent digoxin level should be measured?

Answer:

Digoxin level after giving Digibind will rise and will remain distorted for about 7 days. This is due to ability of Digibind to pull all of the digoxin into blood stream. These are inactive fragments and not toxic. There is no need to follow Dig level after administration of Digibind, as it will be erroneously high and misleading.

Question 10:

Case:

A 58 year-old female was admitted to the ICU with exacerbation of Asthma. The patient is on Coumadin 5 mg per day due to previous DVT, which was continued in the ICU. INR on admission was therapeutic with 2.6. Patient was intubated and started on IV steroid along with antibiotic (Ceftriaxone) and other home medications. Standard ICU protocols for GI prophylaxis with esomeprazole, blood sugar control, enteral nutrition and head of bed elevation were also initiated. Progressively INR continues to rise and on 6th day in the ICU, GI bleeding developed. Which medicine may have interacted with Coumadin to increase INR and subsequently GI bleeding?

Answer:

Esomeprazole (proton pump inhibitor).

Rationale:

Concomitant use of warfarin (Coumadin) and esomeprazole therapy may increase INR, and supratherapeutic prothrombin time can cause abnormal bleeding and even death. Extreme caution needs to be taken who are on concomitant warfarin and proton pump inhibitors and they should be monitored closely for increases in INR and prothrombin time.

Question 11:

Case:

You have a patient in the unit whose blood sugar is hard to control despite aggressive insulin therapy. You wrote an order to prepare all drips and medications in either 0.9 or 0.45 NS (Normal Saline), as far as compatible. Next day, you noticed that pharmacy continued to prepare norepinephrine (levophed) drip in mix with D5W. What do you think?

Answer:

Norepinephrine (levophed) is less stable in normal saline (it looses its potency from oxidation). Dextrose contains solution is preferred, as the dextrose protects against oxidation of the norepinephrine and keeps it active and stable.

Question 12:

Case:

A 39-year-old male is admitted with hypertensive emergency after he ran out of his prescriptions. The “ED Doc” started patient on IV Cardene (Nicardipine) drip and resumed the patient's home medications for BP, which consist of Toprol (Metoprolol) XL - first dose given in ER. On review of CXR you noticed some pulmonary edema and decide to switch to Fenoldopam to get a dual effect of lowering BP as well as

dopaminergic effect to resolve pulmonary edema. Patient dropped his BP precipitously and coded.

Answer:
Probable cause: It is not advisable to start Fenoldopam on patients with β-blocker or at least close caution should be maintained. Concomitant use of beta-blockers in conjunction with Fenoldopam may cause life-threatening hypotension from beta-blocker's inhibition of the sympathetic reflex response to Fenoldopam.

Question 13:

Case:
You have a patient that has been diagnosed with Vancomycin-resistant enterococci (VRE) and has been started on linezolid (Zyvox). While evaluating the patient at your bedside you saw a bag labeled with linezolid, due to be infused in 30 minutes. What would be your instruction to pharmacy?

Answer:
To protect the infusion bag of linezolid from light. Linezolid infusion bags need to be protected from light while awaiting infusion to avoid degradation. Once infusion is started, bag can be unwrapped. Note: IV Zyvox may exhibit a yellow color that can intensify over time, but it is a benign effect and does not affect potency.

Question 14:

What is the best time to draw Vancomycin level in chronic intermittent haemodialysis patients?

Answer:
Vancomycin (random or trough) level in patients undergoing chronic intermittent haemodialysis should be drawn ideally before the hemodialysis session. Or at least 6 hours after the dialysis session.
The Vancomycin plasma concentration decreases dramatically during the dialysis session and then gradually increases when the session is stopped for 4–6 hours. Drawing level during dialysis session or too soon after the session may give falsely low trough level.

Question 15:

Intestinal bacteria synthesize a large amount of *Vitamin K*. Taking broad-spectrum antibiotics can destroy how much of that capacity?

Answer:
2/3rd

Rationale:
Broad-spectrum antibiotics can decrease *Vitamin K* production in the gut by nearly 75% in patients compared with the patients who are not on broad-spectrum antibiotics.

Question 16:
What is the ratio of alpha and beta blockade in Labetalol?

Answer:
As an anti-hypertensive, Labetalol has both alpha-blockade and beta-blockade activity. The ratio of alpha to beta blockade activity is:
1:3 when used orally
1:7 when used intravenously

Question 17:
Why does IV Amiodarone cause hypotension?

Answer:
Hypotension from IV Amiodarone (particularly bolus) is not due to Amiodarone itself but due to its solubilized vehicle called polysorbate 80.
Polysorbate 80 can decreases heart rate by depressing AV nodal conduction and has the property of increasing atrial and ventricular myocardial refractory period; but can also cause hypotension due to histamine releasing effect. Polysorbate 80 is also blamed for Acute Amiodarone-induced hepatitis but literature is scant on it.

Reference(s):
1. Pharmacology and Toxicology of a New Aqueous Formulation of Intravenous Amiodarone (Amio-Aqueous) Compared with Cordarone IV. - American Journal of Therapeutics. 12(1): 9-16, January/February 2005.
2. Effects of amiodarone with and without polysorbate 80 on myocardial oxygen consumption and coronary blood flow during treadmill exercise in the dog - J Cardiovasc Pharmacol. 1991 Jul; 18(1): 11-6.
3. Histamine-releasing properties of Polysorbate 80 in vitro and in vivo: correlation with its hypotensive action in the dog - Agents Actions, 1985 Sep; 16(6): 470-7.

Question 18:
What is the advantage of Meropenem over Imipenem or Imipenem-Cilastatin (Primaxin)?

Answer:
It does not carry the risk of seizures!

Question 19:
How much time does it take for Esmolol to reach steady-state blood levels, if you do not use a loading dose for Esmolol infusion?

Answer:
It takes five minutes to achieve the steady-state levels of Esmolol after the appropriate loading dose of 50-300 mcg/kg/min (0.05-0.3 mg/kg/min). If the appropriate loading dose is not used, then it may take up to 30 minutes to reach the steady state

Esmolol dosing guideline:

The loading dose of 0.5 milligrams/kg (500 micrograms/kg) is infused over one minute.

The loading dose is followed by a maintenance infusion of 0.05 milligrams/kg/min (50 micrograms/kg/min) for the subsequent 4 minutes.
After these initial treatments, the maintenance regimen is adjusted to achieve the desired heart rate. The infusion may be continued at a rate of 0.05 mg/kg/min or increased step-wise (0.1 mg/kg/min, 0.15 mg/kg/min to a maximum of 0.2 mg/kg/min) with each step being maintained for approximately 4 or more minutes.

In situations where rapid slowing of heart rate is needed, the 0.5 mg/kg-loading dose infused over a 1-minute period can be repeated, followed by a maintenance dose of 0.1 mg/kg/min over 4 minutes. Depending on the heart rate, another (final) loading dose of 0.5 mg/kg/min infused over a 1-minute can be administered followed by a maintenance dose of 0.15 mg/kg/min. If necessary , after 4 minutes of the 0.15-mg/kg/min-maintenance dose, the maintenance regimen can be increased to a maximum dose of 0.2 mg/kg/min.

Without loading doses, constant infusion of a particular regimen of eEsmolol reaches pharmacokinetic and pharmacodynamics steady state within 30 minutes.
Maintenance regimens (with or without loading doses) can be continued for up to 24 hours.
Source: www.rxlist.com

Question 20:

What is dose dumping?

Answer:

Dose dumping is a phenomenon of drug metabolism in which environmental factors causes the premature and mostly exaggerated release of a drug, causing particular drug toxicity. Most common reason of drug dumping is taking fatty meals with a particular drug that increases drug delivery. It is mostly described with extended release forms of drug.

Various explanations have been given, including breakdown of the drug's capsule or stimulation of the body's absorptive surfaces to increase the drug uptake.
Alcohol is another major factor, which may cause drug-dumping syndrome.

Question 21:

What is Hemodialysis induced Vancomycin rebound phenomenon?

Answer:

At the end of hemodialysis session there is a rebound in Vancomycin plasma concentration. A vancomycin concentration decrease significantly during the hemodialysis session and then increases when the session is finished. This rebound may occur a result of drug recirculation from plasma protein binding sites.

Clinical Significance: This rebound may be clinically significant, and care must be taken when determining Vancomycin trough levels. Due to this reason, it is usually suggested to perform Vancomycin trough levels before the hemodialysis session.

Reference(s):

Clinical review: Use of vancomycin in hemodialysis patients Crit Care. 2002; 6(4): 313–316

Question 22:

A 72-year-old male, nursing home resident, admitted to ICU for Pneumonia and getting treated with Linezolid started having fever, agitation and myoclonus which is more pronounced in the lower limbs than in the upper limbs. What should your concern be?

Answer:

Serotonin Syndrome

Rationale:

One of the clinical diagnostic clues of Serotonin Syndrome is hyperreflexia and clonus more pronounced in the lower extremities than upper, at least in the moderate cases.

Question 23:

Name at least 3 antibiotics/medicines, which may be, use as adjuvant in treatment of *Clostridium difficile* colitis along with Flagyl or Vancomycin?

Answer:

Actually there are many antibiotics, which have shown partial or full activity again *Clostridium difficile*. To name few for use particularly in suspected resistant out breaks are:

A. Rifampin,
B. Linezolid,
C. Fluoroquinolones,
D. Teicoplanin,
E. Cholestyramine (anion-exchange resin agents),
F. Nitazoxanide,
G. Rifaximin,
H. Tinidazole,
I. Probiotics

Question 24:

Case:

A 79-year-old male, nursing home resident, with abdominal pain, nausea, vomiting, and diarrhea is admitted to ICU with significant hemodynamic instability. While reviewing previous discharge summaries, you found multiple reports of positive stool for *Clostridium difficile*, with successful treatment using *Flagyl*. You started patient on appropriate broad range antibiotics including *Flagyl*. Patient responded well to treatment and is getting transferred out of the ICU after 2 days but before transfer you received strange call from nurse, stating that the patient's urine is black! Will you hold the transfer?

Answer:
No

Rationale:
Metronidazole (Flagyl) induced change of urine color.
Black urine is a rare but benign side effect of Flagyl. The actual metabolite responsible for this phenomenon has not been positively identified yet, but fortunately it has no clinical significance.

Question 25:

Why Haldol (Haloperidol) should be use with caution in burn patients?

Answer:
Neuropsychiatric complications are commonly seen in major burn patients. Haloperidol is frequently used to treat severe psychopathic behavior. The Haldol due to its extrapyramidal side effect may increase the tendency of severe muscle rigidity especially in burn patients. Haloperidol is associated with an imbalance of dopaminergic and cholinergic neuronal activity in the basal ganglia with relative increase in cholinergic activity, responsible for extra pyramidal effects. Burn patients may be more prone to extrapyramidal symptoms because of increased sensitivity of skeletal muscle neuromuscular junctions to acetylcholine post thermal injury.

Reference(s):
Haloperidol Complications in Burn Patients. Journal of Burn Care & Rehabilitation. 8(4): 269-273, July/August 1987

Question 26:

Nicardipine is a Calcium Channel Blocker (CCB) but how it is distinct from other CCBs?

Answer:
Nicardipine (Cardene) is a Calcium Channel Blocker with distinction that it has highly vascular selective calcium channel blockade. It has strong cerebral and coronary vasodilatory effect. It has non-to minimal effect on left ventricular function and conduction. It is now preferred drug of choice as IV infusion in hypertensive crisis.
For rapid blood pressure control, therapy is initiated at a loading dose of 5 mg/hr. and titrated by 2.5 mg/hour every 5 minutes up to 15 mg/hour until the desired results are

achieved. For gradual reduction in blood pressure, the infusion rate is increased every 15 minutes until desired blood pressure is reached.

Question 27:

Case: While you are carrying 'code beeper' as an intensivist, you heard 'code blue in cafeteria'. On arrival you found 36 year old female who was in cafeteria after visiting allergy clinic, where according to daughter she received her 'expensive asthma shot'. While you were resuscitating patient from what appears to be anaphylactic shock, you keep wandering about that 'expensive asthma shot'.

Answer:

Omalizumab (Xolair) is the subcutaneous injection treatment for allergic asthma that works by blocking immunoglobulin E (IgE). Anaphylaxis is rare but the tricky part is it may cause anaphylaxis even after months of successful and uneventful treatment. There is an indication in at least one case report that polysorbate present in Omalizumab may be responsible for it 1.

Question 28:

How Dexilant (Dexlansoprazole) is different from other PPIs (Proton Pump Inhibitors)?

Answer:

Dexilant is known to have a dual delayed release mechanism. It contains two different types of granules for two releases of medication. Dexilant works by releasing one shift of the drug within an hour of taking it to decrease the amount of acid in stomach. After about 4–5 hours later, Dexilant releases the remainder of the medication. .
How much advantage does it provide over other PPIs is yet to be determined in independent studies?

Question 29:

Name at least 3 commonly used drugs in ICU - which should not be infuse via same infusion/port line as furosemide infusion?

Answer:

Labetalol
Ciprofloxacin
Milrinone

Furosemide drip is usually prepared in the weakly alkaline to neutral range. The above listed drugs are usually prepared in acid solutions. Precipitation may occur if furosemide is infused concurrently with these medications through the same line. It is imperative to place caution not to piggy bag any of these acidic drugs with furosemide.

Question 30:
Ibutilide is a type III antiarrhythmic agent approved for the pharmacologic conversion of atrial fibrillation and atrial flutter. Conversion rates are described up to 80% of cases. What is the half-life of Ibutilide?

Answer:
4 hours

Rationale:
Ibutilide (Corvert) is a Class III antiarrhythmic agent that is indicated for acute chemical cardio conversion of atrial fibrillation and atrial flutter of a recent onset to sinus rhythm. Due to unknown reason, better results are seen in patients with atrial flutter in comparison to atrial fibrillation.

Ibutilide should be utilized with caution as it has been shown to degenerate rhythm into sustained Torsade (polymorphic ventricular tachycardia) in about 3% of cases. Also due to its long half life, it's not recommended to repeat dose more than twice as it may take up to 90 minutes before normal sinus rhythm gets restored.

Dose is usually 1 mg over 10 minutes (may repeat once) but in post-cardiac surgery patients, one or two infusions of 0.5 mg are usually effective in terminating atrial fibrillation or atrial flutter.

Question 31:
Haloperidol (Haldol) can be helpful in which 2 non-central (CNS) conditions?

Answer:
Haldol may be utilized in the ICU for

A. Treatment of severe nausea and vomiting resulting likewise from postoperative care or adverse effects from radiation and chemotherapy.
B. Treatment of intractable hiccups

Question 32:
What is the half-life of Precedex (dexmedetomidine), when it is fully on board?

Answer:
About 2 - 3 hours.

Question 33:
Librium (Chlordiazepoxide) is a commonly used drug in ICU. Describe its four essential properties?

Answer:

Chlordiazepoxide is unique in the sense that it is a good choice in alcohol withdrawal not only because its active metabolite has a very long half-life but also because of the following properties it exhibits;

1. Amnestic,
2. Anxiolytic,
3. Hypnotic
4. Skeletal muscle relaxant effects

Question 34:

Case:

A 74-year-old male with chronic renal failure is admitted to ICU after a seizure episode requiring intubation for airway protection. You started Pepcid (famotidine) as GI prophylaxis. What should you watch closely?

Answer:

Dilantin level

Rationale:

The mechanism of drug interaction is unknown. Elderly patients with renal failure seem to be on high risk though. Signs of Dilantin toxicity include ataxia, incoordination, tremor, nystagmus, hypotension, slurred speech, lethargy, nausea, vomiting, mental confusion, and psychosis.

Other medication, which may affect phenytoin level besides H_2 blockers, includes carbamazepine, Depakote, phenobarbital, Trazodone, isoniazid (INH), sulfonamides (a class of antibiotics), and calcium containing antacids, , sucralfate, alcoholic beverages, amiodarone, chloramphenicol, and oral contraceptives.

Question 35:

Case:

How does Fondaparinux (Arixtra) differ in its mechanism of action from heparins (unfractionated and low molecular weights), which may give it an advantage of not causing HIT (Heparin induced Thrombocytopenia)?

Answer:

Fondaparinux (ARIXTRA) is a synthetic pentasaccharide antithrombotic agent inhibiting only factor Xa. . While other antithrombotics may inhibit multiple factors in the coagulation cascade, Fondaparinux selectively inhibits only factor Xa. Fondaparinux is synthetic factor and is not a heparin.

Question 36:

Tachyphylaxis to IV nitroglycerin drip develops in how many hours?

Answer:

Tachyphylaxis to IV nitroglycerin develops approx. in about 16-24 hours.

Reference(s):
Comparison of the degree of hemodynamic tolerance during intravenous infusion of nitroglycerin versus nicorandil in patients with congestive heart failure - Clinical Investigations - American Heart Journal. 134(3): 435-441, September 1997.

Question 37:

Despite being an old player Sucralfate is still very well indicated in stress ulcer prophylaxis. What is the mechanism of action of sucralfate?

Answer:
Sucralfate act by multiple mechanisms

1. Sucralfate acting locally in an acidic environment by reacting with stomach hydrochloric acid to form a viscous, paste-like material causing an acid buffer for duration of six to eight hours.
2. Sucralfate attaches to the proteins on the surface of ulcers, forming stable insoluble complexes. These complexes then serve as protective barriers at the ulcer surface. This barrier prevents further damage from acid, pepsin, and bile.
3. It also prevents hydrogen ions from diffusion back into stomach.
4. Sucralfate helps in adsorbing both bile acid and pepsin.
5. It also stimulates the increase of prostaglandin E_2, epidermal growth factors (EGF), bFGF, and gastric mucus.

Question 38:

Precedex (dexmedetomidine) is stable at room temperature for how long?

Answer:
48 hours

Rationale:
Precedex (dexmedetomidine) is stable at room temperature for 48 hours but preferably total infusion time should not exceed 24 hours.

Dosing: Bolus: 1mcg/kg over 10 minutes (bolus is drawn up from drip and thus will have same concentration as the infusion: 4mcg/ml).

Infusion Rate: 0.2-0.7mcg/kg/hour
Patients with hepatic and renal failure may require lower doses.

Question 39:

What is the recommended dose of cisatracurium (Nimbex) during intubation and how it affects clinical condition during intubation?

Answer:
Commonly use dose of cisatracurium (Nimbex) during intubation is 0.15 mg/kg but recommended dose is 0.2 mg/kg. It has a rapid onset of action of about 30 seconds and provides an advantage in obtaining good condition for intubation.
When administered during the induction of adequate anesthesia good or excellent conditions for tracheal intubation occurred in 2.0 minutes following 0.15-mg/kg dose of cisatracurium and in 1.5 minutes following 0.2-mg/kg dose of cisatracurium.

Question 40:
What is the optimum time to give Fentanyl before intubation to attenuate circulatory responses to laryngoscopy and tracheal intubation?

Answer:
About 5 minutes

Rationale:
Laryngoscopy and tracheal intubation are usually accompanied by increases in arterial blood pressure and Heart Rate. Various methods have been suggested to attenuate these responses, including a beneficial effect of fentanyl.

Fentanyl, at a dose of 2 mcg/kg given 5 minutes before intubation, most effectively attenuated the increases in all four circulatory variables (Heart Rate, Systolic Arterial Pressure, Diastolic Arterial Pressure, and Mean Arterial Pressure).

Reference(s):
Small-Dose Fentanyl: Optimal Time of Injection for Blunting the Circulatory Responses to Tracheal Intubation - Anesth Analg 1998; 86:658-61

Question 41:
Which 2 commonly used medicines in ICU may cause adrenal crisis?

Answer:
Phenytoin and Rifampin
Other common causes of adrenal crisis in the ICU include rapid withdrawal of long-term steroid therapy, septic shock, use of Etomidate, hypovolumia, hypothermia and so on.

Question 42:
What is the most common reason of resistance to heparin therapy (failure of monitoring tests to change or higher than expected doses)?

Answer:

Antithrombin III is the most important cause of apparent resistance to heparin therapy. Antithrombin III replacement in a patient with antithrombin deficiency may restore the heparin efficacy.

Also, it is important to know that the following commonly used medications may cause resistance to heparin therapy.

1. Intravenous nitroglycerin
2. Digitalis,
3. Nicotine (smoking),
4. Tetracycline
5. Some antihistamines

Reference(s):
Bick RL. Disorders of Thrombosis & Hemostasis. Clinical and Laboratory Practice. 1992. ASCP Press. (Figure 1-29 page 20; Table 14-7, page 305).

Question 43:

Case:
A 52 year-old male is admitted with frequent runs of ventricular tachycardia and was started on IV Lidocaine with 2mg/min drip. First lidocaine serum level is 8.5 micrograms/ml. To determine the time period to shut off lidocaine drip, do you know the half-life of intravenous Lidocaine?

Answer:
The elimination half-life of Lidocaine is approximately 1.5–2 hours. Elimination half-life may be prolonged in patients with liver insufficiency up to 6-8 hours. Also, in patients with congestive heart failure, it may be slightly prolonged up to 3 hours. Though Lidocaine is excreted via urine but renal insufficiency doesn't affect its level much as 90% of Lidocaine is metabolized in the liver into its pharmacologically active metabolites.

Lidocaine amends the depolarization in neurons, by blocking sodium (Na^+) channels in the cell membrane, leading to its anesthetic effects. Toxic levels of lidocaine may lead to nervousness, tingling, tinnitus, tremor, dizziness, blurred vision and seizures.
In the above-mentioned case, it would be appropriate to hold lidocaine drip for 4-6 hours and draw the level again to determine the rate of infusion.

Question 44:

Which two commonly use drugs in CHF (congestive heart failure) - may oppose each other's action?

Answer:
Aspirin and Furosemide (Lasix)

Rationale:
Lasix has a direct vasodilator effect and this effect begins within a few minutes after an

administration of IV Lasix. This added effect is very useful in treatment of acute pulmonary congestion. However, nonsteroidal anti-inflammatory drugs including aspirin can block this desirable action.

The mechanism of action is poorly understood however salicylates may inhibit the renal effects of loop diuretics, which are mediated by prostaglandins, including increases in Na^+ excretion, renal blood flow, and plasma renin activity.

Reference(s):
1. Jhund PS, Davie AP, McMurray JJ. Aspirin inhibits the acute venodilator response to furosemide in patients with chronic heart failure. J Am Coll Cardiol. 2001; 37:1234-1238
2. Effect of combined administration of furosemide and aspirin on urinary urate excretion in man - Journal of Molecular Medicine, Volume 57, Number 23 / December, 1979, 1299-1301

Question 45:

Indomethacin is one of the NSAID, which is used, in nephrogenic Diabetes Insipidus (DI). What is the mechanism of action?

Answer:
NSAIDs are used as an adjuvant treatment in DI. NSAIDs may act by inhibiting prostaglandin synthesis in Diabetes Insipidus. Inhibition of prostaglandin synthesis decreases the delivery of solute to distal tubules, reducing urine volume and increasing urine osmolality.

Question 46:

Case:
A 68-year-old male presented to ED with left-sided weakness and CVA (stroke) is suspected. The patient has chronic history of atrial fibrillation and is on Coumadin 4 mg daily and records available shows previously consistent therapeutic INR of 2.6 however today patient's INR is 1.4. According to patient's wife, patient is very compliant with his medicines. Notably, he is very health conscious and has recently started a diet consisting of frequent green tea, fish oil, ginseng, canola oil and so on.

Answer:
Green Tea carries a huge amount of *Vitamin K*. It is also present in clinically significant amount in other healthy diets and herbals like fish oil, ginseng, canola oil and so on.

Question 47:

One dose of intravenous *Vitamin K* antagonizes the effects of warfarin for how many days?

Answer:
One week

Rationale:
A 10 mg dose of vitamin K results in a rapid reversal of elevated INR however, overcorrection and warfarin resistance may pose problems. This dosage could diminish the effect of warfarin on clotting factor synthesis for up to 7 days. A dose in the range of 0.5-2.5 mg of vitamin K, reverses anticoagulation within 24 hours, with less risk of overcorrection or warfarin resistance.

Question 48:

A 70-year-old Chinese male with history of atrial fibrillation and on warfarin presented with acute symptoms of stroke. Patient's family reports that patient is very health conscious and takes his warfarin faithfully. Actually, he recently brought some traditional medicines from china. What could be the probable culprit?

Answer:
Ginseng

Rationale:
In a double blinded, four-week trial, daily doses of ginseng significantly reduced blood levels and the anticoagulant effects of warfarin. The patient-taking ginseng when compared with the placebo group was found to have a significantly lower INR and peak plasma warfarin level.

Reference(s):
Brief Communication: American Ginseng Reduces Warfarin's Effect in Healthy Patients - A Randomized, Controlled Trial - Annals of Internal Medicine, July 6, 2004 vol. 141 no. 1 23-27

Question 49:

What is the equivalent strength of PO vs. IV of Lopressor (Metoprolol)?

Answer:
Equivalent maximal beta-blocking effect of Lopressor is achieved with oral and intravenous doses in the ratio of approximately 2.5:1. But be aware - this is not the standard by any means. Literature shows conversion effect ranging anywhere from 2:1 to 5:1.

Question 50:

How does Desmopressin differ from Vasopressin?

Answer:
Desmopressin, (1-deamino-8-O-arginine-vasopressin (DDAVP)) is an analogue of arginine vasopressin. Its antidiuretic effect is ten times folds more potent than vasopressin alone and its vasoconstrictor properties, fifteen hundred times less than that of vasopressin. These modifications make metabolism slower with half-life of 158 minutes.

Question 51:

How long does it take for Xarelto (Rivaroxaban) to have maximum effect after taking a dose?

Answer:

4 hours

Rationale:

Rivaroxaban (Xarelto) is an oral anticoagulant now preferred in atrial fibrilation for stroke prevention as well as for other needs where anticoagulation is needed such as DVT prophylaxis after knee surgery.

Rivaroxaban has good oral bioavailablity and exhibits maximum inhibition of factor Xa within four hours. Its total effect lasts approximately 8 to 12 hours. It usually takes Xa activity approximately 24 hours to revert to normal, thus making this agent suitable for once daily dosing.

Question 52:

Name at least 3 Antibiotics, which should be, use with caution in patients with active seizure?

Answer:

1. Fluoroquinolones
2. Primaxin (Imipenem and Cilastatin)
3. Zyvox

Question 53:

Each milliliter of insulin glargine injection (LANTUS) contains how many units of insulin glargine injection (LANTUS)?

Answer:

100 units.

Rationale:

Over-dosage/error of insulin and other medications are extremely common in ICUs despite all safeguards and measures put in place.
Each milliliter of LANTUS (insulin glargine injection) contains 100 Units of insulin glargine.

Question 54:

Should PO amiodarone be given with food or empty stomach?

Answer:
With food.

Rationale:
It is well known that PO amiodarone has variable bioavailability ranging from 22 to 95%. Interestingly, it has shown to have better absorption if it is taken with food.

Reference(s):
Siddoway LA (2003). "Amiodarone: guidelines for use and monitoring" - American Family Physician 68 (11): 2189–96.

Question 55:
Is Digoxin and Digitoxin the same medicine?

Answer:
No.

Rationale:
Digoxin, which is also commonly known as digitalis in many countries, is a purified cardiac glycoside extracted from the plant, Digitalis lanata. It is eliminated via kidney. Digitoxin has similar structure and effects as digoxin. Unlike digoxin it is eliminated via the liver.

Question 56:
In methemoglobinemia what dose of methylene blue is used?

Answer:
1-2 mg/kg given intravenously slowly over five minutes then followed by intravenous flush with normal saline. Oxygen supplementation should be administrated to patients. Methylene blue restores the iron in hemoglobin to its normal (reduced) oxygen-carrying form.

Question 57:
A 28 year-old male is recently started on Isoniazid (INH) after he was tested positive for PPD during routine employment exam and is now admitted with seizures. What is the appropriate treatment for this patient?

Answer:
IV Pyridoxine (Vitamin B6)

Rationale:

5 grams of IV pyridoxine given over 5-10 minutes is sufficient to abolish the neurologic effects of isoniazid in most cases. Repeat dosing may be required for persistent seizure activity. Patients usually do not respond to most of the antiepileptics.

Question 58:

Describe any other related IV use of Narcan (NALOXONE) besides its use as an antidote for narcotic overdose?

Answer:

Counteract pruritus associated with epidural analgesia.

Rationale:

To neutralize pruritis caused by an opiate without compromising analgesic effect - continuous drip can be prepared with 4 mg of Narcan in 250 ml D5W or D5NS = 16 mcg/ml and can be given at rate of 1 mcg/kg/hr. It can be titrated up to 5 mcg/kg/hr as tolerated.

Question 59:

A 52-year-old diabetic patient has onset of delirium in ICU. Patient is prescribed quetiapine. What is the concern?

Answer:

Hyperglycemia

Rationale:

Atypical antipsychotics commonly used in ICU for delirium include quetiapine, olanzapine, clozapine etc. These antipsychotics may increase blood glucose levels thus requiring closer monitoring of blood glucose.

Question 60:

How can one of the known side effects of Levetiracetam (Keppra) be decreased?

Answer:

Addition of Pyridoxine (Vitamin B6) helps in decreasing psychiatric side effects, particularly in children.

Reference(s):

Clinical Epilepsy: Pediatrics: Epilepsia 46 (s8): 142–67. 2005

Question 61:

What is the conversion of IV to PO Tylenol (Acetaminophen)?

Answer:

1:1

Rationale:
FDA has approved the IV form of Tylenol (Omfirmev). It has the advantage of opioid sparing effect and very useful in immediate post-op period. Peak serum levels are 70% higher with IV form with onset of analgesia at 10 minutes, Ofirmev peaks at 1 hour and last for about 4-6 hours.

Question 62:
How does prednisone help in the treatment of hypercalcemia secondary to *Vitamin D* intoxication?

Answer:
In hypercalcemia secondary to Vitamin D over-ingestion or other causes of Vitamin D toxicity, prednisone reduces intestinal calcium absorption, which in turn decreases the plasma calcium level.

Question 63:
Esmolol is metabolized in?

Answer:
RBC

Rationale:
Esmolol has side chain called ester-methyl which allows for quick hydrolysis. Esmolol is hydrolyzed by esterases in the cytosol of red blood cells. Since it is metabolized in RBC, its metabolism is not affected by hepatic or renal failures.

Question 64:
What advantage does propofol have as an induction agent in intubation?

Answer:
Propofol reduces airway resistance and can be a useful induction agent for intubation in patients with bronchospasm.

Reference(s):
1. Eames WO, Rooke GA, Wu RS, Bishop MJ. Comparison of the effects of etomidate, propofol, and thiopental on respiratory resistance after tracheal intubation. Anesthesiology 1996; 84:1307.
2. Conti G, Ferretti A, Tellan G, et al. Propofol induces bronchodilation in a patient mechanically ventilated for status asthmaticus. Intensive Care Med 1993; 19:305.

Question 65:
A 58-year-old male is admitted to the ICU with atrial fibrillation with rapid ventricular rate (RVR). Patient's past medical history is significant only with BPH (prostate

hypertrophy) and patient uses Tamsulosin (Flomax) for it. Patient's BP is on lower side so you decide to use amiodarone instead of Cardizem or esmolol. With amiodarone bolus patient's blood pressure dropped drastically and patient coded.

Answer:
IV Amiodarone bolus is known to cause transient hypotension but it may cause dramatic hypotension with concurrent alpha or beta blockade use. Amiodarone (with its active metabolite, desethylamiodarone) blocks sodium, potassium, and calcium channels. Amiodarone itself is a relatively potent noncompetitive alpha and beta-blocker and with concomitant use of alpha, beta-blockers or calcium channel blockers may cause life-threatening situation.
Moreover, Amiodarone itself has direct potent coronary as well as veno vasodilatory properties. Amiodarone acts as a direct venodilator through the cyclooxygenase pathway, activation of nitric oxide synthase, and cyclooxygenase-dependent relaxing endothelial factors.

On a side note, Hypotension from IV Amiodarone (particularly bolus) may in part due to its solubilized vehicle called polysorbate 80 which may have histamine releasing effect.

Question 66:
What is the basic difference between Phenytoin and Fosphenytoin?

Answer:
Since phenytoin (Dilantin) is not water-soluble it must be solubilized in propylene glycol carrier to prepare IV form. Phenytoin dose of more than 50 mg/min carries risk of hypotension and cardiac arrhythmias. There is also a major risk of potential irritation at IV site and vascular compromise at the infused limb.
Fosphenytoin (Cerebyx) on the other hand is a phosphorylated phenytoin prodrug. Fosphenytoin is highly water-soluble and therefore easier to administer than phenytoin. Fosphenytoin is converted to phenytoin after approximately eight minutes and therefore can be administered more rapidly than standard phenytoin.

Question 67:
What are some of the off-label (or experimental) uses of Metformin?

Answer:
1. pre-diabetes or borderline diabetics
2. Polycystic ovary syndrome (PCOS)
3. Non-alcoholic fatty liver disease (NAFLD)
4. Premature puberty
5. Gestational diabetes
6. Prophylactic agent against pancreatic cancer

Question 68:

What is the half-life of Argatroban?

Answer:
About 50 minutes

Rationale:
Argatroban is metabolized in the liver. In-patient with normal liver function, its half-life is about 50 minutes. It is monitored by PTT in the same way as heparin drip.
In contrast, lepirudin, another direct thrombin inhibitor is primarily cleared by kidneys and should be either avoided or adjusted with renal insufficiency.

Question 69:

What dose of Fentanyl is utilized in blunting the sympathetic response to laryngoscopy and intubation?

Answer:
3 mcg/kg

Rationale:
Recommended doses of fentanyl as adjunct in pretreatment for intubation is 3 mcg/kg to avoid hypotension especially in patients dependent on sympathetic tone. Fentanyl has been described to cause thoracic and abdominal muscular rigidity but the incidence is extremely low and usually only happens with doses higher than 15 mcg/kg.

Question 70:

What could be the 4 life threatening side effects of Neupogen (Filgrastim)?

Answer:

1. Neupogen can cause sickle cell crisis after receiving it in patients with sickle cell disorders.
2. Spleen Rupture has been reported after the administration of Neupogen. Patients receiving Neupogen whom report left upper abdominal pain should be evaluated for it.
3. ARDS (Acute Respiratory Distress Syndrome) have been reported secondary to an influx of neutrophils to sites of inflammation in the lungs.
4. Alveolar Hemorrhage and Hemoptysis.

Question 71:

Describe 7 basic properties of midazolam (Versed) making it a good choice of use in ICUs?

Answer:
Midazolam is

1. Fast (due to water solubility) and short acting,
2. Anxiolytic,
3. Anterograde amnestic,
4. Hypnotic,
5. Anticonvulsant,
6. Skeletal muscle relaxant
7. Sedative

Question 72:

Propofol should be given with caution in which common allergy?

Answer:

Egg allergy

Rationale:

Originally Propofol was introduced into the market 32-years-ago but was withdrawn from the due to reports of anaphylactic reactions. AstraZeneca reintroduced it in 1986 under the brand name Diprivan with preparation containing 10% soybean oil and 1.2% purified egg lecithin, a phosphatidylcholine found in egg yolk.

A history of egg allergy does not necessarily contraindicate the use of Propofol. Most egg allergies are related to a reaction to the egg white (albumin) and not to the egg yolk (lecithin). This could explain why 'Propofol' is only very rarely a problem. Egg allergy should be explored in detail in those patients.

Question 73:

Name 3 unusual complications of Propofol beside Propofol infusion syndrome?

Answer:

1. Dystonia and myoclonic movements
2. Euphoria (also sexual hallucinations)
3. Priapism

Question 74:

Out of all fluoroquinolones, which of them is reported to worsen CNS symptoms?

Answer:

Moxifloxacin

Rationale:

Moxifloxacin is reported as worst amongst all fluoroquinolones for causing CNS toxicity. Neurotoxic side effects include tremor, confusion, anxiety, insomnia, agitation, psychosis or even seizure.

Reference(s):
Galatti L, Giustini SE, Sessa A, et al. - "Neuropsychiatric reactions to drugs: an analysis of spontaneous reports from general practitioners in Italy" , Pharmacological Research, Volume 51, Issue 3, March 2005, Pages 211-216

Question 75:
Which 2 commonly used cardiac medicines may interact negatively?

Answer:
Aspirin and ACE inhibitors

Rationale:
Effect of ACE inhibitors are attenuated by aspirin

ACE inhibitors reduce angiotensin II production as well as inhibit breakdown of bradykinin. Bradykinins stimulate vasodilator prostaglandins through a cyclo-oxygenase–Dependent Avenue.

Aspirin inhibits cyclo-oxygenase-1 (COX-1), thus reducing synthesis of vasodilatory prostaglandins.

Above interaction may be of a more academic interest. In clinical practice there are no firm guidelines for not using both drugs simultaneously.

Question 76:
How fast does etomidate works after injection?

Answer:
"One arm-brain circulation time"
It is the time taken for the drug to travel from the site of injection (usually the arm) to the brain.

Question 77:
What is the IV to PO conversion of Tacrolimus (Prograf)?

Answer:
Oral dose 4 x IV dose
the oral dose should be divided every 12 hours with monitoring to a usual target level = 5 - 15g/L.

Question 78:
What commonly used medication in ICU may provide synergistic effect to ondansetron (Zofran) in preventing postoperative nausea and vomiting?

Answer:
Dexamethasone (Decadron)

Rationale:
Dexamethasone and Ondansetron together are more effective than ondansetron alone in preventing postoperative nausea and vomiting.

Reference(s):
Song (2011). "The effect of combining dexamethasone with ondansetron for nausea and vomiting associated with fentanyl-based intravenous patient-controlled analgesia." Anaesthesia 66 (4): 263–7

Question 79:
What is the advantage of fosinopril (Monopril) over other ACE-Inhibitors?

Answer:
Fosinopril is the only phosphinate-containing ACE inhibitor.

Rationale:
Clinical significance: In contrast to other ACE inhibitors, fosinopril is eliminated from the body via both renal and hepatic pathways, which make it a safer choice in patients with impaired kidney function.

Question 80:
What dose of Versed (midazolam) is optimum for antegrade amnesia?

Answer:
Approximately 0.05-0.1mg/kg.

Reference(s):
Bulach R: Double-blind randomized controlled trial to determine extent of amnesia with midazolam given immediately before general anaesthesia. BJA 2005; 94:300-5

Question 81:
What could be the ocular side effects of amiodarone?

Answer:
Most side effects are due to amiodarone intracytoplasmic lamellar deposits in the cornea, lens, retina, and optic nerve.

1. Colored rings around lights.
2. Corneal epithelial opacities which resembles a cat's whiskers
3. Lens opacity
4. Retinopathy (rare)
5. Optic neuropathy

Reference(s):
Ocular side effects of Amiodarone - Surv Ophthalmol. 1998 Jan-Feb; 42(4): 360-6.

Question 82:
What is the equivalency of fentanyl and morphine?

Answer:
100 micrograms of fentanyl is approximately equal to 10 mg of morphine.

Question 83:
What special precautions should be taken while administrating ketorolac (Toradol) in-patient who is also receiving narcotics?

Answer:
Use a different route of IV

Rationale:
When IV, administers Toradol through the same IV catheter as morphine, the two drugs can sometimes precipitate in the IV, which can cause blockage in the line.

Question 84:
Which benzodiazepine is more prone to have paradoxical side effects compared to other benzodiazepines?

Answer:
Lorazepam

Rationale:
Paradoxical side effects of benzodiazepines such as increased hostility, aggression, angry outbursts, and psychomotor agitation are seen more commonly with lorazepam than any other benzodiazepines.

Reference(s):
Sorel L, Mechler L, Harmant J (1981). "Comparative trial of intravenous lorazepam and clonazepam im status epilepticus". Clinical Therapeutics 4 (4): 326–336

Question 85:
Why should tacrolimus (FK/prograf) levels should be drawn peripherally, if patient is on intravenous Tacrolimus?

Answer:
The IV prograf seems to "stick" to the IV line and can falsely elevate any levels that are drawn from the same IV line. Patients on IV Prograf really need to have the levels drawn from a peripheral venous stick or from an A-line.

Reference(s):

Jain AB, Pinna A, Fung JJ, Warty V, Singhal AK, Lever J, Venkataramanan R. - Capillary blood versus arterial or venous blood for tacrolimus monitoring in liver transplantation. - Transplantation. 1995 Sep 15; 60(5): 512-4.

Question 86:

What is the recommendation for giving Haldol (Haloperidol) in patients over age 65?

Answer:

Haldol should be use with caution in elderly patients. Doses should be smaller in 0.25 - 0.5 mg range, and ideally should not exceed more than 2 mg over 24 hours period.

Question 87:

What is the typical increase in potassium level after usual dose administration of succinylcholine?

Answer:

A typical increase of potassium ion serum concentration on administration of succinylcholine is 0.5 mmol per liter.

Question 88:

Which is more effective - IV chloramphenicol or PO chloramphenicol?

Answer:

PO chloramphenicol

Rationale:

Interestingly and unlike most drugs PO chloramphenicol is more effective than IV preparation of chloramphenicol.

Pure chloramphenicol does not dissolve in water so it has to be prepared with succinate ester. Chloramphenicol succinate ester is an inactive prodrug and must first be hydrolysed to chloramphenicol, however, during hydrolysis 30% of the drug is lost. To be effective, the dose needs to be increased to be equivalent to the oral dose!

Question 89:

What is the dose of Ketamine in RSI (Rapid Sequence Intubation)?

Answer:

1 to 2 mg/kg IV. In patients with severe shock, some have advocated half or even one fourth of the dose.

Ketamine has an onset of about 45 to 60 seconds and a duration of action of 10 to 20 minutes.

Ketamine has all good properties for use in "awake intubation" or in "possible difficult intubation". It preserves respiratory drive, has a quick onset of action, good hemodynamic profile and has analgesic properties.

The reemergence phenomenon (disturbing dreams) as patient emerges from ketamine-induced anesthesia, limits use of the drug for procedural sedation. Reemergence phenomena can be decreased with concomitant use of a benzodiazepines

Question 90:

What is the effect of Losartan (Cozaar) and probably other Angiotensin II receptor antagonists (ARBs) on sexual function in patients?

Answer:

It improves markedly!

Rationale:

At least two studies have shown that ARBs improves sexual dysfunction in hypertensive patients markedly.

In one study, 10 weeks of treatment with losartan, 88% of hypertensive males with sexual dysfunction reported improvement in at least one area of sexuality, with overall improvement in sexual satisfaction from 7.3% to 58.5%.

In another study comparing carvedilol (a Beta-Blocker), valsartan also found to improve sexual function.

Reference(s):

1. Llisterri, JL; Lozano Vidal, JV; Aznar Vicente, J; Argaya Roca, M; Pol Bravo, C; Sanchez Zamorano, MA; Ferrario, CM (2001). "Sexual dysfunction in hypertensive patients treated with losartan". The American journal of the medical sciences 321(5): 336–41

2. Fogari, R; Zoppi, A; Poletti, L; Marasi, G; Mugellini, A; Corradi, L (2001). "Sexual activity in hypertensive men treated with valsartan or carvedilol: A crossover study". American journal of hypertension 14 (1): 27–31

Question 91:

Which drug is said to be responsible for various effects on van Gogh's paintings particularly Starry Night?

Answer:

Digoxin

Rationale:

Digoxin may cause disturbance of color vision (mostly yellow and green) called xanthopsia. It is said that Vincent van Gogh's "Yellow Period" was influenced by concurrent digitalis therapy. Digoxin may cause a "halo" around each point of light, which is evident in van Gogh's Starry Night.

Question 92:
Is it possible to have "Red Man Syndrome" (RMS) with oral Vancomycin?

Answer:
Unlikely but yes

Rationale:
"Red man syndrome" (RMS) occurs mostly after parenteral administration of vancomycin. Oral vancomycin is not usually absorbed therefore red man syndrome is usually not seen. Sometimes, in-patient with renal failure some oral vancomycin is absorbed and can lead to RMS.

Reference(s):
1. Rao S, Kupfer Y, Pagala M, Chapnick E, Tessler S - Systemic absorption of oral vancomycin in patients with Clostridium difficile infection. - Scand J Infect Dis. 2011; 43(5): 386
2. Ergeron L, Boucher FD, Possible red-man syndrome associated with systemic absorption of oral vancomycin in a child with normal renal function. - Ann Pharmacother. 1994; 28(5): 581.

Question 93:
What commonly used medication in 'transplant ICUs' may cause acute attack of Gout?

Answer:
Tacrolimus (Prograf)

Rationale:
Cyclosporine was one main culprit in transplants patients to cause hyperuricemia and gout but it has been reported with tacrolimus too.

Question 94:
For average patient, Gentamicin should be given per (choose one)?

A. Ideal or adjusted body weight
B. Actual body weight?

Answer:
A (Ideal body weight)

Rationale:
To administer Aminoglycoside antibiotics, for total dosing

A. For patient's having weight is 1-1.2 times their ideal body weight, ideal body weight is used.
B. For patients whose weighs more than 1.2 times ideal body weight, use adjusted body weight is used.

One should monitor the serum level to ensure safety and efficacy. Also, patients who are likely to receive aminoglycosides for more than 2 weeks should be considered for audiometry test.

Question 95:

Why should etomidate not be pushed fast?

Answer:

Very rapid push of etomidate may cause trismus.
Trismus is the reduced opening of the jaws caused by spasm of the muscles of mouth. Etomidate must be pushed slowly. If trismus is encountered, it may become necessary to use paralytics.

Question 96:

How early does psychosis develop with steroid therapy?

Answer:

As early as 4 days

Rationale:

Psychiatric symptoms may develop as soon as after 4 days of corticosteroid therapy, although they can occur anytime in therapy or even after the completion of treatment. Administration of high dose corticosteroid is one of the key risk factor for psychosis. Primary treatment is tapering off steroid along with various antipsychotic drugs if needed.

Reference(s):
1. Warrington TP, Bostwick JM. Psychiatric adverse effect of corticosteroids. Mayo Clin Proc. 2006; 81(10): 1361-1367
2. Sirois F. Steroid psychosis: a review. Gen Hosp Psychiatry. 2003; 25:27-33.
3. Hall RC, Popkin MK, Stickney SK, et al. Presentation of the steroid induced psychosis. J Nerv Ment Dis. 1979; 167:229-236

Question 97:

In what kind of allergy should protamine be given with caution?

Answer:

Protamine originally was a derivative from the sperm of salmon and other species of fish. It is currently produced primarily through the recombinant biotechnology. The patients with highest risk for protamine allergy include:

A. An allergy to fish
B. Prior protamine exposure
C. Vasectomy

Note: There is a distinct genetic difference between shellfish and vertebrate fish; so, an allergy to shellfish does not predispose the person to an adverse protamine reaction.

Reference(s):
1. Collins and A O'Donnell - Perfusion 2008 23: 369 Does an allergy to fish pre-empt an adverse protamine reaction? A case report and a literature review
2. Watson RA, Ansbacher R, Barry M, Deshon GE Jr, Agee RE - Allergic reaction to protamine: a late complication of elective vasectomy? - Urology. 1983 Nov; 22(5): 493-5.

Question 98:

Which pain medication should be avoided while patient is getting Linezolid (Zyvox)?

Answer:
Meperidine

Rationale:
Meperidine along with Linezolid may cause life threatening Serotonin Syndrome.

Reference(s):
1. Das PK, Warkentin DI, Hewko R, Forrest DL. - Serotonin syndrome after concomitant treatment with linezolid and meperidine. -Clin Infect Dis. 2008 Jan 15; 46(2): 264-5.
2. Elizondo Armendáriz JJ, Pellejero Hernando E, Noceda Urarte MM, Gutiérrez Valencia M. - Probable serotonin syndrome due to linezolid and meperidine interaction, Farm Hosp. 2012 Sep-Oct; 36(5): 448-9. Epub 2012 Mar 21.

Question 99:

After few minutes of getting a first dose of Metronidazole, patient develops tachycardia, fever, shivering, sweating, dilated pupils, twitching, hyper-reflexia, and hyperthermia. Patient became confused, agitated and hypertensive. What is your concern?

Answer:
Serotonin Syndrome from metronidazole.

Rationale:
Symptoms of Serotonin syndrome have been reported with metronidazole. Treatment is discontinuation of drug and supportive treatment.

Reference(s):
Karamanakos, P. N. (2008). "The possibility of serotonin syndrome brought about by the use of metronidazole". Minerva Anestesiologica 74(11): 679.

Question 100:

What are the key features of PRIS (Propofol Related Infusion Syndrome)?

Answer:
Key features include:

A. Lactic acidosis
B. Unexplained metabolic acidosis

C. Hypotension
D. Arrhythmia
E. Rhabdomyolysis
F. Hypertriglyceridemia
G. Fatty liver
H. Acute renal failure

Question 101:

Initiation of ACE-inhibitors and ARBs (Angiotensin Receptor Blockers), may cause approximately what level of increment in baseline creatinine - and at what level should it be ok?

Answer:

ACEIs and ARBs could result in a 25% "permissible" increment of baseline serum creatinine and should not become an indication to stop these families of drugs.
But, a persistent upward trend of serum creatinine while on ACEIs and ARBs should be an alert to the possibility of bilateral renal artery stenosis or renal artery stenosis in solitary functioning kidney.

MEDICATIONS - PEARLS

1. **Warning: Ceftriaxone (Rocephin)—Calcium Interaction**
   The FDA has a warning about Ceftriaxone—Calcium interactions due to potential precipitate/crystalline formation in the IV tubing or vasculature when the two agents are combined. These reactions are potentially lethal. This includes all calcium-containing infusions (*e.g.* Lactated Ringers, Total Parenteral Nutrition). Data is not available on interactions between ceftriaxone and oral calcium products or intramuscular ceftriaxone and calcium containing products.
   Cases of fatal reactions have been seen with calcium-ceftriaxone complex precipitating in the lungs and kidneys among both term and premature neonates. Some of these cases occurred despite ceftriaxone and the calcium-containing products being administered by different routes and at different times. The use of ceftriaxone with calcium products is now contraindicated in all age groups. Ceftriaxone and Calcium containing solutions should not be administered at different times via different infusion lines or within 48 hours of each other in any patient of any age.

2. **Therapeutic monitoring: Total phenytoin vs. Free Phenytoin levels in Critical Care**
   Phenytoin remains one of the most frequently used medications in critical care to treat various seizure disorders, which also require close therapeutic monitoring to prevent toxicity.

   Therapeutic range:
   1. Total 10-20 mcg/ml;
   2. Free 1-2 mcg/ml

   Phenytoin is 90% protein bound. In critical illness, protein synthesis and binding affinity are altered for various reasons including decreased dietary intake, renal/hepatic impairment, and a catabolic state. Also, critically ill patients have numerous drug-drug and drug-food interactions. In these situations, free phenytoin levels may increase by 2-3 fold, potentially resulting in toxicity. Therefore, the monitoring of free phenytoin levels, not total levels, are the most accurate and strongly correlated with clinical toxicity in critical care.

   Reference(s):
1. Von Winckelmann, SL. Pharmacotherapy 2008; 28:1391
2. Evidence-based Implementation of Free Phenytoin therapeutic Drug Monitoring - Clinical Chemistry 46: 1132-1135, 2000

3. **On time lag between Precedex start and its effect**
   The loading dose of dexmedetomidine (precedex) is 1mcg/kg , administered over 10 minutes, followed by a maintenance infusion of 0.2–0.7 mcg/kg/hour.
   An important pearl to remember is that despite a loading dose, the onset of sedation occurs after 10 - 15 minutes, unlike the instant sedation seen with propofol. If a loading dose is not used, the time to onset of the sedative effect may be even be further prolonged.

4. **A note on Methylnaltrexone**

   Subcutaneous methylnaltrexone (Relistor) rapidly induce laxation in patients with opioid-induced constipation. The major advantage is that the treatment usually does not affect central analgesia or precipitate opioid withdrawal. Methylnaltrexone is a quaternary amine selective antagonist of opioid binding at the mu-opioid receptor, which not cross the blood–brain barrier. Thus this agent functions as a peripherally acting mu-opioid receptor antagonist in areas such as the gastrointestinal tract, minimizing constipation effects of opioids, without affecting opioid-modulated analgesic effects within the central nervous system.

   Reference(s):

   Jay Thomas, M.D., Ph.D., Sloan Karver, M.D., Gail Austin Cooney, M.D., Bruce H. Chamberlain, M.D., Charles Kevin Watt, D.O., Neal E. Slatkin, M.D., Nancy Stambler, M.S., Alton B. Kremer, M.D., Ph.D., and Robert J. Israel, M.D. - Methylnaltrexone for Opioid-Induced Constipation in Advanced Illness - N Engl J Med 2008; 358:2332-2343 - May 29, 2008

5. **A note on simvastatin and Amiodarone interaction**

   Usage of Simvastatin is generally very high in the US population. Amiodarone is a very frequently use IV medicine in ICUs mostly for rate control in A.Fib/RVR. If used together, there is a high risk of rhabdomyolysis, leading to life threatening kidney failure. This interaction is dose-dependent and occurs with simvastatin doses of greater than 20 mg.

6. **A note on Megace (Megestrol) and Adrenal insufficiency**

   In some patients Megestrol can alter the pituitary-adrenal axis. Adrenal insufficiency diagnosis should be considered in patients with symptoms of fatigue, hypotension, and asthenia who have been treated with megestrol. Morning free cortisol level should be checked in patients receiving megace for more than 12 weeks and than biweekly.

   Reference(s):

   Megestrol acetate in cachexia and anorexia - Int J Nanomedicine. 2006 December; 1(4): 411–416. Published online 2006 December

7. **Carbamazepine-induced toxic epidermal necrolysis**

   "Toxic epidermal necrolysis (TEN), also known as Lyell's syndrome, is a widespread life-threatening mucocutaneous disease where there is extensive detachment of the skin and mucous membrane. Many factors involved in the etiology of TEN including adverse drug reactions. Here we are reporting a case of toxic epidermal necrolysis in an adult male patient after receiving carbamazepine in a 38-year-old male. On the18th day of carbamazepine, patient developed blisters which first appeared on the trunk, chest and arms. The erythematous rash was covering almost all over the body with epidermal detachment of 70% body surface area. There was loss of eyelashes, congestion of conjunctiva with mucopurulent discharge and exposure keratitis. The clinical impression was TEN induced by carbamazepine. Carbamazepine was stopped immediately. He was treated with high dose intravenous betamethasone and

systemic and topical antibiotics. After one month, the progression of the skin lesions halted and he was discharged".

8. Heparin Induced Hyperkalemia

Hyperkalemia from Heparin is a well know phenomenon and has been detected particularly on geriatric, renal insufficient and diabetic patients. Hyperkalemia can be anywhere from .3 to 1.7 mEq/Liter. It usually occurs around day 3 with SQ heparin (as for DVT prophylaxis) but can occur early with IV heparin. Hyperkalemia has been reported with low- molecular weight heparins too but risk is low.

Mechanism of action: Heparin induces hypoaldosteronism and can subsequently lead to hyperkalemia.

Treatment: Best thing is to discontinue the culprit but if heparin is absolutely required, fludrocortisone (.1 mg/day) has been reported to be effective in heparin-induced hyperkalemia 8.

Reference(s):
1. Case report - Heparin-induced hyperkalemia after cardiac surgery - Ann Thorac Surg 2002; 74:1698-1700
2. Heparin-induced hyperkalemia -The Annals of Pharmacotherapy: Vol. 24, No. 3, pp. 244-246.
3. Heparin Induced Hyperkalemia - Endocrine Abstracts (2002) 4 P26
4. Heparin-Induced Hyperkalemia Confirmed by Drug Rechallenge. American Journal of Physical Medicine & Rehabilitation. 79(1):93-96, January/February 2000.
5. Early onset of hyperkalemia in patients treated with low molecular weight heparin: a prospective study - Pharmacoepidemiol Drug Saf.2004 May; 13(5): 299-302.
6. Effect of Low-Molecular-Weight Heparin on Potassium Homeostasis - Pathophysiology of Haemostasis and Thrombosis 2002; 32:107-110
7. Low Molecular Weight Heparins Can Lead To Hyperkalaemia The Internet Journal of Geriatrics and Gerontology . 2005. Volume 2 Number 2.
8. Fludrocortisone for the treatment of heparin-induced hyperkalemia - The Annals of Pharmacotherapy: Vol. 34, No. 5, pp. 606-610

9. Phenytoin (Dilantin) level

The ideal phenytoin level is to have unbound (free) phenytoin level but if free phenytoin level is not available or turn around time is long, it should be adjusted with albumin level with following formula, called Sheiner-Tozer equation. It is not 100% accurate but gives a good estimate.

Corrected Dilantin = measured level / [(0.2 x albumin) + 0.1]
e.g.: if measured Dilantin level is 8.2 but albumin is 2.2, the corrected Dilantin level would be 8.2 / {(.2 x 2.2) + .1} = 15.2

In renal patients, If patient CrCl is less than 20, use following formula.
Corrected Dilantin = measured level / [(0.1 x albumin) + 0.1]
e.g.: if measured Dilantin level is 8.2 but albumin is 2.2, the corrected Dilantin level would be 8.2 / {(.1 x 2.2) + .1} = 25.6

See the difference. Just don't carry away with low level.

Also be cautious, phenytoin's dose increase is not linearly related to serum levels. Small increase in dose may produce disproportionate and actually toxic serum level.

10. Fentanyl induced chest wall (thoracic) rigidity – FITR

Fentanyl is one of the most commonly used analgesics in ICUs. One of the relatively unknown but common side effects of Fentanyl is chest wall rigidity, which was first reported about 25 years ago and may happen with low dose. Chest wall rigidity itself can lead to respiratory distress causing hypercapnia, and hypoxemia leading to bradycardia. Moreover, it may also make intubation difficult, as often chest wall rigidity is associated with laryngospasm. Treatment is reversal with Naloxone. If respiratory failure does not resolve, airway should be secured followed with sedation and neuromuscular blockade till fentanyl wears off. The mechanism of action is not known but suspected to be neuraxis dopamine antagonism.

Fentanyl induced thoracic rigidity is relatively more common in neonates.

Reference(s):
1. Rigidity and hypercarbia associated with high dose fentanyl induction of anesthesia (Letter). Anesth Analg 1981; 60: 362–3
2. Opioid-induced rigidity after intravenous fentanyl - Obstetrics & Gynecology 1997; 89:822-824

11. On fospropofol disodium (LUSEDRA)

FDA has recently approved Fospropofol for monitored anesthesia care sedation in adult patients undergoing diagnostic or therapeutic procedures. Fospropofol is a water-soluble prodrug of the Propofol. Fospropofol is metabolized into Propofol by the liver. Because of this extra metabolism, blood levels of Propofol after the administration of a bolus of fospropofol reach lower peak levels than for an equipotent dose of Propofol and also lesser sedative effect. This lower sedative effect makes it more desirable to use for procedures such as upper GI endoscopy, colonoscopy, bronchoscopy, cardioversion as well as other bedside surgical procedures.

Fospropofol is a water-soluble agent, thus does not carry some of the side effects associated with propofol, such as: pain at the IV catheter site, hyperlipidemia in long-term administration, major bacteremia.

It takes about 4-5 minutes to achieve desire sedative level so it's important to have patience before administrating second dose. The recommended maximum dose is 12.5 mg/kg. In this month of chest 2, optimum dose of 6.5 mg/kg is described for patients undergoing flexible bronchoscopy.

Reference(s):
1. Lusedra - fda.gov
2. A Phase 3, Randomized, Double-Blind Study To Assess the Efficacy and Safety of Fospropofol Disodium Injection for Moderate Sedation in Patients Undergoing Flexible Bronchoscopy - CHEST January 2009 vol. 135 no. 1 41-47

12. A note on Digoxin-Amiodarone interaction

Prolonged digoxin effect may be seen in patients taking Amiodarone, as Amiodarone may decrease the clearance of digoxin. Also, there may be a synergistic effect on the sinus node. Digoxin level should always be obtained prior to initiation of Amiodarone therapy. Usually, it requires decreasing the dose of digoxin by 25-50% and close monitoring of digoxin levels. In addition, electrolytes should also be closely monitored. Patients with hypothyroidism need extra attention.

13. A note on Propofol and sulfa allergy

Not all Propofol are contraindicated in sulfa allergy. There is one form of generic Propofol, which contains a sulfite. It is intentionally added to retard bacterial growth to avoid contamination. Patients with an allergy to sulfa should not receive this generic form of Propofol, as an anaphylactic reaction may occur. Another form of generic Propofol is available which contains benzyl alcohol for inhibition of bacterial growth instead of a sulfite, and is safer to use in patients with sulfa allergy.

On another note, Propofol contains soybean oil, glycerol, and egg yolk phospholipid. Therefore, contraindications to Propofol administration include allergy to soybeans or egg lecithin.

14. Olanzapine and Hyperglycemia

Olanzapine (Zyprexa) is frequently used in ICU for delirium. One of the side effects to be aware of is hyperglycemia. Olanzapine may induce hyperglycaemia by altering insulin secretion from the pancreatic beta cell via blockade of the muscarinic M3 receptor. It has been reported to induce DKA (Ketoacidosis). If Olanzapine induced hyperglycemia is suspected, it should be withdrawn or switched to some other medicines without worsening the psychiatric condition of patient.

Reference(s):

1. Weston-Green, Katrina; Huang, Xu-Feng; Lian, Jiamei; Deng, Chao (2012). "Effects of olanzapine on muscarinic M3 receptor binding density in the brain relates to weight gain, plasma insulin and metabolic hormone levels". European Neuropsychopharmacology 22 (5): 364–73.

2. Lindenmayer JP, Patel R. Olazapine-induced ketoacidosis with diabetes mellitus (letter) Am J Psychiatry. 1999;156:1471.

3. Roefaro J, Mukherjee SM. Olanzapine-lnduced hyperglycemic nonketonic coma. Ann Pharmacother.2001; 35:300–2.

4. Seaberg HL, McLendon BM, Doraiswamy PM. Olanzapine-Associated Severe Hyperglycemia, Ketonuria, and Acidosis: Case Report and Review of Literature. Pharmacotherapy. 2001; 21:1448–54

5. Ober SK, Hudak R, Rusterholtz Hyperglycemia and olanzapine. Am J Psychiatry. 1999; 156:970.

6. Goldstein LE, Sporn J, Brown S, Kim H, Finkelstein J, Gaffey GK, et al. New-onset diabetes mellitus and diabetes ketoacidosis associated with olanzapine treatment. Psychosomatics. 1999; 40:438–4

15. Update on platelet inhibition assay (for Plavix monitoring)

The P2Y12 assay is used for monitoring platelet inhibition for patients on medications like Clopidogrel (Plavix). The company has modified the assay so

that, from now on, the instrument will only report out in "P2Y12 Reaction Units" or PRU, % inhibition will no longer be reported.

The normal reference range is 194-418 PRU. Based on a review of the literature, the optimal P2Y12 result for patients on Clopidogrel is approximately 240 – 180 PRU.

1. Above 240 PRU the patient is at increased risk of thrombosis,
2. Below 180 PRU the patient is at increased risk of bleeding.

16. On Belviq (lorcaserin)

Belviq is a new anti-obesity pill approved by FDA and expected to have a huge demand. The drug works by activating brain receptors for serotonin, a neurotransmitter that triggers sense of satiety and satisfaction. Makers of Belviq (Arena) claims that drug is designed to seek out only the serotonin receptors that affect appetite - But - central side effects are expected including headache, dizziness, fatigue, nausea, dry mouth and constipation. Diabetic patients may get encounter with hypoglycemia.

It would be interesting to watch from Intensive Care Medicine perspective any incident of Serotonin Syndrome.

17. A note on Phenytoin (Dilantin) stability

Phenytoin is very unstable when diluted even in normal saline. Precipitation may occur which is not visible. It is recommended to administer solutions immediately upon preparation.

18. Propofol induced Myoclonus

Myoclonus is an uncommon side effect of Propofol. Besides myoclonus, opisthotonus, refractory dystonia, ataxia, seizures, delayed-onset seizures and seizure-like activities have been described in patients on Propofol. These neurological symptoms resolves on discontinuation of Propofol, but some literature suggests that the neurological squeal that occurred after the withdrawal of Propofol infusion persisting up to 18 days despite antiepileptic treatment. Several possible mechanisms have been proposed but still the actual etiology is not well understood.

It is important to know that Propofol has a very short half-life but it has a delayed terminal elimination half-life hence, significant concentrations of Propofol may persist for days within the nervous system.

19. On Prograf 'Trough' level

Prograf (FK 506, Tacrolimus) is a commonly used medicine in transplants patients and its level should be monitored closely. It is important to draw prograf level (preferably written as an order) just before dose of next medication (lowest or "trough" blood level). Dosage should be adjusted based on the trough levels of medication. Normal trough level is 5-15 ng/ml.

Important interactions to be aware of in these potentially immunosuppressed patients are with antifungals, especially of the azole class (fluconazole, posaconazole). They increase drug levels by competing for the degradative enzymes. Calcium channel blocker as Diltiazem can also dramatically increase tacrolimus level and may result in tacrolimus toxicity. Other drug interactions are common too.

Prograf toxicity may cause blurred vision, liver and renal failure, tremors, hyperkalemia, hypomagnesemia, and neurological problems such as seizure, encephalopathy, cerebral edema, confusion and so on.

20. 7 Pearls of Vitamin K (phytonadione)

1. Oral Vitamin K has similar efficacy as intravenous Vitamin K.
2. SQ (subcutaneous) Vitamin K absorption is unreliable.
3. IM (intramuscular) Vitamin K may promote intramuscular hemorrhage.
4. IV (intravenous) Vitamin K is effective in 6 - 8 hours.
5. IV Vitamin K should be given very slow (preferably .5 mg/min).
6. IV Vitamin K may cause facial flushing, diaphoresis, chest pain, hypotension, dyspnea, anaphylaxis and cerebral thrombosis but pretreatment with antihistamines or corticosteroids is not routinely recommended.
7. Although IV Vitamin K has been described as safe in a few studies, [3,7] it should be used only in life threatening bleeds from warfarin overdose or due to deficiency of vitamin K as fatality from anaphylactoid reaction could be high 4,5.

Reference(s):

1. Comparison of Oral vs. Intravenous Phytonadione (Vitamin K) in Patients With Excessive Anticoagulation - Arch Intern Med. 2003; 163:2469-2473. - full article available with free registration. 2. Oral Vitamin K Lowers the International Normalized Ratio More Rapidly Than Subcutaneous Vitamin K in the Treatment of Warfarin-Associated Coagulopathy - Annals - 20 August 2002, Volume 137 Issue 4, Pages 251-254 -pdf file. 3. The safety of intravenously administered vitamin K - via pubmed, Vet Hum Toxicol. 2002 Jun; 44(3): 174-6. 4. Anaphylactoid reactions to vitamin K - via pumed, J Thromb Thrombolysis. 2001 Apr; 11(2): 175-83. 5. Anaphylaxis after low dose intravenous vitamin K - via pubmed, J Emerg Med. 2003 Feb; 24(2): 169-72. 6. Comparing Different Routes and Doses of Phytonadione for Reversing Excessive Anticoagulation - Arch Intern Med. 1998; 158:2136-2140. 7. The incidence of anaphylaxis following intravenous phytonadione (vitamin K1): a 5-year retrospective review - Annals of Allergy, Asthma and Immunology, Volume 89, Number 4, October 2002, pp. 400-406(7)

21. Propylene Glycol and Ativan

Being an intensivist it is imperative to understand the dangers of propylene glycol with Lorazepam drip - particularly if it is continued beyond 48 hours and requires a higher dose. Any unexplained high anion gap metabolic acidosis with elevated osmol gap, should prompt the diagnosis of propylene gylcol toxicity. It may also cause CNS depression, arrhythmias and renal dysfunction. Propylene glycol is a viscous, colorless liquid solvent used for many drugs with poor aqueous solubility including lorazepoam, diazepam, Esmolol, nitroglycerin, pentobarbital, phenytoin, Bactrim and others.

Reference(s):

Propylene Glycol-Induced Lactic Acidosis in a Patient with Normal Renal Function: A Proposed Mechanism and Monitoring Recommendations - The Annals of Pharmacotherapy: Vol. 39, No. 10, pp. 1732-1735. 2005.

NEUROLOGY

Question 1:

How to perform oculocephalic and oculovestibular reflex testing as one of the determinant of brain death?

Answer:

Oculocephalic reflex: First, ensure the integrity of cervical spine. Rotate patient briskly, head horizontally and vertically. Eye to head movement should be nil.
Oculovestibular reflex (caloric testing): Confirm patency of the external auditory canal. Elevate head to a 30^{o} angle. External auditory canals should be irrigated with about 50 ml of ice-cold water. Eye movement should be absent to none under, a minute observation. It is recommended that the left and right external auditory canals be tested several minutes apart.

Question 2:

During a lumbar puncture (LP), what is the normal rate of cerebrospinal fluid (CSF) escape via needle into collecting tube?

Answer:

1 drop per second

Rationale:

While performing LP, CSF should drop into tube with approximate rate of one drop/sec. A continuous stream of CSF indicates raised intrameningeal pressure.

Question 3:

Which pattern is indicative of brain death in Transcranial Doppler (TCD)?

Answer:

Observed presence of reverberating flow, systolic spikes, absence of flow in basilar and both middle cerebral arteries from two examinations, is highly specific for prediction of brain death.

Question 4:

What is the dose of 23.4% Saline bolus in refractory Increased Intra-Cranial Pressure (ICP)?

Answer:

30 ml

Rationale:

In patients with intractable elevations in ICP refractory to conventional therapies such as mannitol and hyperventilation, 30 ml of 23.4% hypertonic saline given intravenously helps to decrease ICP and augment the cerebral perfusion pressure for up to three hours. .

Reference(s):

1. Suarez JI, Qureshi AI, Bhardwaj A, Williams MA, Schnitzer MS, Mirski M, et al: Treatment of refractory intracranial hypertension with 23.4% saline. Crit Care Med 26:1118–1122, 1998
2. Ware ML, Nemani VM, Meeker M, Lee C, Morabito DJ, Man ley GT: Effects of 23.4% sodium chloride solution in reducing intracranial pressure in patients with traumatic brain injury: a preliminary study. Neurosurgery 57:727–736, 2005

Question 5:

Combining which 2 antiepileptic drugs may increase the risk of Stevens–Johnson syndrome?

Answer:

Lamotrigine (lamictal) with sodium valproate (Depakote)

Rationale:

Stevens-Johnson syndrome is a rare but life-threatening acute mucocutaneous hypersensitivity reaction, which can occur during the treatment with antiepileptic drugs (AEDs).

Reference(s):

Kocak S, Girisgin SA, Gul M, Cander B, Kaya H, Kaya E. - Stevens-Johnson syndrome due to concomitant use of lamotrigine and valproic acid. Am J Clin Dermatol. 2007; 8(2):107-11.

Question 6:

What is the recommended rate of rewarming following therapeutic hypothermia?

Answer:

It is 0.17 °C/hr. (0.31 °F/hr.)

Rationale:

Most deaths caused by therapeutic hypothermia occurred during the rewarming phase of the procedure. Quick re-warming causes harmful spikes in intracranial pressure.
At least 24 hours should be given to re-warm patient from 32–34 °C.

Question 7:

Which one test may help in distinguishing epilepsy from a psychogenic non-epileptic seizure?

Answer:

A prolactin level

Rationale:

A high blood prolactin level during initial twenty minutes following the seizure may be useful to differentiate an epileptic seizure from the psychogenic non-epileptic seizure.

Reference(s):

1. Luef, G (October 2010). "Hormonal alterations following seizures." Epilepsy & behavior: E&B 19 (2): 131–3.

2. Ahmad S, Beckett MW (2004). "Value of serum prolactin in the management of syncope". Emergency medicine journal: EMJ 21 (2): e3

Question 8:

A 47-year-old male just arrived from OR and now have accelerated hypertension, A.fib with rapid ventricular rate (RVR), Hyperthermia and muscle rigidity. There is a high suspicion of Neuroleptic Malignant Syndrome (NMS). The decision was made to use IV Dantrolene (Dantrium). Which drug should be avoided in treatment of A.fib with RVR?

Answer:
Calcium Channel Blocker (Cardizem or Verapamil).

Rationale:
Concomitant use of calcium channel blockers like Cardizem or verapamil
with intravenous treatment with dantrolene may lead to arrhythmia, severe cardiovascular collapse, myocardial depressions, and hyperkalemia.
Bonus Pearl: Dantrium is incompatible with D5W or normal saline! And is administered by direct injection.

Question 9:

Metabolic encephalopathy causes? (Choose one).
A) Pupillary constriction (miosis).
B) Pupillary dilatation (mydriasis).

***Answer*:**
Pupillary constriction (miosis). If your clinical diagnosis is metabolic encephalopathy but pupils appear dilated, you may need to revisit your diagnosis or may need to consider further radiological workup. In the ICU major causes of pupillary constriction are opiates, metabolic encephalopathy, cholinergic toxicity, or pontine lesions.

Question 10:

Case:
You have been called to ER to consult a critically ill 42-year-old male who presented with mental status change and hypotension. Lab shows finding of pre-renal azotemia with acute renal failure (ARF). Wife reports chills and 'very very excessive sweating' since last 3 months, progressively getting worse. Patient was also reported to be hypothermic. Your diagnosis was simple septic shock and you argued about CT scan of head, which was done by ER physician. Meanwhile, you received a call from radiologist with report from head CT and he strongly recommends MRI of brain to confirm findings. You agreed and it showed agenesis of the corpus callosum. What is your diagnosis?

Answer:

Shapiro's Syndrome

Rationale:
Shapiro's Syndrome is characterized by recurrent episodes of hypothermia, hyperhidrosis and agenesis of the corpus callosum. The Office of Rare Diseases (ORD) of the National Institutes of Health (NIH) lists Shapiro syndrome as a "rare disease". The onset is typically in adulthood. Hyperhidrosis can be so severe that it may cause acute renal failure. Several treatment options have been described including cyproheptadine, clonidine, glycopyrrolate and topiramate.
*W. R. Shapiro, G.H. Williams and F. Plum first described Shapiro's Syndrome in 1969.

Reference(s):
1. Agenesis of the corpus callosum associated with paroxysmal hypothermia: Shapiro's syndrome. Neth J Med. 1997 Jan; 50(1): 29-35.
2. Clonidine therapy for Shapiro's syndrome. Q J Med. 1992 Mar; 82(299): 235-45.
3. HYPOTHALAMIC DYSFUNCTION IN SHAPIRO'S SYNDROME MAY CAUSE ABNORMALITIES OF THIRST AND APPETITE PERCEPTION Endocrine Abstracts (2002) 4 P24
4. Shapiro's Syndrome: A Renewed Appreciation for Vital Signs Clinical Infectious Diseases 2004; 38:e107–e108

Question 11:
Why corticosteroids are added with Praziquantel in treatment of Neurocysticercosis?

Answer:
Praziquantel can excite an inflammatory response in CNS. Corticosteroids help in decreasing inflammation. It's important to note, when corticosteroids are given in combination with Praziquantel, it decreases the action of Praziquantel by enhancing its first pass metabolism. It is recommended to add cimetidine in the regimen. Co-administration of cimetidine raises serum Praziquantel levels.

Reference(s):
1. White, Jr., A. Clinton (2009). "New developments in the management of neurocysticercosis". The Journal of Infectious Diseases 199 (9): 1261–2.
2. Dimitrios K. Matthaiou, Georgios Panos, Eleni S. Adamidi, Matthew E. Falagas "Albendazole versus Praziquantel in the Treatment of Neurocysticercosis: A Meta-analysis of Comparative Trials" PLoS Negl Trop Dis. 2008 March; 2(3): e194
3. Dachman WD1, Adubofour KO, Bikin DS, Johnson CH, Mullin PD, Winograd M. - Cimetidine-induced rise in praziquantel levels in a patient with neurocysticercosis being treated with anticonvulsants. - J Infect Dis. 1994 Mar; 169(3): 689-91

Question 12:
What are 4 basic criteria to label patient as having Delirium?

Answer:
Per American Psychiatric Association's Diagnostic and Statistical Manual of Mental Disorders. 4th ed. (DSM-IV), Patient is having delirium if
1. Disturbance of consciousness (e.g., reduced clarity of awareness of the environment) with reduced ability to focus, sustain, or shift attention.
2. A change in cognition such as memory deficit, disorientation, language disturbance (or the development of a perceptual disturbance that is not better accounted for by a

preexisting, established, or evolving dementia).
3. The disturbance develops over a short period of time (usually hours) and tends to fluctuate during the course of the day.
4. Disturbance caused by a general medical condition or substance intoxication or medication use.

Question 13:

Rewarming after therapeutic hypothermia should begun 24 hours after the
A) time of initiation of cooling or
B) from the time the target temperature (32-34 C) is achieved.
(Choose one).

Answer:
Countdown for rewarming after therapeutic hypothermia should begin 24 hours after the time of initiation of cooling. The patient should be actively cooled to achieve the goal temperature of 32-34ºC in 24 hours. ON cooling the patient it is desired to achieve the goal as quickly as possible, this may be achieved within 3-4 hours of initiation of cooling.

Question 14:

What is Balint syndrome?

Answer:
Balint syndrome is a triad of

1. Visual simultanagnosia
2. Optic ataxia
3. Apraxia of gaze

Visual simultanagnosia: It is the inability of a person to survey the scene and incorporate its parts into a cohesive interpretation. In this, patient can identify specific parts of a scene but are unable to describe the complete picture.
Optic ataxia in this condition where the individual looses hand to eye coordination.

Apraxia of gaze: It this condition there is a supranuclear deficit in the ability to initiate as well as carry out command.
This can occur in patients who have suffered bilateral parieto-occipital infarction, most often after the watershed infarct between the posterior cerebral artery and middle cerebral artery territories.

Question 15:

What is the modus operandi of Subdural Hematomas (SDH)?

Answer:
Contrary to popular belief that SDH happens due to direct trauma. Subdural hematomas actually are most often caused by abrupt change in velocities in the skull. This change could result in stretching and tearing of small bridging veins, which means subdural

hematomas generally result from shearing injuries from numerous linear or rotational forces.

As a result of the above modus operandi, SDH is a classic finding in shaken baby syndrome where shearing forces cause intra and pre-retinal hemorrhage. Cerebral atrophy, which is commonly seen in the alcoholics and elderly patients, tends to increase the length, which the bridging veins have to traverse between the two meningeal layers, thereby increasing the likelihood of shearing forces leading to a tear.

Question 16:

What is the characteristic finding in CSF in Guillain–Barré syndrome (GBS)?

Answer:
Albumino-cytological dissociation

Rationale:
In Guillain–Barré syndrome, cerebrospinal fluid (CSF) shows characteristic finding of albumino-cytological dissociation. In contrast to infectious causes, there is an elevation in protein level (100–1000 mg/dl) without pleocytosis. If the white cell count is elevated, then an alternative diagnosis need to be considered.

Question 17:

A 24-year-old female 2 weeks post partum developed severe headache for a week followed by seizure. While you start workup what would be your presumptive diagnosis and line of management?

Answer:
Postpartum cerebral vasospasm would be high on list

Rationale:
Cerebral angiography or Magnetic Resonance Imaging/angiography should be performing as soon as possible to rule out vasospasm. IV fluid should be started at a rate of least 125 cc/hour with the goal of keeping the blood pressure high. Treatment consists of hyperosmolar, hypervolemic therapy and nimodipine.

Question 18:

While performing LP (Lumbar puncture) you encountered Green color CSF fluid. What may be the cause of it?

Answer:
Hyperbilirubinemia. Purulent CSF may also sometime appear Green. It should be read with other values in CSF.

The cerebrospinal fluid (CSF) is produced from arterial blood by the choroid plexuses of the lateral and fourth ventricles by a combined process of diffusion, pinocytosis and

active transfer. The total volume of CSF in the adult is about 140 ml. The volume of the ventricles is about 25 ml. CSF is absorbed across the arachnoid villi into the venous circulation. The rate of absorption correlates with the CSF pressure.

Question 19:

What is Jacksonian seizure?

Answer:

Jacksonian seizure is a unique type of simple partial seizures in which symptoms start in one part of the body, then spread to another - "epileptic march". Abnormal movements may occur in the hand or foot, and then progress up the limb as the electrical activity spreads in the brain. People are completely aware of what is occurring during the seizure.

Jacksonian seizures are extremely varied and may involve, for example, apparently purposeful movements such as turning the head, eye movements, smacking the lips, mouth movements, drooling, and rhythmic muscle contractions in a part of the body, abnormal numbness, tingling, and a crawling sensation over the skin. These motor symptoms spread slowly from one part of the body to another.
(These seizures are named after an English neurologist, John Hughlings Jackson who described it in 1863)

Question 20:

A 28-year-old male is transferred from the floor to the ICU. The patient was admitted to the floor 6 days ago with acute exacerbation of Multiple Sclerosis (MS). Patient did not show much improvement after high dose of steroid treatment. What could be your next step?

Answer:

Plasmapheresis

Rationale:

A high dose of steroids (such as 1000 mg of solumedrol) remains the mainstay of therapy for acute relapses in MS. Please note oral and IV corticosteroids have a similar efficacy. Severe attacks of MS, which do not respond to steroids, are recommended to be treated by plasmapheresis.

Reference(s):

1. Compston A, Coles A (October 2008). "Multiple sclerosis". Lancet 372 (9648): 1502–17.
2. Multiple sclerosis: national clinical guideline for diagnosis and management in primary and secondary care - London: Royal College of Physicians. 2004. pp. 54–57.
- (http://www.ncbi.nlm.nih.gov/books/NBK48919/pdf/TOC.pdf)

Question 21:

A 28-year-old male is admitted with headache and back pain after a fall. Neurologist was called in ER and ordered CT of head and spine. The ED physician called asking for the

patient to be admitted for observation with diagnosis of pneumorrhachis. What is pneumorrhachis?

Answer:
Pneumorrhachis means the presence of intraspinal air. It usually reabsorbs spontaneously and patients usually are managed conservatively but entrapped air may cause syndromes of intracranial and intraspinal hypertension. The clinical significance lies in finding potentially associated hidden and life threatening injuries.

Question 22:

In the treatment of increased intracranial pressure (ICP), what is the equivalency of 23.4% of NaCl and Mannitol in terms of similar effect?

Answer:
To be precise, 0.686 ml of 23.4% of NaCl is equiosmolar to 1 gram of mannitol in effect. Usual dose is 30-50 ml of 23.4% of NaCl q3-q6 hours as needed.

Question 23:

What is Ribot's law of retrograde amnesia?

Answer:
This law states that there is a time gradient in retrograde amnesia, where recent memories are more likely to be lost than more remote memories.
Some examples are, condition in which bilingual patients recovers different languages with differential speed. In some cases, aphasics recover or preferentially improve only the initial-acquired language.

Please note, in Neurology, Ribot's Law is not universally accepted.

Question 24:

A 54-year-old male is in ICU after a Traumatic Brain Injury (TBI). Follow up with CT scan shows cerebral edema. The resident ordered Mannitol. After 4 doses of Mannitol patient oxygen requirement on ventilator increased and CXR shows pulmonary edema. The resident asks, "If we are using Mannitol to relieve cerebral edema than why does it cause the pulmonary edema"?

Answer:
In patients with underlying cardiac or / and renal insufficiency, circulatory volume overload may occur due to expansion of extracellular fluid after serial Mannitol administration causing pulmonary edema. It is true that Mannitol is an osmotic diuretic but overwhelming hydrostatic pressure due to poor urinary output and underlying compromised cardiac function offsets the increased oncotic pressure and may lead to extravasation of fluid.

Question 25:

A 58-year-old male with history of seizure is admitted to the ICU with aspiration pneumonia requiring mechanical ventilation along with sedation and neuro-muscular blockade (NMB). Despite high dose of Nimbex (Cisatracurium) adequate NMB cannot be achieved. Which anti-seizure medicine may be interacting here?

Answer:

Carbamazepine

Rationale:

Carbamazepine not only increases the clearance of cisatracurium, but also increases the resistance to the neuromuscular blocking effect of cisatracurium. Higher doses of cisatracurium may be required in patients on chronic carbamazepine therapy.

Question 26:

A 53-year-old male is in ICU recovering from DKA. Patient informed you that he has been prescribed an anti-hypertensive in topical form as a treatment for his pain from diabetic neuropathy. He prefers to use the same. Which one it could be?

Answer:

Clonidine

Recently one study showed that clonidine could be an effective agent to use as a treatment to relieve pain from diabetic neuropathy.

Reference:
Campbell, CM; Kipnes, MS; Stouch, BC; Brady, KL; Kelly, M; Schmidt, WK; Petersen, KL; Rowbotham, MC; Campbell, JN (September 2012). "Randomized control trial of topical clonidine for treatment of painful diabetic neuropathy". Pain 153 (9): 1815–1823.

Question 27:

What is the direct effect of Digoxin in brain?

Answer:

Digoxin has shown to decrease CSF production in humans significantly, probably by inhibiting Na-K-ATPase pump. It has been described as an alternate or adjuvant treatment in Pseudotumor Cerebri beside carbonic anhydrase inhibitor (e.g., acetazolamide).

Question 28:

What are the essential components of decorticate and decerebrate posturing?

Answer:
In decorticate posturing:

1. Patients elbows, wrists and fingers flexed
2. Patients legs are extended but rotated inwards

Decorticate posturing indicates damages in cerebral hemispheres, the internal capsule, or the thalamus.
In decerebrate posturing:

1. Patent head is arched back
2. Patient arms are extended by the sides (elbows extended)
3. Patient legs are extended.

Decerebrate posturing indicates damage in the brain stem, either mid brain or cerebellum, specifically with lesions or compression. Progression from decorticate posturing to decerebrate posturing is often indicative of brain herniation.

Question 29:

A 72-year-old male with history of myasthenia gravis is now admitted with GI bleeding. You are writing orders and converting essential meds to IV form. What is the conversion from PO to IV of pyridostigmine (Mastinon)?

Answer:
Conversion is 1/30th of PO dose.
e.g. 90 mg PO would be equivalent to 3 mg IV. Intravenous form should be given preferably via slow infusion.

Question 30:

What is MELAS Syndrome?

Answer:
It stands for:

1. **M**itochondrial myopathy
2. **E**ncephalopathy
3. **La**ctic Acidosis
4. **S**troke like episodes

It occurs due to defect in mitochondrial genome. Important diagnostic feature - it is inherited purely from the maternal parent though it can be manifest in either gender. Early symptoms include muscle weakness, headaches, vomiting, and seizures and lately stroke-like episodes.
"MELAS episode" or attack appears as temporary hemiparesis, altered consciousness, vision abnormalities, seizures and severe headaches like migraines. Most patients with MELAS have a buildup of lactic acid due error in mitochondria.

There is no treatments known, Riboflavin (*vitamin B2*) has been described to be beneficial.

Question 31:

A 53-year-old male with history of HIV is admitted to the ICU with clinical signs of meningitis. Resident performed Lumbar Puncture and called you with panic as opening pressure is noted to be 200 mm H_2O. What is your diagnosis?

Answer:

Cryptococcosis

Rationale:

Cryptococcosisis is a systemic or central nervous system (CNS) fungal infection caused by the yeast Cryptococcus neoformans. Cryptococcal infection is usually asymptomatic and self-limited. Recent exposure or reemergence of cryptococcus infection in HIV infected patients CD4 counts less than 100 cells/μL) could result in potentially fatal illness. A distinct feature of Cryptococcus infection is elevated intracranial pressure (ICP), which significantly increases morbidity and mortality of Cryptococci meningitis and should be managed by draining cerebrospinal fluid (CSF).

The opening pressure of the CSF should be measured on the initial lumbar puncture (LP). It is recommended LP and CSF drainage should be repeated daily as needed to achieve reduction in ICP. In cases where the initial opening pressure is greater than 400 mm H_2O, or in refractory circumstances, ventriculostomy or a ventriculoperitoneal (VP) shunt may be an alternative.

Recommended Reading:

EDITORIAL REVIEW: HIV-associated cryptococcal meningitis, Joseph N. Jarvis and Thomas S. Harrison, AIDS 2007,21:2119–2129

Question 32:

How much cerebral metabolism goes down with reduction of each 1^oC?

Answer:

About 7%

Rationale:

Rationale for the effects of hypothermia as a neuro-protectant is based on the slowing of cellular metabolism. For every one degree Celsius drop in body temperature, cellular metabolism slows by about 7%. Probably hypothermia reduces the harmful effects of ischemia by decreasing the body's need for oxygen. More recent data suggests that hypothermia affects pathways that extend beyond a decrease in cellular metabolism.

Question 33:

A 21-year-old female is admitted with severe headache. There is no known past medical history except that she is recently started on minocycline for the treatment of her acne. What is your suspicion?

Answer:
Pseudotumor cerebri (PTC) or idiopathic intracranial hypertension
Tetracyclines, doxycycline and minocycline are known to cause PTC. The mechanism by which they induce pseudotumor cerebri is unknown.

Minocycline may cause persistently elevated intracranial pressure, and may require medical and surgical treatment beside discontinuation of the medication. It is not a benign condition and aggressive interventions are needed to prevent severe morbidity like vision loss.

Reference(s):
1. A. M. Chiu, W. L. Chuenkongkaew, W. T. Cornblath, et al., "Minocycline treatment and pseudotumor cerebri syndrome," American Journal of Ophthalmology, vol. 126, no. 1, pp. 116–121, 1998.
2. K. Mochizuki, T. Takahashi, M. Kano, K. Terajima, and N. Hori, "Pseudotumor cerebri induced by minocycline therapy for acne vulgaris," Japanese Journal of Ophthalmology, vol. 46, no. 6, pp. 668–672, 2002.
3. D. I. Friedman, L. K. Gordon, R. A. Egan, et al., "Doxycycline and intracranial hypertension," Neurology, vol. 62, no. 12, pp. 2297–2299, 2004.
4. A. Kesler, Y. Goldhammer, A. Hadayer, and P. Pianka, "The outcome of pseudotumor cerebri induced by tetracycline therapy," Acta Neurologica Scandinavica, vol. 110, no. 6, pp. 408–411, 2004.

Question 34:
Which commonly used anti-seizure medication is not effective or actually has been advised not to be used in seizures secondary to Lidocaine?

Answer:
Phenytoin (Dilantin)
In seizures secondary to Lidocaine, benzodiazepines and barbiturates are the drugs of choice. Phenytoin is not effective.

Question 35:
What is Atropine test?

Answer:
Atropine test is a simple pharmacological test based on the absence of cranial parasympathetic nervous influence on the heart in brain dead patients and may be a useful adjunct to testing brain stem function. A tachycardia response would demonstrate an intact cranial parasympathetic outflow. 2-3 mg of Atropine IV is then given. If there is less than 10 % or no increase in heart rate, this supports the diagnosis of brain death. Additional confirmatory tests are however required.

Question 36:
What is Mount Fuji Sign?

Answer:
A sign in massive pneumocephalus
In this condition, there is a massive accumulation of air compressing the frontal lobes, and is known as the Mount Fuji sign.
Pneumocephalus can occur after neurosurgical procedures or after trauma or it can occur spontaneously. Small amounts of air are usually reabsorbed but tension pneumocephalus may occur leading to life threatening situations.
The CT findings resemble the silhouette of a volcano, such as Mount Fuji. A "peaking" sign indicates an increased tension and it occurs when the frontal lobes forms a peak in the midline on account of intact bridging veins.

Question 37:
What is Hakim's triad (also known as Adam's triad)?

Answer:
It is a classic triad of Normal pressure hydrocephalus
gait disturbance, urinary incontinence, and dementia or mental decline.
The triad is named after Hakim and Adams who first described it in 1965.

Question 38:
You have been called to ED to evaluate a patient with severe headache. You ruled out Subarachnoid hemorrhage (SAH) with radiological imaging and you strongly suspect acute migraine. What one non-narcotic medicine may help you to treat severe acute migraine?

Answer:
Metoclopramide

Rationale:
A meta-analysis of 13 randomized controlled trials showed that in emergency departments, intravenous metoclopramide is considered a primary agent in the management of migraine.

Reference(s):
Colman I, Brown MD, Innes GD, Grafstein E, Roberts TE, Rowe BH. Parenteral metoclopramide for acute migraine: meta-analysis of randomized controlled trials. BMJ. 2004; 329(7479): 1369–1373

Question 39:
"Worst headache of life" or "like being kicked in the head" is the classic presentation in subarachnoid hemorrhage (SAH). Many patients report neck stiffness too. What is the usual lag time reported between headache and neck stiffness, and strongly suggests SAH?

Answer:
Approximately 6 hours.

Rationale:
In classic SAH presentation, neck stiffness usually presents within six hours after the initial onset of SAH.

Reference(s):
Warrell, David A; Timothy M. Cox, et al. (2003). Oxford Textbook of Medicine, Fourth Edition, Volume 3. Oxford. pp. 1032–34

Question 40:
Describe direct effect of Lasix on brain?

Answer:
Lasix reduces ICP by decreasing the production of CSF. It interferes with the Na transport and in turn slows down the production of CSF fluid from the choroid plexi. Another cardiovascular drug, which has similar effect, is Digoxin.

Question 41:
What is Peek sign?

Answer:
Manifestation of Myasthenia gravis includes weakness, predominantly in bulbar, facial, and extra-ocular muscles.
The peek sign is the manifestation of fatigue of the orbicularis muscle when patient is asked to close the eyelid, it initially closes for a minute, but later due to fatigue of the orbicularis muscle the lid separates to show the scleral rim. This gives the impression as patients is peeking the examiner, hence peeking sign has been named. With profound fatigue of the orbicularis muscle, the cornea may become visible.
The peek sign can also be seen with VII cranial nerve palsies.

Question 42:
Lorazepam (Ativan) and Diazepam (Valium) both have been used as first line treatment of Status Epilepticus. What advantage does Lorazepam have over Diazepam?

Answer:
Lorazepam and diazepam both have been used as a first line drugs in the management of Status Epilepticus. Though diazepam acts slightly faster than lorazepam its effective duration of action may be only 5-10 min, and may require repeated doses or quick follow-up with administration of phenytoin (or fosphenytoin). On the other hand once effective dose(s) of lorazepam is given, the effective duration of action of lorazepam is 8-10 hours, and so is more recommended for initial treatment of status epilepticus.

Question 43:

A 34-year-old male patient had lumbar puncture (LP) 4-days ago but continues to complain of severe headache. Analgesics are not working. What would be other simple recommendation?

Answer:
Caffeine - 300-500 mg q4-6h

Rationale:
In severe cases Caffeine sodium benzoate (500 mg) in 1 liter of fluid (D5LR) can be given intravenously over one and a half hour. The patients usually have complete resolution of symptoms and no recurrence of headache.

Caffeine sodium benzoate is a simple treatment of post-lumbar-puncture headaches. It should be considered as a safe alternative to an epidural blood patch for the treatment of post-lumbar-puncture headaches.

Reference(s):
A simple treatment of post-lumbar-puncture headache. - J Emerg Med. 1989 Jan-Feb; 7(1): 29-31.

Question 44:
What is the off-label use of levetiracetam (Keppra) beside its usual role as an anti-seizure?

Answer:
To treat neuropathic pain

Rationale:
Like gabapentin (Neurontin), it is also sometimes used to treat neuropathic pain.

Reference(s):
Price MJ. Levetiracetam in the treatment of neuropathic pain: three case studies., Clin J Pain. 2004 Jan-Feb; 20(1): 33-6.

Question 45:
A 32-year-old otherwise healthy male with 2 weeks history of sinusitis presented with seizure. The ED physician called you while he sent patient to CT scan. What would be your primary concern and line of action?

Answer:
Neurological symptoms after prolong bout of sinusitis is highly suggestive of Subdural empyema.

Rationale:
Subdural empyema is a neurosurgical emergency and besides instituting antibiotics and anti-seizure meds, it would be appropriate to ask neurosurgical service to review CT scan while patient is in neuroradiology department. It has a tendency to spread rapidly through the subdural space.

Question 46:

Central pontine myelinolysis (CPM) is well known to occur due to rapid correction of sodium in hyponatremia. What other conditions may cause CPM?

Answer:

It is true that most common cause of Central pontine myelinolysis (CPM) is too rapid correction of low sodium in hyponatremia. Second most common cause is withdrawal of chronic alcoholism.

Other conditions described to cause CPM include following hematopoietic stem cell transplantation, severe liver disease, following liver transplant, severe burns, and malnutrition and hyperemesis gravidarum.

Question 47:

What is the usual target for magnesium levels for vasospasm prevention after aneurysmal Subarachnoid Hemorrhage?

Answer:

To prevent vasospasm and improve outcomes after aneurysmal subarachnoid hemorrhage, it is recommended to keep magnesium level between 3.0 - 4.5mEq/l Central line is suggested for administration. Bolus Dose of 2g of $MgSO_4$ is given over 30 minutes and maintenance rate of 1g of $MgSO_4$/hr is recommended with goal of serum Mg level of3.0 - 4.5mEq/l. Serum Mg levels should be checked before starting the infusion, 2 hours after initiation, 2 hours after any dose or rate change and every 12 hours afterwards.

It is to note that ionized Ca and serum K levels should be checked twice a day. Calcium repletion is needed if Calcium level is less than 1.1 mmol/L. Magnesium drip should be stopped if serum K is greater then 6 mmol/L or if there is a new prolongation of PR interval or onset of new AV block.

Question 48:

Ciprofloxacin is not a good choice in patients with myasthenia gravis. Why?

Answer:

Ciprofloxacin is now known for more than 20 years to cause worsening of myasthenia gravis (MG), including muscle weakness and breathing problems - and may require ventilatory support.
Other drugs, which may worsen MG includes beta-blockers, lithium, procainamide, verapamil, prednisone and neuromuscular blocking agents.

Question 49:

During traumatic spinal tap, protein may also get introduce into the CSF beside RBCs. What rule of thumb may help in differentiating between traumatic protein tap vs. otherwise unsuspected neurologic disease?

Answer:
An approximation of 1 mg of protein for every 750 RBCs may be used as a guide for probable traumatic tap. It is advisable to repeat spinal tap to confirm diagnosis.
A high CSF protein level can be a clue to demyelinating polyneuropathies.

Question 50:
What is the conversion of PO pyridostigmine (Mestinon) to IV pyridostigmine in patients with Myasthenic Crisis, who is intubated now and is NPO?

Answer:
Conversion of PO pyridostigmine to IV pyridostigmine is 30:1

Question 51:
Kernig's sign and Brudzinski's sign are well known in Meningitis. What is the Jolt test or "jolt accentuation maneuver" to rule out meningitis?

Answer:
The "Jolt accentuation maneuver" helps to rule out meningitis in patients with fever and headache. The patient is instructed to rapidly rotate head horizontally. If this does not cause worsening of the headache, meningitis is unlikely.

Question 52:
A 52 year-old male with chronic pain and muscle spasm problem and on baclofen pump brought to ED with delirium and mental status change.

Answer:
Baclofen withdrawal syndrome.

Rationale:
Abrupt withdrawal of baclofen due to mechanical or other reason may cause serious and even life-threatening symptoms including fluctuation of consciousness, agitation, restlessness, delusions, hallucinations, delirium, tachycardia, autonomic changes, seizures, spasticity and tremors. Severe rebound spasm may cause severe rhabdomyolysis.
The treatment is to resume the drug. If intrathecal route is not available, oral replacement should be started as soon as possible. .

Question 53:

What is the optimum time of administrating Nimodipine in Subarachnoid Hemorrhage (SAH)?

Answer:
In subarachnoid hemorrhage (SAH), nimodipine's is use primarily in the prevention of cerebral vasospasm. It should be started within 4 days of a subarachnoid hemorrhage (SAH) and should be continued for 21 days. Nimodipine is a calcium channel blocker and has selectivity for cerebral vasculature.

Question 54:
What are the best places to obtain TCD (Trans Cranial Doppler)?

Answer:
Since the skull bones blocks the ultrasound transmission, most preferred areas are the temporal region above the cheekbone/zygomatic arch, through the eyes, below the jaw, and from the back of the head. These areas are called insonation window, through which ultrasound images can be obtained.

Question 55:
Why Succinylcholine should be use with caution in Myasthenia Gravis patients?

Answer:
Succinylcholine can have unpredictable effects in patients with myasthenia gravis.
Firstly, the relative lack of acetylcholine receptors makes these patients somewhat resistant to succinylcholine.
Secondly, higher doses may be required to achieve the desirable effect.
Thirdly, the paralytic effect of succinylcholine may be prolonged.

Reference(s):
Juel VC. Myasthenia gravis: management of myasthenic crisis and perioperative care. Semin Neurol. Mar 2004; 24(1): 75-81

Question 56:
What is Bickerstaff's brainstem encephalitis (BBE)?

Answer:
Bickerstaff's brainstem encephalitis (BBE) is a variant of Guillain–Barré syndrome. It is characterized by acute onset of

1. Ophthalmoplegia
2. Ataxia
3. Clouding of consciousness
4. Babinski's sign or hyper-reflexia

The disease course can be remitting-relapsing or monophasic. This disease has good prognosis. Findings on MRI showed large, irregular hyperintense lesions located predominantly on the brainstem, particularly in the pons, midbrain and medulla.

Question 57:

What is the equivalency of fosphenytoin sodium to phenytoin sodium?

Answer:

Fosphenytoin sodium is a prodrug and its active metabolite is phenytoin.
1.5 mg of fosphenytoin sodium is equivalent to 1 mg phenytoin sodium.

Question 58:

What are the 20-30-40 rules in myasthenia crisis?

Answer:

The 20-30-40 rules is the most helpful and reliable indicator to decide when intubation is necessary in Myasthenia Crisis.

1. Patient vital capacity less than 20ml/kg;
2. Patient with peak inspiratory pressure less than 30 cm H_2O
3. Patient having peak expiratory pressure less than 40 cm H_2O

Question 59:

A 42 year-male with no previous history known is brought to ER with mental status changes, fever and nuchal rigidity. CT scan obtained does not provide much information. ER doctor performed lumbar puncture and transferred patient to ICU. You get STAT call from lab that there is a spider web clot in the collected CSF. What does it mean?

Answer:

A spider web clot in the collected CSF is characteristic of TB meningitis though not always present.

The CSF usually has a high protein, low glucose and increase lymphocytes. An acid-fast bacillus commonly grown in culture but the culture of TB from CSF takes about two weeks, and therefore the majority of patients with TB meningitis are started on treatment before the diagnosis is confirmed.

Question 60:

How is the laboratory diagnosis made for Miller Fisher syndrome (MFS)?

Answer:

Anti-GQ1b antibodies

Rationale:

Miller Fisher syndrome (MFS) is a variant of GBS (Guillain–Barré syndrome), which accounts for approximately 5% of the cases. MFS is diagnosed via descending paralysis, ensuing in the reverse order of the more common form of GBS. Eye muscles are typically initially affected and is presented with the trio of:

1. Ophthalmoplegia
2. Ataxia, and
3. Areflexia

Ataxia is known to fundamentally affect the gait and trunk, with the limbs rather spared. Anti-GQ1b antibodies are observed in 90% of patients.

Question 61:

What are the 2 major differences on clinical exam between Myasthenia Gravis (MG) and Lambert-Eaton syndrome (LES)?

Answer:

1. In MG weakness gets worse on exercise whereas in LES it improves with exercise. This is also known as Lambert's sign.
2. In MG reflexes are normal whereas in ELS they are decreased.

Question 62:

What one precaution should be taken before giving rTPA to patient with acute ischemic stroke?

Answer:

Insert another large bore IV

Rationale:

Once decision is made to administer rTPA to a patient with ischemic CVA, another large-bore intravenous line should be inserted.
Placement of arterial lines, venipuncture, and insertion of nasogastric tubes should be avoided for at least 24 hours after the rtPA due to increased risk of bleeding.

Reference(s):

Adams H.P. Jr., del Zoppo G., Alberts M.J., et al. Guidelines for the early management of adults with ischemic stroke: a guideline from the American Heart Association/American Stroke Association Stroke Council, Clinical Cardiology Council, Cardiovascular Radiology and Intervention Council, and the Atherosclerotic Peripheral Vascular Disease and Quality of Care Outcomes in Research Interdisciplinary Working Groups. Stroke 2007;38:1655-711.

Question 63:

What is Todd's Paresis?

Answer:

Todd's paresis is focal paralysis, which occurs after seizure, and usually resolves within a day or two. This typically presents as hemiplegia. Todd's paresis may also present as

difficulty in speech, gaze problems or blurred vision. This is usually evident in about 10% of seizures.

The most challenging part is to determine whether seizure is the cause of motor weakness or is the result of CVA. Fortunately, in most cases it resolves quickly.

Question 64:

What is the major clinical difference between Parkinson's disease and tardive dyskinesia patients on examination?

Answer:

Patients with Parkinson's disease have difficulty moving, whereas patients with tardive dyskinesia have no problem in moving and ambulation.

Rationale:

Tardive dyskinesia is usually a side effect of anti psychotics and is characterized by repetitive, involuntary, purposeless movements like grimacing, tongue protrusion, lip smacking, puckering, pursing of the lips, rapid eye blinking etc.

Question 65:

What is Foster Kennedy syndrome?

Answer:

Foster Kennedy syndrome is a group of findings associated with tumors of the frontal lobe. It causes optic atrophy in the ipsilateral eye but disc edema in the contralateral eye. Also, it causes central scotoma in the ipsilateral eye and anosmia ipsilaterally. Usually intracranial mass and increase ICP causes optic nerve and olfactory nerve compression.

It may cause other frontal lobe symptoms too such as memory loss, emotional labiality etc.

Question 66:

What is the level of Sodium (Na), you will target if hypertonic solution (3% NS) has been chosen as a management plan in cerebral edema and intracranial hypertension.

Answer:

145-155 Meq/L.

Rationale:

Although mannitol with close monitoring of serum osmolality remains mainstay of treatment, no major clinical trial is yet to establish the use of Hypertonic Solution (3% NS) as standard of treatment in cerebral edema and intracranial hypertension. However, literature available has increasingly shown its comparable and sustained effect on

lowering ICP (Intra-cranial pressure).

Reference(s):
1. Use of hypertonic saline solutions in treatment of cerebral edema and intracranial hypertension. Critical Care Medicine. 28(9): 3301-3313, September 2000.
2. Treatment of elevated intracranial pressure in experimental intracerebral hemorrhage: Comparison between mannitol and hypertonic saline. Qureshi AI, Wilson DA, Traystman RJ: Neurosurgery 1999; 44: 1055-1064 -via pubmed
3. Hypertonic saline for cerebral edema and elevated intracranial pressure - Cleve Clin J Med. 2004 Jan; 71 Suppl 1:S9-13.
4. Introducing Hypertonic Saline for Cerebral Edema: An Academic Center Experience - Neurocritical Care Winter 2004, Volume 1, Issue 4, pps. 435-440
5. Treatment of intracerebral haemorrhage - Lancet Neurology 2005; 4:662-672

Question 67:

What is the pathological basis of 'paradoxical undressing' in severe hypothermia?

Answer:

Up to half of the deaths in severe hypothermia may be in some way related to paradoxical undressing. As the patient gets disoriented and combative, he/she may begin removing his/her clothing, which, in turn increases the rate of heat loss.
Multiple mechanisms have been proposed for this phenomenon including malfunction of the hypothalamus secondary to cold, causing dysregulation of body temperature system. Also, peripheral blood vessels losses vasomotor tone due to exhaustion (muscle contractions) and massive vasodilatation occurs, leading to a sudden increase in blood flow to the extremities, giving a misleading sensation to the person that he is actually warm and overheated.

Reference(s):
1. Wedin B, Vanggaard L, Hirvonen J (July 1979). ""Paradoxical undressing" in fatal hypothermia". J. Forensic Sci. 24 (3): 543–53.
2. Ramsay, David; Michael J. Shkrum (2006). Forensic Pathology of Trauma (Forensic Science and Medicine). Totowa, NJ: Humana Press. p. 417.

Question 68:

A 42-year-old male who developed acute Transverse Myelitis - failed treatment options with high dose steroids and plasma exchange. What could be your third salvage option?

Answer:

Intravenous cyclophosphamide

Rationale:

If there is continued progression despite high dose IV steroid and Plasma Exchange therapy, pulse dose of intravenous cyclophosphamide (800–1000 mg/m2) can be given with consultation of neurology and oncology services.

Question 69:

Central Pontine Myelinolysis (CPM) may be a complication of which surgery?

Answer:
Complication of Liver transplant surgery
This complication is distinct from other causes of central pontine myelinolysis such as

1. Chronic alcoholism
2. Malnourishment
3. Rapid correction of hyponatremia
4. Wilson's disease
5. Burn patients having extended duration of serum hyperosmolality

Reference(s):
1. Singh N, Yu VL, Gayowski T. Central nervous system lesions in adult liver transplant recipients: clinical review with implications for management. Medicine (Baltimore). Mar 1994; 73(2): 110-8.
2. Adams RD, Victor M, Mancall EL. Central pontine myelinolysis: a hitherto undescribed disease occurring in alcoholic and malnourished patients. AMA Arch Neurol Psychiatry. Feb 1959; 81(2): 154-72.
Kumar S, Fowler M, Gonzalez-Toledo E, Jaffe SL. Central pontine myelinolysis, an update. Neurol Res. Apr 2006; 28(3): 360-6.

Question 70:

What is the theoretical basis of inducing "Barb-Coma"?

Answer:
A barbiturate-induced coma, commonly called barb coma, is a temporary coma induced by a controlled administration of a barbiturate drug,
usually pentobarbital or thiopental. Barbiturates are used in various settings in neuro ICUs to protect the brain especially in instances such persistent intra-cranial hypertension, resistant status epilepticus etc.
Barbiturate decreases the brain metabolism, as well as the brain blood flow. This causes narrowing of brain blood vessels, decreasing intracranial pressure by a reduction in the amount of space occupied by the brain.

55% glucose and oxygen use by the brain is for electrical activity and the rest for other activities, including metabolism. Barbituates decrease brain electrical activity, which leads to, decreases brain metabolic and oxygen requirements.

Reference(s):
1. *Use of barbiturates in the control of intracranial hypertension". Journal of Neurotrauma (The Brain Trauma Foundation) 17 (6–7): 527–30. Jun-July 2000.*
2. *Schalén, W; Sonesson B, Messeter K, Nordström G, Nordström CH (1992). "Clinical outcome and cognitive impairment in patients with severe head injuries treated with barbiturate coma". Acta Neurochir 117 (3–4): 153–9.*

Question 71:

Name at least 4 conditions where "Asterixis" can be a clinical sign?

Answer:
Asterixis is a tremor of the hand when the wrist is extended. It can be a clinical sign of

1. Hepatic encephalopathy
2. Uremia

3. Severe Hypercarbia, and
4. Wilson's disease

Question 72:
What are 80-10-10 distributions in brain?

Answer:
80% - Parenchyma
10% - Blood
10% - CSF

Question 73:
A 76-year-old male is admitted to the ICU for bradycardia secondary to beta-blocker prescribed for his essential tremor. You received a nursing call at night that patient is now requesting alcohol to abort his symptoms of essential tremor as it is always helpful to him?

Answer:
It is true that Alcohol decrease the symptoms of essential tremor. The mechanism of tremor reduction by alcohol is unknown.
The recommended treatment is propranolol. When propranolol is contraindicated, primidone is a suitable alternative. Other drugs, which have shown effects, include gabapentin, clonazepam or topiramate.
Surgical treatment is reserved for the severe cases include thalamotomy and deep brain stimulation.

Question 74:
Name an epileptic drug, which can be given rectally if required?

Answer:
Depakote (valproic acid) dilute syrup 1:1 with water for use as a retention enema; loading dose: 17-20 mg/kg one time; maintenance: 10-15 mg/kg/dose every 8 hours

Question 75:
A 74-year-old male is admitted with Alzheimer's related dementia into ICU with uncontrolled hypertension. Patient was initially started on nitroprusside drip in ER and later weaned off to oral antihypertensive. You decided to start Lopressor and Cardizem as oral antihypertensive and the patient was noted to have good blood pressure control. Before transferring to floor you resumed his only home medication for his Alzheimer's related dementia - RAZADYNE ER (galantamine hydrobromide). 12 hours later, just before transfer, patient coded and on bedside note to be in 3rd degree AV block with

barely palpable blood pressure?

Answer:
RAZADYNE (galantamine hydrobromide), formerly known as Reminyl, is a commonly used drug for Alzheimer's related dementia. One of the major side effects of this medicine is bradycardia due to vagotonic effects on the sinoatrial (SA) and atrioventricular nodes (AV). The Food and Drug Administration has also issued a warning for its use in patients with supraventricular cardiac conduction disorders and those receiving concomitant treatment with other drugs that significantly slow heart rate. Objective of this question is to bring awareness of this side effect as this is a commonly used drug in geriatric population and β-blockers and calcium channel blockers always remained the first line of drug for BP control.

It is advisable to avoid or at least be cautious of concomitant use of β-blockers and calcium channel blockers with RAZADYNE (galantamine hydrobromide).
Note: The Company changed the drug's name from Reminyl to Razadyne in an effort to avoid confusion between it and glimepiride (Amaryl).

NEUROLOGY - PEARLS

1. **4 stages of Neurocysticercosis**

   4 stages of cyst itself are:
   i. Vesicular cyst: These are well-defined scolex, minimal contrast enhancement, and mass effect.
   ii. MRI showing colloidal cyst.
   iii. MRI shows the nodular/granular stage.
   iv. Noncontrast computed tomography showing multiple punctuate calcifications.

2. **Diamox (acetazolamide) - an antiepileptic!**
   Do you know that Diamox was originally introduced as an antiepileptic drug in 1952? It has been used to treat various types of seizures including generalized tonic clonic, absence, and as add-on therapy for partial seizures. Acetazolamide's property of inhibiting carbonic anhydrase appears to retard abnormal, paroxysmal, excessive discharge from central nervous system neurons.

   Diamox has been described as an effective drug of choice for Catamenial epilepsy (epilepsy related to the menstrual cycle).

   Reference(s):
   1. Diamox - rxlist.com
   2. Diamox - epilepsyfoundation.org
   3. Acetazolamide in Women with Catamenial Epilepsy, Epilepsia, Volume 42, Number 6, June 2001, pp. 746-749(4)

3. **Ice test - Poor man's test for Myasthenia Gravis**
   Most of the Myasthenia Gravis patients present along with other symptoms of weakness usually exhibiting ptosis. While at bedside place an ice cube over eyelids for 2 minutes. Cooling improves neuromuscular transmission. Resolution of ptosis with cooling is a positive test for Myasthenia Gravis and reported up to 80% reliable to diagnose ocular myasthenia.

4. **Lumber Puncture Headache**
   Lumber puncture is a frequently performed procedure in the ICUs. One of the bothersome problems to patients is post-lumbar puncture headache.
   Lumbar puncture headache is believed to be as a result of leakage and depletion of cerebrospinal fluid, causing traction on or distortion of anchoring pain-sensitive structures in the brain resulting in orthostatic headache. There may also be an effect of physical changes in the cerebral veins and venous sinuses.
   Treatment options for post–lumbar puncture headache include hydration, caffeine, adrenocorticotropic hormone, sumatriptan, pregabalin, epidural saline, and epidural patches.

   According to the results of a small study, IV theophylline promptly relieves the common problem of headache after lumbar puncture. In the study, mean half-life was within 30 minutes of treatment without adverse effects reducing pain scores,

researchers reported in a poster presentation at the 24th Meeting of the European Neurological Society (ENS).
Researchers administered theophylline, 200 mg in 100 mL of IV 5% dextrose, over 40 minutes. Patients in a sitting position reported pain on a 10-point visual analogue scale (VAS) at time 0 and at 30 and 60 minutes after the beginning of the infusion. All patients reported relief of pain at 30 and 60 minutes, with the greatest percentage decrease seen at 30 minutes.

Reference(s):
24th Meeting of the European Neurological Society (ENS): Abstract PP1104. Presented May 31, 2014.

5. **Can a patient make a movement and still meet criteria for brain death?**
Yes!

Spinally mediated reflexes and automatisms can be present in the setting of brain death. These movements are often misinterpreted by laypersons as signs of purposeful brain function. Careful neurologic examination can differentiate between reflexive movements and purposeful motor movements.

These are non-purposeful movements released by lack of descending inhibition of primitive spinal motor reflex pathways.

i. Deep-tendon reflexes: For example, Achilles, patellar, and biceps are by definition monosynaptic spinally mediated reflexes and hence often preserved despite brain death.
ii. Abdominal reflexes: Deviation of the umbilicus toward a light stroking of the skin. Often preserved in brain-dead patients, it may be absent in normal or obese patients.
iii. Triple flexion response or limb posturing: Stereotyped, non-purposeful flexion or extension and internal rotation in response to noxious stimulus. (A movement may be purposeful if the limb reliably moves away from, rather than toward, an applied noxious stimulus.)
iv. Lazarus sign: Considered a variant of opisthotonus. It consists of extensor posturing of the trunk, which may look like chest expansion, simulating a breath. Raising and crossing of the arms in front of the chest or neck may accompany it. This sign most often occurs in the setting of apnea testing or disconnection from the ventilator. Hence it may be upsetting for family members or health care providers to witness this reflex.

6. **Levetiracetam (keppra) and Vitamin B6 - something to think of when writing Keppra!**

Levetiracetam (keppra) has been reported to cause many behavioral and psychiatric disturbances including anxiety, irritability, depression etc. Recent literature (though mostly from pediatric population) suggests that the addition of pyridoxine (vitamin B6) may curtail some of these symptoms.
Pyridoxine supplementation for the treatment of levetiracetam-induced behavior side

effects in children: preliminary results - Epilepsy Behav. 2008 Oct; 13(3): 557-9. Epub 2008 Aug 3.

Reference(s):
Behavioral effects of levetiracetam mitigated by pyridoxine. - J Child Adolesc Psychopharmacol. 2009 Apr; 19(2): 209-11

7. Use of Ketamine in malignant Status Epilepticus

A young female with history of epilepsy and mitochondriopathy presented with status epilepticus not responding to conventional therapies with benzodiazepines, phenytoin, thiopental, and Propofol. Once ketamine was initiated, it helped in aborting the seizure in conjunction with midazolam. The case published in Epilepsy Research suggested strong anticonvulsant properties of ketamine even after failure of GABAergic anesthetics. Ketamine should be incorporated into the epilepsy therapeutic armamentarium.

Reference(s): *Ketamine successfully terminates malignant status epilepticus - Epilepsy Research, (2008) 82, 219—222*

8. Neurologic Outcomes After Cardiac Arrest

Patients in a coma less than 12 hours after resuscitation usually make a favorable recovery. Comas lasting more than 12 hours often have neurologic deficits due to focal or multifocal infarcts of the cerebral cortex.

Somatosensory evoked potentials (SEPs) have the highest prognostic reliability and are the most frequent clinically applied method in experimental studies evaluating outcome after CPR. Bilateral absence of median nerve-stimulated SEPs is associated with a <1% chance of awakening from coma since it implies that widespread cortical necrosis has occurred. Importantly, the presence of cortical responses is not a guarantee for awakening from coma.

Absence of pupillary responses on the first day or absence of corneal reflexes after the first day following CPR predicts poor outcome. If there are no purposeful motor responses after 3 days, there is a high risk of persistent vegetative state or severe disability.

Verbal responses, purposeful eye movements or motor responses, normal ocular reflexes, and response to verbal commands at 1 day following CPR predict at least a 50% chance of regaining independent function. Patient age, gender, or presence of post-anoxic seizure failed to correlate with outcome.

9. Intra arterial Nicardipine and Milrinone

Intra-arterial administration of nicardipine and/or milrinone requires use of vasopressors to maintain arterial blood pressure. Despite high doses of vasoconstrictors, treatment has low mortality, minimal end-organ ischemic damage or

systemic acidosis, and results in improved caliber of cerebral vessels affected by vasospasm.

Reference(s):
Hemodynamic Management and Outcome of Patients Treated for Cerebral Vasospasm with Intraarterial Nicardipine and/or Milrinone - Anesthesia & Analgesia, March 2010 vol. 110 no. 3 895-902

10. Metoprolol and CNS effect

One lesser-known side effect of metoprolol (Lopressor) is CNS effect, which may be of importance in the ICU. Lopressor's CNS effect is dose dependent. It has high penetration across the blood brain barrier due to its lipophilic nature. In return, it may cause sleep disturbances, vivid dreams, nightmares, depression, and vision problems.

11. Neuroleptic Malignant Syndrome (NMS)

Mnemonic used to remember the features of NMS is FEVER.
F – Fever
E – Encephalopathy
V – Vitals (unstable)
E – Elevated enzymes (CPK)
R – Rigidity of muscles

12. Reading intracranial bleed on CT scan - a bedside tip!

Intracranial bleed (ICH) on CT scan appears as an area of increased attenuation, which usually remains present on scan for about 7-10 days. This may be of importance to know since the increased density of blood in relation to the surrounding parenchyma of the brain relates to the hemoglobin protein contained in extravasated blood. So, in severely anemic patients, you may have to look carefully for acute bleed as it may deceive you and may appear isodense or hypodense to the surrounding brain parenchyma.

13. Note on LP in spinal epidural abscess

Lumbar puncture (LP) is relatively contraindicated in spinal epidural abscess. MRI is the modality of choice for diagnosis. If LP is required to rule out meningitis, extreme caution should be exercised, as lumbar puncture may introduce purulent material into the subarachnoid space.

Needle should be slowly advanced with gentle syringe aspiration if spinal epidural abscess is suspected. If purulent liquid is encountered, it should be aspirated very gently to obtain culture, and the needle should not be advanced further.

14. 5 Grades of SAH (Subarachnoid Hemorrhage)

In subarachnoid hemorrhage (SAH) there is presence of blood within the subarachnoid space as a result of pathologic process (traumatic and nontraumatic hemorrhages).

Grade I – Patient has mild headache with or without meningeal irritation
Grade II – Patient has severe headache but with nonfocal examination. Patient may

or may not have mydriasis
Grade III – Patient has mild alteration in neurologic examination, including some mental status changes
Grade IV – Patient has depressed level of consciousness or focal deficit
Grade V - Patient is either comatose or posturing

15. Lazarus Syndrome - after therapeutic hypothermia!

Interesting case report published in June 2011 issue of Critical Care Medicine.
"A 55-yr-old man presented with cardiac arrest preceded by respiratory arrest. Cardiopulmonary resuscitation was performed, spontaneous perfusion restored, and therapeutic hypothermia was attempted for neural protection. After rewarming to 36.5°C, neurologic examination showed no eye opening or response to pain, spontaneous myoclonic movements, and sluggishly reactive pupils, absent corneal reflexes, intact gag and spontaneous respirations. Over a period of 24 hours, the remaining cranial nerve function was lost. The neurologic examination was consistent with brain death. Apnea test and repeat clinical examination after duration of 6 hours. Confirmed brain death. Death was pronounced and the family consented to organ donation. Twenty-four hours after brain death was pronounced, on arrival to the operating room for organ procurement, the patient was found to have regained corneal reflexes, cough reflex, and spontaneous respirations. The care team faced the challenge of offering an adequate explanation to the patient's family and other healthcare professionals involved".

Authors recommended caution in the determination of brain death after cardiac arrest when hypothermia has been used. They also suggested that confirmatory testing should be considered and a minimum observation period after rewarming of patient should be undertaken, before brain death testing performed and brain death established.

Reference(s):
Reversible brain death after cardiopulmonary arrest and induced hypothermia - Critical Care Medicine. 39(6): 1538-1542, June 2011

16. "Locked-in" Syndrome (coma vigilante)

The "patient is a silent and unresponsive witness to everything that is happening"
A patient with Locked-in syndrome is a fully conscious person, but all the voluntary muscles of the body are completely paralyzed, other than those that control eye movement. Plum and Posner first introduced term about 25 years ago with complete occlusion of the basilar artery.

Any catastrophy involving ventral pons can cause this syndrome like massive stroke, traumatic head injury, and ruptured aneurysm, pontine infarction after prolonged vertebrobasilar ischemia, hemorrhage, tumor, central pontine myelinolysis, pontine abscess or postinfective polyneuropathy. As all of the nerve tracts responsible for voluntary movement pass through the ventral pons but fortunately or unfortunately, consciousness are above the level of the ventral pons.[2]

only supportive rehabilitation is the answer. Being an intensivist, it is extremely important to educate staff and to protect patient from any physical or psychological harm (like procedure without adequate analgesia), with the utmost understanding that it is an "imprisoned mind buried alive in a dead body'' (as said for character with paralysis like locked-in syndrome in Thérèse Raquin by Emile Zola - 1868).

Reference(s):
1. The patient's journey: Living with locked-in syndrome - BMJ 2005; 331:94-97 (9 July)
2. Plum F, Posner JB. The diagnosis of stupor and coma. Philadelphia: FA Davis, 1982; 377
3. Locked-in syndrome: a catastrophic complication after surgery - British Journal of Anaesthesia, 2004, Vol. 92, No. 2 286-288

17. Malignant Hyperthermia: Agent of choice…Dantrolene

Malignant Hyperthermia is a rare, but potentially lethal musculoskeletal disorder associated with exposure to halogenated anesthetic gases or succinylcholine. Some signs/symptoms include tachycardia, hyperthermia, supraventricular and ventricular arrhythmias, and even cardiac arrest.

The mainstay of treatment is Dantrolene. It is a direct-acting skeletal muscle relaxant that blocks calcium release from intracellular stores in the sarcoplasmic reticulum. Dantrolene is dosed 1mg/kg to a maximum cumulative dose of 10 mg/kg. It is infused over approximately 1 hour. Doses may be repeated until signs of malignant hyperthermia are reversed.

It is highly lipophilic, thus poorly soluble in water. Dantrolene is currently available for IV use in vials containing 20 mg lyophilized dantrolene sodium added to 3 gm mannitol to improve water solubility. Once the medication is reconstituted, it should be used within 6 hours and should be protected from light. Due to the high irritability, it is recommended that dantrolene be infused into a large vein. Dantrolene peaks in 6 hours, and has a half-life of 12 hours. It is metabolized by liver microsomes and is excreted mainly via urine and bile.

Reference(s):
1. Krause T, et al. Anaesthesia 2004; 59:364
2. Rosenbaum HK, et al. Anesthesiology Clin N Am 2002; 20:623

18. What's new on Central pontine myelinolysis (CPM)

Central pontine myelinolysis, a demyelinating disorder of central pons characterized by pseudobulbar palsy and spastic quadriplegia, is co-diagnosed by specific MRI findings under know clinical settings or risk factors. Specific MRI findings are increased signal in the central pons on fluid-attenuated inversion recovery images (FLAIR) and hypointense lesions on T1-weighted images. Five decades ago it was described in chronic alcoholism but over time it was found in association with malnourished status, renal failure, diabetes mellitus, and post-orthotopic liver transplantation and became known as hallmark of rapid correction of hyponatremia - but in recent years it has been reported with hypophosphetemia and in Diabetes Ketoacidosis (DKA) despite normal sodium level or no rapid correction of sodium. Treatment is supportive and prognosis thought to be universally fatal. In recent years

there are reports of good recovery and long-term survival with proper supportive management.

Reference(s):
1. Central Pontine Myelinolysis Following Hemodialysis - grand round at Department of Medicine, Maulana Azad Medical College, New Delhi
2. MR imaging of seven presumed cases of central pontine and. extrapontine myelinolysis.-Acta Neurobiol. Exp. 2001, 61: 141-144.
3. Management and Treatment of Psychotic Manifestations in Older Patients with Alcoholism: Part II - Clinical Geriatrics: 2004; 12[5]: 33-40
4. Central pontine myelinolysis temporally related to hypophosphataemia - Journal of Neurology Neurosurgery and Psychiatry 2003; 74:820
5. Central pontine myelinolysis in a patient with diabetic ketoacidosis - The Journal of Critical Illness - Vol. 20, No. 4 - December 2005

19. The Rancho Los Amigos Scale

Following a closed head injury, including traumatic brain injury, the *Rancho Los Amigos Scale* is a scale used for assessing the patient, based on cognitive and behavioral disposition from coma.

Patients with brain injury receive a score from 1-8. A score of 1 represents non-responsive cognitive functioning, whereas a score of 8 suggests purposeful and appropriate functioning. Each of the 8 scores expresses the incessant progression of recovery from brain damage. The individual recovers from one stage to next with different frequency and their progress may be plotted at any given stage. This scale was later revised to group to 10.

20. ICP (Intracranial pressure) waveforms

ICP monitoring waveform has a flow of 3 upstrokes in one wave.
P1 = (percussion wave) represents arterial pulsation
P2 = (Tidal wave) represents intracranial compliance
P3 = (Dicrotic wave) represents aortic valve closure
In normal ICP waveform P1 should have highest upstroke, P2 in between and P3 should show lowest upstroke. On eyeballing the monitor, if P2 is higher than P1 - it indicates intracranial hypertension.

NUTRITION

Question 1:

Risk of re-feeding syndrome increases after how many days of patient having taken nothing by mouth (NPO) or with poor intake?

Answer:

5 days

Rationale:

It is not uncommon in ICUs for patients to go without food for few days. It is important to understand that any patient who has had marginal nutrient intake for more than five consecutive days is at risk of re-feeding syndrome. Re-feeding syndrome usually occurs within four days of starting to feed.

Question 2:

How you define trophic enteral feeding?

Answer:

Trophic feeding provides a small volume of balanced enteral nutrition that is inadequate for the patient's nutritional needs but it yields some positive gastrointestinal and systemic benefits. If less than 25% of the patient's nutritional needs are provided enterally, the feeding is considered trophic. The commonly identified benefits of trophic feeding are improved feeding tolerance, maintenance of intestinal function, and prevention of intestinal bacterial overgrowth and bacterial translocation.

Question 3:

Propofol may lower the serum concentration of which essential element?

***Answer*:**

Zinc

Rationale:

There is greater urinary loss of zinc and iron as well as lower serum zinc concentration in patients receiving propofol. Clinical significance of trace metal losses is unclear and further studies are suggested.

Reference(s):

Trace element homeostasis during continuous sedation with Propofol containing EDTA versus other sedatives in critically ill patients - Intensive care medicine Supplement 2000, vol. 26, n4, pp. S413-S421 (30 ref.)

Question 4:

Which common conditions encountered in ICU may give falsely normal or a higher level of Pre-albumin?

Answer:

1. After binge drinking, alcoholics may have false elevated levels of prealbumin. In acute alcohol intoxication, there is leakage of proteins from damaged hepatic cells, which may cause an increase in the prealbumin level. It takes about a week before levels return to baseline.
2. Prednisone therapy may cause falsely higher prealbumin levels.
3. Patients on chronic progestational agents may have falsely higher prealbumin level.

Reference(s):
1. Staley MJ, Naidoo D, Pridmore SA. Concentrations of transthyretin (prealbumin) and retinol-binding protein in alcoholics during alcohol withdrawal [Letter]. Clin Chem. 1984; 30:1887.
2. Oppenheimer JH, Werner SC. Effect of prednisone on thyroxine-binding proteins. J Clin Endocrinol Metab. 1966; 26:715–21.

Question 5:

What is the pitfall of oral amiodarone?

Answer:

When given orally, the absorption of amiodarone ranges from 22%-95%. Amiodarone oral absorption is better when given with food.

Question 6:

Which vitamin deficiency may cause life threatening lactic acidosis?

Answer:

Thiamine (Vitamin B1) deficiency.

Rationale:

Thiamine is part of the pyruvate-dehydrogenase (PDH) complex. Its deficiency inhibits pyruvate entry into mitochondria.
Clinical implication: It is important to give Thiamine to patients requiring long-term parenteral nutrition (TPN)

Reference(s):
1. Thiamine deficiency as a cause of life threatening lactic acidosis in total parenteral nutrition - Klin Wochenschr. 1991; 69 Suppl 26:193-5.
2. Metabolic acidosis and thiamine deficiency - Mayo clinic Proceedings, March 1999 vol. 74 no. 3 259-263
3. Severe Lactic Acidosis Related to Acute Thiamine Deficiency - Journal of Parenteral and Enteral Nutrition, Vol. 15, No. 1, 105-109 (1991)

Question 7:

What factor should be taken into consideration in terms of calorie intake in patients with peritoneal dialysis?

Answer:
The peritoneal dialysis fluid typically contains a high percentage of glucose to ensure hyperosmolarity, which can add as many as 1000 calories to the diet per day.

Question 8:

How much calories per ml does Diprivan (propofol) provide to patient?

Answer:
1.1 kilocalories per ml.

Rationale:
The emulsion portion of the Diprivan is identical to that found in Intralipid 10%. Triglycerides account for about 85% of the total calories. Triglyceride levels should be checked in patients receiving prolonged infusion to avoid pancreatitis.

Question 9:

Why is Prealbumin referred to as "Prealbumin"?

Answer:
This is because it runs faster than albumins on electrophoresis gels, which is in contrast to general belief that it is a precursor of albumin. It should not be confused with albumin. The right name for Prealbumin is Transthyretin (TTR). TTR is a carrier of serum, thyroid hormone thyroxine (T4), retinol in the serum and cerebrospinal fluid.
In patients nutritional status can be evaluated by measuring concentrations of prealbumin in the blood. Prealbumin is preferred due to its shorter half-life. Caution needs to be taken as it may reflects recent dietary intake rather than overall nutritional status.

NUTRITION - PEARLS

1. **Should critically ill patients in shock and/or receiving vasopressors receive Enteral Nutrition (EN)?**
   Ischemic bowel is a very rare complication of EN but has been reported in critically ill patients and can be fatal. Therefore the general recommendation is that EN be avoided in patients who are in shock and in whom resuscitation is active, vasopressors are being initiated, or vasopressor doses are increasing. Once patients are resuscitated and hemodynamically stable, EN may be initiated, even if they are receiving stable lower doses of vasopressors.
   However, special attention should be paid to signs of enteral feeding intolerance such as abdominal distention or increasing gastric residual volumes.

2. **A little known effect of ACE inhibitor**
   The ACE inhibitors have also shown to reduce cardiac cachexia in patients with congestive heart failure. Actually, ACE inhibitors are now used to reverse frailty and muscle wasting in elderly patients without heart failure.

3. **Insulin in TPN - A bad idea?**
   Insulin has been added to the TPN bag for a long time. It is also chemically compatible. The real challenge and issue have been raised as to how much of that insulin actually makes it to the patient. It has been suggested that amount of insulin which is adsorbed to the plastic bag or glass bottle can be as high as 80%. The type of container may affect the adsorption; previous exposure to the tubing is the administration set. Some studies have done with priming the line with dilute insulin solution to prevent the significant adsorption. Other option, which has been suggested, is to add albumin in small amount, which can increase the amount of insulin delivery by decreasing the amount of available insulin, which can bind to tubing or container. Flushing the tubing with the insulin containing solution 2 hours prior to infusion has also been suggested. Next time we use insulin, think of the insulin adsorption to the tubing and container.

4. **Zinc Supplementation in Critically Ill Patients: - Just a Myth?**
   When considering critically ill patients, there is limited data available for routine use of high-dose zinc supplementation. The initial step in zinc supplementation is to determine the optimal safe dose with risk-benefit in mind. Well-designed large randomized trials are needed to assess the efficacy of such doses of zinc supplementation among critically ill patients.

Reference(s):

Zinc Supplementation in Critically Ill Patients: A Key Pharmaconutrient? - Journal of Parenteral and Enteral Nutrition, Vol. 32, No. 5, 509-519 (2008)

5. **Back to the Basics - Essential trace elements**
   The importance of 7 essential trace elements is relatively higher amongst ICU patients due to hypermetabolic state. Being an intensivist it is important to have some knowledge about these elements. Except for iron and iodine, all others need

to be provided with enteral and parenteral formulae to satisfy at least their RDA.
1. Iron: In ICU merely checking iron level may not give real answer of its deficiency. Always check Ferritin level (below 18 indicates deficiency).
2. Selenium: Important anti-oxidant and unfortunately many times not included in available enteral/parenteral formulae.
3. Chromium: Necessary for normal glucose utilization.
4. Copper: Essential for formation of hemoglobin.
5. Iodine: Needed for proper thyroid metabolism.
6. Manganese: Part of Ca+/phos+ metabolism.
7. Zinc: Needed for proper wound healing.

Reference(s):
1. Trace minerals in ICU patients: a forgotten cause of delayed recovery? - Critical Care 2004, 8(Suppl 1):P264
2. Trace element supplementation modulates pulmonary infection rates after major burns:American Journal of Clinical Nutrition, Vol 68, 365-371
3. Levels of oligo-elements and trace elements in patients at the time of admission in intensive care units - Nutr Hosp. 1990 Sep-Oct; 5(5): 338-44.
4. Canadian clinical practice guidelines for nutrition support in mechanically ventilated, critically ill adult patients - Journal of Parenteral and Enteral Nutrition, Vol 27, Issue 5, 355-373
5. EARLY ENTERAL SUPPLEMENTATION WITH PHARMACONUTRIENTS IN CRITICALLY ILL PATIENTS - Critical Care Medicine: Volume 32(12) Supplement December 2004 p A4

6. A note on volume based Enteral feed

Critically ill patients placed on enteral nutrition (EN) are usually underfed as most of them are placed on "Frequency-based Enteral nutrition" (FBF). Interruptions are frequent due to various reasons.
A "volume-based feeding" (VBF) allows adjusting the infusion rate to make up for interruptions in delivery. Studies have shown that VBF strategy is safe and improves delivery to better meet caloric requirements than the standard more commonly used frequency-based strategy.

PULMONARY

Question 1:

What are the three levels of BPF (Broncho-pleural Fistula)?

Answer:

The severity of the air leakage is generally measured into 3 levels from least to most severe:

1. Bubbling during inspiration only
2. Bubbling during both inspiration and expiration
3. Bubbling during both inspiration and expiration, as well as a detectable difference in the inspired and expired tidal volumes

The last category suggests that there is an air leak greater than 100 to 150 mL per breath.

Question 2:

How much Talc powder is needed for pleurodesis?

Answer:

3 to 5 grams

Rationale:

For pleurodesis, 3 - 5 grams of talc are insufflated into the pleural space. For pneumothorax pleurodesis, 3 grams of talc are sufficient.

Question 3:

Case:

You have been called to see a consult for a patient with mental status change and anasarca. Upon arrival you noticed a young man lying supine in bed with facial edema, upper extremity edema, lethargy, and papilledema and neck veins visible. You suspect Superior Vena Caval Syndrome. What is the first thing you will do, maybe even before you start talking to patient?

Answer:

Have patient sit upright.

Rationale:

Patients with apparent clinical SVC syndrome gain significant symptomatic improvement from elevation of the head of the bed due to release of fluid pressure with gravity. It is a very benign maneuver but very significant for a patient as it provides dramatic relief of symptoms.

Question 4:

What happens to surfactant in ARDS?

Answer:
During inspiration diaphragm goes down creating a negative pressure, which in turn, inflates the lung. However, lung mechanical properties resist inflation due to the ingrained elasticity of lung tissue and the airway resistance. Surfactant lines the alveoli in mammals helping to reduce the surface tension of the alveolar membrane and, as a consequence, allows the lungs to inflate with relatively small transpulmonary pressure generations. In addition, surfactants have important anti-inflammatory properties.

Interestingly, In ARDS, the total amount of surfactant present in the lung may actually be elevated! However, type 2-cell injury in ARDS alters surfactant metabolism/recycling and the surfactant that is produced is often dysfunctional. As a consequence, surface tension in the alveoli of patients with ARDS is usually markedly elevated. This contributes to the poor compliance and ventilation-perfusion mismatch seen in ARDS. It may also be a factor in reduced host defenses with the loss of surfactant anti-inflammatory processes.

Question 5:

What are the 2 major different risk factors in Acute Eosinophilic pneumonia (AEP) and chronic Eosinophilic pneumonia (CEP)?

Answer:
AEP has been associated with smoking. Men are affected twice as much as women. CEP on the other hand occurs more frequently among women and is unrelated to smoking history. Association of CEP with radiation treatment for breast cancer has been suggested.

Question 6:

What is Platypnea-orthodeoxia?

Answer:
Platypnea-orthodeoxia is a clinical syndrome characterized by dyspnea and deoxygenation accompanying a change to a sitting or standing from a recumbent position.

Two conditions must coexist to cause platypnea-orthodeoxia:
An anatomical component - in the form of an interatrial communication such as patent foramen ovale (PFO) or atrial septal defect (ASD) and a functional component which produces deformity in the atrial septum and results in a redirection of shunt flow when the patient assumes an upright posture. This functional component includes pericardial effusion, constrictive pericarditis, emphysema, pneumonectomy, cirrhosis, ileus, aortic aneurysm, and so on.

Standing upright results in stretching of the interatrial communication, allowing more

flow of venous blood from inferior vena cava through the defect. Functional component present clinically enhances these redirections of flow caused by an anatomic abnormality of the right atrium or the atrial septum.

Reference(s):
Cheng TO. - Platypnea-orthodeoxia syndrome: etiology, differential diagnosis, and management. Cathet Cardiovasc Interv. 1999; 47: 64–66.

Question 7:

How long do cells stay viable after Broncho-Alveolar lavage (BAL)?

Answer:
About 4 hours

Rationale:
The cells remain viable in BAL fluid for up to 4 hours if stored around 25°C. BAL fluid can be transported at room temperature to lab if processing will occur in less than 1 hour, otherwise it should be transported in ice.

Question 8:

What advantage does linezolid have over vancomycin in MRSA pneumonia?

Answer:
Penetration of linezolid into bronchial fluids is much higher than that of Vancomycin. Also, linezolid has high bioavailability and allows easy switching to oral therapy. Moreover, it does not require any adjustment in kidney dysfunction. But, high cost of the drug still makes vancomycin a preferred choice over linezolid.

Question 9:

What is Nitrogen narcosis?

Answer:
Nitrogen Narcosis affects scuba divers and is also called 'rapture of the deep'. As we all know, air comprises 79% of Nitrogen. At the normal atmospheric pressures, it has no sedating effect. Atmospheric pressure is significantly increased, the effects of nitrogen on the brain is same as nitrous oxide (laughing gas). The effect (onset and loss) is instantaneous. Experienced divers with normal brain function at 20 meters, develop altered function at 30 meters, moving back 20 meters will almost instantly result in normal functioning. Divers suffering nitrogen narcosis may place themselves at risk by inadvertently taking off their scuba mask etc., placing them at life threatening risk.

Question 10:

The nurse at bedside has called you as she noticed some fresh blood in ETT. Patient has pulmonary artery catheter (PAC) in place. You are worried about pulmonary artery perforation. What would be your first response before you initiate whole 9 yards of workup and management?

Answer:

"Get good lung up".

Rationale:

Figure out which pulmonary artery (right or left) has distal end of PAC; then get the patient's position changed to lateral decubitus with good lung up, to avoid soiling of good lung.

If the patient is on a ventilator, an alternative approach would be to increase PEEP (literature is controversial about its efficacy but there is no harm in increasing PEEP to control catastrophy). Overall management is supportive if pulmonary artery perforation is confirmed. Actually it is better to leave PAC intact with balloon in inflated position. Reversal of anticoagulation if needed, hemodynamic support and preventing good lung from soiling (like applying double lumen ETT) are the initial mainstay of treatment - followed by attempt to control bleeding with interventional radiology help.

Reference(s):

1. Pulmonary Artery Rupture Induced by a Pulmonary Artery Catheter: A Case Report and Review of the Literature. University of Miami School of Medicine, Miami, Florida. Ref: Journal of Intensive Care Medicine, Vol. 19, No. 5, 291-296 (2004)

Question 11:

Case:

You have bee asked in the ICU to evaluate a 22-year-old previously healthy patient after a craniotomy for GSW, who was supposed to get extubated this morning, but unexpectedly his pre-extubation PaO_2 is only 60. Also, "something happened" with his ETT. It was reported to you that earlier RT had to push it back. Patient was left on CPAP.

You look at the patient and see the ETT goes across his mouth from one side to the other and is at 23 cm on the lips. He appears to be biting on the ETT a little and is a little sleepy but cooperative. SpO_2 is 95% on 40% FiO_2. You consider the cuff might be broken and try inflating it; but it seems to be taking quite a bit of air. Eventually it seems to stay firm but you think there might be a very slow leak, like there is sometimes from minuscule holes. You think there may be some atelectasis that needs to be opened so you try the Ambu bag but the bag cannot hold the lungs inflated! Actually you hear the air coming out the mouth and as you inflate the cuff a little more still, the patient desaturates What happened?

Answer:

Patient had coughed up the ET tube and is above the cords.

Rationale:
The pre-extubation $PaO_2$was low as he was getting some room air from around the ETT by a Venturi effect. The T-E fistula is another possibility. As patient was extubated his saturation jumped to 100% - indeed he was ready for extubation. Patient desaturated with ambu bag as he got hypoxic he bit the ETT closed. Also, as you occluded the air coming in from around the cuff (balloon) - by inflating more air inside - he lost the venturi effect too.

Note: The objective of the above question is to raise awareness about importance of secure and patent airway. You may feel this is a classic (or common and easy) scenario, but even a seasoned intensivist can get scared and confused a little when facing this situation.

Moral of the story: Airway is no place to fool around (as in above scenario RT by pushing ETT inward and later physician by inflating more air in cuff and by ambu bagging - made situation worse).

Question 12:
Which life-threatening pulmonary complication may happen with Daptomycin infusion?

Answer:
Eosinophillic Pneumonia

Rationale:
Per FDA report, seven confirmed cases of eosinophilic pneumonia were identified between 2004 and 2010 and an additional 36 possible cases. The seven confirmed cases were patients older than 60 years of age and their symptoms appeared within two weeks of initiation of therapy.

Reference(s):
Acute Eosinophilic Pneumonia Secondary to Daptomycin: A Report of Three Cases - Becky A. Miller, Alice Gray, Thomas W. LeBlanc, Daniel J. Sexton, Andrew R. Martin, and Thomas G. Slama - Clin Infect Dis. (2010) 50 (11): e63-e68.

Question 13:
Name a few treatment modalities in Status Asthmaticus if all conventional treatments including mechanical ventilation fail?

Answer:
Ketamine: It helps to improve lung compliance, improve airway resistance, particularly the lower airways.
Dose: loading dose of 1 mg/kg (IV), followed by a continuous infusion of 1 mg/kg/hr. for 2 hours. Peak airway pressure, $PaCO_2$ and PaO_2 should be monitored.
Deep anesthesia: Halothane or Enflurane in combination with Propofol or Ketamine can also be affective as potent bronchodilators.

Nitric oxide: There have been isolated case reports suggesting its use.
Nebulized Lidocaine in combination with either albuterol or levalbuterol has been effective in vocal cord dysfunction, which may be present in many patients with status asthmaticus.
ECMO: Extracorporeal life support has been used as a last resort therapy.

Reference(s):
Use of ketamine in severe status asthmaticus in intensive care unit. Iran J Allergy Asthma Immunol. Dec 2003; 2(4): 175-80
Anaesthetic management in asthma. Minerva Anestesiol. Jun 2007; 73(6): 357-65.
Life-threatening status asthmaticus treated with inhaled nitric oxide - The Journal of Pediatrics, Volume 137, Issue 1, Pages 119-122
Emergency extracorporeal life support for asphyxic status asthmaticus. Respir Care. Nov 2007; 52(11): 1525-9.

Question 14:

What volume of chest tube drainage should you be comfortable removing?

Answer:
Once your drainage comes down to less than or equal to 200 ml over 24 hours without any evidence of air leaks - you may be in safe zone to discontinue chest tube 1.

Reference(s):
When to remove a chest tube? A randomized study with subsequent prospective consecutive validation - J Am Coll Surg. 2002; 195:658-662.

Question 15:

A 65-year-old female was admitted to the ICU 9 days ago, with small bowel obstruction. Patient is now stable and actually is about to get transferred out of the unit. The patient suddenly starts complaining of choking sensation with two hands on her neck. Monitor shows oxygen desaturation. Patient intubated emergently. There is no laryngeal or vocal edema seen on laryngoscope but vocal cord paralysis is noted. What is going on here?

Answer:
Nasogastric tube syndrome

Rationale:
Sofferman *et al* described Nasogastric tube syndrome about 25-years ago. It is a life-threatening complication of an in-dwelling (more than a week) nasogastric tube. The syndrome may present as complete vocal cord abductor paralysis. The syndrome is thought to result from perforation of the NG tube-induced esophageal ulcer and infection of the posterior cricoid region (postcricoid chondritis) with subsequent dysfunction of vocal cord abduction. Unilateral paralysis of the cord is also described. The treatment involves airway protection, removal of NG tube and antibiotics. Some physicians advocate use of antireflux therapy as well. Another variant is described with no esophageal ulcer but possibly because of ischemia of the laryngeal abductor muscle secondary to physical compression of the postcricoid blood vessels by NG tube.

Reference(s):
1. The nasogastric tube syndrome: two case reports and review of the literature. Head Neck. 2001 Jan; 23(1): 59-63.
2. A variant form of nasogastric tube syndrome. Intern Med. 2005 Dec; 44(12): 1286-90.
3. Case Report - Nasogastric Tube Syndrome: The Unilateral Variant - Medical Principles and Practice Vol. 12, No. 1, 2003
4. Sofferman, R.A. and Hubbell, R.N., "Laryngeal Complications of Nasogastric Tubes," ANNALS OTOLOGY, RHINOLOGY, AND LARYNGOLOGY, 90:465-468, 1981.

Question 16:

What is Pseudochylothorax?

Answer:

Chylothorax must be distinguished from pseudochylothorax or cholesterol pleurisy. Pseudochylothorax is seen in patients with rheumatoid arthritis, tuberculosis, and poorly treated empyema. It results from accumulation of cholesterol crystals in a chronic existing effusion.

Question 17:

What is Hamman's syndrome?

Answer:

First described by Louis Hamman (1877-1946), and named after the physician, Hamman's syndrome is a clinical condition that frequently requires ICU admission for observation. It is a spontaneous pneumomediastinum with subcutaneous emphysema. It occurs mostly in young females peripartum or postpartum, usually during the second stage of labor, but can sometimes be seen in the postparturm stage. An association with prolonged labor has been proposed (increase intrathoracic pressure) with rupture of alveoli.

Treatment is supportive and course is usually benign.

Reference(s):
Dudley DK, Patten DE. Intrapartum pneumomediastinum associated with subcutaneous emphysema. CMAJ 1988; 139:641-2

Question 18:

A 32-year-old 26 weeks pregnant female was brought to ED with shortness of breath, requiring intubation in field and severe hypotension. According to husband she complains of some coughing and an unpleasant taste in the mouth, followed by shivering and shortness of breath. What is your concern?

Answer:

Amniotic fluid Emboli.

Rationale:

Amniotic fluid emboli are a fatal complication of pregnancy marked by hemodynamic collapse and coagulopathy. Amniotic fluid enters into the mother circulation along with fetal cells, hair and other debris and triggers an allergic reaction. One diagnostic clue is history of "premonitory symptoms" consists of shivering, coughing, vomiting, and an unpleasant taste in the mouth.

Diagnosis can be made via Pulmonary Artery Catheter insertion and obtaining fetal debris from pulmonary artery. Treatment is supportive.

Question 19:

How strikingly different is pleural effusion finding in Acute Eosinophilic Pneumonia (AEP)?

Answer:

The presence of eosinophils in the pleural effusion is usually considered non-diagnostic. However, if the pleural fluid is exudative with an increased percentage of eosinophils, AEP should be strongly considered. It makes diagnosis very susceptible with hypoxemia, pulmonary infiltrates, eosinophils in bronchoalveolar lavage fluid, and prompt response to steroid therapy.

Other reasons for eosinophilia in pleural fluid are previous thoracentesis with air or blood in contact with the effusion.

Reference(s):

1. Pope-Harman AL, Davis WB, Allen ED, Christoforidis AJ, Allen JN. Acute eosinophilic pneumonia. A summary of 15 cases and review of the literature. Medicine (Baltimore) 1996; 75 (6) 334–342

2. Fitzgerald DJ1, Chaudhary BA, Davis WB. - Eosinophilic pleural effusion: is it always nondiagnostic? - J Fam Pract. 1996 Apr; 42(4): 405-7.

Question 20:

Why should oxygen therapy be administered to every patient with suspected PE, even when the arterial PO_2 is perfectly normal?

Answer:

Oxygen should be administered to every patient with suspected PE, even when the arterial PO2 is perfectly normal, because increased alveolar oxygen may help to promote pulmonary vascular dilatation.

Question 21:

Case:

A 48-year-old male with coronary artery disease has been taken for CABG. At the end, protamine reversal was instituted. After few minutes of protamine infusion start, the pulmonary artery pressure (PAP) suddenly increased to 90/40 mm Hg. The protamine was discontinued. PAP noted to return to normal. The protamine was restarted but the PAP again rapidly increased to 85/37 mm Hg, and patient became hypotensive.

Answer:
Protamine induced acute pulmonary hypertension.

Rationale:
Mechanism of action: Complement activation, leading to thromboxane A2 generation causing acute pulmonary hypertension.
Treatment is use of inhaled nitric oxide (NO) and hemodynamic support. Interestingly, Protamine can be restarted if needed to complete surgery under protection of inhaled NO. By using NO, a full reversal dose of protamine can be administered to a patient. NO can be weaned off within the next 24-hours after surgery.
Alternatives to protamine for heparin reversal, such as heparinase or recombinant platelet factor 4 can be used when available.

Reference(s):
1. The Use of Nitric Oxide for Managing Catastrophic Pulmonary Vasoconstriction Arising from Protamine Administration Anesth Analg 1999; 88:505
2. Lessons from studying an infrequent event: adverse hemodynamic response associated with protamine reversal of heparin anticoagulation. J Cardiothorac Anesth 1989; 3:99–107

Question 22:
What is Haldane effect?

Answer:
The Haldane effect (named after John Scott Haldane) describes that deoxygenation of the blood increases its ability to carry carbon dioxide. Conversely, oxygenated blood has a reduced capacity for carrying carbon dioxide.

The Haldane effect causes dissociation of CO_2 from hemoglobin in the presence of O_2. In the lung where the capillaries are rich in oxygen, this property causes the displacement of CO_2 to plasma as venous blood enters the alveolus. This partially explains the observation that some patients with emphysema might have an increase in $PaCO_2$ following administration of supplemental oxygen even if content of CO_2 remains same. Oxygenation of Hb promotes H^+dissociation from Hb, and shifts the bicarbonate buffer balance towards CO_2 formation, thus resulting in CO_2 being released from RBCs.

Question 23:
What is Catamenial hemoptysis?

Answer:
It is recurrent hemoptysis, which coincides with menstruation.
These patients usually have intrathoracic endometriosis, which involves the pulmonary parenchyma. In some cases the airways may be affected.

Question 24:
What is pseudo-pulmonary embolus syndrome?

Answer:
The clinical scenario in which the patient collapses shortly after an intravenous heparin bolus. It is though most likely to be due to one of the HIT type II and is called 'pseudo pulmonary embolus'. It is thought to be due to endothelial injury rather than major pulmonary embolism. There is sudden augmentation and release of IL-6, von Willebrand factor, and other adhesion molecules, which can lead to sudden vascular leak, hypotension and hypoxia and causing acute adult-type respiratory distress syndrome.

Question 25:
A 56-year-old male is intubated in ICU with COPD exacerbation. In last one hour there are frequent "vent. Alarms" but silenced by bedside staff. Patient now went into pulseless electrical activity (PEA). RT disconnected patient from ventilator but even before bagging is resumed, patient recovered good pulse and blood pressure?

Answer:
Auto-PEEP induced PEA

Rationale:
Elevated end-expiratory pressure ("auto-PEEP") decreases venous return and may cause decrease in cardiac output. Transient withdrawal of ventilation allows the patient to exhale and in turn the dynamic hyperinflation is decreased causing reduction in intrathoracic pressure. This causes improvement in venous return and return of spontaneous circulation. On the same token, it is important to avoid aggressive bagging during cardiopulmonary resuscitation.

Reference(s):
Auto-PEEP and Electromechanical Dissociation - Volume 335:674-675, Number 9, August 29, 1996, NEJM

Question 26:
Case:
A 72-year-old male presented after midnight when ancillary services (ultrasound or CT scan) are not available. Initial diagnosis is pneumonia with pleural effusion. What may help you in deciding "to tap or not to tap" (thoracentesis) the patient?

Answer:
If there is confusion about the size of pleural effusion, obtain lateral decubitus film. Measure the width of the layering pleural fluid. If the width of the fluid is less than 10 mm, the effusion can be managed medically or thoracentesis may be deferred, and if the effusion is wider than 10 mm, thoracentesis is recommended.

Question 27:

A 42-year-old female with recent refractory hypoxemia has been salvaged with adjuvant treatment of inhaled Nitric Oxide (iNO). Patient is now improved and requires discontinuation of iNO?

Answer:

Sudden discontinuation of iNO after prolonged use may cause rebound acute hypoxemia and acute pulmonary hypertension. iNO should be weaned gradually. One recommended strategy is to reduce the dose by 10ppm every 2 hours till it reaches to dose of 10ppm, and then reduce the dose by 2.5ppm over several hours with close monitoring.

Question 28:

What amount of air is usually needed to cause clinical symptoms in Venous Air Embolism (VAE)?

Answer:

Around 50 ml

Rationale:

Most occurrences of VAE go unreported because they are asymptomatic due to very small amount of air entering system, but when of large quantities of intravascular gas enter the venous system it can lead to severe neurologic injury, cardiovascular collapse, or even death. There are several factors, which may impact the morbidity and mortality rate. It ranges from the patient's entrainment, rate and volume of air introduced and the position of the patient at the time of embolization. Although very small volumes of air can lead to severe sequelae, generally it is accepted that at least 50 mL of air is required to cause clinical symptoms.

But again, all precautions should be taken to avoid even the smallest amount of air getting introduced into the vascular system; as there are case reports in literature showing a lethal effect of venous embolism with air as little as 20 ml or even 0.5 ml of air in the left anterior descending coronary artery causing ventricular fibrillation.

Question 29:

A 34-year-old male with previous history of lung transplant is admitted to the ICU with sepsis. The patient is recovering well but continues to have persistent ileus. A junior resident writes for erythromycin to increase GI motility. What is needed to be watched for in this patient?

Answer:

Tacrolimus level

Rationale:

Tacrolimus has clinically major drug interactions with erythromycin, Dilantin and rifampin. Erythromycin may increase Tacrolimus to a toxic level. It is recommended

that concurrent administration of erythromycin and tacrolimus should be avoided. However, if concomitant therapy is necessary, tacrolimus concentrations should be monitored.

Other significant interaction Tacrolimus may have is with amphotericin, barbiturates, calcium channel blockers, itraconazole, ketoconazole, fluconazole, cyclosporine, and cimetidine.

Question 30:

In HFOV (High frequency ventilation) respiratory rate is set as Hertz with usual initial setting of 5-6 Hertz per minute. One Hertz is equal to how many breaths?

Answer:

One Hertz is equal to 60 breaths per minute in HFOV

Question 31:

How to define submassive PE?

Answer:

Submassive PE is an acute PE without systemic hypotension but patient having either right ventricular dysfunction or myocardial necrosis.

Reference(s):

Management of Massive and Submassive Pulmonary Embolism, Iliofemoral Deep Vein Thrombosis, and Chronic Thromboembolic Pulmonary Hypertension - A Scientific Statement from the American Heart Association - Circulation. 2011; 123: 1788-1830

Question 32:

A 54-year-old male with ESRD is admitted with hyperkalemia. While hemodialysis is pending patient is administered calcium, insulin, glucose, Kayexalate and albuterol. Patient went into respiratory distress requiring intubation. CXR shows no pulmonary edema and repeat labs showed potassium level in normal range of 4.8 mEq/L. Physical exam shows severe wheezing?

Answer:

Paradoxical bronchospasm to albuterol

Rationale:

Paradoxical bronchospasm is a rare complication of albuterol therapy. The true mechanism of the phenomenon is unknown. Confirmed diagnosis is based on rechallenges.

Reference(s):

Raghunathan K, Nagajothi N., Paradoxical bronchospasm: a potentially life threatening adverse effect of albuterol. South Med J.2006 Mar;99(3):288-9.

Question 33:

Which phase of respiration on CXR is better to detect pneumothorax (like after inserting central venous catheter), inspiration or expiration?

Answer:

Expiration

Rationale:

Inspiration or expiration does not affect the volume of air in pleural space and pneumothorax can be detected better in expiration with less air volume in lung parenchyma, visually magnifying the air in pleural area.

Question 34:

What is the advantage of adding Sildenafil with inhaled Nitric Oxide (NO) in the treatment of pulmonary hypertension?

Answer:

Sildenafil not only decreases pulmonary artery pressures, but also prevents rebound pulmonary vasoconstriction on withdrawal of inhaled NO.

Reference(s):

Mehta S. Sildenafil for pulmonary arterial hypertension: exciting, but protection required. Chest. 2003 Apr; 123(4): 989-92.

Question 35:

A 68-year-old female is admitted into the ICU with fever and mental status change. MRI, lumbar puncture and laboratory work-up has been done along with medical treatment including seizure prophylaxis. Diagnosis of viral encephalitis is made. 3-days post admission, patient is now hemodynamically stable and neurologically improved but since admission, she continues to have hyponatremia despite treatment with normal saline. What should be your concern?

Answer:

Syndrome of inappropriate secretion of antidiuretic hormone (SIADH)

Rationale:

SIADH is common in encephalitis and should raise concern with persistent hyponatremia. SIADH is probably caused by disturbance of the hormonal control at the hypothalamus on the pituitary gland due to the spreading of inflammation to these areas.

Question 36:

Case:
You have a patient with acute exacerbation of asthma. The pharmacy informed you that the only steroid available is hydrocortisone. What is the dose of hydrocortisone in acute exacerbation of asthma?

Answer:
Hydrocortisone (Cortef) 100 to 250 mg IV q 6 hours

Rationale:
Following are different steroids that can be use in exacerbation of asthma

Hydrocortisone -
Parenteral: 100 to 150 mg intravenous/intramuscular every 206 holy prn
Oral: 20 to 240 mg/day orally in divided dose.

Methylprednisolone -
Parenteral (Solu-Medrol) 10 to125 mg intravenous/intramuscular every 6 hrly
Oral (Medrol) 4 to 48 mg orally daily.

Betamethasone - 0.5 to 0.9 mg intramuscular/orally daily

Cortisone - 25-300 mg orally daily

Dexamethasone - 0.75-9 mg orally/intramuscularly/intravenous every 6 hrly

Question 37:

Case:
A 37-year-old otherwise healthy male brought to the ED with acute upper airway obstruction after developing severe angioedema secondary to seafood. In view of compromised airway, emergent intubation was performed. Despite securing airway, patient oxygen saturation remained low and required significant support of PEEP and FiO2 on mechanical ventilator. Patient's JVP is noticed to be elevated with bilateral crackles on lung auscultation. CXR showed pulmonary edema. What is your probable diagnosis?

Answer:
Post-obstructive pulmonary edema (POPE).

Rationale:
POPE is the sudden onset of pulmonary edema following upper airway obstruction. There are two main types of POPE.

Type 1 POPE: It occurs after a severe episode of upper airway obstruction such as postextubation laryngospasm, epiglottitis, croup, and choking.
Type II POPE: This may develop following surgical relief of chronic upper airway obstruction like tonsillectomy or removal of upper airway tumors.

Reference(s):
1. Guffin TN, Har-el G, Sanders A, Lucente FE, Nash M. Acute postobstructive pulmonary edema. Otolaryngol Head Neck Surg 1995; 112:235-7.
2. Lang SA, Duncan PG, Shephard DA, Ha HC. Pulmonary oedema associated with airway obstruction. Can J Anaesth 1990; 37:210-8.
3. Oswalt CE, Gates GA, Holmstrom FM. Pulmonary edema as a complication of acute airway obstruction. Rev Surg 1977; 34:364-7.
4. Galvis AG. Pulmonary edema complicating relief of upper airway obstruction. Am J Emerg Med 1987; 5:294-7.
5. Scarbrough FE, Wittenberg JM, Smith BR, Adcock DK. Pulmonary edema following postoperative laryngospasm: case reports and review of the literature. Anesth Prog 1997; 44:110-6.
6. Dicpinigaitis PV, Mehta DC. Postobstructive pulmonary edema induced by endotracheal tube occlusion. Intensive Care Med 1995; 21:1048-50.

Question 38:

What is singer's embolus?

***Answer**:*
Helium gas emboli in singers

Rationale:
An interesting cause of "helium emboli" can occur from inhalation of pressurized helium. Some singers intentionally inhale high-pressure helium for entertainment or to produce a change in their voice. Inhaled high-pressure gas can produce high transpulmonary pressure sufficient to rupture alveoli and surrounding blood vessels, introducing gas into the pulmonary veins and allowing systemic embolization through the left heart; particularly in an upright person.

A more common cause of "helium emboli" is from Intra Aortic Balloon Pump (IABP). IABP counter pulsation utilizes helium gas to inflate its balloon. As helium is a low density as well as an inert gas, in case of balloon rupture it is easily absorbed into the bloodstream. A good number of incidents of "helium emboli" following balloon rupture have been described in literature.

Major clinical sign of helium embolus is neurological deficit associated with other findings of balloon rupture as blood in the tubing. The treatment is hyperbaric oxygen.

Reference(s):
1. Cerebral and coronary gas embolism from the inhalation of pressurized helium Critical Care Medicine: May 2002 - Volume 30 - Issue 5 - pp 1156-1157
2. Cerebral Gas Embolism Resulting From Inhalation of Pressurized Helium - Annals of Emergency Medicine Volume 28, Issue 3, Pages 363-366, September 1996

Question 39:

Why is Daptomycin a bad choice for use in Pneumonia?

Answer:
Daptomycin is a bad choice in the treatment of respiratory tract infections because surfactant in lungs binds to Daptomycin, leaving free drug concentrations in pulmonary

secretions to very minimal. This is the only known organ-specific inhibition of an antibiotic.

Reference(s):
Inhibition of daptomycin by pulmonary surfactant: in vitro modeling and clinical impact. - J Infect Dis. 2005 Jun 15; 191(12): 2149-52.

Question 40:
What is Osler-Weber-Rendu syndrome?

Answer:
Osler-Weber-Rendu syndrome is an inherited condition. People with this condition develop abnormal blood vessels called arteriovenous malformations (AVMs) in several areas of the body. If they are on the skin, they are called telangiectasias. The AVMs can also develop in other areas of the body, such as the brain, lungs, liver, or intestines.

Question 41:
What is 'Buffalo chest'?

Answer:
An inter-pleural communication which results in a single pleural space within the chest (or communicating pneumothoraces on both sides of chest) is called "Buffalo chest'.

Rationale:
The term 'Buffalo chest' is used because the North American buffalo, or bison, lacks an anatomical separation between the two hemithoraces as the humans have. This can result in death by bilateral tension pneumothoraces from a hunter's single arrow to the chest.

Question 42:
Why is it that blood in pleural fluid does not clot?

Answer:
Hemorrhage within the pleural space generally does not clot due to three reasons:

1. Mechanical defibrination (movement of lungs)
2. Activation of fibrinolytic mechanisms
3. Disappearance of platelets within hours following hemorrhage

Question 43:
A 52-year-old male in the ICU is under treatment for MRSA pneumonia with Zyvox (Linezolid). The patient was taken for incision and drainage (I n D) by surgery. Post-op patient has symptoms of shivering. The Resident wrote an order for Demerol. Pharmacy called you to confirm the order. What would be their concern?

Answer:
Serotonin syndrome

Rationale:
Meperidine (Demerol) with linezolid (Zyvox) may cause serotonin syndrome with symptoms of confusion, hallucination, tachycardia, fever, sweating, and muscle spasms.

Question 44:
Which type of lung cancer is mostly associated with lung abscess?

Answer:
Squamous Cell Carcinoma

Rationale:
Lung cancer should be suspected when a pulmonary abscess fails to improve with appropriate medical management.

Reference(s):
L.E.L. Hendriks and co. - A pulmonary abscess, beware of lung cancer! Respiratory Medicine CME - Volume 4, Issue 4, 2011, Pages 157–159

Question 45:
Case:
A 32-year-old lean and thin man presented to ED with four days of right-sided chest pain associated with shortness of breath. CXR showed spontaneous pneumothorax (PTX) on the right side. Chest tube is inserted with immediate resolution of PTX. Two hours later patient complains of shortness of breathe again. Physical exam shows crackles on the left side?

Answer:
"Contralateral" Re-expansion Pulmonary Edema

Rationale:
Re-expansion pulmonary edema (REPE) is a rare but known complication of evacuation of pleural effusion or pneumothorax. It may occur on the same side, or both sides; it may also occur only in contralateral lung. Mechanism for this phenomenon is not known.

The risk for REPE is high if the lung is collapsed for more than three days. If it is secondary to pleural effusion it is recommended to remove no more than 1 liter of fluid. The treatment is supportive with supplemental oxygen, positive pressure ventilation, and diuresis.

Question 46:

How is Hemothorax defined on the basis of Hematocrit?

Answer:
A Hematocrit value of more than 50% in a pleural effusion when compared to that of the circulating hematocrit is considered a hemothorax.

Question 47:
How much pleural fluid drainage indicates a successful Pleurodesis?

Answer:
Less than 100-150 cc/24 hours

Question 48:
Case:
A 48-year-old male presented to the ED with Shortness of Breath. CXR showed massive left-sided pleural effusion. The ED physician inserted a chest tube, but to their surprise, a white milky fluid gets drained from the chest. You made a diagnosis of Nontraumatic Chylothorax. What are the five major causes of Nontraumatic Chylothorax?

Answer:
1. Lymphoma
2. Cirrhosis
3. Tuberculosis
4. Sarcoidosis
5. Amyloidosis

Lymphoma is the most common cause of Nontraumatic Chylothorax, representing about 60% of all cases. Non-Hodgkin lymphoma causes chylothorax more likely than Hodgkin lymphoma. After lymphoma, trauma is the second most common case of chylothorax comprising of approximately 25% of cases. This occurs as a result of trauma to the thoracic duct.

Question 49:
How can Transfusion-Associated Circulatory Overload (TACO) be clinically distinguished from Transfusion-Related Acute Lung Injury (TRALI)?

Answer:
TACO typically responds to diuretics with symptomatic improvement, while TRALI is usually unresponsive to diuretics. Moreover, TRALI usually presents with hypotension and TACO with hypertension, given other cardiovascular and renal conditions stable.

Question 50:

What is Naclerio's sign?

Answer:
The most common tear in Boerhaave's syndrome occurs at the left posterolateral wall of the lower third of the esophagus, 2–3 cm before the stomach. Tears are vertically oriented, 1-4 cm in length.

Naclerio's sign is a V-shaped air collection. One limb of the V is produced by mediastinal air outlining the left lower lateral mediastinal border. The other limb is produced by air between the parietal pleura and medial left hemidiaphragm

Question 51:
What is the typical finding to look for in Broncho-Alveolar Lavage (BAL) in AEP (Acute Eosinophilic Pneumonia)?

Answer:
In AEP, eosinophils count is greater than 20% of in Broncho-Alveolar Lavage (BAL) fluid in most patients and an average 37 to 54%.

Reference(s):
1. Pope-Harman AL, Davis WB, Allen ED, Christoforidis AJ, Allen JN. Acute eosinophilic pneumonia. A summary of 15 cases and review of the literature. Medicine (Baltimore) 1996; 75 (6) 334–342
2. Philit F, Etienne-Mastroïanni B, Parrot A, Guérin C, Robert D, Cordier JF. Idiopathic acute eosinophilic pneumonia: a study of 22 patients. Am J Respir Crit Care Med 2002; 166 (9) 1235–1239

Question 52:
How much fluid is needed at least to produce clinical symptoms in Pleural effusion?

Answer:
About 300 ml

Rationale:
Usually patients can tolerate mild pleural effusion without having any clinical symptoms.

Question 53:
Which one disease process is found to be protective in ARDS?

Answer:
Diabetes.

Reference(s):
Singla A, Modrykamien AM (2012) Diabetes Mellitus: Protective in Development of ARDS. J Pulmon Resp Med 2:e119

Question 54:
What is the difference between "Blue" and "Green" acapella?

***Answer**:*
Acapella is a vibratory Positive Expiratory Pressure (PEP) Therapy System, which also combines the benefits of airway vibrations to mobilize pulmonary secretions.
PEP devices work by having a one-way valve that creates resistance when the patient breathes out against it. With PEP therapy, the pressure difference that occurs when a patient breathes out allows the lungs to fill with additional air, which in turn will push the mucus out as the lungs try to return to an equilibrant volume.

Patient inhales deeply with a 3 to 4 second breath hold, alternating with normal breathing. Inspiratory to expiratory ratio is kept around 1:3 to 1:4. After 5-10 exhalations of alternating regular/deep breaths, patient is asked to cough.

Blue Acapella - has low expired lung volumes with less than 15 lpm for 3 seconds.
Green Acapella - has high-expired lung volumes with more than 15 lpm for 3 seconds.

Question 55:
What is the target $PETCO_2$ (Capnography) value during CPR?

Answer:
Between 10 and 20 mm Hg.

Rationale:
If $PETCO_2$ values less than 10 mm Hg or less measured after initiation of ACLS, it is associated with poor outcome. Also, if the value starts rising abruptly, it indicates Return of Spontaneous Circulation (ROSC).

$PETCO_2$ is the maximum partial pressure of CO_2 at the end a breath. It is about 36- 40 mm Hg in healthy adults.

Question 56:
For how many days should air travel be avoided after resolution of pneumothorax?

Answer:
Air travel should be avoided for up to 7-days after complete resolution of a pneumothorax. Some guidelines even prefer to wait for 2-weeks. A follow-up CXR should be obtained prior to air travel to re-confirm resolution of pneumothorax.

Reference(s):
1. MacDuff A, Arnold A, Harvey J, BTS Pleural Disease Guideline Group (December 2010). "Management of spontaneous pneumothorax: British Thoracic Society pleural disease guideline 2010". Thorax 65 (8): ii18–ii31
2. Practice Guideline, Orlando Regional Medical Center. Air travel following traumatic pneumothorax. October 2009.

Question 57:

Which lab tests may help in distinguishing between cardiogenic pulmonary edema and TRALI (Transfusion related acute lung injury)?

Answer:

Brain natriuretic peptide (BNP) aid in differentiating cardiogenic pulmonary edema observed in circulatory overload state from noncardiogenic pulmonary edema, which are usually present in TRALI.

Other laboratory findings may include unexpected haemoconcentration and a sudden fall in the serum albumin level (TRALI on the other hand has high albumin level). Also, neutropenia has been reported but neutrophilia is more common.

Reference(s):

1. Skeate RC, Eastlund T. Distinguishing between transfusions related acute lung injury and transfusion associated circulatory overload. Curr Opin Hematol. Nov 2007; 14(6): 682-7
2. The pathology of transfusion-related acute lung injury. Am J Clin Pathol 1999; 112: 216–21

Question 58:

A 54-year-old Asian male presented to the ED with cough and left-sided chest pain. CXR showed pleural effusion. Radiologist calls you with the result adding, "There is relative enlargement of the left-sided ribs". What does it imply?

Answer:

Chronic pleural effusion

Rationale:

The most common cause is tuberculosis and requires close workup and possible isolation. Changes in the ribs of patients with tuberculosis as well as the other patients with chronic effusion are due to local hyperemia from an adjacent inflammatory process. In advanced cases, the affected side of the thorax is also contracted; so gravitational and postural factors might also play a role.

Remember these rib changes are not a case of direct or metastasize skeletal tuberculosis, as there is no destruction of bone.

Reference(s):

Rib Enlargement in Patients with Chronic Pleural Disease - AJR: 167, October 1996

Question 59:

What is Rasmussen's aneurysm?

Answer:

Rasmussen's aneurysm is a pulmonary artery aneurysm, which is adjacent to or within a tuberculous cavity. It may lead to rupture and fatal hemoptysis. Rasmussen's aneurysm

occurs as a result of weakening of the pulmonary artery wall from the adjacent cavitary tuberculosis.

Question 60:

Case:

A 39-year-old male developed 10% right-sided pneumothorax with no major clinical signs after subclavian central line placement. Conservative observation with application of NR-mask did not resolve the pneumothorax. Now the size has increased to 30%. You inserted a chest tube with resolution of pneumothorax and proper chest tube placement as documented by immediate CXR at bedside. 10-minutes later the patient went into shortness of breath. Upon clinical examination, bilateral breath sounds are audible but with rales more pronounced on the right side. While waiting for repeat CXR, what is your probable diagnosis?

Answer:

Re-expansion pulmonary edema (REPE).

Rationale:

REPE is a rare complication occurring after the insertion of a chest tube for drainage of pneumothorax or pleural effusion. REPE can occur on the same or contralateral side, and can be bilateral and in some cases patients may be asymptomatic.

The exact pathophysiology for this complication is unknown. Oxygen radicals produced during hypoxemia in the collapsed lung have been postulated to be a possible cause. Moreover, the activity of various cytokines has also been implicated in the pathogenesis of REPE.

Major risk factors associated with REPE:

1. Younger age (especially with patients less than 40 years)
2. Longer duration of lung collapse (usually more than 4 days)
3. Large pneumothorax (occupying more than 30% of a single lung)

Reference(s):

Ipsilateral reexpansion pulmonary edema after drainage of a spontaneous pneumothorax: a case report - J Med Case Reports. 2007; 1: 107. Published online 2007 September 29

Question 61:

Which is more sensitive, bedside diagnostic in ruling out Pneumothorax - CXR or ultrasound?

Answer:

Ultrasound

Rationale:

It is now pretty much established that bedside ultrasound (which can be easily learned and performed by intensivist) is more sensitive in detecting pneumothorax.

Reference(s):
Wilkerson RG, Stone MB (January 2010). "Sensitivity of bedside ultrasound and supine anteroposterior chest radiographs for the identification of pneumothorax after blunt trauma". Acad. Emerg. Med. 17 (1): 11–17

Question 62:

What are the three catheter based interventions to perform mechanical thrombectomy in massive/submassive pulmonary embolism?

Answer:

The three categories of percutaneous catheter based intervention in pulmonary emboli are:

1. Aspiration thrombectomy
2. Thrombus fragmentation,
3. Rheolytic thrombectomy*

Mechanical thrombectomy should be avoided beyond the main and lobar pulmonary arterial branches. Direct intra-arterial delivery of thrombolytics, may be helpful if mechanical thrombectomy is ineffective.

*In Rheolytic thrombectomy catheters use a high-velocity saline jet to fragment the adjacent thrombus by creating a Venturi effect.

Reference(s):
1. Fava M, Loyola S. Applications of percutaneous mechanical thrombectomy in pulmonary embolism. Tech Vasc Interv Radiol. 2003; 6: 53–58.
2. Cho KJ, Dasika NL. Catheter technique for pulmonary embolectomy or thrombofragmentation. Semin Vasc Surg. 2000; 13: 221–235.
Kucher N, Windecker S, Banz Y, Schmitz-Rode T, Mettler D, Meier B, Hess OM. Percutaneous catheter thrombectomy device for acute pulmonary embolism: in vitro and in vivo testing. Radiology. 2005; 236: 852–858

Question 63:

What are the absolute and relative contraindications to Extracorporeal Membrane Oxygenation (ECMO) in patients with ARDS?

Answer:

Absolute contraindications to ECMO include:

A. Terminal patient
B. Contraindication to anticoagulation
C. Intracranial hemorrhage
D. Patient refusing to receive blood products

Relative contraindications to ECMO (due to historically poor survival rates):

A. Mechanical ventilatory support for more than 10 days and;
B. High pressure mechanical ventilatory support for more than 7 days

Reference(s):

Extracorporeal membrane oxygenation (ECMO) in Patients with ARDS - Pauline K. Park M.D., James M. Blum M.D., Lena M. Napolitano, M.D., Gail Annich, M.D., Jonathan W. Haft, M.D., and Robert H. Bartlett, M.D. - University of Michigan Health System -http://www.thoracic.org/clinical/critical-care/refractory-ards/pages/ecmo.php

Question 64:

What is Catamenial pneumothorax?

Answer:

Catamenial pneumothorax is a rare condition characterized by a pneumothorax coinciding with the onset of menses. It is almost always right-sided, and generally occurs in women in their thirties and forties.

Exact etiology is unknown but endometriosis is suspected with possible diaphragmatic fenestrations. Damage to endometriosis occurs, with air passing into the pleural space through these holes. It may be accompanied with hemothorax if blood from endometriosis enters pleural cavity.

Acute treatment is drainage of pneumo (air), Chest tube, Pleurodesis in recurrent cases and surgical closure of diaphragmatic fenestrations if required.

Referral should be made to the gynecological service for hormonal and related management of endometriosis.

Question 65:

Which lung cancer is more prone to produce Syndrome of Inappropriate Antidiuretic Hormone (SIADH)?

Answer:

Small cell lung cancer

Rationale:

SIADH is associated with several malignancies but is most notably associated with small-cell lung cancer.

SIADH can also occur following head injury, neck dissection, with a few drugs such as morphine, NSAIDs and in a number of other pulmonary processes like pneumonia, abscess, and tuberculosis. It can also occur with endocrine diseases like hypothyroidism and glucocorticoid deficiency.

Question 66:

What is Fat Embolism Syndrome?

Answer:

Fat embolism syndrome usually occurs within 1-3 days after a traumatic injury and are predominantly the following:

1. Pulmonary: Patients have shortness of breath, hypoxemia
2. Neurological: Patients have agitation, delirium, or coma
3. Dermatological: Patients may have petechial rash
4. Haematological: Patients having anemia and low platelets

They most commonly occur after fracture of long bones or pelvis. The petechial rash is the pathognomonic hallmark of the syndrome. Treatment is supportive.

Question 67:

A 64-year-old male, admitted to ICU for unrelated reason, is found to have about 10% of pneumothorax (PTX) after subclavian central venous line placement. Patient is hemodynamically stable, alert, oriented and saturation is 98% on room air. You decided to observe the patient. What amount of oxygen should be applied at least via nasal cannula to increase the absorption of pneumothorax?

Answer:

3 L/min

Rationale:

By applying oxygen, you may be able to treat stable, low volume, PTX by process called *Nitrogen washout*. On room air, most of the air volume trapped in the pleural space is Nitrogen. By breathing higher amounts of oxygen, one lowers the level of Nitrogen within the alveoli and, thus, the nitrogen in the pleural space will diffuse across (down the gradient).

Though it would not be harmful to apply 100% non-rebreather mask (NRM) in a patient who has no contraindication, oxygen administration with 3 L/min nasal cannula or higher flow oxygen is associated with a 4-fold increase in the rate of pleural air absorption compared with the patients receiving room air alone.

Reference(s):

Moore FO, Goslar PW, Coimbra R, et al. Blunt Traumatic Occult Pneumothorax: Is Observation Safe? –Results of a Prospective, AAST Multicenter Study. J Trauma. May 2011; 70(5): 1019-1025

Question 68:

Why is it important to look at CXR for a patient presenting with symptoms consistent with Myasthenia Gravis?

Answer:

To Rule out Lambert-Eaton Myasthenic syndrome. Lung cancer has strong association with this syndrome.

Question 69:
Why is Daptomycin not a good choice to treat pulmonary infections?

Answer:
Daptomycin binds to pulmonary surfactant, and therefore is not a good choice in the treatment of pulmonary infections, due to minimal free drug concentrations available in pulmonary secretions.

Question 70:
A 52-year-old male presented to the ED with massive PE. Diagnosis is confirmed with CT Angio and bedside Echo showed RV strain. You decided to use Thrombolytics but the Pharmacy informed you that none of the FDA approved thrombolytics are available (Alteplase, Urokinase and Streptokinase). The only available thrombolytic is Reteplase?

Answer:
Although the FDA has not approved Reteplase for PE (only approved for AMI), it is widely used off label for life threatening PE. The dosing used is the same as for patients with AMI: 2 IV boluses of 10 U each, administered 30 minutes apart. No adjustment is required for patient's weight.

Actually, Reteplase works more rapidly and tends to have less bleeding risk than alteplase.

Question 71:
A 69-year-old male with history of COPD is now recommended to have aerosolized colistin for his pulmonary infection. Which simultaneous order may benefit him?

Answer*:*
Administration of aerosolized colistin may cause bronchospasm, especially in patients with previous related history. Orders to give bronchodilators prior to administration of colistin may prevent the problem.

Question 72:
Beside Erectile Dysfunction (ED) and Pulmonary Hypertension (PAH), Sildenafil is an acceptable treatment in which condition?

Answer:
Altitude sickness

Rationale:
The phosphodiesterase 5 (PDE-5) inhibitors (both, sildenafil and tadalafil) have effectively shown to prevent hypoxic pulmonary hypertension. They have been used for

the prevention as well as treatment of high-altitude pulmonary edema, occurring in altitude sickness. Different doses have been described for sildenafil, from a single dose of 50 or 100 mg just prior to exposure for acute ascent, to 40 mg three times a day while at high altitude. For tadalafil, 10 mg every 12 hours is the described dose.

Reference(s):
1. Richalet JP, Gratadour P, Robach P, et al. (2005). "Sildenafil inhibits altitude-induced hypoxemia and pulmonary hypertension". Am. J. Respir. Crit. Care Med. 171 (3): 275–81.
2. Perimenis P (2005). "Sildenafil for the treatment of altitude-induced hypoxaemia". Expert Opin Pharmacother 6 (5): 835–7.
3. Fagenholz PJ, Gutman JA, Murray AF, Harris NS (2007). "Treatment of high altitude pulmonary edema at 4240 m in Nepal". High Alt. Med. Biol. 8 (2): 139–46.
4. Ghofrani HA, Reichenberger F, Kohstall MG, et al. Sildenafil increased exercise capacity during hypoxia at low altitudes and at Mount Everest base camp: a randomized, double-blind, placebo-controlled crossover trial. Ann Intern Med 2004; 141:169.

Question 73:

Define chylothorax and describe different treatment modalities?

Answer:

Chylothorax is defined as triglycerides more than 113 mg/dl (1.24 mmol/L) in the pleural cavity.

A number of therapeutic interventions have been used to reduce chyle production and promote resolution of a chylothorax. Initial management typically includes restriction or temporary cessation of enteral feedings. Enteral feedings high in medium-chain triglycerides (MCT), or parenteral nutrition may be used. Total parenteral nutrition typically results in resolution in 75 to 80% of cases by that time. In resistant cases, pleurodesis, ligation of the thoracic duct, or placement of drains and pleuroperitoneal shunts may be considered.

Octreotide has become another option for management of patients with chylothorax. Although the exact mechanism by which the drug exerts its effects has not been defined, it is believed that the multiple effects of Octreotide on the gastrointestinal tract and the reduction in splanchnic blood flow reduces thoracic duct flow and decrease the triglyceride content of chyle.

PULMONARY - PEARLS

1. **A note on end-tidal carbon dioxide ($ETCO_2$) during CPR**

   Expired carbon dioxide is a reliable measure of pulmonary perfusion and thus cardiac output (if ventilation is held constant) because the blood into the lungs excretes carbon dioxide. Carbon dioxide is easily measured with a portable capnometer placed between the end of an endotracheal tube and a resuscitation bag.

   Several studies have shown the correlations between $ETCO_2$ and cardiac output and myocardial perfusion pressure, implying that continuous measurement may gauge the effectiveness of ongoing CPR. A patient with higher $ETCO_2$ partial pressures during CPR has higher chances of return of spontaneous circulation (ROSC). At least $ETCO_2$ partial pressure of 10 mm Hg (or greater) is a predictor of survival - preferably 15 or more mm Hg.

   Levine *et al* prospectively measured $ETCO_2$ in 150 consecutive victims of cardiac arrest outside the hospital. The sensitivity, specificity, positive predictive value, and negative predictive value of a 20-minute $ETCO_2$ level of less than10 mm Hg were all 100%.

2. **Management of empyema thoraces**

   Intrapleural streptokinase was used commonly in the management of loculated empyema thoraces. Due to its immunogenicity and its inability to reduce pus viscosity, tissue plasminogen activator (tPA) has been suggested as better alternative to facilitate drainage of empyema thoraces. tPA induces fibrinolysis by preferentially activating plasminogen bound to fibrin and is less immunogenic.

   Another alternative is to use recombinant human deoxyribonuclease (DNase), which is known to reduce pus viscosity by causing fragmentation of the free uncoiled deoxyribonucleic acid found in pus.

   Interestingly, at least one randomized trial has shown that combination of TPA and DNase is superior, but DNase or TPA alone is ineffective. Moreover, DNase alone appears to be associated with an increased frequency of surgery or death. Most pulmonary physicians are currently using the combination of rtPA and DNase.

   Reference(s):

Rahman NM, Maskell N, Davies CW, West A, Teoh R, Arnold A, et al.Primary result of the second multicentre intrapleural sepsis (MIST2) trial; randomized trial of intrapleural tPA and DNase in pleural infection. Thorax 2009; 64:A1

3. **CPR and Venous Thromboembolism**

   If CPR is required in venous air embolism, the patient should be placed in a supine and head-down position. CPR in venous air embolism serves a dual purpose. Besides maintaining cardiac output, CPR may also help to break large air bubbles into smaller ones. Literature exists to show that the efficacy of cardiac

massage equals to that of placing patient in the left lateral position, as well as intracardiac aspiration of air via central venous catheter.

Reference(s):
1. Mirski MA, Lele AV, Fitzsimmons L, Toung TJ. Diagnosis and treatment of vascular air embolism. Anesthesiology. Jan 2007; 106(1): 164-77.
2. Sviri S, Woods WP, van Heerden PV. Air embolism--a case series and review. Crit Care Resusc. Dec 2004; 6(4): 271-6.
3. Muth CM, Shank ES. Gas embolism. N Engl J Med. Feb 17 2000; 342(7): 476-82.
4. Pronovost PJ, Wu AW, Sexton JB. Acute decompensation after removing a central line: practical approaches to increasing safety in the intensive care unit. Ann Intern Med. Jun 15 2004; 140(12): 1025-33.

4. One relatively less known fact on NRM (Non-Rebreather Mask)

The reason the Non-rebreather masks are called Non-rebreather mask is because it captures the first 150 ml of the exhaled breath into the reservoir bag for re-inhalation during the subsequent breath.

Clinical significance: This portion of the breath was initially delivered at the end of inhalation and was therefore delivered to the "dead space" anatomy where gas exchange does not occur. Therefore, there is neither depletion of O_2, nor gain of CO_2 during the rebreathing component.

5. Respiratory Failure Classification:

The classification divides respiratory failure into IV types:
Type I: Hypoxemic Failure ($PaO_2 < 60$ at sea level)
Type II: Hypercapnic Failure ($PCO_2 > 45$ mm hg)
Type III: Perioperative respiratory failure (as seen in patients with atelectasis due to low functional residual capacity)
Type IV: Respiratory failure due to Shock. Type IV describes patients who are intubated and ventilated in the process of resuscitation for shock.

6. Octreotide for the Management of Chylothorax

Several case reports have suggested that Octreotide is safe and effective for the treatment of chylothorax due to various reasons. The property of Octreotide (somatostatin) to induce leak closure is due its decelerating effect on lymph flow, although the exact mechanism of action is not well understood.

Treatment usually lasts for 1-2 weeks (mean 11 days). Octreotide may be given subcutaneously at a dose of 20-70 mcg/kg/day, divided as three doses, or as an IV infusion starting at a dose of 1-4 mcg/kg/hr and titrating up to 10 mcg/kg/hr. Infusion can be weaned and adjusted on the basis of chylous fluid drainage.

Reference(s):
1. Dalokay Kilic, MD, Octreotide for Treating Chylothorax after Cardiac Surgery - Tex Heart Inst J. 2005; 32(3): 437–439.
2. Kalomenidis I., Octreotide and chylothorax. - Curr Opin Pulm Med. 2006 Jul; 12(4): 264-7.
3. Cheung Y, Leung MP, Yip M. Octreotide for treatment of postoperative chylothorax. J Pediatr 2001; 139:157-9.

4. Rosti L, Bini RM, Chessa M, et al. The effectiveness of octreotide in the treatment of post-operative chylothorax. Eur J Pediatr 2002; 161:149-50.
5. Al-Zubairy SA, Al-Jazairi AS. Octreotide as a therapeutic option for management of chylothorax. Ann Pharmacother 2003; 37:679-82.

7. Fentanyl Cough

Fentanyl is probably the most commonly used opioid in ICUs. Fentanyl is associated with coughing in up to 30% of patients. Usually it is benign but may become explosive causing discomfort and increased intracranial and intra-ocular pressures. The various mechanisms proposed to explain fentanyl induced cough are inhibition of central sympathetic outflow leading to vagal predominance, histamine release or deformation of the tracheobronchial wall-stimulating the irritant receptors.

Treatment is aerosol inhalation of Salbutamol, beclomethasone or sodium chromoglycate if needed.

8. Varicella pneumonia and pregnancy

"Acyclovir is not currently licensed for use in pregnancy, however, the risks from withholding treatment (particularly in the second half of pregnancy), when severe complicated chicken pox are more common, probably outweigh the risks of adverse drug effects on the fetus or mother".

Reference(s):

Varicella pneumonia in adults - from European Respiratory Journal - ERJ, May 1, 2003, Vol. 21, No. 5, 886-891

9. Hyponatremia and non-cardiogenic pulmonary edema

During the management of hyponatremia, less attention is paid to non-cardiogenic pulmonary edema, which can develop at sodium levels below 121 ± 3 mmol/L. In these settings usually EKG and echocardiograms are normal. CXR shows pulmonary edema with a normal heart. Also, cardiac enzymes are normal, and pulmonary wedge pressure is not elevated. Cerebral edema may simultaneously be present. This situation is usually reversible with reversal of hyponatremia.

Reference(s):

1. J. Carlos Ayus, MD; Joseph Varon, MD; and Allen I. Arieff, MD Hyponatremia, Cerebral Edema, and Noncardiogenic Pulmonary Edema in Marathon Runners, Ann Intern Med. 2000; 132(9): 711-714
2. Ayus JC, Arieff AI. Pulmonary complications of hyponatremic encephalopathy. Noncardiogenic pulmonary edema and hypercapnic respiratory failure. Chest. 1995 Feb; 107(2): 517-21.

10. A note on contralateral re-expansion pulmonary edema

Re-expansion pulmonary edema (RPE) is a rare but life threatening complication of evacuation of pleural fluid or air (pneumothorax). One interesting but poorly understood complication is development of RPE on the side contralateral to the lung that was drained.

RPE usually occurs if a lung is collapsed for more than three days. It is recommended not to remove more than 1 liter of fluid in such an instance. In

other scenarios, if patient complains of sudden chest pain during the procedure, then the procedure must be stopped immediately. Supplemental oxygen may be helpful along with NIPPV and diuresis.

11. Helium embolus

Intra Aortic Balloon Pump (IABP) counter pulsation utilizes helium gas to inflate its balloon. As Helium is a low density as well as an inert gas, incase of balloon rupture it is easily absorbed into the bloodstream.
But fairly well numbered incidents of "Helium emboli" after balloon rupture have been described in literature. Major clinical sign of helium embolus is neurological deficit associated with other findings of balloon rupture as blood in the tubing. Treatment is hyperbaric oxygen.

Reference(s):
Arterial helium embolism from a ruptured intraaortic balloon - Ann Thorac Surg. 1988 Dec; 46(6): 690-2.

12. Oxygen toxicity!

Oxygen is essential to life but can turn into a poison too. Most molecular oxygen used by mitochondria is metabolically reduced completely to water during normal cellular respiration, but a certain quantity of partially reduced, reactive oxygen metabolites is also generated. Chief among these toxic metabolites are superoxide anion, hydrogen peroxide and reactive hydroxyl radicals. Of these, the last are believed to be the most toxic.

According to literature available - On 100% oxygen breathing

1. After 6 hours - decreased tracheal mucus velocity is detectable
2. After 12 hours - signs of tracheobronchitis appear
3. Between 24 - 30 hours - abnormalities in gas exchange are detectable
4. At 72 - 96 hours - edema can be documented
5. After 96 hours - fibrosis may begin

Reference(s):
Jackson RM. Oxygen therapy and toxicity. In: Ayres SM, Grenvik A, Holbrook PR, Shoemaker WC, eds. Textbook of Critical Care. 3rd ed. 784-789

13. Geneva Risk Score: Predicting adverse outcome in patients with acute PE (Pulmonary Embolism)

A study by Wicki helps us to predict adverse outcome in patients with acute PE. Score of less than or equal to 2 suggest low risk, whereas score of 3 or greater than 3 suggest high risk of adverse outcome in patients with PE

Risk Factors with Points
Cancer = 2 points
CHF = 1 points
Previous DVT = 1 Points
SBP less than 100 mm hg on admission = 2 points
Arterial PaO2 less than 8kPa on admission = 1 point
Presence of DVT on Ultrasound = 1 point

Reference(s):
Wicki J, Perrier A, Perneger TV, et al. Predicting adverse outcome in patients with acute pulmonary embolism: a risk score. Thromb Haemost 2000; 84(4): 548-552

14. Extracorporeal life support in children with acute respiratory failure

Study published in *Critical Care Journal* looks at the factors predicting higher survival rate among children who are:

1. Younger
2. Have been on mechanical ventilator for few days before the initiation ECLS
3. Have lower PIP
4. They had higher PaO_2/FiO_2 ratio;
5. Were less acidotic
6. Did not required the use of iNO
7. Patients who had no immunocompromising diagnosis
   (all p values less than .05)
   These variables were obtained on the analysis of the
8. ELSO registry has data from over 145 centers worldwide that contributed information on ECLS for severe respiratory or cardiac failure, with 2,879 pediatric patients between 1 month and 19 yrs of age, treated with ECLS for respiratory failure.

Reference(s):
Extracorporeal life support for severe respiratory failure in children with immune compromised conditions - Pediatric Critical Care Medicine. 9(4): 380-385, July 2008.Pediatr Crit Care 2008; 9(4); 380-385

15. Risk factors for increased mortality in ICU Asthmatic patients

One review of 2152 ICU admissions with Asthma showed that the following factors were associated with higher risk of death in hospitalized patients.

1. Older age
2. Female sex
3. Patients who have received CPR within 24 hours prior to admission
4. Patients who have suffered a neurological injury during the first 24 hours in the ICU
5. Patient with tachycardia
6. Patients with hypercapnia

Lesson Learned: Early intervention (including intubation) in Asthma patients is key in decreasing mortality.

Reference(s):
Characteristics and outcome for admissions to adult, general critical care units with acute severe asthma: a secondary analysis of the ICNARC Case Mix Programme Database -Critical Care 2004, 8:R112-R121

16. Index to Predict Death in COPD Patients

The BODE index, a simple functional grading system, has been shown to be better than the FEV1 in predicting the risk of death from respiratory and any other cause among patients with COPD.

BODE index is a 10-point scale: Higher scores indicate a higher risk of death.
B = the body-mass index (B)
O = the degree of airflow obstruction
D = Dyspnea (D)
E = Exercise capacity (E), measured by the six-minute–walk test.

17. Is Confirmatory Chest X-ray Always Necessary?

It is a standard of practice to have follow-up chest-x-ray following endotracheal intubation and central venous catheter insertion. But do we always absolutely need it?

See these 2 interesting studies both comprised of 100 patients.
For endotracheal tube: Prospective study of 101 patients done at Cooper Hospital, Camden, NJ showed that the incidence of acutely significant malposition of endotracheal tube, when performed by experienced critical care personnel, were rare (one out of 101 intubations), and may be followed by routine, rather than the 'stat' chest radiographs[1].

For central venous catheter (IJ): Prospective study of 100 patients done at Lenox Hill Hospital, New York showed that 98 catheters were in accurate position post uncomplicated Triple-Lumen Catheter insertion into the right internal jugular vein via anterior approach. They concluded it is safe to omit the routine chest radiograph post uncomplicated insertion of a TLC and that IV treatment can be started early[2].

(We found at least one study in literature arguing against this work. Study of 107 patients from NIH showed 14% incidence of malposition, and conclusion was: Chest radiographs are necessary to ensure correct internal jugular catheter positions)[3].

Reference(s):

1. Utility of postintubation chest radiographs in the intensive care unit - Critical Care 2000, 4:50-53
2. Is Chest Radiography Necessary After Uncomplicated Insertion of a Triple-Lumen Catheter in the Right Internal Jugular Vein, Using the Anterior Approach? - Chest. 2005; 127:220-223*
3. Cannulation of the internal jugular vein: Is postprocedural chest radiography always necessary? - Critical Care Medicine: Volume 27(9) September 1999 pp 1819-1823
4. Value of postprocedural chest radiographs in the adult intensive care unit - Crit Care Med 1992; 20:1513-1518

18. "Berlin" definition of ARDS

The "Berlin" definition of ARDS is a consensus panel's new definition and severity classification system for Acute Respiratory Distress Syndrome (ARDS). Its aim is to simplify diagnosis, and come up with better prognostic factors and outcomes. It was published in JAMA (online), May 21, 2012. It took into account

cohort of 4,400 patients from previous randomized trials.

It deviates from the 1994 classification of ARDS by following a new standard, where there is no need to exclude patients with heart failure in the new ARDS definition. Patients with high pulmonary capillary wedge pressures may still have ARDS.

Following the new criterion, respiratory failure simply may not be "fully explained by cardiac failure or fluid overload," in the physician's best clinical judgment. An "objective assessment" meaning an echocardiogram is highly recommended. The New Berlin definition for ARDS also categorized ARDS as being mild, moderate, or severe.

1. Mild is P/F ratio of 200 – 300 with predicted mortality of 27%
2. Moderate is P/F ratio of 100 – 200 with predicted mortality of 32%
3. Severe is P/F ratio less than 100 with predicted mortality of 45%

In the 'Berlin definition', clinical variables that are widely believed to be important such as static compliance, radiographic severity and a PEEP score of more than 10, were not predictive of mortality.

The panel's observations, endorsed by the European Society of Intensive Care Medicine, the American Thoracic Society (ATS) and the Society of Critical Care Medicine (SCCM), arose from meetings in Berlin to try to work on limitations of the earlier AECC definition.

Renal

Question 1:

52-year-old female with End Stage Renal Disease (ESRD) - on Peritoneal Dialysis (PD) for many years is admitted to ICU post-op after orthopedic surgery. Patient is requiring fair amount of narcotics for pain relief. Nurse calls you to report outflow problem with her peritoneal dialysis catheter. What could be the most probable cause?

Answer:

Constipation

Rationale:

Constipation in peritoneal dialysis patient is a very common cause of outflow problem, particularly in patients who have otherwise stabilized catheter (late complication). Use of laxatives to relieve constipation usually takes care of this problem. Obviously, proper physical exam should be carried out, and other causes should be ruled out.

Question 2:

Is Amiodarone dialyzable?

Answer:

No

Rationale:

Neither Amiodarone nor N-desethylamiodarone (DEA) is dialyzable. N-desethylamiodarone (DEA) is the major active metabolite of Amiodarone.

Question 3:

No adjustment is needed for Linezolid in ESRD (Renal failure) patients. But what is the recommendation for patients on Hemodialysis (HD)?

Answer:

Though there is no adjustment needed for Linezolid (Zyvox) in ESRD patients, it should be administered after HD session as linezolid clearance is increased by 80% during intermittent hemodialysis.

50% of a linezolid dose is metabolized in the liver to two inactive metabolites, whereas 30% is excreted renaly as unchanged drug. No renal dosing is recommended however; it should be administered after HD.

For patient undergoing CRRT, no dose adjustment is suggested.

Question 4:

Case:

34-year-old male with recent kidney transplant is admitted to your unit with mental status change and family reports witnessed seizure. While evaluating patient, the nurse hands over critical lab to you with magnesium of 0.2 mg/dl, your first response is to ask for the potassium level but it is actually on hyperkalemic side with 5.5 mEq/l. You call his renal transplant physician, who reports severe hypomagnesemia and seizure but normal BUN/ Cr level, his first question is to read patient's medication list. Why?

Answer:

Tacrolimus (FK-506 or Prograf) is a macrolide (an immunosuppressive drug), which is used in organ transplant to reduce the risk of organ rejection. It causes hyperkalemia due to renal tubular acidosis, Type 4 (RTA-IV) but simultaneously cause hypomagnesemia. It unusual to find both together. Other side effects of Tacrolimus include seizures, tremors, hypertension, confusion, calciuria, hyperglycemia, weakness, depression, cramps, and neuropathy.

Reference(s):

1. Downregulation of Ca2+ and Mg2+ Transport Proteins in the Kidney Explains Tacrolimus (FK506)-Induced Hypercalciuria and Hypomagnesemia - J Am Soc Nephrol 15:549-557, 2004
2. FK 506-induced neurotoxicity in liver transplantation. - Wijdicks EF, Wiesner RH, Dahlke LJ, Krom RA. - Ann Neurol 1994; 35:498–501.
3. Prograf Warning Letter - fda.gov
4. Tacrolimus leukoencephalopathy: A neuropathologic confirmation Lavigne et al. Neurology.2004; 63: 1132-1133
5. Progressive neurological disease induced by tacrolimus in a renal transplant recipient: Case presentation - BMC Nephrology 2006, 7:7

Question 5:

A 52-year-old male with history of End Stage Renal Disease (ESRD) - is admitted at 12 midnight with fluid overload, hypertensive crisis and mild hyperkalemia after he missed his dialysis session. The patient required intubation for hypoxemia but is now saturating 100% on ventilator. Nephrology service informed you that it would take at least 4 hours before hemodialysis can be arranged. Why would Labetalol be a bad choice for the control of hypertension?

Answer:

Labetalol may make hyperkalemia worse

Rationale:

Intravenous Labetalol, a nonselective α- and β-blocking drug, is commonly used to treat severe hypertension, but it can cause hyperkalemia. In patients with renal failure, it can be life threatening, particularly in situations where emergent hemodialysis is not available.

Reference(s):

Life-Threatening Hyperkalemia after Intravenous Labetalol Injection for Hypertensive Emergency in a Hemodialysis Patient - Am J Nephrol 2001; 21:241-244

Question 6:

Case:

A 57-year-old female, newly hemodialysis patient, transferred from floor to ICU after she developed seizure at the end of her dialysis session. No significant risk factor could be found otherwise. Nurse reports that the patient appears irritable and restless before episode and is complaining of headache, nausea and blurred vision. Resident was called to evaluate patient, and also noticed muscular twitching and confusion. Symptoms progressed and seizure was witnessed.

Answer:
Dialysis disequilibrium syndrome.

Rationale:
Dialysis disequilibrium syndrome is common during hemodialysis, particularly during patient's first few dialysis sessions. It is characterized by neurologic symptoms of varying severity and actually may lead to herniation and death. The rapid reduction in BUN lowers the plasma osmolality, creating a transient osmotic gradient that promotes water movement into the cells, causing cerebral edema and consequently acute neurologic dysfunction. With better understanding of the process and newer dialysis techniques, severe form of syndrome is now not commonly seen. This not only explains that why our nephrology colleagues start with gentle but frequent sessions but also explains one of the several benefits of mannitol during dialysis.

Question 7:

Which beta-blocker is prone to cause life-threatening hyperkalemia particularly in kidney transplant patient?

Answer:
Labetalol

Rationale:
One of the relatively unknown and fortunately benign side effects of beta-blockers is hyperkalemia. Most of the hyperkalemia is benign particularly with cardio-selective β-blockers. But life-threatening hyperkalemia may occur after IV dose of labetalol, particularly in patients with chronic renal failure, hemodialysis patients and post kidney transplant patients.

Reference(s):
1. Labetalol-Induced Hyperkalemia in Renal Transplant Recipients, American Journal of Nephrology 2002; 22:347-351
2. Possible Metoprolol-Induced Hyperkalemia, Journal of Pharmacy Practice, Vol. 19, No. 5, 320-325 (2006)

Question: 8

What advantage does plasma exchange provide in acute exacerbation of Wegner's Granulomatosis?

Answer:

It does not improve mortality but may rescue renal failure

Reference(s):
1.Klemmer PJ, Chalermskulrat W, Reif MS, et al. Plasmapheresis therapy for diffuse alveolar hemorrhage in patients with small-vessel vasculitis. Am J Kidney Dis 2003; 42:1149–1153.
2.Nguyen T, Martin MK, Indrikovs AJ. Plasmapheresis for diffuse alveolar hemorrhage in a patient with Wegener's granulomatosis: case report and review of the literature. J Clin Apher 2005; 20:230–234.

Question 9:

What is the most important clinical relevance of the Trans-Tubular Potassium Gradient (TTKG)?

Answer:

TTKG is calculated by following formula

TTKG = urine K^+ x serum osmolality/serum K^+ x urine osmolality

1. A TTKG of greater than eight indicates that aldosterone is present and collecting duct is responsive to it.
2. A TTKG of less than five in the presence of hyperkalemia indicates deficiency or resistance to aldosterone.

Question 10:

Is Amiodarone dialyzable?

Answer:

No

Rationale:

Amiodarone's is not excreted renally. It is excreted mainly via hepatic and biliary route. Amiodarone half-life is over 58 days and is not dialyzable. Its active metabolite, desethylamiodarone (DEA) also have a long half-life of 36 days. Accumulation of Amiodarone and DEA occurs in liver, lung and adipose tissue.

Question 11:

Technically, when Renal Failure is called "End Stage Renal Failure or ESRD?

Answer:

When patient requires renal replacement therapy (RRT) for more than 3 months.

Question 12:

Is Daptomycin dialyzable?

Answer:

No

Rationale:

In renal failure patients on CRRT and HD - every 48-hour dosing is recommended.

Question 13:

Case:

A 58-year-old male is admitted to ICU with Atrial fibrillation with RVR (rapid ventricular rate). Patient did well with rate control therapy and has been discharged from hospital on Metoprolol, aspirin, lisinopril, simvastatin and Amiodarone. Patient presented back after 2 weeks to ED with complaint of severe generalized weakness. Patient was found to be in acute renal failure. Beside hyperkalemia and elevated creatinine, patient found to have CPK in 60,000 ranges. Troponin is normal. What is your diagnosis?

Answer:

Acute renal failure secondary to rhabdomyolysis caused by simultaneous use of simvastatin with Amiodarone.

Rationale:

Though it has been reported in literature earlier, FDA recently issued warning regarding above drug interaction[1]. This risk is dose-related and occurs with the dose of simvastatin greater than 20 mg.

The precise mechanism is not clear, but Amiodarone inhibits the cytochrome P450 3A4 (CYP3A4) enzyme. This is the same enzyme that metabolizes simvastatin[2].
Use of other statins without relevant CYP metabolism (e.g. pravastatin) should be ok.

Reference(s):

1. Simvastatin (marketed as Zocor and generics), Ezetimibe/Simvastatin (marketed as Vytorin), Niacin extended-release /Simvastatin (marketed as Simcor), used with Amiodarone (Cordarone, Pacerone) - fda.gov

2. Rhabdomyolysis in Association with Simvastatin and Amiodarone - The Annals of Pharmacotherapy: Vol. 38, No. 6, pp. 978-981.

Question 14:

What is Calciphylaxis?

Answer:

Calciphylaxis is a syndrome in which there is vascular calcification, thrombosis and skin necrosis. It results in chronic non-healing wounds and in most cases it is fatal. Though it has been described in other disease processes like primary hyperthyroidism, post-chemo state in breast cancer, alcoholic cirrhosis, cholangiocarcinoma, Crohn's disease, rheumatoid arthritis, SLE and others - it is a hallmark of patients with end-stage renal disease who are on hemodialysis or who have recently received a renal transplant. Diagnosis is made from clinical observation, and biopsy. Treatment is usually ineffective. If it involves the heart, it causes diastolic heart failure and is called *heart of stone*.

Question 15:
What is the difference between Renagel and Renvela?

Answer:
Sevelamer is indicated for the control of serum phosphorus (P) in patients with Chronic Kidney Disease on hemodialysis. Sevelamer controls phosphorus and "Ca x P product" without the concerns of metal accumulation. Renagel and Renvela are two forms of Sevelamar.

Renagel is Sevelamar Hydrochloride while Renvela is Sevelamar carbonate. Both tablets are produced by the same company and available in 800 mg forms.
Renvela, being in carbonate form has an advantage as an acid buffer, and reduces the risk of acidosis. Renvela is a next generation phosphate binder, which will eventually replace Renagel (sevelamer hydrochloride).

Question 16:
A 57-year-old male with severe diabetes and ESRD coded in the catheter laboratory. The patient is now in ICU after VA-ECMO (inserted by surgeon after cut down). Looking at previous record you found that the patient is extremely vasculopath and putting dialysis catheter would be next to impossible. Nephrology wrote orders to start CVVHD. What would be your option?

Answer:
Doing CRRT via ECMO cannulation, if the situation arises, CRRT can be performed simultaneously via same cannulas.

Question 17:
What's the difference between Levofloxacin (Levaquin) dose in hemodialysis and CRRT?

Answer:
In hemodialysis, Levaquin dose is 500 mg initial dose, followed by 250 mg every 48 hours. It should be administrated after the dialysis on the dialysis day.

In CRRT, as Levaquin gets cleared during CRRT the dose is 500 mg Q48 hours or 250 mg daily.

Of note: it should be taken into consideration that clearance is also dependent on filter type, flow rates, and other variables.

Question 18:
Case:
A 38-year-old female presented to the ED with severe pain going from "loin to groin". Patient has established diagnosis of Sarcoidosis?

Answer:
Nephrolithiasis in sarcoidosis is usually caused by hypercalcemia and hypercalciuria, which is secondary to increase in 1,25-dihydroxyvitamin D and calcitriol production by activated macrophages. Hypercalcemia is generally treated with intravenous hydration. If EKG changes noted than systemic steroids are indicated. Ketoconazole is said to decrease 1,25-dihydroxyvitamin D and is helpful in minimizing hypercalcemia and hypercalciuria.

Question 19:
A 54-year-old male is admitted to the ICU with Acute Renal Failure and diagnosed with Adult Polycystic Kidney Disease (ADPKD). 3 hours after his first hemodialysis session patient complains of severe headache. What would be your major concern?

Answer:
Intracranial berry aneurysm

Rationale:
Approximately 10% of patients with ADPKD die of a ruptured, intracranial berry aneurysm. Patients also may develop hepatic cysts, pancreatic cysts, splenic cysts and pulmonary cysts.

Question 20:
What is the recommended time period between 2 contrast related studies to avoid contrast-induced nephropathy?

Answer:
Ideally about 5 days

Rationale:
If multiple studies are needed, ideally 5 days should be kept between the studies to allow the kidneys to recover fully from the contrast.
Other steps should be taken like

A. All nephrotoxic drugs should be discontinued
B. The minimal amount of contrast material should be used
C. Nonionic agents should be preferred
D. Patients should be well-hydrated 12 hours before and 2 hours after a contrast-enhanced study

Question 21:
How would you write an order for soda bicarbonate infusion, for preventing contrast-induced nephropathy?

Answer:

Use 154meq/L of sodium bicarbonate (3 amps) in 1 liter of D5W. Give 3ml/kg/hr one hr prior to the exam. Give 1ml/kg/hr during the exam and for 6 hrs. after the exam.

Question 22:

Why do we use citrate (when heparin is not used) to avoid filter clotting in continuous renal replacement therapy (CRRT) / CVVHD?

Answer:

Citrate combines with calcium and causes extracorporeal chelation of calcium and blocks calcium dependent steps of clotting cascade. When extracorporeal blood mixes with venous blood, the ionized calcium level gets restored and systemic anticoagulation gets avoided. Also citrate gets metabolized via liver and chelated calcium gets released back into circulation, which prevents hypocalcemia (though frequent checks are required particularly in patients with liver insufficiency).

Question 23:

A 38-year-old female is admitted into the ED for unilateral acute nephrolithiasis. Patient is admitted to the ICU because of spiking fever, severe dehydration and azotemia. Renal ultrasound was performed in the ED. The radiologist calls you to report "a fluid-fluid level" in renal pelvis. What does this mean?

Answer:

Pyonephrosis

Rationale:

"A fluid-fluid level" means urine on top of purulent debris. Ultrasound is a much better indicator in identifying pyonephrosis than CT imaging, which is usually performed without contrast in such situations due to severe dehydration and worsening azotemia. Needless to say, antibiotics are required.

Reference(s):

Jeffrey RB, Laing FC, Wing VW, Hoddick W. Sensitivity of sonography in pyonephrosis: a reevaluation.AJR Am J Roentgenol. Jan 1985; 144(1): 71-3.

Question 24:

Ideally, mature Arterio-Venous Fistula (AVF) for hemodialysis should have which basic properties?

Answer:

Ideally, mature AVF should have the following characteristics to be safely punctured:

1. The AVF should have discernible vein margins
2. The flow should be greater than 600 mL/min
3. The vein diameter should be at least 0.6 cm
4. AVF should be not be located deeper than 0.6 cm

Reference(s):
Y. C. Kim, J. Y. Won, S. Y. Choi, H. K. Ko, K. H. Lee, Y. do Lee, B. C. Kang, S. J. Kim, 2009 Percutaneous treatment of central venous stenosis in hemodialysis patients: long-term outcomes. Cardiovasc Intervent Radiol 32 2 271 278

Question 25:

A 53-year-old male with ESRD (Renal failure) is in the ICU. The nurse asks you to write some prn medicine for BP control. The patient is already on high dose β-blocker. You write for IV Hydralazine. One hour after administration of Hydralazine you have been asked to evaluate the patient for mental status change?

Answer:

Patients, particularly those with renal failure/uremia hydralazine may produce a marked decrease in blood pressure, resulting in central reactions such as anxiety, delirium, disorientation, depression, and coma.

Also Hydralazine is a cerebral vasodilator and is known to increase intracranial pressure, which, together with its effect upon systemic blood pressure, reduces the cerebral perfusion pressure.

Question 26:

What is Xanthogranulomatous pyelonephritis?

Answer:

Granulomatous abscess formation, destruction of renal tissue, and a clinical picture, which resembles renal cell carcinoma, characterize Xanthogranulomatous pyelonephritis. Patients with Xanthogranulomatous pyelonephritis usually presents with episode of recurrent fevers, recurrence of urosepsis and a tender renal mass. Microscopically, there are granulomas and lipid-laden macrophages. Antibiotics are used just as a temporizing measure in patients. Usually Nephrectomy is required. Limited cases may get away with partial nephrectomy.

Question 27:

Zosyn (Piperacillin/tazobactam) needs to be adjusted in renal failure patients on hemodialysis. Does it need to be adjusted in patients on CVVHD?

Answer:

NO

Rationale:

Dose Zosyn (Piperacillin/tazobactam) does not need to be adjusted in renal failure patients on CVVHD. It would be as like a patient with normal kidney function.
In patients on HD, dose is usually: 2.25 g IV Q8h
In patients on CVVHD, dose is usually: 3.375g IV Q6hrly or 4.5gIV Q8hrly.

Question 28:

Citrate is used in continuous renal replacement therapy (CRRT) for extracorporeal anticoagulation. What is the added advantage of using citrate?

Answer:

Citrate partially enters the systemic circulation. Citrate is also a buffer substrate, besides being an anticoagulant. The generation of buffer is secondary to the conversion of sodium citrate to citric acid:

Na_3 citrate + $3H2CO_3$ = citric acid + $3NaHCO_3$

Citric acid is metabolized via Krebs cycle mainly in the liver, but also in renal cortex and skeletal muscle entering as citric acid and leaving as sodium bicarbonate.

Question 29:

Which one renal failure (crisis) is treated/managed by ACE inhibitor?

Answer:

Scleroderma Renal Crisis.

Rationale:

Scleroderma Renal Crisis is one of the few rheumatological emergencies where early diagnosis and treatment can make big difference in outcome. Wrong diagnosis may lead to wrong management pathway and eventually to very high risk of mortality. SRC is heralded with hypertensive crisis associated with acute renal failure but the pearl is to avoid IV Labetalol or nitroprusside and gradually decrease blood pressure with PO angiotensin-converting enzyme (ACE) inhibitors. Calcium channel blockers may help. Renal dialysis is a last resort. It has been suggested that use of steroids is associated with onset of scleroderma renal crisis.

Question 30:

How does Desmopressin (DDAVP) help in uremic bleeding (mechanism of action)?

Answer:

The mechanism of action of DDAVP is believed to be - by releasing factor VIII from storage sites, which leads to an increase in the concentration of factor VIII and minimize the effects of dysfunctional vWF. Larger vWF–factor VIII multimers have been seen in the plasma after infusion of DDAVP, which likely helps in reducing bleeding time.

Question 31:

What is Captopril test?

Answer:

It is a simple poor man's test to diagnose renal cause for hypertension. It has high sensitivity but a low specificity.

In this test, the baseline level of renin in the blood is determined by drawing blood. Then an oral dose of captopril is given and, after an hour, the plasma renin level is determined again. Because captopril blocks the activity of one of the proteins that renin works on, the blood pressure should fall. Both kidneys detect this decrease in blood pressure, but especially by the one that has a blocked blood supply. This kidney responds by secreting a large amount of renin. Thus an exaggerated renin response after the dose of captopril is suggestive of a renovascular hypertension.

Reference(s):

The captopril test for identifying renovascular disease in hypertensive patients. - Am J Med. 1986 Apr; 80(4): 633-44.

Question 32:

A 54-year-old male with End Stage Renal Disease (ESRD) is admitted into the ICU post-operatively. Patient has significant "oozing" from surgical site. The surgeon has ruled out surgical bleeding. You correct coagulopathy and give one dose of DDAVP (Desmopressin), with only partial response. Hematology recommends IV Estrogen. What is the dose?

Answer:

The dose of estrogen is 0.6 mg/kg IV over 30 minutes per day. It can be repeated up to 5 days. The onset of action is in 6 hours.

Estrogens improves bleeding time and decrease clinical bleeding significantly particularly in uremic patients. Estrogens have also been successfully used in uremic patients with dysfunctional platelets and GI bleed.

Question 33:

Case:

A 57-year-old female, who has newly become a hemodialysis patient, was transferred from floor to the ICU after she developed seizure at the end of her dialysis session. No significant risk factor could be found otherwise. The nurse reports that the patient appeared irritable and restless before episode; and complained of headache, nausea and blurred vision. The resident was called to evaluate patient. The patient was also noticed to have muscular twitching and confusion. Symptoms progressed and a seizure was witnessed.

Answer*:*

Dialysis disequilibrium syndrome.

Rationale:

Dialysis disequilibrium syndrome is common during hemodialysis particularly patient's first few dialysis sessions. It is characterized by neurologic symptoms of varying severity and actually may lead to herniation and death. The rapid reduction in BUN lowers the plasma osmolality, creating a transient osmotic gradient that promotes water movement into the cells, causing cerebral edema and consequently acute neurologic dysfunction. With better understanding of the process and newer dialysis techniques, severe form of syndrome is now not commonly seen. This not only explains why our nephrology colleagues start with gentle but frequent sessions; but also explains one of the several benefits of mannitol during dialysis.

Reference(s):

Dialysis Disequilibrium Syndrome: Brain death following hemodialysis for metabolic acidosis and acute renal failure- A case report followed with discussion and different management modalities (Ref.: BMC Nephrol. 2004; 5: 9.)

Question 34:

It is well known that Keppra (levetiracetam) is eliminated via renal route. Approximately how much of levetiracetam is removed during a standard 4-hour hemodialysis procedure?

Answer:

Standard hemodialysis removes approximately 50% of levetiracetam in the body. Supplemental doses should be given to patients after dialysis.

Rationale:

Clearance of levetiracetam depends on creatinine clearance. Clearance of levetiracetam is reduced in patients with renal insufficiency by 40%-60% in mild to severe renal insufficiency. In patients with ESRD the clearance of levetiracetam is decreased by 70%.

RENAL - PEARLS

1. **Acute Kidney Injury from Traumatic Rhabdomyolysis**
   Rhabdomyolysis occurs mostly after trauma. It may also occur as a result of intake of medications, exercise, heat exhaustion, toxins, infections, muscle enzyme deficiencies or endocrinopathies.

   In rhabdomyolysis, creatinine kinase level is elevated. Levels above 5000 U/L are associated with acute injury to kidney; and treatment is recommended above this level.

   Alkalinization of urine with sodium bicarbonate or mannitol has not convincingly been shown to reduce the need for neither dialysis nor mortality benefit.

   Aggressive volume resuscitation early in the course of the disease has been the main therapy.

   Reference(s):
   1. Brown CV, Rhee P, Chan L, et al. Preventing renal failure in patients with rhabdomyolysis: do bicarbonate and mannitol make a difference? Journal of Trauma 56 (6), 1191–6.
   2. Huerta-Alard´ın AL, Varon J, Marik PE (2005) Benchto- bedside review: Rhabdomyolysis—an overview for clinicians. Critical Care 9 (2), 158–69.

2. **Which biomarker provides the earliest detection of acute kidney injury?**
   Acute kidney injury (AKI) is a one of the common complication among ICU patients and its incidence has been increasing over recent years. Currently the diagnosis is based mainly on serum creatinine (sCr) as supported by Risk, Injury, Failure, Loss, and End-Stage Kidney Disease (RIFLE) criteria. The serial assessment of changing craetinine may take few days to predict the renal failure. Biomarkers testing should be undertaken at the time of ICU admission in order to distinguish between acute renal insufficiency from volume responsive renal dysfunction, chronic kidney disease (CKD) and normal renal function.

3. **Classification of CKD (chronic kidney disease)**
   Normal kidney function – GFR >90mL/min/1.73m^2 and no proteinuria

   CKD1: GFR > 90mL/min/1.73m^2 with evidence of kidney damage
   CKD2: GFR 60 to 89 mL/min/1.73m^2
   CKD3: GFR 30 to 59 mL/min/1.73m^2
   CKD4: GFR of 15 to 29 mL/min/1.73m^2
   CKD5: GFR less than 15 mL/min/1.73m^2
   CKD5D: Patients with CKD5 and requiring dialysis

4. **A note on Dialysis Dementia**
   Patients undergoing chronic hemodialysis may suffer from dementia. Aluminum in the dialysis bath has been felt to be responsible. The incidence has decreased since the centers have started using the aluminum-free water.

   Symptoms are dysarthria, apraxia, slurred speech, stuttering and hesitation. Later myoclonus, asterixis, seizures, personality changes and frank psychosis are reported

with frequent suicide. Disease has variable course. Within few months, the disease may even progress to apneic spells. In some patients, however, the disease is transient. Drug-resistant seizures are said to be part of it but it is mostly due to removal of pyridoxine during hemodialysis.

Treatment is to stop aluminum-containing phosphate binders. Aluminum chelation with deferoxamine have resulted dramatic improvement. In addition decreasing the aluminum absorption from the gut by controlling secondary hypoparathyroidism, iron deficiency anemia, and hyperphosphatemia have been beneficial. Patients should also receive the Pyridoxine supplementation. Benzodiazepines are effective in controlling the myoclonus. Phenytoin has also been used for patients having tonic-clonic seizures as little phenytoin is removed by hemodialysis.

5. **Gadolinium, MRIs, Renal failure and Nephrogenic systemic fibrosis**
Nephrogenic systemic fibrosis (NSF) is a rare but a serious disease that involves fibrosis of skin, joints, eyes, and internal organs. It is found to be associated with exposure to gadolinium for MRIs in patients with severe kidney failure. It can happen anywhere from a few hours to months after exposure.

NSF is a clinical and histopathological diagnosis. Most patients with NSF require quick diagnosis and aggressive hemodialysis. Gadolinium-containing contrast is now considered relatively contraindicated in patients with an estimated GFR fewer than 60 and especially fewer than 30 ml/min.
Not all but 4 of the 7-gadolinium contrast agents have been implicated in NSF.

6. **Dialysis and the central catheter's diameter!**
Internal diameter of each lumen of dialysis catheter is about twice the diameter of each lumen in a triple-lumen central venous catheter.

Clinical application: As per Hagen-Poiseuille equation, just 2 fold increase in radius increases the flow by 16 fold.

7. **Vancomycin dosing in Continuous Renal Replacement Therapy (CRRT)**
Vancomycin dosing is different in CRRT than it is in Intermittent Hemodialysis (IHD), as Vancomycin is effectively removed during CRRT. Vancomycin is 14K Daltons and CRRT filter removes up to 20K Dalton's size molecules. Frequent monitoring of the Vancomycin level is required. Different intervals have been described from 24 - 48 hours. Most agree on 10 mg/kg every 24 hours. The ultimate goal is to keep Vancomycin trough at least between 10 - 15 mcg/ml.

Reference(s):
1. Vancomycin dosing and monitoring - Division of Infectious Diseases, Department of Medicine, Columbia University Medical Center (CUMC), columbia.edu
2. CVVH Initial Drug Dosing Guidelines - from thedrugmonitor.com

Surgical Critical Care

Question 1:

Which drug is found to be associated with Vasoplegia Syndrome in post cardiac surgery patients?

Answer:

ACE inhibitors and ARBs

Rationale:

Though there is weak evidence, many reports have suggested that preoperative administration of ACEI/ARBs in patients undergoing cardiac surgery contributes to the lowering of systemic vascular resistance (vasoplegia syndrome), during the postoperative period. It is also suggested, if possible to hold ACEI/ARBs for 24 hours prior to the cardiac surgery to avoid postoperative vasodilation.

Reference(s):

Lee YK, Na SW, Kwak YL, Nam SB - Effect of pre-operative angiotensin-converting enzyme inhibitors on haemodynamic parameters and vasoconstrictor requirements in patients undergoing off-pump coronary artery bypass surgery. J Int Med Res 2005; 33:693-702.

Question 2:

One of the measures used to correct severe metabolic acidosis during or after cardiac bypass surgery is to use Tris-Hydroxymethyl Aminomethane (THAM). How is it used?

Answer:

Tham Solution is very effective in correcting metabolic acidosis, which may occur during, or immediately following cardiac by-pass surgery. If chest is open, 2-6 g of THAM can be injected directly into ventricular cavity, avoiding injection in cardiac muscles.

Otherwise, it can be given intravenously with following formula:
Tham Solution (mL of 0.3 M) required = Body Weight (kg) x Base Deficit (mEq/L) x 1.1
or simply 9 mL/kg IV.

Question 3:

What are the antibiotics of choice for prophylaxis in "abdomen left open"?

Answer:

The open abdomen (or abdomen left open after damage control) does not require antibiotic prophylaxis (unless there is an evidence of infection).

Question 4:

Name 5 drugs, which can be used for post-operative shivering?

Answer:
There is no gold standard of pharmacological treatment identified for post-operative shivering. The Following drugs have been used with various successes, with meperidine being the most responsive:

1. Meperidine
2. Tramadol
3. Magnesium
4. Clonidine
5. Dexmedetomidine

Reference(s):
1. Kranke P, Eberhart LH, Roewer N, Tramer MR. Pharmacological treatment of postoperative shivering: a quantitative systematic review of randomized controlled trials. Anesth Analg. 2002; 949(2): 453-460.
2. Kranke P, Eberhart LH, Roewer N, Tramer MR. Single-dose parenteral pharmacological interventions for the prevention of postoperative shivering: a quantitative systematic review of randomized controlled trials. Anesth Analg. 2004; 99(3): 718-727.
3. Schwarzkopf KRG, Hoff H, Hartmann M, Fritz HG. A comparison between meperidine, clonidine, and urapidil in the treatment of postanesthetic shivering. Anesth Analg. 2001; 92(1): 257-260.

Question 5:

Beside its use in prevention of vasospasm in Subarachnoid hemorrhage - what could be the other less known uses of Nimodipine?

Answer:
Though not as effective, Nimodipine can be used as an alternative or an adjuvant to magnesium for seizure prophylaxis in women with severe preeclampsia.
Also it has an adjuvant value in the treatment of intractable seizure.
Please note that the FDA has warned against using Nimodipine capsules as IV.
Nimodipine has been originally designed for the treatment of high blood pressure but is not used for this indication anymore.

Question 6:

Your nerdy ED doctor calls you to admit a 54-year-old male with Mackler's triad.
What is Mackler's triad?
Hint: Patient has previous history of alcohol abuse and perforated duodenal ulcer.

Answer:
Mackler's triad includes

1. Lower chest pain,
2. Vomiting, and
3. Subcutaneous emphysema

It is a classic presentation of esophageal rupture (Boerhaave's syndrome) but present only in few patients (14%).

Note that the triad has been reported without esophageal perforation too.

Tachypnea and abdominal rigidity are usually present along with tachycardia, diaphoresis, fever, and hypotension. Unusual clues include hoarseness caused by involvement of the recurrent laryngeal nerve, tracheal shift, cervical vein distention, and proptosis.

Condition can quickly progress to multi-organ failure.

Question 7:

A 53-year-old female post-operatively developed Propofol induced dystonia. What could be a possible treatment besides stopping Propofol?

Answer:

Prone position.

Question 8:

Describe at least 5 clinical signs at the bedside, for diagnosis of acute appendicitis?

Answer:

Various clinical maneuvers have been described to diagnose acute appendicitis. Some, which are easy to perform, are:

1. ***Rovsing's sign:*** Here, the physicians performs continuous deep palpation counter clockwise starting from the left iliac fossa upward. This maneuver may cause pain in the right iliac fossa

2. ***Psoas sign or Obraztsova's sign:*** With the passive extension of the patient's right hip there is right lower-quadrant pain is produced. This occurs due to inflammation of the peritoneum.

3. ***Dunphy's sign:*** With coughing, there is an increase in pain in the right lower quadrant.

4. ***Sitkovskiy or Rosenstein's sign:*** When the patient lies on his/her left side there is increased pain in the right iliac region.

5. ***Rebound tenderness:*** There is pain on deep palpation of the viscera over the suspected inflamed appendix followed by sudden release (Blumberg's sign).

Question 9:

What is the rule of thumb for diagnosing Rhabdomyolysis using CPK level?

Answer:

Once CPK levels reach above 5 times the upper limit of normal, it can be labeled as rhabdomyolysis.

Question 10:

A 37-year-old male admitted to ICU with inability to walk and severe pain in lower extremities. On examination in ER, he was found to have cold feet. No pulses were palpable even in femoral area. Previous record available in hospital computer shows outpatient visits to urology clinic for 'impotency'?

Answer:

Leriche's syndrome

Rationale:

Leriche's syndrome is a triad of

1. Absent or diminished femoral pulses
2. Intermittent claudication
3. Penile impotence.

It usually affects males and is caused by atheromatous involvement or occlusion of the abdominal aorta by a thrombus slightly above the site of its bifurcation. Age of onset is between 30 and 40 years. The treatment is surgical.

Question 11:

What is the recommended DVT prophylaxis in patients with no major risk undergoing spinal surgery?

Answer:

For patients having no major risk factors, antithrombotic prophylaxis following elective spinal surgery is not recommended.

Question 12:

Though lately Etomidate has become unpopular due to its side effect of adrenal insufficiency in ICU patients - but still it has a unique advantage in traumatic brain injury patients, what is this advantage?

Answer:

Etomidate simultaneously decreases intracranial pressure but maintains a normal arterial pressure.

Question 13:

Case:

A 52-year-old male after emergent exploratory laparotomy is admitted to ICU. Patient has Lactated Ringer's solution going at 125 cc/hr. 2 units of pRBC has been ordered.

Why it is a bad idea to mix Lactated Ringer's solution and pRBC through same IV line?

Answer:
Lactated Ringer's solution contains calcium, which may bind to the citrate (use as anticoagulant) in blood products. This may promote clot formation.

Question 14:

A 52-year-old male developed intracranial hemorrhage after receiving thrombolytic therapy for CVA. What is the treatment?

Answer:
Transfusion of cryoprecipitate.

Prepare for administration of 6 - 8 units of cryoprecipitate containing factor VIII. It is not a bad idea to also administer 6 - 8 units of platelets.

Question 15:

Case:
An immunocompromised patient who had several rounds to chemotherapy is transferred to Critical Care Unit due to fever, right lower quadrant tenderness, diarrhea and vomiting. A CT scan demonstrates marked thickening of colonic wall.

Answer:
The diagnosis is Typhlitis or Neutropenic Enterocolitis. This is a life threatening condition and bears high mortality rate. The treatment is supportive and management of complications, like intra abdominal abscess or perforated viscous. Neutropenic colitis is characterized by intramural bacterial invasion without an inflammatory reaction. It may lead to edematous thickening and induration of the caecal wall or other segments of the colon and distal small bowel. On CT the thickened cecum may be isodense to surrounding normal bowel or may contain intramural low-density areas consistent with edema, hemorrhage or necrosis, or pneumotosis. The differential diagnosis of caecal wall thickening associated with neutropenic colitis includes lymphomatous or leukemic intramural deposits and hemorrhage. Lymphomas and leukemia may occur simultaneously with neutropenic colitis.

Question 16:

Case:
A 38-year-old male presented to the ED with severe chest pain. The patient informs you that he carries the diagnosis of Loeys-Dietz syndrome. What is your concern?

Answer:
Aortic aneurysm rupture

Rationale:
Loeys-Dietz syndrome is an autosomal dominant genetic syndrome which has many features similar to Marfan syndrome, which is caused by mutations in the genes encoding transforming growth factor beta receptor 1 (TGFBR1) or 2 (TGFBR2). The disorder was first observed and described by Dr. Bart Loeys and Dr. Hal Dietz at the Johns Hopkins University School of Medicine in 2005.

Many of the physical findings typical in Loeys-Dietz syndrome are also found in Marfan syndrome cases, including increased risk of ascending aortic aneurysm and aortic dissection, abnormally long limbs and fingers, and dural ectasia (a gradual stretching and weakening of the dura mater that can cause abdominal and leg pain). However, it also has some additional traits not typical of Marfan patients, including widely spaced eyes, a split uvula in the back of the throat, and skin findings such as easy bruising or abnormal scars.

Bonus Pearl: Animal research has suggested that the angiotensin II receptor antagonist losartan, which appears to block TGF-beta activity, can slow or halt the formation of aortic aneurysms in Marfan syndrome. A large clinical trial sponsored by the National Institutes of Health is currently underway to explore the use of losartan to prevent aneurysms in Marfan syndrome patients. Both Marfan syndrome and Loeys-Dietz syndrome are associated with increased TGF-beta signaling in the vessel wall. Therefore, losartan also holds promise for the treatment of Loeys-Dietz syndrome.

Question 17:

Case:
A 53-year-old male is going for urgent thoracic aortic aneurysm repair. On which side should you place the radial arterial line?

Answer:
On right radial artery

Rationale:
This is done on the right side because if the origin of the aortic aneurysm is around the left subclavian artery, then the left subclavian artery might be included in the aortic clamp and reconnected separately into the new aortic graft. In that scenario, one may not be able to measure the arterial pressure during that time. Also, both right and left radial arteries can be cannulated to visualize circulation in both arms.

Question 18:

To develop ischemic colitis, how much of the blood supply to colon should be cut off?

Answer:
About 50%

Rationale:

Contrary to popular belief, it takes about 50% of blood supply to shunt away before symptoms of ischemic colitis develop. Under healthy conditions, the colon receives between 10%-35% of the total cardiac output.

Question 19:

What precaution should be taken while giving IV Ketorolac in postoperative patients who are also getting IV Morphine?

Answer:

Ketorolac and morphine when given together via IV have been known to precipitate. Different ports should be use for both drugs.

Question 20:

What is HTK solution?

Answer:

HTK stands for Histidine-tryptophan-ketoglutarate. It is a solution used during transplantation for preservation of the organs.
The composition of HTK is similar to that of extracellular fluid. It also contains Histidine, which does intensive buffering of the extracellular space, so as to prolong the period during which the organs can tolerate interruption of oxygenated blood supply. It also contains Mannitol and its osmolarity is 310 mOsm/L.

Reference(s):

Transplantation: HTK solution: should it replace UW solution for kidney preservation? , Nature Reviews Nephrology 5, 429 (August 2009)

Question 21:

What is Valentino's Syndrome?

Answer:

A duodenal ulcer with retroperitoneal perforation presenting with pain in the right lower quadrant is called Valentino's syndrome. Usually surgery can be avoided and the treatment is hydration and antibiotics.

Question 22:

What is the disadvantage Lactate Ringer (LR) has when it comes to compatibility while using IV lines?

Answer:

LR contains calcium in lactated Ringer's in amount of 1.5 mmol/L. While using same IV lines or as a 'drip line', Ca^{+} in LR can bind to some drugs and may reduce their efficacy.

Another under-appreciated effect in surgical ICUs is binding of calcium to the citrated anticoagulant in blood products. This can inactivate the anticoagulant and may promote the formation of clots in donor blood.

Question 23:

A 37-year-old male is going for kidney transplant. The patient has End Stage Renal Disease (ESRD) secondary to hyperoxaluria. What suggestion will you have for the surgery team?

Answer:
Removal of the native kidneys.

Rationale:
In ESRD secondary to hyperoxaluria it is recommended to remove native kidneys at the time of renal transplantation. Native kidneys have residual stones, which makes them highly susceptible to recurrent infections and sepsis.

Question 24:

What is Delta-p value in extremity's compartment syndrome?

Answer*:*
Delta-p is diastolic blood pressure minus intracompartmental pressure. It is a measure of perfusion pressure. Delta-p measurements of less than 30 mm Hg are used for fasciotomy. Other clinical situations should be taken into consideration.

Question 25:

Case:
You have a patient with intracranial bleed. ICP monitor has been inserted by neurosurgical service. You have been asked by the nurse to clarify confusion about the level of transducer for Mean Arterial pressure (MAP); so that the correct CPP (Cerebral Perfusion Pressure) can be calculated. What is the answer?

Answer:
To calculate CPP, tansducer should be "zeroed" at the height of the head to calculate MAP. There is a misconception that transducer should always be leveled / zeroed at heart level. This is not true. For Cerebral Perfusion Pressure calculation, MAP should be calculated with transducer at head (or ear) level.

Cerebral Perfusion Pressure (CPP) is defined as the difference between the Mean Arterial Pressure (MAP) and the Intracranial Pressure (ICP).
CPP = MAP - ICP

Question 26:

What is "Round belly sign" on CT scan in patients with suspicion of intra abdominal compartment syndrome (IACS)?

Answer:

Round-belly sign will be termed positive for IACS if abdominal distention has an increased ratio of anteroposterior-to-transverse abdominal diameter of more than 0.80 with 100% sensitivity and 94% specificity. Using a value of 0.82, increase the specificity to 99%.

Reference(s):

Pickhardt PJ, Shimony JS, Heiken JP, Buchman TG, Fisher AJ. The abdominal compartment syndrome: CT findings. AJR1999; 173:575 -579

Question 27:

Why it is recommended to perform head imaging (CT or MRI) in patients with severe hypernatremia OR what central complications may occur secondary to severe hypernatremia?

Answer:

CT scan or MRI of the head is suggested in all patients with severe hypernatremia as intracranial hemorrhage can occur due to traction on dural bridging veins and sinuses caused by movement of water from the brain and brain shrinkage. Also, dural thrombosis can occur due to hemoconcentration as a result of total body water loss. On another note, imaging studies may also reveal a central cause for hypernatremia.

Question 28:

What is the modus operandi of Subdural Hematomas (SDH)?

Answer:

Contrary to popular belief that SDH happens due to direct trauma, subdural hematomas actually are usually caused by rapidly changing velocities within the skull, which may cause stretching and tear within small bridging veins.

Due to above modus operandi, SDH is a classic finding in shaken baby syndrome, where similar shearing forces may cause intra and preretinal hemorrhages.

Question 29:

What are Duret hemorrhages?

Answer:

These are small punctate hemorrhages of the midbrain and pons, which occur as a result of stretching of arteriole during primary injury.

Question 30:

You received call from an old fashioned experienced ER physician to consult a patient with hypotension and positive Blumberg's sign?
What is Blumberg's sign?

Answer:

Stabbing pain on sudden release of steadily applied pressure on a suspected area of the abdomen is an indication of peritonitis. Ideal technique requires watching patient's face to assess severity of pain while doing above maneuver (there is an innocent tendency to watch abdomen).

Historically this maneuver was described to assess peritoneal inflammation as an early sign of appendicitis by pressing hands over McBurney's point. The sign was first described by a German surgeon and gynecologist, Jacob Moritz Blumberg (1873 -1955).

Surgical Critical Care - PEARLS

1. **A note on Isopropyl alcohol inhalation in Post operative Nausea Vomiting (PONV)**

   Isopropyl alcohol has been tried as an aromatherapy in PONV. Couple of inhalations from a standard alcohol (70%) wipe has been said to be effective. They are a few studies done in this regard leaning towards the theory that isopropyl alcohol may be therapeutically equivalent, inexpensive and useful trick in ICU.

   Reference(s):
   1. Langevin RB, Brown MM. A simple, innocuous, and inexpensive treatment for postoperative nausea and vomiting. Anesth Analg. 1997; 84:A16.
   2. Merritt BA, Okyere CO, Jasinski DM. Isopropyl alcohol inhalation: alternative treatment of postoperative nausea and vomiting. Nurs Res. 2002; 51:125-8.
   3. Winston AW, Rinehart RS, Riley GP et al. Comparison of inhaled isopropyl alcohol and intravenous ondansetron for treatment of postoperative nausea. AANA J. 2003; 71(2): 127-32.
   4. Wang SM, Hofstadter MB, Kain ZN. An alternative method to alleviate postoperative nausea and vomiting in children. J Clin Anesth. 1999; 11:231-4.

2. **'Insensible' water loss**

   In the ICU, the total volume status is the key the patient care. An often-ignored aspect is 'insensible' water loss. The most important point to understand is that, this is the loss of pure water without any associated solute loss. 'Insensible' water loss happens via 2 routes.

   1. Water evaporation via skin (call transepidermal diffusion), which is about 400 ml/day in healthy adult and
   2. Water evaporation loss from the respiratory tract, which is also about 400 ml/day in healthy adult

   In the ICU patients, 'insensible' water loss is higher due to fever, increase catabolism, surgical status and higher minute ventilation. It is estimated that in a hospitalized patient it may reach up to 1200 ml/day; or may even be higher in sicker or surgical patients. The management should take the full clinical picture into consideration, based on blood pressure, heart rate, CVP, urine output etc.

   In ventilated patients, 'insensible' water loss can be minimized by humidification of inspired gas at 37°C.

   Surgery itself is a big contributor in 'insensible' water loss. One study on routine cardiac surgery in adults, finds that insensible losses of 1 liter of water is to be expected.

   Reference(s):
   Insensible fluid loss during cardiac surgery - Critical Care 2001, 5(Suppl 4): 2

3. **Etomidate speech and memory test (eSAM)**

   Another less known use for Etomidate is “to determine speech lateralization in patients prior to performing lobectomies to remove epileptogenic centers in the brain.
   Etomidate is injected into the carotid artery and will anesthetize the ipisilateral brain hemisphere for 5–10 minutes. During such time, rudimentary speech and

memory tasks are performed in order to determine if removal of a particular part of a hemisphere will affect the patient's language abilities or induce severe memory impairments".

Prior to and during the procedure the patient is shown a series of objects. Once the anesthesia has worn off, the patient is shown some of the same objects and asked if he had seen them. If the patient does not recognize the objects that were shown during the procedure, it is clear that the medial temporal structures that were left un-anesthetized during the procedure are not functioning properly.

Reference(s):
Etomidate speech and memory test (eSAM) A new drug and improved intracarotid procedure - Neurology December 13, 2005 vol. 65 no. 11 1723-1729.

4. **Cialis/Viagra in the treatment of cerebral vasospasm**
Tadalafil has shown to have a vasodilatory effect during both acute and chronic periods of cerebral vasospasm.

Reference(s):
A new approach to the treatment of cerebral vasospasm: the angiographic effects of tadalafil on experimental vasospasm - Acta Neurochirurgica, - Published online: 20 October 2009.

5. **Omentum in the management of complex cardiothoracic surgical problems**
Vascularized, pedicled tissue flaps are often used for cardiothoracic surgical problems complicated by factors that adversely affect healing, such as previous irradiation, established infection, or steroid use. Use of omentum was prophylactic to aid in the healing of closures or anastomoses considered to be at high risk for failure. Overall, omental transposition is successful in its prophylactic or therapeutic purpose. Complications of omental mobilization are rare. Omentum's unique properties render it an excellent choice of vascularized pedicle in the management of the most complex cardiothoracic surgical problems.

Reference(s):
Omentum is highly effective in the management of complex cardiothoracic surgical problems. J Thorac Cardiovasc Surg. 2003 Mar; 125(3): 526-32.

6. **Heparin rebound phenomenon**
Heparin rebound phenomenon, is considered to be a contributive factor in excessive postoperative bleeding after cardiac surgery. It is due to the reappearance of anticoagulant activity, despite adequate neutralization with protamine. This phenomenon has been well known, at least for the 45 years.

The underlying etiology is due to the fact that a significant amount of heparin remains bound to plasma proteins and escape neutralization by protamine. Later this heparin gets released and may contribute to excessive postoperative bleeding after cardiac surgery. Though logically, the treatment is more administration of protamine but caution should be taken as high and inappropriate protamine dose may lead to Acute Pulmonary Hypertension; and interestingly fails to show a decrease in blood product administration or any difference in the thrombelastographic profiles or coagulation screen (PT, PTT, ACT and platelets).

Also life threatening protamine reactions is another risk needed to be considered.

Note: This Heparin rebound phenomenon is different from rebound increase in thrombin generation and activity after cessation of intravenous heparin in patients with acute coronary syndromes, which is also often referred as heparin rebound phenomenon.

Reference(s):
1. Heparin rebound phenomenon in extracorporeal circulation - Surg Gynecol Obstet.1962 Aug; 115:191-8.
2. Heparin rebound phenomenon--much ado about nothing? - Blood Coagul Fibrinolysis. 1992 Apr; 3(2): 187-91.
3. Can extra protamine eliminate heparin rebound following cardiopulmonary bypass surgery? - J Thorac Cardiovasc Surg 2004; 128:211-219
4. Rebound Increase in Thrombin Generation and Activity After Cessation of Intravenous Heparin in Patients With Acute Coronary Syndromes - Circulation. 1995; 91:1929-1935.
5. Life Threatening Protamine Reactions In Cardiac Surgery: Literature Review With A Case Report - The Internet Journal of Thoracic and Cardiovascular Surgery. 2005. Volume 7 Number 1.

7. Revisting Intra-Abdominal Hypertension (IAH)

Intra-Abdominal Hypertension (IAH) and Abdominal Compartment Syndrome (ACS) are encountered in critical care settings, which require prompt identification and management.

Grades of IAH:
Grade I: Intraabdominal Pressure (IAP) of 12-15 mmHg
Grade II: IAP of 16-20 mmHg
Grade III: IAP of 21- 25 mm Hg
Grade IV: IAP> than 25 mm Hg

8. Grading of Intra-abdominal Hypertension (intra-abdominal compartment syndrome)

Burch and co. defined a grading system of IAH:
Grade I (10-15 cmH2O),
Grade II (15-25 cmH2O),
Grade III (25-35 cmH2O) and
Grade IV (>35 cmH2O).

With massive fluid resuscitation as part of critical care management, intensivist needed to be constantly cautious of this complication. End-organ damage has been described with bladder pressure as low as 10 cm H_2O. Intra-abdominal Hypertension is defined as sustained or repeated pressure more than/= 12 and Intra-abdominal compartment syndrome as sustained or repeated pressure more than/= 20.

Although bladder pressure is not the accurate method of diagnosing IAH, but so far has been used as the standard due to its bedside ease. Dr. Cheatham has proposed APP (Abdominal Perfusion Pressure) as better indicator with formula
APP = MAP- IAP (like CPP = MAP - ICP).

Where MAP is mean arterial pressure and IAP is intra-abdominal pressure. Intra-abdominal Hypertension is defined as sustained or repeated APP less than or = 60

Reference(s):
1. The abdominal compartment syndrome. - Burch JM, Moore EE, Moore FA, Franciose R Surg Clin North Am. 1996 Aug; 76(4): 833-42.
2. Abdominal Perfusion Pressure: A Superior Parameter in the Assessment of Intra-abdominal Hypertension Journal of Trauma-Injury Infection & Critical Care. 49(4): 621-627, October 2000.

TOXICOLOGY

Question 1:
What is the next level of treatment in methemoglobinemia, if Methylene blue fails?

Answer:
Exchange transfusion

Rationale:
Methylene blue is the primary and emergent treatment for symptomatic methemoglobinemia. It should be remembered that Methylene Blue cannot be used in patients with G6PD deficiency. Exchange transfusion should be considered for patients who do not respond to methylene blue or have G6PD- deficiency.

Question 2:
IV magnesium is usually not indicated when hyperkalemia exists except in one condition?

Answer:
Magnesium can potentiate myocardial conduction abnormalities and therefore is contraindicated in patients with hyperkalaemia. In digoxin poisoning with hyperkalemia, intravenous magnesium sulphate is helpful in eliminating refractory ventricular tachycardia and decreasing the serum potassium level.

Question 3:
Which poison smells like Almonds?

Answer:
Cyanide

Question 4:
You admitted a patient with acetaminophen (Tylenol) overdose and started on 21 hour regimen of IV acetylcysteine / mucomyst (Acetadote). After a while as passing through the bedside, you noticed the color of liquid in bottle is changed to pink. What would be your next step?

Answer:
Nothing

Rationale:
There is change in color of acetadote from colorless to light pink or purplish once the medication stopper is punctured. This color change is benign and expected and requires no intervention. Some hospital pharmacies prepare their own generic IV acetylcysteine

and this color in those circumstances is not always seen.

Caution: It is advisable to keep IV Benadryl and steroid handy, as flushing, urticaria and angioedema are frequent side effects of IV acetylcysteine, mostly during the first hour of loading. It is suggested to use caution especially in patients who have history of asthma or bronchospasm.

Question 5:

Which Calcium Channel Blocker overdose may not produce noticeable hypotension but severe heart blocks (and may deceive the diagnosis)?

Answer:
Diltiazem.

Rationale:
Most of the CCB overdose produces significant hypotension as expected but Diltiazem may deceive you by just producing heart blocks.

The following are 2 important pearls in treating CCB overdose beside calcium infusion and standard hemodynamic support.

1. 1. 5 - 15 mg IV Glucagon is a viable adjuvant treatment in calcium channel blocker overdose. It is advisable to administer Glucagon before calcium infusion is given however, as erratic blood calcium level may mask full effect of glucagon. Glucagon via cAMP increases cardiac contractility and counter heart blocks.
2. Consider adding Ionocor (amrinone) infusion. It is a Phosphodiesterase inhibitor and has 2 actions. 1) It delays release of calcium into the cell 2) it increases cardiac contractility via cAMP.

Question 6:

What is the first and major concern in person who may have clonidine overdose/toxicity?

Answer:
Respiratory depression/Apnea and need of endotracheal intubation.

Rationale:
CNS toxicity in clonidine overdose is similar to that seen in opiates - which are many time missed by caregiver. Central effect of clonidine includes CNS lethargy or coma, miosis and respiratory depression or apnea. Other CNS signs and symptoms include Hypotonia or hyporeflexia, Seizures, Ataxia, dysarthria, Weakness and Hallucinations.

Question 7:

While on a "Rapid response team", you have been called to drug rehabilitation unit to evaluate a 34-year-old female who was found hypotensive and dizzy. Nurses confirmed that under strict watch, patient has taken no narcotic. As you hook the monitor, it shows frequent runs of Torsades de pointes. Review of medicine list shows patient under treatment with methadone and 3-days ago started on Levofloxacin for suspected UTI?

Answer:
Methadone induced QT prolongation, converted into Torsades due to Levaquin interaction.

Rationale:
Methadone is a long-acting narcotic pain medication commonly used in the treatment of narcotics addiction. Methadone causes prolongation of the QT interval and this explains the development of Torsades de pointes. Methadone also causes dose-related prolongation in the QTC interval. Patients who are on methadone and taking other medications may have serious drug interactions as prolongation of QT interval, which can have serious consequences.

Question 8:

Case:
A 74-year-old male has been found to have arrhythmia with runs of wide complex ventricular tachycardia. Patient so far remained hemodynamically stable. You request crash cart near bed, applied pads to chest and send STAT labs and start reviewing patient's chart. You noticed 4-days ago digoxin level was 1.9 and since then his serum creatinine is steadily rising from 1.6 to 2.8. You suspected "digoxin toxicity" and called lab to run STAT digoxin level. Indeed Dig. Level is back with 3.4 and accompanying labs showed K+ level of 6.9. You ordered "Digi-bind" (digoxin Immune Fab). Pharmacy informed you, "It will take time before Digi-bind gets to ICU". Interim you started treating hyperkalemia with IV insulin, D-50, IV bicarb. IV calcium and albuterol nebulizer treatments.
Where did you go wrong?

Answer:
Calcium has shown to make digoxin toxicity worse. It may be wiser to avoid calcium in management of hyperkalemia from digoxin toxicity. Some literature has shown the similar membrane stabilizing effect from magnesium and may be used instead of calcium.

Caution should be taken not to go very aggressive in treating hyperkalemia, or at least potassium should be followed very closely if DigiFab is planned. With administration of DigiFab (Digibind), potassium shifts back into the cell and life-threatening hypokalemia may develop rapidly. Digoxin causes a shift of potassium from inside to outside of the cell and may cause severe hyperkalemia but overall there is a whole body deficit of potassium. With administration of Digi-bind, actual hypokalemia may manifest which could be equally life threatening.

Reference(s):
1. Calcium for hyperkalaemia in digoxin toxicity - Emerg Med J 2002; 19:183
2. Using calcium salts for hyperkalaemia - Nephrol Dial Transplant (2004) 19: 1333-1334
3. Slow-release potassium overdose: Is there a role for magnesium? Emergency Medicine 1999; 11:263–71

Question 9:

Case:
A 62-year-old male with long history of atrial fibrillation and chronically on digoxin admitted with dizziness and found to have 3rd degree AV block. Patient is hemodynamically stable. Patient informed you that about a year ago, he had a similar episode and was found to have high digoxin level and was treated with "antidote of digoxin". Later his cardiologist decreased his digoxin dose. You assume "Dig toxicity" and indeed Digoxin level reported as 3.4 micrograms/ml. You ordered "Digibind". What step you should take in view of history of previously received "Digibind"?

Answer:
Skin allergy test for digoxin immune Fab.

Rationale:
During life threatening situations, allergy testing can cause delay in the treatment, it is not mandatory to do the skin testing, but is strongly suggested if the time permits.

Skin testing should be considered for high-risk individuals with a history of multiple allergies, or in patients who have previously been treated with digoxin immune Fab or in patients who are allergic to papaya extracts. Papain is used to breakdown the whole antibody into Fab and Fc fragments, and inactivated papain residues or traces of papain may be present in digoxin immune Fab (ovine).

Even after the first dose, one should also consider the possibility of anaphylactic, hypersensitivity or febrile reactions to digoxin immune Fab (ovine).

To perform the skin testing one should take 0.1 mL of reconstituted Digibind (9.5 mg/mL) in 9.9 mL sterile isotonic saline (1:100 dilution, 95 µg/mL). The patient is then injected with 0.1 mL of the 1:100 dilutions intradermally and patient is observed for any urticarial wheal surrounded by a zone of erythema. After the intradermal injection, the patient is checked for any reaction or wheal in twenty minutes.

If there is any systemic reaction to the allergy testing, a tourniquet is applied above the site of testing. In case of full blown anaphylactic, hypersensitivity or febrile reactions to patient should be treated with volume resuscitation, oxygen therapy, diphenhydramine and corticosteroids. Epinephrine should be used very cautiously and only if needed due to higher risk of arrthymias in the setting of digitalis toxicity.

Question 10:

Reglan (Metoclopramide) is a very commonly use drug in ICU. Does it get removed via CVVHD?

Answer:
No!

Rationale:
(Reglan) Metoclopramide is excreted principally through the kidneys. In patients with creatinine clearance below 40 mL/min, dose should be curtailed at approximately one-half the recommended dosage. Dialysis removes relatively little Metoclopramide. Similarly, continuous ambulatory peritoneal dialysis does not remove significant amounts of the drug.

Higher dose may manifest as tardive dyskinesia, a syndrome consisting of potentially irreversible, involuntary, dyskinetic movements. Elderly patients are likely to develop the syndrome. Anticholinergic or antiparkinson drugs or antihistamines with anticholinergic properties may be helpful in controlling the extrapyramidal reactions. Symptoms are self-limiting and usually disappear within 24 hours.

Reference(s):
Drug Dosing in Critically Ill Patients with Renal Failure: A Pharmacokinetic Approach - Journal of Intensive Care Medicine, Volume 15 Issue 6 Page 273-313

Question 11:

You have been called to ED to evaluate 46-year-old male with probable exacerbation of Myasthenia gravis (MG). Patient is still protecting his airway. Though you arrange intubation at bedside, you decide to give Tensilon (edrophonium) challenge test. As soon as you administer 3 mg of edrophonium, patient develops increase salivation, bronchopulmonary secretions, became diaphoretic, and smelled to have flatus (symptoms of SLUDGE syndrome). You required to intubate the patient. What is your diagnosis?

Answer:
Cholinergic crisis

Rationale:
One of the challenges in treating patients with Myasthenia gravis is either insufficient medication (i.e., myasthenic crisis) or excessive medication dosage (i.e., cholinergic crisis). In patients with myasthenic crisis, muscular strength will improve with edrophonium, otherwise there will be no response or weakness will increase along with unmasking symptoms of cholinergic crisis (SLUDGE syndrome).

Patient with myasthenia gravis can have the cholinergic crisis as a result of higher dose of their cholinergic medicines. I cholinergic crisis, muscle fails to respond to acetylcholine resulting in flaccid paralysis and respiratory failure increased sweating, salivation, bronchial secretions and miosis.

Tensilon (edrophonium) challenge test is good way of differentiating between myasthenic

crisis (insufficient medication) and cholinergic crisis (excessive medication).
SLUDGE = Salivation, Lacrimation, Urinary Incontinence, Diarrhea, GI hypermotility, Emesis.

Question 12:

Which antibiotic may give false positive urine drug screen for opiates?

Answer:

Gatifloxacin (Tequin) and other Fluoroquinolones.

Rationale:

Fluoroquinolones as a class cross-react with the enzyme immunoassay urine drug screens for opiates. The exact mechanism is unknown. False-positive results could have negative effects on patient care so analysis with another assay method should be done to verify the urine drug screen.

Editors' note: Tequin has been taken off USA market last year but as mentioned in JAMA's article (reference # 2), 13 quinolones were tested and 11 of the 13 quinolones caused some opiate activity by at least 1 assay system. So be careful with all quinolones. Actually, JAMA report mentioned Levaquin as one of the top 3!

Question 13:

A 54-year-old male on Pradaxa (Dabigatran) for atrial fibrillation is now admitted to ICU from OR as patient continues to bleed generally from incision as well as orifices, after emergent abdominal hernia repair. Patient was re-explored in OR twice to rule out any surgical bleed. Patient received multiple blood products including FFP, PCC, Platelets and 10 units of pRBC. What else could be done to stop bleeding secondary to Pradaxa?

Answer:

Trial of Dialysis

Rationale:

All new oral Direct Thrombin Inhibitors (DTIs) can cause problems in OR and ICU as they do not have any effective reversal. Pradaxa is mostly excreted via Kidney and some literature supports success in reversing bleeding with dialysis. In contrast, Xeralto (Rivaroxaban) is highly protein bound and major metabolic pathway is via liver, and cannot be reversed with dialysis

Reference(s):

1. Stangier J, Rathgen K, Stahle H, Mazur D. Influence of renal impairment on the pharmacokinetics and pharmacodynamics of oral dabigatran etexilate: an open-label, parallel-group, single-centre study. Clin Pharmacokinet. 2010; 49:259-268.
2. Wanek MR, Horn ET, Elapavaluru S, Baroody SC, Sokos G. Safe use of hemodialysis for dabigatran removal before cardiac surgery. Ann Pharmacother. 2012; 46:e21.

Question 14:
How long does the effect of Naloxone lasts?

Answer:
About 45 minutes.

Rationale:
Naloxone is commonly given intravenously in ICU for fastest action to reverse the opioid overdose. Naloxone acts within a minute, and last up to 45 minutes. If no IV access is available, it can also be given via intramuscular or subcutaneous route. Newer nasal forms are available too.

Objective of above question to emphasize the fact that, if patients should be monitored for extended duration as the effects of naloxone may wear off before those of the opioids and for this very reason patient may need the repeat dosing or even the naloxone drip.

Question 15:
Why is Albumin the fluid of choice for resuscitation in Fat Embolism?

Answer:
Albumin has been recommended for volume resuscitation in Fat Embolism Syndrome (FES), because it not only restores blood volume but also binds fatty acids, and may help in decreasing the extent of lung injury.

Question 16:
What is the target of Urine PH in Aspirin overdose?

Answer:
In Aspirin overdose, target urine pH is between 7.5 - 8.

Rationale
Salicylate causes "neuroglycopenia" (lower CNS glucose level) despite normal serum glucose. As patient gets more and more acidotic, salicylate enters CNS and by direct effect cause neuroglycopenia. In such case more aggressive management is required including hemodialysis.

Hemodialysis is recommended in salicylate overdose patients with a level at or above 100 mg/dL (cut it to half if history suggest chronic ingestion). But if there is any sign of neurological manifestation, dialysis is indicated despite normal level.

7 indications of Hemodialysis in Salicylate poisoning:
1. Mental status change
2. Pulmonary edema
3. Cerebral edema

4. Associated or with renal failure
5. Level at or above 100 mg/dL (half if chronic ingestion)
6. If fluid overload prevents alkalinization.
7. Patient continues to deteriorate clinically.

Question 17:

A 52-year-old male while on trip to Arizona encountered Scorpion sting and probable envenomation. Patient is intubated in field and transferred to ED. Anascorp (only commercially available anti venom for scorpion bite) has been administered. Which factors should keep you on high alert for anaphylactic reaction from Scorpion anti venom administration?

Answer:

Anascorp® is made from equine (horse) plasma. Patients who have allergies to horse protein are at risk for an anaphylactic reaction. Patients who previously had therapy with Anascorp® or another equine antivenom/antitoxin may have become sensitized because of prior exposure, may also be at risk.

Question 18:

A 48-year-old male s/p single lung transplants ten days ago developed tremors all over the body associated with confusion. What could be the likely cause?

Answer:

Prograf toxicity

Rationale:

Prograf (FK 506, Tacrolimus) is a commonly used medicine in transplants patients and its level should be monitored closely. Dosage should be adjusted based on the trough levels of medication. Normal trough level is 5-15 ng/ml.

Prograf toxicity may cause blurred vision, liver and renal failure, tremors, hyperkalemia, hypomagnesemia, and neurological problems such as seizure, encephalopathy, cerebral edema, confusion and so on.

Question 19:

What is the dose of Glucagon in severe life threatening Beta-blocker toxicity?

Answer:

The doses of glucagon for life threatening beta-blocker overdose is 50 micrograms/kg IV initially as the loading dose. This is followed with a continuous infusion titrated at 1-15 mg/h, to patient response.

Rationale:

Glucagon increases heart rate and myocardial contractility, and improves atrioventricular conduction. In patients with beta-blocker poisoning, glucagon still maintains these effects.

Question 20:

Case:

A 52-year-old home bound male with chronic history of seizure presented with hyperreflexia, confusion and nystagmus. You are worried about phenytoin toxicity but level is reported as 18 mcg/mL (normal is 10-20 mcg/mL). You secure ABC (airway, breathing and circulation). You start treating patient with IV Lorazepam. What should be your next step?

Answer:

Check free phenytoin level

Rationale:

It's true that the therapeutic range of phenytoin is 10-20 mcg/mL and plasma levels have an association with acute neurological symptoms. In individuals with decreased protein binding - nursing home residents, poor diet, chronically ill etc. may have signs of toxicity despite a normal total phenytoin level. Free phenytoin levels should be checked in those circumstances. Free phenytoin levels range from 1-2 mcg/mL and correlate well with clinical evidence of toxicity.

If free phenytoin level is not available, it should be adjusted with albumin level with following formula, called Sheiner-Tozer equation. It is not 100% accurate but gives a good estimate.

Corrected Dilantin = measured level / [(0.2 x albumin) + 0.1]
E.g. if measured Dilantin level is 8.2 but albumin is 2.2, the corrected Dilantin level would be 8.2 / {(.2 x 2.2) + .1} = 15.2
in renal patients, If patient CrCl is less than 20, use following formula.
Corrected Dilantin = measured level / [(0.1 x albumin) + 0.1]
E.g. if measured Dilantin level is 8.2 and albumin is 2.2, the corrected Dilantin level would be 8.2 / {(.1 x 2.2) + .1} = 25.6

Question 21:

Case:

You transferred a patient from a nearby community hospital with acetaminophen-induced acute liver failure. ALT / AST reported in thousands and last PT-INR of 2.7. On clinical examination patient is alert and oriented. Hemodynamics is stable. You alerted the hepatology team and send STAT labs. After 45 minutes you received a call from the laboratory with 'critical value' of phosphate with 0.9 mg/dl. Is it a good sign or a bad sign?

Answer:

Good Sign. Hypophosphatemia in the setting of acetaminophen-induced acute liver failure is a good sign. It indicates regeneration of hepatocytes and reversal of acute liver failure. You may have to replace it aggressively. Conversely, hyperphosphatemia suggest impaired regeneration and is a poor prognostic sign and actually also said to be a sign of impending hepato-renal failure due to kidney's lost ability of lowering of serum phosphate[1].

Question 22:

Does Phenytoin (Dilantin) get cleared by hemodialysis or hemoperfusion?

Answer:

No (clinically insignificant removal).

Rationale:

Clinical significance:

1. In Phenytoin toxicity/overdose, Hemodialysis or hemoperfusion are ineffective for enhancing elimination.
2. Hemodialysis patients do not require extra dosing post dialysis though require frequent monitoring due to lower albumin level.

Question 23:

Why flumazenil should be use with caution in patients with Cocaine overdose.

Answer:

Use of flumazenil in the cocaine-intoxicated patient may induce seizures.

Rationale:

It is common for patients to present with simultaneous overdose/abuse of benzodiazepine and cocaine. Administration of flumazenil to patients with benzodiazepine use may become life threatening. Cocaine is a gamma-aminobutyric acid (GABA) antagonist that may be potentiated by flumazenil.

Question 24:

A 44-year-old male with history of seizure is admitted with breakthrough seizure and has been loaded with phenytoin. His regular dose has been increased. Since morning patient is complaining of vision problem. On examination he has opthalmoplegia. What is your concern?

Answer:

Phenytoin overdose

Rationale:

One of the side effects of Phenytoin intoxication is ophthalmoparesis, also know as opthalmoplegia. This opthalmoplegia may take weeks to resolve.

Question 25:

Name 3 commonly used drugs in intensive care unit, which may cause Thrombotic thrombocytopenic purpura (TTP)?

Answer:

1. Plavix (Clopidogrel)
2. Acyclovir
3. Tacrolimus (FK506)

Question 26:

What is Scombroidosis?

Answer:

Scombroidosis refers to the condition in which patient suffers histamine poisoning as a result of ingestion of fish which has been stored incorrectly at an elevated temperature. Various bacteria produce histamine and cis-urocanic acid, which multiplies in the spoiled fish.

Patients suffering from scombroidosis presents with a flush without urticaria, nausea, vomiting, or diarrhea, palpitation and syncope.

Question 27:

Case:

A 23-year-male while working in the refinery while disconnecting the hose was exposed to hydrofluoric acid. Patient had inhalation of hydrofluoric acid. Patient had no past medical history. Which of the following should be done first?

A. Albuterol nebulizer with 2.5 mg albuterol
B. Albuterol nebulizer with 10mg albuterol
C. Calcium gluconate nebulizer treatment
D. 10% mucomyst treatment

Answer:

C

Rationale:

Calcium gluconate should be used after hydrofluoric acid exposure, and if there are any skin lesions it should be applied there too. Patient should be observed for 24-48 for development of pulmonary edema. Ionized calcium should be monitored very closely, and should be supplemented with intravenous calcium gluconate if low.

Question 28:

Why Glycopyrrolate is always used with Neostigmine for 'reversal' of neuromuscular blockade after surgery?

Answer:

Glycopyrrolate is used in conjunction with neostigmine; to prevent neostigmines muscarinic affects particularly bradycardia. In case if not available atropine can be used.

Question 29:

What is the best measure of titrating Atropine drip in Organophosphate poisoning?

Answer:

Control of hypersecretions served as the best monitoring parameter for titration of the drip rate. Organophosphate (OP) toxicity itself is a clinical diagnosis. There are no clinical lab values, which can be followed except for above clinical objective finding. Following mnemonic can be used to remember the muscarinic effects of organophosphates.

SLUDGE:
Salivation
Lacrimation
Urination
Diarrhea
GI upset
Emesis

DUMBELS:
Diaphoresis and diarrhea
Urination
Miosis
Bradycardia, bronchospasm and bronchorrhea
Emesis and excess lacrimation
Salivation.

Question 30:

You confirmed Propofol infusion syndrome in a patient on prolong high concentration infusion. Once you stop Propofol how long does it take to recover from Propofol associated lactic acidosis?

Answer:

About 6 hours

Rationale:

Propofol infusion syndrome (PRIS) has been observed in patients receiving Propofol at high dosages and for prolonged periods though reported with lower doses as well as short infusion time. It is said to be synergistic when given concomitantly with catecholamines or steroids in the setting of acute neurologic or inflammatory diseases.
Propofol infusion syndrome is said to occur in patients with genetic mitochondrial abnormalities.

Question 31:

Fomepizole can be use in methanol or ethylene glycol poisoning, but not in Ethanol poisoning. Why?

Answer:

Fomepizole not only prolongs the half-life of ethanol but also allows for greater level of intoxication at lower doses.
Fomepizole slows the production of acetaldehyde by alcohol dehydrogenase and allows more time for acetaldehyde dehydrogenase to detoxify it. Consequently, a patient will have a prolonged and deeper level of intoxication for even at small dosage of ethanol.

Question 32:

Give one non-infectious condition, which can be treated by IV penicillin G?

Answer:

A phalloides mushroom intoxication

Rationale:

There is no definitive antidote available for a phalloides mushroom intoxication, but high-dose continuous intravenous penicillin G has been reported to help but the exact mechanism is unknown.
Another useful treatment is said to be intravenous silibinin.
As with other toxin gastric decontamination with either activated carbon or gastric lavage should be done. Also like in other hepatic conditions associated with toxin ingestions N-acetylcysteine should also be used. Liver transplant team should be involved too.

Question 33:

Role of Ethanol, Fomepizole and Hemodialysis are well known in Methanol toxicity. Describe the role of bicarbonate in Methanol toxicity meanwhile above 3 treatments/antidote gets arranged?

Answer:

It is true that Ethanol, Fomepizole and Hemodialysis are mainstay of treatment in Methanol toxicity but often ignored is the role of bicarbonate in Methanol toxicity.

Rationale:

Actually Methanol per se doesn't have much toxicity. The main toxicity from Methanol ingestion is due to accumulation of is metabolite formic acid. After ingestion of methanol, it is absorb from the GI tract, and undergo degradation via alcohol dehydrogenase (ADH) to formaldehyde in the liver. The formaldehyde is then converted to formic acid by the enzyme aldehyde dehydrogenase. Bicarbonate may help to decrease the amount of active formic acid. In addition, Bicarbonate is also helpful in reversing the visual deficits.

Question 34:

A 28-year-old male is recently started on Isoniazid (INH) after he was tested positive for PPD during routine employment exam. He is now admitted with seizure. What is the treatment?

Answer:

IV Pyridoxine (Vitamin B6).

Rationale:

Five grams of IV pyridoxine given over 5-10 minutes is sufficient to abolish the neurologic effects of isoniazid in most cases. Repeat dosing may be required for persistent seizure activity. Patients usually do not respond to most of the antiepileptic medications.

Question 35:

What percentage of patients may experience neurotoxicity from Amiodarone?

Answer:

About 3%

Rationale:

Amiodarone toxicity can also cause other neurological symptoms as ataxia, gait disturbances, peripheral neuropathy, tremor and cognitive impairment. The major risk factor for amiodorone neurotoxicity is the duration of therapy rather than dose. Higher incidence of neurotoxic in the early Amiodarone era may be due to higher daily dose.

Reference(s):

Frequency, Characteristics, and Risk Factors for Amiodarone Neurotoxicity - Arch Neurol. 2009; 66(7): 865-869

Question 36:

Case:

29-year-old patient presented to the emergency room with complaint of 3 days history of muscular weakness, which is symmetric and descending, and diplopia. Patient does give the history of facial injury. Patient symptoms have gone progressively worse. Patient had bradycardia with heart rate of 43 beats/minute and blood pressure of 130/82 mm hg. Patient SVC (Slow vital capacity) was 1 liter, which was 33% of predicted. Patient was

admitted to the intensive care unit. What is the diagnosis?

Answer:
Botulism (there are 110 cases in US per year with 3% of those are due Botulism)

Key features include:
Blurred vision, symmetrical neurological defect, fevers, with patient being responsive, normal blood pressure, bradycardia and no sensory deficit.

Question 37:

Flumazenil can be effective in overdose of which drugs beside benzodiazepines?

Answer:
Flumazenil is traditionally use as an antidote in patients with benzodiazepines overdose but it has been used and found to be effective in overdoses due to non-benzodiazepine sleep enhancers as zolpidem (ambien) and zaleplon (sonata).

Flumazenil reverses the effect of benzodiazepines by competitive inhibition at the benzodiazepine-binding site on the GABA-a receptor. In addition it has also been used in hepatic encephalopathy.

Question 38:

Which one electrolyte could be a marker of morbidity and mortality in Organophosphate (OP) poisoning?

Answer:
Potassium (Hypokalemia).

Rationale:
Potassium homeostasis is altered during acute OP poisoning, though actual mechanism is not completely understood. With the progression of hypokalemia, patients manifest signs such as muscle twitching, respiratory distress and so on. Studies have shown that alteration in serum potassium concentration is directly proportional to the life threatening signs and symptoms. In fact, Hypokalemia is a powerful marker of morbidity and mortality in OP poisoning. Also class II anti-arrhythmic agents have been described as a candidate to become a therapeutic agent in OP poisoning.

Reference(s):
1. Sultana c, basking s (2002). "Organophosphate caused cardiac toxicity: action potential dynamics in atrial tissue". Army research laboratory: 1–15.
2. Significance of hypokalemia in acute organ phosphorous poisoning, abstract, d.r.mahadeshwara prasad, department of forensic medicine and toxicology, Jawaharlal Nehru medical college, nehru nagar, belgaum, karnataka, india,

Question 39:

According to new 2010 ACLS guidelines what is the recommendation for jellyfish stings?

Answer:

To inactivate venom load, also prevent further spread of the jellyfish venom, the stings should be liberally washed with vinegar (4% to 6% acetic acid solution) ASAP for at least 30 seconds. After the nematocysts are removed or deactivated, the pain from jellyfish stings should be treated with hot water immersion when possible. Data has suggested that vinegar is most effective medication for inactivation of the nematocysts. For treating the pain after jellyfish sting, immersion of the affected area in hot water for 20 minutes, is most effective for treating the pain.

Question 40:

What is the indication of hemodialysis in acute ethanol poisoning solely depending on blood level?

Answer:

Ethanol blood level > 400 mg%

Rationale:

Hemodialysis should be considered in patients if the blood concentration is dangerously high, >400 mg%. Or if clinical conditions remain unstable with metabolic acidosis, severe CNS depression, life threatening respiratory failure or hypotension refractory to pressors.

Question 41:

In Salicylate toxicity what is the target of Urine PH?

Answer:

8

Rationale:

Renal elimination of salicylate can be achieved by alkaline diuresis to increase urine pH, ideally to more than/= 8. Alkaline diuresis is indicated for patients with any symptoms of poisoning and should not be delayed until salicylate levels are determined. This intervention is safe and exponentially increases salicylate excretion. Because hypokalemia may interfere with alkaline diuresis, patients are given a solution consisting of 1 L of 5% D/W, with 3 (50-mEq) ampules of NaHCO3, and 40 mEq of KCl. Serum K should be closely monitored.

Question 42:

Keppra (Levetiracetam) dialyzable?

Answer:
Yes!

Rationale:
Keppra (Levetiracetam), an anti-epileptic drug is now available in IV form and is frequently used in ICU. It is important to remember that Keppra metabolized through kidney and the dose needs to be reduced in renal insufficiency by 50%. Also keppra is dialyzable and ideally should be given after dialysis.

Question 43:

What is the first and major concern in a person who may have clonidine overdose/toxicity?

Answer:
Respiratory depression/Apnea and need of endotracheal intubation.

Rationale:
CNS toxicity in clonidine overdose is similar to that seen in opiates - which are many times missed by the caregiver. The central effect of clonidine includes CNS lethargy or coma, miosis and respiratory depression or apnea. Other CNS signs and symptoms include Hypotonia or hyporeflexia, Seizures, Ataxia, dysarthria, Weakness and Hallucinations.

Question 44:

Glucagon bypasses the beta-adrenergic receptor site and is a good alternative therapy for profound beta-blocker intoxications. Glucagon increases the heart rate and myocardial contractility, and improves atrioventricular conduction. What is the dose of Glucagon in B-blocker overdose?

Answer:
Dose of glucagon in beta blocker overdose is 50 micrograms/kg iv loading dose, followed by a continuous infusion of 1-15 mg/h, titrated to patient response is the dose required for beta blocker toxicity/overdose.
Glucagon has shown similar benefit but to lesser extent in Calcium-channel blockers overdose.

Question 45:

A 28-year-old male has been brought to the ED with possible ethylene glycol toxicity. Osmol gap is greater than 10 mOsm/L and reportedly urinary oxalate crystals are present. Unfortunately, Fomepizole is not available and you decide to treat the patient with Ethanol. Before initiating treatment which laboratory value you would like to see?

Answer:
Ethanol level itself

Rationale:
It is not uncommon to have both Ethanol and Ethylene Glycol ingestion together. Overly aggressive ethanol administration may cause apnea that requires intubation. The goal is to maintain blood ethanol levels 100-150 mg/dL. Measuring initial blood level of Ethanol is important; if Ethanol level is more than 100 mg/dL, loading dose may be unnecessary.

Doses:
Initial loading dose is 7-10 mL/kg IV of 10% ethanol (V/V) in dextrose 5% in water. This is given over 30 min to achieve blood ETOH concentration of 100-130 mg/dL
If given orally the loading dose is 1 mL/kg of 95% ethanol mix with orange juice over 30 min. Oral maintenance dose is 0.15 mL/kg/h of 95% ETOH; whereas the IV maintenance dose is 1.5 mL/kg/h of a 10% solution.

Question 46:
Which Venom poisoning does the following 10 clinical signs mark?

1. Mydriasis,
2. Nystagmus,
3. Hypersalivation,
4. Dysphagia,
5. Restlessness (out of proportion)
6. Bronchoconstriction,
7. Bronchorrhea,
8. Pharyngeal secretions,
9. Diaphragmatic paralysis,
10. Anaphylaxis

Hint: It is not a snake envenomation and signs occur within a few minutes after the sting

Answer:
Scorpion Sting

Question 47:
What is “oxygen saturation gap”?

Answer:
The “oxygen saturation gap” is defined as the difference between the calculated oxygen saturation and the reading from a pulse oximeter. If the difference is greater than 5%, then the patient’s hemoglobin may be abnormal, as seen in carbon monoxide poisoning, methemoglobinemia, or sulfhemoglobinemia.

Question 48:

Case:

A 54-year-old female is admitted to the ICU with pneumonia. The patient is found to be moderately anemic. To be complete in evaluation and to rule out possible GI bleeding, you asked the resident to do a rectal exam for guaiac stool. Resident performed Guaiac stool via rectal exam with latex free glove and surgilube (surgical lubricant). 10 minutes later patient coded with severe anaphylactic reaction. What could be a reason assuming no new medication administered?

Answer:

Possible allergic reaction to Chlorhexidine

Rationale:

Surgilubes (surgical lubricants aka KY Jelly) are usually considered innocuous compound but it contains chlorhexidine. Patients with severe allergy to chlorhexidine may react badly particularly if it enters blood circulation as possible with rectal exam.

Reference(s):

1. A Case of Anaphylaxis to Chlorhexidine during Digital Rectal Examination - J Korean Med Sci. 2008 June; 23(3): 526–528.

2. Anaphylaxis to the chlorhexidine component of Instillagel®: a case series - Advance Access published online on November 5, 2008, - British Journal of Anaesthesia

3. Chlorhexidine anaphylaxis in Auckland - Br. J. Anaesth. May 1, 2009; 102(5): 722 - 723.

4. Chlorhexidine anaphylaxis: case report and review of the literature - Contact Dermatitis. 2004 Mar; 50(3): 113-6.

Question 49:

Name at least one drug overdose, which may give negative, or very low anion gap (AG)?
AG = Na+ - (Cl- + CO2)

Answer:

Lithium toxicity

Rationale:

Lithium is basically read as a charged ion, which may give very low or even negative anion gap.

Overdose of cough syrup containing dextromethorphan bromide may do the same as bromide may get measured as chloride.
Other 2 conditions known to do that are: hypo-proteinemia and multiple myeloma.

Question 50:

What could be the 4 life threatening concerns in Flouride toxicity?

Answer:

Electrolyte imbalance

1. Hyperkalemia
2. Hypocalcemia
3. Hypoglycemia
4. Hypomagnesemia

Fluoride overdose can happen in over ingestion of toothpaste, vitamins, and dietary supplements, but ingestion of insecticides and rodenticides (e.g., sodium fluoride) are most of concern.

Fluoride inhibits Na /K ATPase, which may lead to hyperkalemia by extracellular release of potassium. Seizures may result from severe hypomagnesemia.
There is no antidote and the treatment is electrolyte correction.

Question 51:

What is an antagonist of Meperidine (Demerol)?

Answer:
Naloxone

Rationale:
The naloxone is a narcotic antagonist and acts as a specific antidote against respiratory depression, which may occur as a result of meperidine sensitivity or overdose. Caution should be taken not to administer antagonist in the absence of clinically significant respiratory or cardiovascular depression. Supportive treatments as like oxygen, IVF and other supportive measures should be instituted.

Remember, in an individual physically dependent on meperidine by chronic use, the administration of the usual dose of a naloxone may precipitate an acute withdrawal syndrome. If an antagonist is administered to treat respiratory depression only one-fifth to one-tenth the usual initial dose administered.

Also, oral Meperidine is a big "no no"! As only 50% of ingested drug escapes first pass metabolism and carries very high risk of delirium, seizure and other side effects via its metabolite normeperidine. Moreover, it is significantly less effective by the oral route.

Question 52:

Why should patients with Citalopram (Celexa) overdose be observed in hospital or ICU for a longer period of time than other SSRIs?

Answer:
Patients with citalopram (and escitalopram) overdose should be observed in telemetry bed for at least 13 hours and preferably for 24 hours due to delayed risk of toxicity, resulting in QTc interval prolongation and consequently cardiac dysrhythmias like Torsades de pointes. Another life threatening side effect is occurrence of seizures.

Patients with other SSRIs overdose are usually OK to discharge after observation for 8-10 hours.

In general, doses for Celexa above 40 mg/day are not recommended because of the risk for QT prolongation.

Reference(s):
1. Pacher P, Ungvari Z, Nanasi P, et al. Speculations on difference between tricyclic and selective serotonin reuptake inhibitor antidepressants on their cardiac effects. Is there any? Current Medicinal Chemistry 1999; 6:469-480.
2. Grundemar L, Wohlfart B, Lagersteedt C, et al. Symptoms and signs of severe citalopram overdose. Lancet 1997; 349: 1602.
3. Catalano G, Catalano MC, Epstein MA, et al. QTc interval prolongation associated with citalopram overdose: a case report and literature review. Clin Neuropharmacol 2001; May-June: 2-6.

Question 53:

Ethylene glycol intoxication causes Hypocalcemia or Hypercalcemia? (Choose one).

Answer:
Hypocalcemia

Rationale:
Ethylene glycol toxicity (anti-freeze) causes hypocalcemia and it usually occurs approximately 12 to 36 hours after ingestion. Ethylene glycol metabolized to oxalate and binds to calcium to form Calcium Oxalate crystals.

One of the clues almost always given in Critical Care Board exams is presence of envelope shaped Calcium Oxalate crystals in urine, though the presence of this signifies pretty advanced stage of toxicity.

Question 54:

A 22-year-old female presented to ED after 4 hours of Tylenol (acetaminophen) toxicity. Lactic acid level is 5 mmol/L. After 12 hours it is 4 mmol/L. What does it signifies?

Answer:
Poor prognosis

Rationale:
If lactate levels are high at 4 hours (more than 3.5 mmol/L) and remain elevated at 12 hours (more than 3.0 mmol/L) then these are early predictors of acute liver failure in acetaminophen toxicity. Lactate levels are elevated due to a combination of impaired tissue perfusion and decreased clearance by the liver.

Transfer to tertiary care center for transplant should be considered.

Reference(s):

1. Macquillan GC, Seyam MS, Nightingale P, Neuberger JM, Murphy N. Blood lactate but not serum phosphate levels can predict patient outcome in fulminant hepatic failure. Liver Transpl 2005; 11: 1073–1079.
2. Bernal W, Donaldson N, Wyncoll D, Wendon J. Blood lactate as an early predictor of outcome in paracetamol-induced acute liver failure: a cohort study. Lancet 2002; 359: 558–563.

Question 55:

What is the treatment of hypermagnesemia?

Answer:

IV calcium

Rationale:

IV calcium should be coupled with IVF combined with Lasix. If clinical signs become unstable dialysis is the ultimate answer.

Question 56:

A 36-year-old male is admitted to the ICU with severe metabolic acidosis. You suspect sepsis and ordered pan-culture. While reviewing laboratory report you see that urine screen is reported with calcium oxalate crystals. What is your concern?

Answer:

Ethylene glycol poisoning

Rationale:

Ethylene glycol's major toxicity is a result of its metabolites: glycoaldehyde, oxalic acid, glycolic acid, and glyoxylate. Oxalic acid combines with calcium to form calcium oxalate crystals.

Question 57:

Which patients are at high risk of protamine reaction?

Answer:

Diabetics on NPH insulin,

1. Patients allergic to fish,
2. Pregnant and nursing women,
3. Previous protamine exposure, and
4. Men who have had vasectomies.

Question 58:

A 52-year-old male patient has been overdosed in ICU with Ambien (Zolpidem) due to medication error. What intervention may help to diagnose as well as reverse the effect of Ambien?

Answer:
Flumazenil

Rationale:
Zolpidem's (ambien) hypnotic effects are similar to those of the benzodiazepine, though molecularly it is distinct from the classical benzodiazepine. Due to similarity in their hypnotic effects, Flumazenil, which is a benzodiazepine receptor antagonist, also reverses zolpidem's sedative/hypnotic effect.

Question 59:
Why does GI decontamination have a limited role in lithium toxicity?

Answer:
Lithium does not bind to charcoal.
Whole-bowel irrigation with polyethylene glycol is said to have partial effectiveness.

Question 60:
Which poisons presents with garlic odor?

Answer:
Organophosphate poisoning

Question 61:
What precaution should be taken while giving Pralidoxime as antidote for organophosphate poisoning?

Answer:
It should be given slowly over 30 minutes. If given as bolus it may precipitate respiratory or cardiac arrest. Dose is 30 mg/kg.
If intravenous access is not available, it may be given as intramuscular or subcutaneous injection.

Question 62:
Which drug overdose may present as ST elevation MI?

Answer:
Eszopiclone (lunesta)

Rationale:
Lunesta is unique in a sense that its overdose may presents as ST elevation MI with increased Troponin due to coronary vasospasm. It may lead to Ventricular Fibrillation as

well as cardiac arrest.

Reference(s):
Lunesta overdose: ST-elevation coronary vasospasm, troponemia, and ventricular fibrillation arrest. - Am J Emerg Med. 2006 Oct; 24(6): 741-6.

Question 63:

"Hot as a hare, dry as a bone, red as a beet, mad as a hatter" describes which toxicity?

Answer:
Anticholinergic toxicity. Symptoms include:

1. Hyperthermia,
2. Dry skin,
3. Tachycardia,
4. Delirium,
5. Urinary retention
6. Mydriasis

Anticholinergic include Atropine, ipratropium bromide, Glycopyrrolate and so on.

Question 64:

A 24-year-old hiker is brought to the ED after a snakebite. The patient is reporting a severe symptom of mint taste in his mouth. Which snake is the likely culprit?

Answer:
Rattlesnake

Rationale:
Victims complain of a "rubbery," "minty," or "metallic" taste if bitten by certain species of rattlesnake, after 30 - 90 minutes of event.
Clinical significance: Rattlesnake bites can be poisonous and need rapid treatment, *i.e.* administration of antivenin.

Question 65:

A 17-year-old male presented to the ED after he accidentally ingested only 1 teaspoon of oil of wintergreen at his farmhouse. Initially he decided to stay away due to minor ingestion but was later brought to ED by parents 'just for checkup'. What is your concern?

Answer:
Salicylate Toxicity
One teaspoon of oil of wintergreen (98% methyl salicylate) contains 7000 mg of salicylate (nearly 90 baby aspirins). It should be considered as true toxicology emergency.

Question 66:

An extremely vasculopath patient (almost impossible to obtain central line) presented to ER with organophosphate poisoning. Till the Vascular team accesses the vessel what could be an alternate route of Atropine in its symptomatic treatment?

Answer:

Sublingual

Reference(s):

Rajpal S, Ali R, Bhatnagar A, Bhandari SK, Mittal G. Clinical and bioavailability studies of sublingually administered atropine sulfate. Am J Emerg Med. Feb 2010; 28(2): 143-50.

Question 67:

Describe 3 side effects of quetiapine (Seroquel), which may be significant in ICU?

Answer:

1. Swelling of the sinuses or pharynx
2. Tardive dyskinesia
3. Lower seizure threshold

Question 68:

A 52-year-old female with previous history of atrial fibrillation was admitted with new onset seizure after hemodialysis. CT scan is negative and there is no deficit. Neurology thinks it may be due to metabolic derangement. Phenytoin (Dilantin) is started after loading dose. Next day patient develops severe GI bleed. What could be the reason?

Hint: Its drug interaction question

Answer:

Patient is probably on warfarin for her atrial fibrillation and Phenytoin increases effects of warfarin. Actual basis of interaction is unknown.

Rationale:

The Multidisciplinary Medication Management Project that is a collaboration project of the American Society of Consultant Pharmacists and the American Medical Directors Association lists phenytoin and warfarin among its top 10 drug interactions.

Question 69:

What is the treatment (chelating agent) to treat arsenic poisoning?

Answer:

Dimercaprol

Rationale:
Dimercaprol segregates arsenic away from blood proteins and is used in the treatment of acute arsenic poisoning. The most important side effect is hypertension. In addition to arsenic, dimercaprol is also used in the treatment of mercury, gold and lead, and other toxic metal poisoning. It also has been used in the treatment of Wilson's disease.

Question 70:
Fomepizole and ethanol are both used as treatment in Ethylene Glycol toxicity. What other medicines should be considered as adjuvant therapy in Ethylene Glycol toxicity?

Answer:
Pyridoxine and Thiamine

Pyridoxine and Thiamine are cofactors in ethylene glycol metabolism and can be administered parenterally. As a side note, while preparing antidotes early treatment with sodium bicarbonate should be initiated essential to correct acidosis. It may require up to 500-1000 mmol of bicarbonate within the first hours, especially if antidotal therapy is delayed.

Question 72:
A 22-year-old female with severe peanut allergy presented to the ED with asthma exacerbation. Which commonly used drug should be avoided or at least be used with caution in this patient?

Answer:
Atrovent

Rationale:
Actually, nebulized Atrovent does not pose a problem, but it was the soy lecithin additive in the propellant in the MDI's that could trigger a reaction in those with peanut and/or soy hypersensitivity.

Question 73:
A nurse calls you to report that patient's blood on draw appears to be bluish. What would be your concern?

Answer:
Methemoglobinemia

Rationale:
Drugs are the most common cause of Methemoglobinemia in the ICU including dapsone, trimethoprim, sulfonamides, local anesthetics, metoclopramide and iNO (commonly used in cardio-vascular ICUs).

It gives the blood a bluish or chocolate-brown color.
Treatment is methylene blue 1% solution 1 to 2 mg/kg administered intravenously slowly over five minutes. Supplemental oxygen should be added.

Question 74:

Describe the role of urine alkalinization in barbiturate overdose?

Answer:

Alkalinization of the urine is useful for long-acting barbiturates like phenobarbital and butalbital but is not recommended for short-acting barbiturate toxicity.

Rationale:

Phenobarbital has a higher water solubility and slow hepatic metabolism, which allow a larger proportion of drug to be renally excreted. Urinary elimination may be achieved with an initial sodium bicarbonate bolus followed by an infusion to maintain a urine pH of greater than 7.5 (watch arterial pH). The goal should be a urine output of 150-250 mL/h.

TOXICOLOGY - PEARLS

1. **Call for dialysis in Lithium overdose**
   Call for Hemodialysis in Lithium toxicity is "clinical" depending on symptoms particularly neurological symptoms such as myoclonus, seizure, confusion or coma. There is no laboratory cutoff value as patient with chronic exposure to lithium may show clinical signs at much lower value. Also some recent data favors CVVHD (or HD followed by CVVHD) as it has been shown to prevent rebound of lithium serum concentration.

2. **A short note on Lidocaine therapeutic profile**
   CNS toxicity increase from 10%-80% with increasing the Lidocaine dose from 1 mg/kg to 1.5 mg/kg. Seizure is uncommon with Lidocaine levels of less than 10 mcg/mL but other CNS effects may occur like lightheadedness, dizziness, visual disturbance, headache, numbness, impaired concentration, dysarthria, tinnitus, muscular twitching etc.

3. **Propofol induced priapism**
   Priapism following the infusion of Propofol has been reported in literature - which may last for hours. Actual mechanism is not known but various theories have been proposed. It may be secondary to lipid content of the drug causing fat emulsion-related increased thrombin, erythrocyte aggregation and/or fat embolism. Vasodilatation, well know with Propofol, has also been speculated as a cause of priapism. Another possibility described is spinal cord anesthesia, which can block the sympathetic vasoconstrictor action or enhance the parasympathetic vasodilatory action leading to an abnormal erection. Propofol causing relaxation of smooth muscle via the nitric oxide pathway may be another alternative mechanism. The effect of Propofol on GABAa and adrenal steriodogenesis may also have an additional role.

   Reference(s):
1. Vesta, Kimi; Shaunta' Martina, Ellen Kozlowski (25 April 2009). "Propofol-Induced Priapism, a Case Confirmed with Rechallenge". The Annals of Pharmacotherapy 40 (5): 980–982.
2. Fuentes, Ennio; Silvia Garcia, Manuel Garrido, Cristina Lorenzo, Jose Iglesias, Juan Sola (July 2009). "Successful treatments of propofol-induced priapism with distal glans to corporal cavernosal shunt". Urology 74 (1): 113–115.

4. **Cocaine overdose and Rimcazole**
   Cocaine overdose causes tachyarrhythmia's and life-threatening hypertensive crisis. Moreover, Cocaine is very pyrogenic due to increased muscular activity and inhibited heat loss due to severe vasoconstriction.

   Treatment of Cocaine overdose consists of administering a benzodiazepine, physical cooling, acetaminophen, and non-beta-blocker treatment for hypertension and other supportive treatments.

Though not officially approved, dexmedetomidine and rimcazole have been found to be useful for treating cocaine overdose.

Rimcazole was initially studies as a potential antipsychotic but later was found have an effect in reducing the effects of cocaine.

Reference(s):
1. Katz JL, Libby TA, Kopajtic T, Husbands SM, Newman AH. Behavioral effects of rimcazole analogues alone and in combination with cocaine. European Journal of Pharmacology. 2003 May 9; 468(2): 109-19.
2. Matsumoto RR, Hewett KL, Pouw B, Bowen WD, Husbands SM, Cao JJ, Hauck Newman A. Rimcazole analogs attenuate the convulsive effects of cocaine: correlation with binding to sigma receptors rather than dopamine transporters. Neuropharmacology. 2001 Dec; 41(7): 878-86.

5. **Amiodarone induced optic neuritis!**
   Amiodarone is one of the most commonly used medicines in ICU. One of the other unusual and common presentations of Amiodarone toxicity is optic neuritis. Optic neuritis may occur at any time during the therapy. If any visual symptom appears, as change in visual acuity or peripheral vision impairment, prompt ophthalmic consultation is recommended.

6. **First Antidote for Scorpion sting!**
   The U.S. Food and Drug Administration (FDA) have approved the first treatment for the excruciatingly painful sting of the Centruroides or "bark" scorpion - the most commonly encountered scorpion in the nation.
   Before Anascorp, there was no effective way to ease the pain of scorpion stings, according to the FDA.
   "Severe stings can cause loss of muscle control and difficulty breathing, requiring heavy sedation and intensive care in a hospital," said Keith Boesen, Managing Director of the Arizona Poison and Drug Information Center, in an FDA press release.

7. **Regarding Confusion on hemodialysis in B-Blocker overdose**
   Hemodialysis (HD) has been described in extreme B-blocker overdose when all other remedies fail. It is important to note that not all β-blockers respond to dialysis.

   β-blockers, which respond to HD: These are mostly low protein binding. Atenolol have been described mostly to respond to HD. Nadolol and Sotalol also are removed by hemodialysis. Acebutolol is also dialyzable.

   β-blockers, which are not removed by hemodialysis include:
   1. Propranolol
   2. Metoprolol
   3. Timolol

8. **Precedex (dexmedetomidine) for Cocaine overdose?**
   The data advance the novel hypothesis that central sympatholysis with dexmedetomidine constitutes a highly effective countermeasure for cocaine's

sympathomimetic actions on the human cardiovascular system, even in individuals carrying the 2CDel322-325 polymorphism.

Reference(s):
Central Sympatholysis as a Novel Countermeasure for Cocaine-Induced Sympathetic Activation and Vasoconstriction in Humans - J Am Coll Cardiol, 2007; 50:626-633

9. Sulfonylurea overdose

Anti-diabetic pills overdose remained one of the leading cause of drug overdose worldwide. Among anti-diabetic pills sulfonylureas are the most dangerous and hard to correct. Overdose of metformin rarely causes clinically evident hypoglycemia (It has its own danger of cardiovascular collapse and renal failure, due to severe lactic acidosis).

Unfortunately very few clinicians use the real antidote for sulfonylurea, which is Octreotide (Sandostatin) in resistant hypoglycemia. Infusion of glucose to achieve euglycemia in the early phase is an appropriate treatment but there is some literature available that argues that prolong infusion of dextrose in sulfonylurea overdose may make hypoglycemia longer and worse by stimulating insulin release. The dose for Octreotide is 50 mcg SC every 8 hours with adjustment of dose according to blood glucose level. Octreotide is a somatostatin analogue, which activates G-protein K channel and hyperpolarization of the beta cell results in inhibition of Ca influx and insulin release. Another antidote for sulfonylurea overdose beside Octreotide is Diazoxide.

Exact mechanism is unknown but probably it increases blood glucose by inhibiting pancreatic insulin release. It is found to be effective within 60 minutes of administration. The usual dose is 5 mg/kg/day intravenously and should be divided every 8 hours. Dose can be increased if needed but still its experience in comparison to Octreotide is limited.

Reference(s):
1. Octreotide for sulfonylurea-induced hypoglycemia following overdose - The Annals of Pharmacotherapy: Vol. 36, No. 11, pp. 1727-1732
2. Clinical spectrum of sulfonylurea overdose and experience with diazoxide therapy - Archives of Internal Medicine Vol. 151 No. 9, September 1, 1991

10. Ecstasy

Ecstasy (MDMA) may cause Hyponatremia (SIADH), leading to cerebral edema and seizures. In the ED/ICU, always consider this possibility in any patient with known or suspected MDMA ingestion who presents with an altered mental status as it may progress quickly.

11. Do not treat acidosis aggressively in CO poisoning

Non-invasive Pulse-ox is not reliable in CO Poisoning and 100% NRM should be applied ASAP in any suspected CO poisoning irrespective of pulse-ox on monitor. CO has high affinity for Hemoglobin (HB) - forming HbCO and it absorbs light almost identically to that of oxyhemoglobin, making pulse-ox very unreliable.

100% Oxygen delivery displaces CO from Hb and decreases its half-life from 4.5 hours to 1 hour.

But the most unknown point in CO poisoning management is to not to treat acidosis very aggressively and PH of even 7.15 is acceptable for 2 reasons:

1. Acidosis is good in CO poisoning, as it causes rightward shift in the oxyhemoglobin dissociation curve, increasing tissue oxygen availability (Bohr Effect).
2. Simultaneously, acidosis improves progressively by itself with 100% oxygen therapy and over treatment may push patient later into severe alkalosis.

12. Hemodialysis in Salicylate overdose with normal level

Hemodialysis is recommended in salicylate overdose patients with a level at or above 100 mg/dL (cut it to half if history suggest chronic ingestion). But if there is any sign of neurological manifestation, dialysis is indicated despite normal level. Salicylate causes "neuroglycopenia" (lower CNS glucose level) despite normal serum glucose. As patient gets more and more acidotic, salicylate enters CNS and by direct effect cause neuroglycopenia.

7 indications of Hemodialysis in Salicylate poisoning:

1. Mental status change
2. Pulmonary edema
3. Cerebral edema
4. Associated or with renal failure
5. Level at or above 100 mg/dL (half if chronic ingestion)
6. If fluid overload prevents alkalinization.
7. Patient continues to deteriorate clinically.

Reference(s):
1. Toxicity, Salicylate - please register free at emedicine.com
2. An evidence based flowchart to guide the management of acute salicylate (aspirin) overdose -Emerg Med J 2002; 19:206-209

13. Propylene Glycol

Being an intensivist it is imperative to understand the dangers of propylene glycol in ICU particularly with Lorazepam drip. Risks are too high if drip is continued beyond 48 hours and dose more than 10 mg/hr. Any unexplained high anion gap metabolic acidosis with elevated osmol gap, should prompt the diagnosis of propylene gylcol toxicity. It may also cause CNS depression, arrhythmias and renal dysfunction.

Propylene glycol is a viscous, colorless liquid solvent used for many drugs with poor aqueous solubility including lorazepoam, diazepam, Esmolol, nitroglycerin, pentobarbital, phenytoin, trimethoprim/sulfamethoxazole and others.

14. Salicylate overdose and "neuroglycopenia"

Salicylate causes "neuroglycopenia" (lower CNS glucose level) despite normal serum glucose. As patient gets more and more acidotic, salicylate enters CNS and

by direct effect cause neuroglycopenia.

15. Angel dust!!

Phencyclidine is probably one of the most dangerous available street drugs and as with widest variety of symptoms. 7 Pearls regarding Phencyclidine (PCP) toxicity.

1. PCP can also get absorb percutaneously.
2. Patient may exhibit waxing and waning symptoms of PCP due to its reabsorption in duodenum.
3. It has 5 properties of sympathomimetic, serotoninergic, cholinergic, anticholinergic, and narcotic effects and so can present with wide variety of symptoms including hyper salivation and bronchorrhea.
4. Nystagmus is a common presentation but hyperthermia or status epilepticus may be a presenting symptom.
5. Muscle rigidity can present as dystonia, opisthotonos or torticollis, and may cause life-threatening rhabdomyalysis.
6. Positive urine screen is usually diagnostic.
7. Dialysis does not help and treatment is supportive.

Reference(s):
1. PCP - streetdrugs.org
2. PCP (Phencyclidine) - The National Institute on Drug Abuse (NIDA)
3. Toxicity, Phencyclidine - emedicine.com

8. Regarding Valproic acid (VPA; Depakote) overdose

A few important points to know in valproate toxicity:

1. Hyperammonemia could occur without liver function test abnormalities.

2. Cerebral edema may become apparent even up to 4th day post ingestion and is not dose related so close monitoring is required despite level shows normalization.

3. Mechanism of action is unknown but in some patients Naloxone shows improvement in mental status so it should be considered.

4. There is no antidote available but administration of L-carnitine (50 mg/kg/day) in patients with hyperammonemia and neurological symptoms may help.

5. Hemodialysis (Charcoal hemoperfusion is preferred if available) works only if level is above 100 ug/ml as protein-binding sites become saturated and free drug is available for hemodialyzing.

6. Free valproate level should be sending in patients with unexplained altered cognition, but normal serum (protein bound) levels.

Reference(s):
1. Toxicity, Valproate - emedicine.com
2. Valproic acid toxicity: overview and management. - J Toxicol Clin Toxicol. 2002; 40(6): 789-801
3 Neurotoxicity Associated With Free Valproic Acid - Am J Psychiatry 162:810, April 2005
4. Delayed valproic acid toxicity: A retrospective case series - Ann Emerg Med. 2002 Jun; 39(6): 616-21

MISCELLANEOUS

Question 1:

Consumption of which meat may cause Rhabdomyolysis?

Answer:

Quail

Rationale:

Rhabdomyolysis after consumption of Quail meat is known as "coturnism" as the main quail genus is called Coturnix.

Migrating quail usually consume large amounts of hemlock plant, which is a known cause of rhabdomyolysis due to its property of containing neuro-muscular blocker like chemical.

Question 2:

A 62-year-old male was admitted with community-acquired pneumonia and is responding well with treatment. Patient continues to complain of right ear pain. On examination patient noted to have cerumen impaction. Patient is already on broad-spectrum antibiotics. You ordered cerumenex (Triethanolamine polypeptide). You received a call from the nurse, saying that pharmacy substituted cerumenex with Docusate sodium or colace (stool softener) and needs your approval. What do you think?

Answer:

The pharmacy's recommendation is right. Docusate sodium is an effective alternative to facilitate the removal of cerumen from patient's ear. Mechanism of action is same as for stool softener that it helps water or saline to mix with the hardened secretions and produce a softer cerumen, which drains easily. Instill 1 ml and keep head to keep solution inside canal for 10- 15 minutes and then let it drain.

Reference(s):

1. Ceruminolytic effects of docusate sodium: a randomized, controlled trial. Ann Emerg Med. 2000 Sep; 36(3): 228-32.
2. Docusate Sodium for Use as a Ceruminolytic Agent. Amer Fam Phys. 2001 Mar; 63(5): 947.
3. How does liquid docusate sodium (Colace) compare with triethanolamine polypeptide as a ceruminolytic for acute earwax removal? Journ of Fam Pract. 2000 Dec; 49(12): 1076.
4. Ear drops for the removal of earwax - Cochran reviews

Question 3:

As you are reviewing the labs from patient, you noticed a note at the end of UA (urinalysis) - Ictotest positive. Do you know what Ictotest is?

Answer:
The Ictotest® is an ultra-sensitive test to detect bilirubin in urine (detects even 0.05 mg/dL of bilirubin). It is a sensitive, reliable and easy test to diagnose bilirubinuria. Actually, it is a tablet of diazonium salt and when combines with bilirubin, it changes to blue or purple color (any other color change is a negative test). The Laboratory runs this test if there is a suspicion of bilirubinuria.

Caution: Test should be performed on fresh urine specimen and specimen should be protected from excessive light exposure. On standing, bilirubin is oxidized to biliverdin and may not react with diazonium salt tablet.
Note: Presence of Pyridium in urine may give a false positive Ictotest.

Question 4:
Which test would be better in predicting septic arthritis?

Answer:
CRP

Rationale:
An elevated CRP (C-reactive protein) is helpful in deciding the presence of a septic joint. The ESR and CRP are almost always raised on admission, CRP being more specific in diagnostics. Both elevated erythrocyte sedimentation rate (ESR) or C-reactive protein (CRP) is useful in following response to therapy.

Reference(s):
Usefulness of CRP and ESR in predicting septic joints South Med J. 2010 Jun; 103(6): 522-6.

Question 5:
What is Purple toe syndrome?

Answer:
It is a rare complication that may occur usually within first 2 months of commencement of warfarin treatment. Recently, it has been reported after 1 year of warfarin therapy[1].
With anti coagulation, minor deposits of cholesterol break loose and flow into the feet, which causes a bluish purple and painful toe. It typically affects the big toe, but it can affect other parts of the feet as well.

Treatment is discontinuation of warfarin.

Reference(s):
Late Onset Purple Toe Syndrome with Warfarin Successfully Treated with Fondaparinux - American Journal of Therapeutics: November 2011 - Volume 18 - Issue 6 - pp e277-e279

Question 6:

The ED papers say that the patient received Halivan, what is that?

Answer:

Halivan is a common medical slang for 'combo' of 5 mg Haldol with 2 mg Ativan to 'cool down' agitated or delirious patient. If you add 25 mg or 50 mg of Benadryl - it is called B52 cocktail!

Question 7:

What is the relationship of CO_2 production with level of hypothermia?

Answer:

For every degree below 37°c, CO_2 production decreases approximately by 10%, due to decrease metabolic demand. During post-operative warming, it should be kept in mind, anticipating rise in CO_2 while weaning ventilator.

Question 8:

Case:

A 67-year-old s/p colectomy patient in ICU went into acute agitation and psychosis. He pulled all his IVs and is not allowing the nurses to insert any IV. What could be your option to 'cool him down' before further evaluation, but without any IV access and inability to use enteral route?

Answer:

Orally disintegrating olanzapine (Zedis)

Rationale:

Zydis® (olanzapine) is an orally disintegrating tablets of formulation of ZYPREXA which dissolves in the patient's mouth on contact with the saliva. It is available in 5mg, 10mg, 15mg, and 20mg tablets. The mode of action of olanzapine's antipsychotic activity is unknown.

Question 9:

Ideally, how frequently should lubricant should be applied in ICU patients, who have exposed cornea to prevent keratopathy/keratitis?

Answer:

Some degree of keratopathy develops in about 60% of intubated and sedated patients. Incomplete lid closure increases the risk of corneal damage, which is very high (70% vs. 30%). Fluid imbalance and positive pressure ventilation (Ventilator eye) may make it impossible to close eyelids completely. Lubricant should be applied ideally every two hours, particularly if any sort of cornea is exposed. Overall, literature leans more towards moist chamber application than lubricant application.

Reference(s):
1. Imanaka H, Taenaka N, Nakamura J, et al: Ocular surface disorders in the critically ill. Anesth Analg 1997; 85:343-346
2. McHugh J, Alexander P, Kalhoro A, et al: Screening for ocular surface disease in the intensive care unit. 2008; 22:1465–1468
3. Mercieca F, Suresh P, Morton A, et al: Ocular surface disease in intensive care unit patients. Eye 1999; 13:231-236
4. Koroloff N, Boots R, Lipman J, et al: A randomized controlled study of the efficacy of hypromellose and Lacri-Lube combination versus polyethylene/Cling wrap to prevent corneal epithelial breakdown in the semiconscious intensive care patient. Intensive Care Med 2004; 6:1122-1126
5. Parkin B, Turner A, Moore E, et al: Bacterial keratitis in the critically ill. Br J Ophthalmol 1997; 12:1060-1063
6. Suresh P, Mercieca F, Morton A, et al: Eye care for the critically ill. Intensive Care Med 2000; 2:162-166

Question 10:

Which commonly used pressor in ICU may cause significant thrombocytopenia?

Answer:
Vasopressin

Rationale:
Vasopressin can cause platelet aggregation and induce thrombocytopenia. Its clinical significance is still undetermined.

Question 11:

Which one immunization status should be checked in burn patients?

Answer:
Tetanus

Rationale:
Burn patients are very prone to tetanus. A tetanus booster shot is required if patient has not been immunized within the last 5 years.

Question 12:

What does we mean by graded compression stockings for deep venous thrombosis (DVT) prophylaxis?

Answer:
Compression stockings are stockings, which offer the patient graded pressure, making it possible for the stockings to squeeze the patient's leg muscles. They are made of a strong elastic material, which are tighter at the feet, than they are at the knee, and thigh.
This pressure gradient (high pressure at ankle level minus low pressure level at thighs) helps to drive blood back to the heart, reducing swelling in the feet, and preventing blood clot formation. They come in various strengths. 18 mm Hg at ankle level with 8 mm Hg at thigh level which gives gradient of 10 mm Hg. 10 mm hg gradient is considered standard for DVT prophylaxis.

Question 13:
What temperature defines clinical hypothermia?

Rationale:
95 F (35 C)

Reference(s):
Thermal disorders – Critical Care Medicine: The Essentials [Third Edition] by John J Marini, Arthur P Wheeler – page 467

Question 14:
A 28-year-old female is admitted into the ICU with HELPP syndrome. Delivery was planned. Patient starts complaining of bilateral blurring of vision. What could be the complication?

Answer:
Retinal detachment

Rationale:
Retinal detachment is an unusual but very well documented complication of severe preeclampsia and patients with HELLP syndrome. Emergent ophthalmic consultation should be obtained along with planned delivery.

Reference(s):
1. McEvoy M, Runciman J, Edmonds DK, Kerin JF. Bilateral retinal detachment in association with preeclampsia. Aust N Z J Obstet Gynaecol 1981; 21: 246–247
2. Ramaesh K, Nagendran S, Saunders DC. Choroidal ischaemia and serous retinal detachment in toxaemia of pregnancy. Eye 1999; 13: 795–796
3. Sibai BM, Ramadan MK, Usta I, Salama M, Mercer BM, Friedman SA. Maternal morbidity and mortality in 442 pregnancies with haemolysis, elevated liver enzymes, and low platelets (HELLP syndrome). Am J Obstet Gynecol 1993; 169: 1000–1006

Question 15:
A 48-year-old male, now comfort care in ICU, start having a lot of upper respiratory noises from secretions. Family is extremely distressed and asked for some symptomatic relief?

Answer:
Noises caused by upper airways secretions are heard in half of dying patients as the patient is unable to clear or swallow their own secretions. The presence of respiratory secretions is a strong predictor of death within 48 hours. This could be very discomforting to family as well as to patient. Different options to utilize include
Glycopyrrolate: 0.2 mg as a single dose SC. If good response, may continue using 0.2 mg q4h and prn SC. It can be given as IV also with caution.
(Glycopyrolate is an excellent choice also in other ICU patients who continue to display high respiratory secretions, particularly vented patients)
Atropine: 0.6-0.8 mg SC. If effective, continue, using q4h and prn

Hyoscine butylbromide: 20 mg as a single dose SC. If effective, continue, using 20 mg q4h SC

Reference(s):
1. Bennett M, Lucas V, Brennan M, Hughes A, O'Donnell V, Wee B. Association for Palliative Medicine's Science Committee. Using antimuscarinic drugs in the management of death rattle: evidence-based guidelines for palliative care. Palliat Med 2002; 16(5): 369-74.
2. Downing GM, Wainwright W, editors. Medical care of the dying. 4th ed. Victoria (BC): Victoria Hospice Society; 2006. p. 363-393.

Question 16:

What is the advice for nursing staff taking care of patient on Ribavarin inhalation therapy?

Answer:
Pregnant nursing staff or staff planning or anticipating pregnancy should not take care of patient on Ribavarin inhalation therapy. It has shown to cause fetal abnormalities.

Rationale:
Ribavirin is distributed widely in all tissues including brain, CSF and RBC. Ribavirin has large volume of distribution is large and the length of time the drug is confined in the tissue varies greatly from tissue to tissue. Ribavirin is stored in the RBC for the life of the RBC.

Question 17:

Which one regularly uses sedative in ICU can be a very good choice and getting evaluated for end of life comfort?

Answer:
Dexmedetomidine

Rationale:
Recently there is an interest in using Precedex (dexmedetomidine) in treating cancer patients who are on comfort care and towards the end of their life to relieve intractable pain, agitation or delirium.

Reference(s):
Jackson KC, Wang Z, Wohlt P, Fine PG (2006). "Dexmedetomidine a novel analgesic with palliative medicine potential". J Pain and Palliative Care Pharmacotherapy 20 (2): 23–7

Question 18:

What is Uremic frost?

Answer:

Uremic frost is a dermatological manifestation of severe azotemia. When the blood urea nitrogen level is high, the concentration of urea in sweat increases greatly. Evaporation of sweat with high urea concentration causes urea to crystallize and deposit on the skin.

Question 19:

Case:

A 24-year-old male admitted with left thigh cellulitis and abscess. Incision and Drainage was performed and cefazolin (ancef) was initiated. Patient did not respond to cefazolin and antibiotic was changed to Vancomycin after availability of sensitivity from micro lab. Patient showed marked improvement over next 3 days except patient complaint of new rash on his body which you attributed to "Red man syndrome" and wrote an order to infuse Vancomycin slowly and with increase dilution. Next day, as you reached the hospital, the outgoing intensivist informed you that patient deteriorated overnight and required intubation. You were baffled and as you examined the patient, you find extensive dermal exfoliation along with axillary and inguinal lymphadenopathy. On lab, LDH and liver enzymes were markedly elevated and kidney function deteriorated from normal to anuria. CBC showed eosinophilia.

Answer:

Vancomycin-induced Stevens-Johnson syndrome

Rationale:

Stevens-Johnson syndrome is an acute mucocutaneous process characterized by severe exfoliative dermatitis and mucosal involvement of the gastrointestinal tract and conjunctiva. Pathogenesis is unclear, but an immunological mechanism, probably cell-mediated, has been suggested. Clinical diagnosis of Stevens-Johnson syndrome is based on the presence of "target" or "iris" lesions involving the skin and erosive lesions of two or more mucosal surfaces. Associated findings include extensive dermal exfoliation, nephritis, lymphadenopathy, hepatitis, and multiple serologic abnormalities. Vancomycin, a glycopeptide antibiotic, has case reports in literature producing immunologically mediated adverse reactions such as interstitial nephritis, linear IgA bullous dermatosis, exfoliative erythroderma, necrotizing cutaneous vasculitis and toxic epidermal necrolysis. The treatment consists of cessation of Vancomycin and administration of antihistamine and/or steroid.

Reference(s):

1.Vancomycin-induced Stevens-Johnson syndrome Allergy Asthma Proc. 1996 Mar-Apr; 17(2): 75-8.
2.Stevens-Johnson-type reaction with Vancomycin treatment. - Ann Pharmacother. 1992 Dec; 26(12): 1520-1
3 Uncommon Vancomycin-Induced Side Effects - Brazilian Journal of Infectious Diseases - 2002; 6(4): 196-200

Question 20:

Why is it important to recognize drug rash with eosinophilia and systemic symptoms (DRESS) syndrome?

Answer:

The DRESS syndrome has a high mortality rate of approximately 10%. The majority of deaths are due to fulminant liver failure. It is very important to recognize DRESS Syndrome as a treatment curative with steroids otherwise, can be highly fatal.

Question 21:

What is the medical term for "cool, clammy, and mottled skin" in cardiogenic shock due to vasoconstriction and subsequent hypoperfusion of the skin?

Answer:

Cutis Marmorata

Question 22:

How much blood does a patient on average loose via phlebotomy per week of ICU stay?

Answer:

500 cc (about 1 unit of whole blood) per week

Rationale:

Phlebotomy (blood draws) is the major or probably the # 1 cause of anemia in ICUs. In very anemic patients, if blood workup were necessary it would be advisable to use pediatric tubes except for blood cultures where 10-20 cc of blood draw is required. As it was given as pearl earlier on this site that with each 100 ml of blood draws, Hb drop by 0.7 g/dL. Best practice would be to avoid unnecessary blood workup.

Question 23:

Case:

A 50-year-old patient who is Jehovah's Witness by religious belief said that he will not take any blood or even any product from human blood including fresh frozen plasma, platelets and so on. The patient's hemoglobin is 9.2 and they are scheduled to have coronary artery bypass graft (CABG). You consider Epoetin Alfa as an alternative. What do you need to discuss with patient first before writing the order?

Answer:

Erythropoiesis-stimulating agent Epoetin alpha (Procrit and Epogen) contains albumin, which is a product from human blood. Beside Epoetin Alpha, Darbopoetin alpha (Aranesp) is available in 2 forms: albumin and polysorbate (albumin free). It is important to inform patient about albumin inclusion in given Erythropoiesis-stimulating agent.

Question 24:

To obtain venous blood gas (VBG), what is the minimum time for the tourniquet to be off?

Answer:
At least one minute.

Rationale:
If a tourniquet is used to facilitate venipuncture, it should be released approximately one minute before drawing venous blood gas (VBG) to avoid false values in VBG induced by local ischemia.

Reference(s):
Cengiz M, Ulker P, Meiselman HJ, Baskurt OK. Influence of tourniquet application on venous blood sampling for serum chemistry, hematological parameters, leukocyte activation and erythrocyte mechanical properties. Clin Chem Lab Med 2009; 47:769.

Question 25:
How do you make IABP more visible radiographically (on CXR) after insertion?

Answer:
Shoot CXR on standby mode.

Rationale:
As in stand by mode there is no movement of balloon, chances to have better capture of IABP tip is high.

Question 26:
What is the role of hyperbaric oxygen in the management of lethal Carbon-monoxide (CO) poisoning?

Answer:
It decreases the half-life of CO from 5 hours to half hour and so the possible complications. It prevents lipid peroxidation in the brain and preserves ATP levels in tissue exposed to carbon monoxide. It has shown to decrease the cognitive squeal by 46% when compared with 'normobaric' group at 6 weeks 2.

Limitations: Hyperbaric oxygen in CO poisoning has its own limitations. It may induce "hyperoxic" seizures (rare) 3. Other adverse effects of hyperbaric oxygen include reversible myopia, rupture of the middle ear, barotrauma to lungs 4. Hyperbaric oxygen should be reserved for lethal cases of CO poisoning.

Alternate: If hyperbaric oxygen is not available, apply 100% oxygen, high PEEP and if needed high-frequency ventilation. 100% O_2 reduces half-life of CO effectively to about one and half hour.

Reference(s):
1. Diagnosis and treatment of carbon monoxide poisoning - respir care clin n am. 1999 Jun; 5(2): 183-202.
2. Hyperbaric oxygen for acute carbon monoxide poisoning - volume 347:1057-1067, Oct. 3, 2002
3. Central nervous system oxygen toxicity during hyperbaric treatment of patients with carbon monoxide poisoning -

hampson nb, simonson sg, Kramer cc, piantadosi ca - undersea & hyperbaric medicine 23 (4): 215-219 Dec 1996
4. Hyperbaric-oxygen therapy - volume 334:1642-1648, June 20, 1996

Question 27:

In the close environment of the ICU it is sometimes difficult to be far off during portable radiographs. It is best to avoid any x-ray exposure or have a shield but in case, what is the minimum distance should be kept to minimize hazards of radiation?

Answer:

One should stand at least 6 feet from the patient and the machine. In all cases, the direct beam should be avoided. Often, a nurse must hold uncooperative or mentally agitated patients. In such situations, the nurse should be wearing protective lead apron and gloves.

Question 28:

A 34-year-old Jehovah's Witnesses (JW) patient is anemic post operatively. Surgeon wants to start erythropoietin or equivalent but patient refuses to have any albumin?

Answer:

You may start Aranesp's (darbepoetin alpha) formulation without albumin. As of January 2007, the albumin-free version of Aranesp (R) has been available in the United States. This is the Polysorbate80 based version.

Question 29:

Inhaled nitric oxide is given/measured as parts per million (ppm). What does this mean?

Answer:

This is the expression of diluting the concentrations of substances. Parts per million (ppm) means out of a million. INO (nitric oxide) is a pulmonary vasodilator and is a gaseous blend of nitric oxide and nitrogen (0.01% and 99.99%, respectively for 100 ppm). It is supplied in aluminum cylinders as a compressed gas under high pressure (2000 pounds per square inch gauge [psig]).

Question 30:

Toradol (ketorolac) is a very effective painkiller due to its non-steroidal anti-inflammatory property. What is another interesting use of Toradol beside its analgesic and antipyretic properties?

Answer:

It can be use as a tocolytic agent to arrest pre-term labor!

Rationale:

Since prostaglandin synthetase inhibitors are known to have tocolytic effect, and because short-term use of less than 48-hours is of little risk to the fetus at less than 32 weeks gestation, parenteral ketorolac appears to be a viable alternative for acute tocolysis since it more rapidly leads to uterine quiescence without increasing maternal/fetal adverse effects.

Dosage: Ketorolac 60 mg loading dose followed by 30 mg every 6 hours for a maximum of 24 hours.

Reference(s):
A Comparative Study of Ketorolac (Toradol) and Magnesium Sulfate for Arrest of Preterm Labor. - Southern Medical Journal. 91(11): 1028-1032, November 1998.

Question 31:

We prescribe Thiamine in alcohol withdrawal as it protects against delirium tremens (DTs).

A. True
B. False

Answer:
B: False

Rationale:
Thiamine is recommended in alcoholic patients for prevention of Wernicke encephalopathy (triad of confusion, ataxia, and ophthalmoplegia) and Korsakoff syndrome (consist of anterograde and retrograde amnesia, confabulation, lack of insight and apathy). Thiamine however, has no effect on the symptoms of alcohol withdrawal or on the prevention of seizures or DTs.

Moreover, thiamine when administered orally may have poor enteral absorption in alcoholic patients, so in the initial phase or in high-risk patients, parenteral thiamine (100-250 mg once daily) should be prescribed.

Question 32:

Where did Lasix get its name?

Answer:
Furosemide is selling under brand name Lasix. The name Lasix is derived from the phrase "lasts six (hours)," referring to its duration of action of 4 to 6 hours!

Question 33:

Assume you do not have the luxury of time, and you have to send a patient for CT scan with IV contrast, where the patient has listed allergy to IV contrast. What would be your recommendation?

Answer:
200mg Hydrocortisone IV 4 hours (or as soon as possible) before injection. Also, 50mg Benadryl (Diphenhydramine) IV/PO before (or as soon as possible) 1 hour following the injection.

If time permits, it would be ideal to give 50mg Prednisone PO 13, 7 and 1 hour before the injection, and, 50mg Benadryl (Diphenhydramine) IV/PO before 1 hour of the injection.

Question 34:

Case:
You inserted central line. While you were on your way to check CXR to confirm line placement, nurse requested that you to check KUB and also to confirm enteral feeding tube placement (DHT). Interestingly, the KUB shot this morning had IVC filter, which is no more present there?

Answer:
Guide wire during central line procedure probably travelled into the inferior vena cava and dislodged IVC filter!

Question 35:

Name at least 4 drugs which may turn color of urine green?

Answer:
Metoclopramide (Reglan)
Propofol (diprivan)
Methylene blue
Methocarbamol (robaxin)

Reference(s):
1. Intravenous medications and green urine JAMA 1981; 246: 216
2. Green urine in a critically ill patient. Am J Kidney Dis 2002; 39: E20
3. Green urine: an association with metoclopramide - Nephrology Dialysis Transplantation 2004 19(10): 2677

Question 36:

Why it is not advisable to draw blood from Cordis (introducer) for blood sampling?

Answer:
Given their large diameters, accurate lab draws would be difficult considering that the amount of waste that needs to be withdrawn, even to get a good blood sample (which is not visibly diluted), is substantial.

On the other hand, Cordis is preferable for resuscitation. The flow rates are incredible. Technically Central line (TLC or PICC line) is not ideal for resuscitation due to longer length and smaller radius. 2 Large bore (say 18 gauge) peripheral IVs or one large bore central IV (cordis) is the best method for aggressive resuscitation, due to bigger radius and shorter length.

Remember as per Hagen-Poiseuille, the equation is: 2-fold increase in radius increases flow by 16 fold, furthermore a 2-fold increase in length decreases flow by 50%.

Question 37:

Which two relatively non-pharmacologic tricks can work in intractable hiccups in the ICU?

Answer:

1. Give 2 ml Nebulized 0.9% saline over 5 minutes. It helps to relieve hiccups by pharyngeal stimulation.
2. Give peppermint water. Peppermint water helps by relaxing the lower esophageal sphincter.

Reference(s):

Twycross R, Wilcock A. - Symptom Management in Advanced Cancer. 3rd Edt. Radcliffe Medical Press. 2008

Question 38:

What is "Whoosh test"?

Answer:

The whoosh test is done by rapidly injecting air down the nasogastric tube while auscultating over the epigastrium. Gurgling indicates probability of NGT in the stomach, whilst its absence suggests NGT is elsewhere (lung, esophagus, or pharynx).

Question 39:

Nurse calls you to evaluate the tongue of patient who is admitted with a diagnosis of urosepsis?

Answer:

Geographic Tongue.

Rationale:

Geographic tongue, commonly known as benign migratory glossitis, is an inflammatory condition of the tongue. It is characterized by discoloration in the region of taste buds. The condition usually manifests after eating exacerbating foods, or during times of stress, illness, or in women during menstruation. It is benign, and appears and disappears frequently. It may cause some discomfort but no pain.

Question 40:

A 28-year-old female with previous history of postpartum cardiomyopathy is again admitted to the ICU with 28 weeks pregnancy and shortness of breath. Cardiology service wrote for Cardiac MRI. Nurse needs your input on safety in view of pregnancy?

Answer:

Cardiac MRI is safe to perform after first trimester of pregnancy. So far, there is no evidence found that MRI is dangerous to a fetus. The only precaution required is to avoid MRI contrast in pregnant patients.
Also, Cardiac MRI is safe with coronary stents, joint replacements, sternal wires, and prosthetic heart vales.

Question 41:

What is Fox's sign?

Answer:

Fox's sign is ecchymotic patches seen over the inguinal ligament or just below the inguinal ligament along the anterolateral aspect of one or both thighs. The discoloration occurs as a result of bloody fluid tracking extra-peritoneally along the fascia plane of the psoas and iliacus muscles, becoming subcutaneous in the upper thigh. It occurs in patients with retroperitoneal bleeding, usually due to acute hemorrhagic pancreatitis. The sign is named after the Dermatologist, Dr. Fox.

Question 42:

Prune juice is frequently used in the medical settings for constipation. Why should it be use with caution in ICU?

Answer:

Prune juice should be used with caution in renal patients due to its high potassium content. 6 oz. of prune juice contains 528 mg of potassium, or 5 prunes contain 313 mg of potassium.

Question 43:

How do you write the drip of soda bicarbonate in preventing contrast-induced nephropathy?

Answer:

Use 154meq/L of sodium bicarbonate (3 amps) in 1 liter of D5W.
Give 3ml/kg/hr one hour prior to the exam.
Give 1ml/kg/hr, during the exam and for 6 hours after the exam.

Question 44:

A 30-year-old pregnant female is admitted with Hyperemesis Gravidarum (HG). The patient is hypotensive, dehydrated and hypoglycemic. Before writing IVF orders what would be your concern and which additional order will you consider?

Answer:

Wernicke's encephalopathy (WE)

There is a high risk of WE in HG after 3-4 weeks of persistent vomiting. Thiamine should be given prior to glucose and dextrose infusion.

Question 45:

Is Amniotic fluid embolism (AFE) an anaphylactoid reaction?

Answer:

Yes

Rationale:

Amniotic fluid embolism (AFE) is a misnomer as clinical picture is more or less like acute collapse from pulmonary embolism but in fact it is an allergic type reaction.

Amniotic fluid embolism (AFE) is an obstetric emergency whereby amniotic fluid, fetal cells, hair, as well as other debris enter into the mother's blood stream and triggers an allergic reaction resulting in cardiorespiratory collapse. Another hallmark of the disease is severe coagulopathy.

Diagnosis: In a patient who is suspected of having AFE, a blood sample should be obtained by aspiration of blood from the distal port of a pulmonary artery catheter. If there is prescience of fetal squamous cells it is highly suggestive of AFE syndrome, but its absence does not completely rule in or rule out other causes too.

Treatment: Immediate delivery of baby. Support coagulopathy and hemodynamics as per standard procedures.

Question 46:

Phenergan can turn urine to which color?

Answer:

Blue

Rationale:

Some of the common medications that may cause urine to turn dark green or blue include amitriptyline, cimetidine, indomethacin and phenergan.

Question 47:

What is Paradoxical CNS acidosis?

Answer:
It is a condition, which occurs when Bicarbonate (HCO3) is infused, CO2 enters the blood brain barrier and forms carbonic acid. Its clinical significance remains controversial.

Question 48:
Which blood vessel draw is preferred for lactic acid?

Answer:
Arterial

Rationale:
Arterial and venous lactate levels differ considerably. The determination of lactate, arterial level is more accurate. Normal lactate level from venous blood draw is 0.5 to 2.2 mmol/L, and 0.5 to 1.6 mmol/L from arterial blood draw.

Question 49:
Case:
A 58-year-old female with rheumatoid arthritis was admitted to ICU with community-acquired pneumonia. Home medications included methotrexate. Which group of antibiotics should be preferably avoided?

Answer:
Penicillin

Rationale:
Penicillin competes with methotrexate at the renal tubular secretion of methotrexate. Therefore methotrexate clearance is affected, when both agents are prescribed concurrently. Concurrent use of methotrexate and penicillin may increase methotrexate toxicity, particularly neutropenia.
Similar effects are reported from concurrent use of sulfamethoxazole/trimethoprim (Bactrim) and methotrexate as well.

Reference(s):
1. Methotrexate induced neutropenia associated with co prescription of penicillins: serious and under-reported? - Rheumatology 2006 45(3): 361-362
2. Pharmacokinetic interaction between methotrexate and piperacillin/tazobactam resulting in prolonged toxic concentrations of methotrexate - Journal of Antimicrobial Chemotherapy 2006 58(1): 228-230
3. Methotrexate-induced pancytopenia associated with co-prescription of penicillin and trimethoprim Clinical Rheumatology, Volume 26, Number 1, January 2007, pp. 134-135(2)

MISCELLANEOUS - PEARLS

1. **Transdermal patch burn and MRI**
   Certain transdermal patches contain aluminum or other metals in the patches. Patches, which contains metal, can become overheated during an MRI scan and may cause skin burns in the immediate area of the patch. Patches usually contain metals in the layer of the patch that is not in contact with the skin (backing).

   FDA has identified the following patches:
   Catapres TTS (Clonidine)
   Neupro (Rotigotine)
   Lidopel (Lidocaine HCl and epinephrine)
   Synera (Lidocaine/Tetracaine)
   Transderm-Scop (Scopolamine)
   Prostep (Nicotine transdermal system)
   Habitrol (Nicotine transdermal system)
   Nicotrol TD (Nicotine transdermal system)
   Androderm (Testosterone transdermal system)
   Fentanyl (Fentanyl)
   Salonpas Power Plus (Methyl Salicylate/Menthol)"

   Reference(s):
   FDA Public Health Advisory Risk of Burns during MRI Scans from Transdermal Drug Patches with Metallic Backings - fda.gov

2. **What are the possible Bioterrorism Agents that might be used in an attack?**
   The CDC classifies six pathogens as class "A" bioterrorism agents:
   A. Smallpox
   B. Plague
   C. Botulism
   D. Tularemia
   E. Viral hemorrhagic fever (VHF)
   F. Anthrax.

   These agents are considered to have the greatest potential for mass casualties, large-scale dissemination, and public panic and social disruption. All of them except VHF have been developed as biological weapons. They are stable in aerosol form and would be most likely delivered in this manner. Most of the civilian population remains susceptible to them, and most cause illnesses not typically seen by providers, causing delayed or missed diagnoses.

3. **Passive Leg Raising (PLR) and EtCO2 connection**
   Passive Leg Raising, induced increase in EtCO2 >5 % predicted a fluid induced increase in CI >15 % with sensitivity of 71 % (95 % confidence interval: 48–89 %) and specificity of 100 (82–100) %.

   Reference(s):
   End-tidal carbon dioxide is better than arterial pressure for predicting volume responsiveness by the passive leg raising test - Intensive Care Med (2013) 39:93–100

4. **On Hypothermia**

The following are generally witnessed clinical responses of body as temperature (in centigrade) changes

A. 37°C: Considered as normal oral temperature

B. 36°C: At this temperature metabolic rate increased

C. 35°C: Maximum shivering seen, patients may develop impaired judgment

D. 33°C: Patients may have severe clouding of consciousness

E. 32°C: Patients may have severe shivering and dilatation of pupil

F. 31°C: Patients blood pressure may be obtainable

G. 28-30°C

a. There is bradycardia and decrease in respiration
b. There is increased muscle rigidity
c. There is loss of consciousness
d. There is ventricular fibrillation

H. 27°C

a. There is loss of deep tendon, and loss of skin and capillary reflexes
b. The patients appear clinically dead
c. There is usually complete cardiac standstill

5. **French Gauge diameter**

The French gauge system is commonly used to measure the size of a catheter. It is often abbreviated in the USA as F.
A catheter of 1 French has a diameter of ⅓ mm. So, if the French size is 9, then the catheter diameter is 3 mm.
An increasing French size corresponds to the larger external diameter.

6. **Purple Urine Bag Syndrome**

Purple urine bag syndrome is characterized by purple discoloration of urine, collecting bag, and draining tube. It is a rare condition associated with chronic catheterization of the urinary tract. It is also called The King's Royal Urine as England's "Mad" King George III in early 19th century reported to have bouts of bluish/purplish color urine. The exact etiology is unknown and many explanations have been described. It is said to be a triad of:

A. Constipation,
B. Alkaline urine
C. Bacturia, which produces the enzyme sulphatase / phosphatase-like *Pseudomonas aeruginosa*, *Proteus mirabilis, Morganella morganii* and *E. coli*.

It has been said that constipation leads to bacterial overgrowth in colon and in combination with UTI causes this syndrome. The Purple color is produced by the combination of red and blue colors. Indirubin (red) is produced in this process and

gets dissolved in the plastic of the drainage bag, ostomy pouch, or urinary catheter, and indigo crystals (blue) in the urine coat the bag or tube, combining to form the purple color. The longer the duration the drainage system is used, the deeper the color. A strong odor often is associated with purple urine bag syndrome, which gets stronger as the room temperature rises. Due to unknown reasons, it is more common in female patients. Overall, it is a benign condition. Treatment includes good hygiene, changing catheters as needed, avoiding constipation and if needed antibiotics.

7. **What is Mortality Index?**

One extra value, which Intensivists brings, is their ability to improve Core Measures, and quality improvement in the ICU in particular, and hospital in general. Mortality Index, is one of several Core Measures.
Mortality Index tracks "unexpected" mortalities based on how sick patients are when they come to the hospital. (An unexpected mortality is one in which the patient did not come to the hospital with a fatal disease).

A score of "1.0" would equal the expected number of patient mortalities given the medical condition of the patients upon arrival. A number lower than 1.0 would indicate success and a number higher than 1.0 would indicate less success. Mortality Index is calculated, on a risk score using a national sample. Usually a third party vendor is by hospital to analyze and benchmark data against other hospitals nationally.

Keeping mortality Index below 1 should be one of the goals of the Intensivist team. So, your mortality rate may be high if you are working in an institution getting sicker patients but your mortality index may be low.

8. **AIMS65 Score**

   A. **A**lbumin less than 3.0 g/dL (30 g/L)
   B. **INR** greater than 1.5
   C. Altered **mental** status
   D. **S**ystolic blood pressure of 90 mmHg or less
   E. Age older than **65** years

The mortality rate predicted

A. No risk factors: 0.3%
B. One risk factor: 1%
C. Two risk factors: 3%
D. Three risk factors: 9%
E. Four risk factors: 15%
F. Five risk factors: 25%

9. **Serotonin syndrome**

Serotonin syndrome is a potentially lethal condition caused by overstimulation of the central and peripheral serotonin receptors. SSRI, MAOI and other antidepressants are the biggest culprits. (Everybody seems to be on some type of antidepressant these days!). Mild cases of serotonin syndrome may present with nausea, vomiting, flushing, and diaphoresis. Severe cases may present with hyperreflexia, myoclonus, muscular rigidity, hyperthermia, and autonomic instability. Diagnosis is clinical and no lab tests are available.
Treatment includes discontinuation of all serotonergic medications. The initial treatment of serotonin syndrome is with benzodiazepines and cyproheptadine. Cyproheptadine (Periactin) appears to be the most effective antiserotonergic agent in humans. The initial dose is 4 - 8 mg PO. This dose can be repeated in 2 hours, if no response is observed with the initial dose. Periactin therapy should be discontinued if no response is noted after 16 mg has been administered. Patients who respond to cyproheptadine are usually given 4 mg every 6 hours for 48 hours, to prevent recurrences. Dantrolene (0.5-2.5 mg/kg IV every 6 hours, maximum of 10 mg/kg/day, or 50 to 100 mg bid PO) is a nonspecific muscle relaxant that is used occasionally in serotonin syndrome, presenting with hyperthermia.

Reference(s):
1. Serotonin syndrome from McGill University, Montreal. CMAJ • May 27, 2003; 168 (11) followed with letter Serotonin syndrome: not a benign toxidrome CMAJ • September 16, 2003; 169 (6)
2. The Serotonin Syndrome - NEJM, March 2005 Volume 352:1112-1120

10. Paradoxical abdominal movement - often ignored sign
Scenarios:

1. You have a patient who looks "ok" for extubation base on parameters and vital signs, but you noticed paradoxical abdominal movement (movement of the abdominal contents inward during inspiration). Would you extubate the patient?
2. You have a patient with Guillain-Barré syndrome who relatively looks "ok" and you are in grey zone to intubate or wait, as the patient will soon get his third dose of plasmapheresis. You noticed paradoxical abdominal movement. Will you intubate the patient?

Answers:
1) No and 2) Yes

Many times when clinically patients appear in to be in the grey zone either for intubation or extubation, signs of paradoxical abdominal movement help. Paradoxical abdominal movement is an important physical sign of diaphragmatic and other muscular weakness. Patients may have generalized neurological illnesses affecting muscle, neuromuscular transmission (myasthenia gravis) or inflammatory polyneuropathies (Guillain-Barré syndrome).
In such situations early intubation for impending respiratory failure or holding extubation to rule out critical illness polyneuropathy or myopathy is appropriate.

11. Therapeutic ranges for anti-Xa level adequate in anticoagulation

It is important to note that therapeutic ranges for anti-Xa levels are different with different anticoagulants.

Heparin: 0.3-0.7 units/mL
LMWH:

1. In patients receiving subcutaneous heparin, Q12h dosing, the therapeutic range is 0.4-1.1 units/mL
2. A patient on once daily dosing of LMWH, the therapeutic range is approximately 1-2 units/mL.
3. Patients receiving the DVT prophylaxis regimen, there is no defined range. When anti-Xa levels are measured, the values are lower 0.45 units/mL.

12. Scleroderma Renal Crisis (SRC)

Scleroderma Renal Crisis is one of the few rheumatological emergencies where early diagnosis and treatment can make a big difference in outcome. Wrong diagnosis may lead to wrong management pathway and eventually to very high mortality.
SRC is heralded with hypertensive crisis associated with acute renal failure but the pearl is to avoid IV labetalol or nitroprusside and gradually decrease blood pressure with oral angiotensin-converting enzyme (ACE) inhibitors. (Yes! It is a renal crisis but require ACE inhibitors). Calcium channel blockers may help. Renal dialysis is the last resort.

Another important differential diagnosis is from SLE (renal). It has been suggested that use of steroids is associated with onset of scleroderma renal crisis.

Reference(s):

1. What Is Scleroderma Renal Crisis and How Is it managed? via medscape.com with free registration
2. Systemic Sclerosis with Renal Crisis and Pulmonary Hypertension - stanford.edu
3. Long-Term Outcomes of Scleroderma Renal Crisis - 17 October 2000 Volume 133 Issue 8 Pages 600-603 - annals
4. Scleroderma Renal Crisis: The Sword of Damocles. - JCR: J. of Clinical Rheum. 10(5): 234-235, October 2004.
5. Rheumatologic Renal Disease: SLE vs. Scleroderma - ucsf.edu

13. Propofol and Green urine

Propofol infusion is noticed to turn the color of urine green. It is a benign potential side effect of propofol. Recognition of this side effect is important as it averts unnecessary further workup and limits medical expenditures.

14. Dexmedetomidine (precedex) Infusion as Adjunctive Therapy for Acute Alcohol Withdrawal

Emerging literature is very promising for dexmedetomidine (Precedex) infusion as an adjunctive therapy to benzodiazepines in acute alcohol withdrawal.
Review of the literature shows that dexmedetomidine was shown to be beneficial in alcohol withdrawal delirium first in rats about 10 years ago! But later many case series in humans demonstrated a rapid response to alcohol withdrawal delirium after

standard treatment. Dexmedetomidine is a selective alpha-2 adrenergic agonist that possesses a high ratio of specificity for alpha-2 versus alpha-1 receptor.
The biggest advantage of Dexmedetomidine over benzodiazepines in acute alcohol withdrawal therapy is that it does not suppress respiratory drive and carries simultaneous properties of analgesia, sedation and anxiolytics.

15. Ramsay Sedation Scale

Clinical Score depending on Level of Sedation Achieved

6: Patient is asleep and no response
5: Patient is asleep, with sluggish response to light glabellar tap or loud auditory stimulus
4: Patient is asleep, but have a brisk response to light glabellar tap or loud auditory stimulus
3: Patient responds to verbal commands
2: Patient is cooperative, oriented, and tranquil
1: Patient is anxious, agitated, or restless

16. Clinical Institute Withdrawal Assessment for Alcohol—Revised (CIWA-Ar)

The most objective tool to assess the severity of alcohol withdrawal is the Clinical Institute Withdrawal Assessment for Alcohol, Revised (CIWA-Ar). The score consists of 10 items and can be performed within 5 minutes at the patient's bedside. The questions comprises of ten parameters:

1. Anxiety
2. Tremor
3. Nausea and vomiting
4. Auditory disturbances,
5. Visual disturbances,
6. Tactile disturbances,
7. Headache,
8. Clouding of sensorium
9. Sweating
10. Agitation

For each item except the last one, 0 to 7 points are assigned and for the last item, 0-4 points are assigned with a total possible score of 67.
The CIWA-Ar is not copyrighted and may be reproduced freely. Patients scoring less than 10 do not usually need additional medication for withdrawal.
CIWA-Ar has been demonstrated to have high reliability, reproducibility, and validity. Careful and frequent monitoring with the CIWA-Ar is clinically found to be very helpful.

17. Phenytoin induced Purple glove syndrome (PGS)-Very Rare

Purple glove syndrome also known as PGS is a progressive distal limb edema, discoloration, and pain after peripheral administration of phenytoin. If unrecognized, it may lead to severe skin necrosis, limb ischemia and to

compartment syndromes. It is a fairly unknown and under diagnosed complication with IV Phenytoin and reported in up to 5% of cases. It is mostly overlooked due to reflex made diagnosis of cellulitis at IV site.

Mechanism of action: Two probable mechanisms have been described.
1. Phenytoin is poorly soluble at neutral PH. Solutions like sodium hydroxide, propylene glycol and ethanol are added to enhance solubility by increasing PH. Highly alkaline solution may induce vasoconstriction and thrombosis in vessels – may allow leakage into interstitial space.

2. Mixing alkalinic phenytoin solution with blood may induce precipitation of phenytoin crystals, leading to obstruction of micro vessels causing ischemia and also may induce leakage.
Treatment: is mostly supportive with elevation of limb, compression, dry, gentle heat, galvanic stimulation and in severe cases fasciotomy, skin grafting or amputation.

Reference(s):
1. Incidence and clinical consequences of purple glove syndrome in patients receiving intravenous phenytoin, Neurology, 1998:51:1034-1039.
2. A prospective study of the purple glove syndrome, Epilepsia, 2001:42(9): 1156-1159.
3. Purple glove syndrome: A complication of intravenous phenytoin, J. of Neuroscience Nursing, 1992:24(8): 340-345.
4. Purple glove syndrome: a complication of intravenous phenytoin. - J Neurosci Nurs.1992 Dec; 24(6): 340-5

18. Propofol, colorful urine and hair!

Propofol infusion is known to turn the color of urine green. There are also case reports describing other colors with propofol, such as
pink, white and brown, although green urine carries the trademark. The incidence is around 1% and usually associated with propofol infusion longer than 72 hours. It takes about 2-6 hours for urine to resume its natural color after stopping propofol infusion. It is associated with respiratory alkalosis as respiratory alkalosis increases the formation of metabolites responsible for the green color.
There is at least one case report in literature where discoloration of hair secondary to propofol has been reported.
It is a benign potential side effect of propofol and does not require any intervention. Recognition of this side effect is important as it averts unnecessary further workup and limits medical expenditures.

Reference(s):
Propofol and the color green. Anaesthesia 1989; 44(1): 82.

MCQ’s

Question 1:

Which finding in CBC is highly suggestive of Adrenal crisis? (Select one)
A) Neutrophilia
B) Eosinophilia
C) Thrombocytopenia
D) Neutropenia
E) Polycythemia

Answer:
Eosinophilia

Rationale:
Hyponatremia, hyperkalemia, metabolic acidosis, and hypoglycemia may be present along with anemia and lymphocytosis, but eosinophilia with above serum chemistry findings is highly suggestive of Adrenal Crisis.

Question 2:

Case: A 64-year-old female developed *Clostridium difficile* colitis in the ICU, two days later, the urine color changed to dark brown and progressively became black! What is your diagnosis? - Choose one
A) Worsening C. difficile colitis despite treatment
B) Developing rhabdomyolysis
C) Benign side effect of metronidazole (Flagyl) treatment - continue metronidazole
D) Life threatening side effect of metronidazole treatment - stop metronidazole

Answer:
C

Rationale:
Darken urine - dark brown to black - is a benign a side effect of metronidazole. It is due to water-soluble pigments formed during metabolism. No intervention is needed.

Question 3:

What is the main purpose of trendelenburg position during upper body central line insertion? (Choose one)
1. To increase blood flow to vessels
2. To increase ease of anatomical landmarks
3. To prevent venous air embolism
4. To counteract hypotension by sedative medicines, if used

Answer:

To prevent venous air embolism

Rationale:
Venous Air Embolism is a rare but potentially fatal complication of central line insertion in the upper body area and could be prevented with trendelenburg positioning (at least 15 degrees), given no orthopnea. In case, Venous Air Embolism is suspected during line procedure with symptoms of sudden occurrence of cardiopulmonary dysfunction like hypotension, hypoxia or churning murmur over the left sternal border ("millwheel murmur") - following 7 immediate maneuvers are essential:
1. Clamp the line (do not withdraw) - to prevent further air.
2. Rotate patient to left lateral decubitus position - to decrease air leaving through RV outflow tract.
3. Enhance (or do if not done yet) Trendelenburg position - to help air trapped in the apex of the ventricle.
4. Increase oxygen to 100% - Supplemental oxygen reduces the size of embolus. (Avoid High PEEP as it may increase the risk of paradoxical emboli).
5. Advance the catheter little, unclamp the line and aspirate from the 'distal port' to attempt to remove air. (PA-catheter is not as effective as triple lumen catheter in aspirating air).
6. If hypotension occurs - start IVF wide open and add pressor if needed (catecholamine are preferred).
7. Continue supportive treatment till air is absorbed or further management for complications like paradoxical emboli or hyperbaric oxygen therapy is planned.

Reference(s):
1. An Infrequent but Life-Threatening Complication of a Simple Procedure - Journal of Intensive Care Medicine, Vol. 17, No. 2, 92-94 (2002)
2. Venous Air Embolism - emedicine.com
3. Gas Embolism - NEJM, Feb. 2000, Volume 342:476-482
4. Venous air embolism: a review. J Clin Anesth 1997; 9:251-257

Question 4:
Which electrolyte condition has been found life threatening in recent years in Marathon runners (Choose one)?

A) Hyponatremia
B) Hypernatremia
C) Hypercalcemia
D) Hyperphosphatemia
E) Hyperkalemia

Answer:
A: Hyponatremia

Question 5:
How does amiodarone affects level of digoxin? (Choose one)
A) It increases digoxin level

B) It decreases digoxin level
C) It can have unpredictable erratic effect
D) There is no interaction between these two drugs
E) It all depends on potassium level

Answer:
A: It increases digoxin level

Rationale:
Amiodarone does increase digoxin level. From the ICU perspective, it is important as it may occur within the twenty-four hours of concurrent administration. It may be therefore, appropriate to decrease the dose of digoxin.
Different mechanisms of this interaction are proposed but it is not entirely known. Proposed reasons include reduction in renal clearance of digoxin, displacement of digoxin from tissue-binding sites and altered GI absorption. Amiodarone is known to have spasmolytic effect on the smooth muscle of the intestine and may prolong the intestinal transit time of digoxin and thus its absorption.

Question 6:

Out of following, which one may be used as an adjuvant treatment in Thyrotoxic Periodic Paralysis (TTP)?
A) Calcium Channel Blockers
B) Non selective Beta Blockers (propranolol)
C) Corticosteroids
D) Intravenous magnesium
E) Intravenous dextrose

Answer:
B: Non selective Beta Blockers -propranolol

Rationale:
In Thyrotoxic Periodic Paralysis (TTP), propranolol, a nonselective beta-blocker, has been shown to prevent intracellular shift of potassium and phosphate by blunting the hyperadrenergic stimulation of Na+/ K+–ATPase. Studies have shown that propranolol given alone (orally or iv) normalizes serum potassium levels on an average of 2 hours. It is recommended to be used with the main treatment, if blood pressure issues can tolerated.

Reference(s):
1. Shayne P, Hart A. Thyrotoxic periodic paralysis terminated with intravenous propranolol. Ann Emerg Med. 1994; 24(4): 736–740.
2. Birkhahn RH, Gaeta TJ, Melniker L. Thyrotoxic periodic paralysis and intravenous propranolol in the emergency setting. J Emerg Med. 2000; 18(2): 199–202.
3. Lin SH, Lin YF. Propranolol rapidly reverses paralysis, hypokalemia, and hypophosphatemia in thyrotoxic periodic paralysis. Am J Kidney Dis. 2001; 37(3): 620–623.
4. Huang TY, Lin SH. Thyrotoxic hypokalemic periodic paralysis reversed by propranolol without rebound hyperkalemia. Ann Emerg Med. 2001; 37(4): 415–416.
5. Yeung RT, Tse TF. Thyrotoxic periodic paralysis: effect of propranolol. Am J Med. 1974; 57(4): 584–590.

Question 7:

Which of the following drugs has a strong anti-emetic property?
A) Heparin
B) Digoxin
C) Cefepime
D) Haldol (Haloperidol)
E) Zantac (Ranitidine)

Answer:
D: Haldol

Rationale:
The peripheral antidopaminergic effects of haloperidol account for its strong antiemetic activity. There, it acts at the chemoreceptor trigger zone (CTZ). Haloperidol is useful to treat severe forms of nausea/emesis such as those resulting from chemotherapy. The peripheral effects lead also to a relaxation of the gastric sphincter muscle.
None of the other drugs has anti-emetic property.

Question 8:

The half-life of cisatracurium (Nimbex) is prolonging in?
A) Hepatic failure
B) Renal failure
C) Geriatric patients
D) Hypothermia
E) Both C and D

Answer:
E: Both C and D

Rationale:
The half-life of cisatracurium (Nimbex) is approximately 22 to 29 minutes, following administration of a single intravenous dose. The half-life is not substantially affected by the duration of administration (approximately 26 ± 11 minutes in ICU patients receiving cisatracurium via intravenous infusion), type of anesthesia, or hepatic or renal function impairment, but is slightly longer in geriatric patients than in younger adults. In individuals undergoing induced hypothermia (body temperature of 25 to 28 °C), the half-life is prolonged as compared with the half-life during normothermia.

Question 9:

A 48-year-old obese male with renal failure with baseline creatinine of 3.8 mg/dl but not yet on dialysis, presented with infection and needs IV fluid resuscitation. The patient's ABG showed acidosis with PH of 7.24. Which of the following IV fluids will be relatively contraindicated in this patient?

A. Lactated Ringer's solution
B. Hydroxyethyl starch (Hespan)
C. THAM (tris-hydroxymethyl aminomethane)
D. Normal Saline with potassium
E. All of the above

Answer:
E: All of the above

Rationale:
The objective of this question is to establish that choice of IV fluid is an immensely important factor in the treatment of any patient and should be chosen with caution.
Lactated Ringer's solution contains 4 mEq/L of potassium and may not be a good choice in patients with renal failure.
There is substantial amount of literature available showing deleterious effect of hydroxyethyl starch (Hespan) on kidney particularly with already decreased function.
THAM is excreted by the kidneys and is contraindicated in renal failure.
Simply, normal saline is a good choice in hypovolemia but addition of potassium should be avoided in renal failure.

Reference(s):
1. Hydroxyethyl starch and renal dysfunction Transfusion Alternatives in Transfusion Medicine, Volume 9, Number 3, September 2007, pp. 182-188(7)
2. Hydroxyethyl starch and change in renal function in patients undergoing coronary artery bypass graft surgery - Kidney International (2003) 64, 1046–1049

Question 10:

Conivaptan (Vaprisol), a vasopressin antagonist, which is indicated for the management of euvolemic hyponatremia - can increase the concentration of the following drugs if use concomitantly? (Choose one).

A) Amlodipine (Norvasc).
B) Simvastatin (Zocor).
C) Digoxin (Lanoxin).
D) Midazolam (Versed).
E) All of the above.

Answer:
E: All of the above

Rationale:
Administration of oral conivaptan 40 mg twice daily with amlodipine besylate (Norvasc) resulted in a two-fold increase in the AUC concentration and increased half-life of amlodipine.
The combined use of IV conivaptan and midazolam should be avoided, because the AUC concentration of midazolam may be increased by two-fold to three-fold when these agents are used together.

The coadministration of conivaptan and HMG-CoA reductase inhibitors (statins) such as simvastatin (Zocor) should also be avoided because the AUC concentration of the statin is increased by three-folds.
Digoxin when taken with oral conivaptan, results in a 30% reduction in clearance of digoxin.

Question 11:

A 26-year-old male presented to the emergency department with severe (10/10 in severity) abdominal pain. Results of CT scan and laboratory tests were reported to be normal. The patient responded to analgesic therapy, and admitted to hospital for observation and discharged the following day. Two days later the patient presented with complain of witnessing bright red blood in stool. Again all workup, along with upper and lower GI scope were negative. The patient did not ask for any pain medication. Just before discharge, the patient called nurse, stating "I am having hematuria" and indeed the urine appeared reddish as well as UA showed RBCs. Ultrasound of KUB was reported to be negative. Urology consult obtained for scope and was without any finding. While in the recovery area after Cystoscopy, the patient complained of sub-sternal chest pain and was admitted to your ICU. Initial cardiac enzymes are normal.

What is your diagnosis? (Choose one).

A) Undiagnosed pernicious anemia
B) Hemolytic anemia.
C) Munchausen syndrome
D) Subclinical rhabdomyolysis

Answer:

C: Munchausen syndrome

Rationale:

Munchausen syndrome is a condition in which a patient fakes a disease, illness, or psychological trauma in order to draw attention or sympathy. This "factitious disorders" are either self-induced or falsified. Another common name is hospital addiction syndrome.

Patients with Munchausen's syndrome are usually knowledgeable about the practice of medicine and medical terminologies, and are able to manipulate physicians by inducing fever by keeping warm coffee in their mouth, making stool tarry with iron tablets or urine tainted with drops of blood. These patients are not hypochondriac as they know that they are purposely faking the disease to gain attention or sympathy.
Suspicion should arise if symptoms appear dramatic but inconsistent with medical history or change once treatment has begun, or presence of symptoms only when the patient is alone or not being observed. Some patients have multiple surgical scars and are promptly willing to have medical tests, procedures or even surgeries.
It is a psychological disorder and need to be treated accordingly, though hard to treat.

Question 12:

A 23-year-male while working in the refinery, and when disconnecting a hose was exposed to hydrofluoric acid. The patient had inhalation of hydrofluoric acid. The patient had no past medical history. Which of the following should be done first?

A) Albuterol nebulizer with 2.5 mg albuterol
B) Albuterol nebulizer with 10 mg albuterol
C) Calcium gluconate nebulizer treatment
D) 10% mucomyst treatment

Answer:

C: Calcium gluconate nebulizer treatment

Rationale:

Calcium gluconate should be used after hydrofluoric acid exposure, and if there are any skin lesions it should be applied there as well. The patient should be observed for 24 to 48 hours for the possible development of pulmonary edema. Ionized calcium should be monitored very closely, and should be supplemented with intravenous calcium gluconate if low.

Question 13:

Dexmedetomidine (Precedex) should be use in caution with?

A) Renal failure
B) Liver Failure
C) Adrenal crisis
D) Tachycardia
E) Coagulopathy

Answer:

B: Liver failure

Rationale:

Dexmedetomidine undergoes hepatic metabolism. Caution should be used in patients with severe hepatic failure as the elimination half-life may more than doubled. Normally dexmedetomidine has an elimination half-life of 2 hours.
It has not been implicated in renal failure or adrenal crisis. It does no effect on coagulation. Dexmedetomidine causes bradycardia and should be used with caution in bradycardia.

Question 14:

Which anti-epilectic drug can be used as an antidote in Tacrolimus toxicity?

A) Phenytoin
B) Levetiracetam,
C) Carbamazepine

D) Diazepam
E) Toprimate

Answer:
A: Phenytoin

Rationale:
Tacrolimus is known to be metabolized by the CYP3A4 isoenzyme. Tacrolimus has several drug-drug interactions and CYP3A4/PGP inhibitors may increase tacrolimus levels, whereas inducers may decrease Tacrolimus concentrations. Phenytoin and Phenobarbital are commonly used antiepileptics and potent enzyme inducers. Another well-known inducer is Rifampin.

No treatment recommendations exists for Tacrolimus toxicity, as hemodialysis, plasma exchange, gastric lavage or activated charcoal are ineffective. Phenytoin and phenobarbital seem to have some benefit in seizure prevention, as neurologic toxicities, including seizure and coma, are common in tacrolimus toxicity.

Reference(s):
1. Arin S. Jantz, Samir J. Patel, Wadi N. Suki, Richard J. Knight, Arvind Bhimaraj, and A. Osama Gaber - Case Reports in Transplantation, Volume 2013 (2013)
2. R. E. Quirós-Tejeira, I. F. Chang, L. J. Bristow, S. J. Karpen, and J. A. Goss, "Treatment of acute tacrolimus whole-blood elevation with phenobarbital in the pediatric liver transplant recipient," Pediatric Transplantation, vol. 9, no. 6, pp. 792–796, 2005.
3. G. E. McLaughlin, M. Rossique-Gonzalez, B. Gelman, and T. Kato, "Use of phenobarbital in the management of acute tacrolimus toxicity: a case report," Transplantation Proceedings, vol. 32, no. 3, pp. 665–668, 2000.
4. Z. Karasu, A. Gurakar, J. Carlson et al., "Acute tacrolimus overdose and treatment with phenytoin in liver transplant recipients," Journal of Oklahoma State Medical Association, vol. 94, no. 4, pp. 121–123, 2001.
5. K. Wada, M. Takada, T. Ueda et al., "Drug interactions between tacrolimus and phenytoin in Japanese heart transplant recipients: 2 case reports," International Journal of Clinical Pharmacology and Therapeutics, vol. 45, no. 9, pp. 524–528, 2007.

Question 15:

Adenosine can cause:

A) Asystole
B) Atrial fibrillation
C) Ventricular fibrillation
D) All of the above

Answer:
D: All of the above

Rationale:
Certain SVTs can be successfully terminated with adenosine. This includes any re-entrant arrhythmias - AV reentrant tachycardia (AVRT), AV nodal reentrant tachycardia (AVNRT) - by causing transient heart block in the AV Node. This is mediated via the A1 receptor, inhibiting adenylyl cyclase, reducing cAMP and so causing cell hyperpolarization by increasing outward K+ flux.

Adenosine has an indirect effect on atrial tissue causing a shortening of the refractory period and may initiate atrial fibrillation. In individuals with accessory pathways, the onset of atrial fibrillation can lead to a life-threatening ventricular fibrillation.

Question 16:

Case:

Nurse calls you as a patient's SVRI (Systemic Vascular Resistance Index) is only 372. As you ask for further hemodynamics data, you were given following:
MAP (Mean Arterial Pressure) = 80 mmHg
CI (Cardiac Index) = 4.0 L/min/m^2
CVP = 10 mmHg

What is your response?

1. Do Nothing - you are happy with these numbers
2. Recalibrate and recheck the SVRI again as it appears to be an error.
3. Titrate the vasopressor up.
4. Give fluid.
5. Give Lasix.

Answer:

2: Recalibrate and recheck the SVRI again.

This is probably an error as the formula for SVRI is
SVRI = (MAP - CVP) / CI x 80
So SVRI in the above case should be:
(80 - 10)/4 x 80 = 1400

Rationale:

The objective of above question is to emphasize the point that, with high dependence on technology and computer chips, errors are common and it is very important to obtain the full picture when things appear to be abnormal for no reason and do not fit with the full picture. It is more important to know "What not to do" than to know "what to do"!

Question 17:

While performing cardioversion for atrial flutter, synchronization of electric shock should occur with (Select one).

A) P wave in EKG
B) QRS complex in EKG
C) R wave in EKG
D) T wave in EKG
E) ST segment in EKG

Answer:

C: R wave in EKG

Rationale:
While performing cardioversion for atrial flutter, synchronization of electric shock should occur to R waves.

Question 18:

A 42- year-old male admitted with Guillain-Barré syndrome and intubated due to rapidly falling vital capacity. The patient otherwise remained fairly stable and sedated with average the dose of 5 mg/kg/hr, propofol. Unfortunately, the patient failed 5 days of plasma exchange therapy. On day 6, the patient develops exacerbation of his baseline asthma and was started on IV solumedrol but steroids were discontinued the next day on neurology's recommendation as it may prolong recovery from GBS. All laboratory data and clinical examination otherwise remained stable, including mental status which was assessed briefly each morning while off sedation. Prophylaxis for DVT and GI prophylaxis were in place. Enteral feeding was started on day 2. Bedside percutaneous tracheostomy and PEG were planned.

While on 'shift' on night of day 7, you noticed some downward BP "trend" but as labs and exam data so far remain rock stable, you attributed it to sedation. While browsing through the 5 AM labs you noticed PH of 7.25 and bicarbonate of 14. Chem-7 showed Cr of 2.1 mg/dl (baseline 1.1 mg/dl) and K of 5.7 mEq/L. As you get more attentive to the patient, you noticed frequent episodes of bradycardia on the monitor. Tracking back the monitor over the last few hours showed multiple alarms for bradycardia, which were 'silenced' as this was the most stable patient in unit. Also pulse oximetry trends from the upper 90s to the lower 90s. You ordered lactate level, cardiac enzymes, EKG, CXR, broad spectrum antibiotics, panculture, adjusted ventilator settings, and gave bolus intravenous fluids. Results of the lactate level came back, and was 7.2, and indeed patient has NSTEMI with Troponin-I of 7.1. CPK is reported in the 5 K range. You call the primary physician, as well as consulted cardiology, nephrology and infectious decease services. The Patient required another two intravenous fluid boluses before you left at 7 AM. The patient however continued to deteriorate and died 48 hours later despite combined endeavor of all services to salvage his hemodynamic collapse.

What is your diagnosis? (Choose one).
A) Acute MI from plasma exchange therapy
B) Acute septic shock due to use of steroid
C) Side effect of Propofol
D) Acute renal failure from hypotension
E) Ventilator associated pneumonia

Answer:
C: Propofol infusion syndrome.

Rationale:
As Propofol has gained enormous popularity in ICUs, it is extremely important to be aware of "Propofol infusion syndrome", particularly when the drip is continued for more

than 48 hours. This syndrome consists of myocardial failure, metabolic acidosis, renal failure, lipemia, rhabdomyolysis, and hyperkalemia. Clues to "Propofol infusion syndrome" are unexplained elevated lactate levels, bradycardia and increasing need of vasopressors. It's a clinical diagnosis.
Due to poorly understood reasons, this syndrome is associated with acute neurological illnesses or acute inflammatory diseases and receiving steroids in addition to Propofol. Also, an independent syndrome, which consists of bronchospasm, hypotension and anaphylactic type picture has been reported with the start of infusion apart from the "Propofol infusion syndrome" above. Some critics blame high lipid content of infusion for syndrome.
A) Is wrong as acute MI is associated with IVIG therapy for GBS and unlikely with plasma exchange. Also, this patient finished his therapy 2 days ago.
B) Is wrong as there is no clear evidence of sepsis and short-term use of steroid has less likely reason for acute sepsis. But please note that it is very important to practice aseptic technique while handling propofol.
D) Is possible but extreme hypotension is unlikely to go unnoticed and does not explain all the clinical features.
E) VAP is not associated with this clinical picture

Question 19:

A 28-year-old male is started on levetiracetam (Keppra) in the ICU for new onset of seizure. The patient developed generalized mild rash all over the body after a 3rd dose. What should be the next step? (Choose one best answer)
A) Add an anti-histamine with each dose
B) Add Steroid
C) Discontinue levetiracetam
D) Switch IV formulation to oral
E) Add Pyridoxine (Vitamin B6)

Answer:
C: Discontinue levetiracetam

Rationale:
Approximately 1 out of 3000 patients on levetiracetam may develop Stevens-Johnson syndrome (SJS) and Toxic Epidermal Necrolysis (TEN). The recommendation is to discontinue levetiracetam upon signs of any unexplained rash. Ideally, levetiracetam should not be resumed and alternative drug should be considered. Pyridoxine (vitamin B-6) is said to curtail some of the psychiatric symptoms associated with the use of Levetiracetam (Keppra).

Question 20:

Use of steroid along with Propofol ... (choose one)
A) Prevent propofol infusion syndrome
B) Increase the chance of propofol infusion syndrome
C) Can have erratic effect on sedation

D) Can increase infection rate
E) has no association

Answer:
B: Increase the chance of propofol infusion syndrome

Rationale:
Propofol when combined with steroids acts as a triggering factor for Propofol infusion syndrome[1].

Among other choices, D) is worth mentioning as improper unsterile handling of propofol may increase the infection rate, though not associated with steroid. Steroids may independently increase the rate of infection.

When continued at rates higher than 5 mg/kg/h for more than 48 hours, propofol may cause rhabdomyolysis, acute renal failure, metabolic acidosis, hyperkalemia, bradycardia, arrhythmia and hyperthermia. Mortality is very high at more than 80%. The syndrome is known as 'Propofol Infusion Syndrome' or PRIS. Recently PRIS has been reported even at lower doses or in less than 48 hours.[2, 3]

Bonus Pearl: Propofol may turn the color of urine green. It is a benign effect of propofol. Recognition of this side effect is important as it averts unnecessary workup and limits medical expenditures.

Reference(s):
1. The pathophysiology of Propofol infusion syndrome: a simple name for a complex syndrome - Volume 29, Number 9 / September 2003, Intensive Care Medicine
2. Propofol Infusion Syndrome—A Fatal Case at a Low Infusion Rate - Anesth. Analg. Vol. 103, Issue 4, 1050 October 1, 2006
3. Propofol Infusion Syndrome Associated with Short-Term Large-Dose Infusion During Surgical Anesthesia in an Adult - Anesth Analg 2005; 100:1804-1806

Question 21:

In Tension pneumothorax, atelectasis, pulmonary edema, and pneumonia (Choose one)
A) Both static and dynamic compliance fall
B) Only dynamic compliance falls
C) Only static compliance falls
D) Both static and dynamic compliance remain unchanged

Answer:
A: Both static and dynamic compliance fall

Rationale:
Formulae for compliances are as follows:
Static compliance is based on plateau pressure (no air is flowing)
Cstat = Vt/(Pplat - PEEP)
Dynamic compliance is based on peak pressure (air is flowing)

Cdyn = Vt/(Ppeak - PEEP)
In tension pneumothorax, atelectasis, pulmonary edema, and pneumonia both peak and plateau pressures rise and so cause both compliances to fall

Question 22:

In which of the following conditions could mixed venous oxygen saturation (SvO_2) be more than 80%?

A Sepsis
B Cirrhosis
C VSD (Ventricular septal defect)
D Cyanide poisoning
E All of the above

Answer:

E: All of the above conditions are associated with higher than normal value for mixed venous oxygen saturation (SvO_2).

Question 23:

Uremia prolongs
A) PT
B) PTT
C) PT and PTT
D) Bleeding Time
E) PT, PTT and Bleeding Time

Answer:

D: Bleeding time

Rationale:

Uremia is unique in the sense that it does not affect PT or PTT. DDAVP is the first line treatment, which acts promptly but has a shorter duration of action of a few hours and exhibits tachyphylaxis. Conjugated estrogens have also shown promise but onset of action is slow (about 6 hours) but the effect lasts for about 2 weeks.

Question 24:

Which route is least preferable for inserting a central dialysis catheter in a patient presented with acute renal failure? - Choose one
A) Internal Jugular
B) Subclavian
C) Femoral
D) Axillary
E) Transhepatic

Answer:

B: Subclavian

Rationale:
The internal jugular vein is the most preferred site due to its easy access and low rate of complications. The subclavian route should be avoided if possible, since it results in high stenosis and thrombosis rates, which subsequently prevent the use of the upper extremity for the creation of A-V fistulas if needed. The femoral route is another good choice for temporary measure with easy access but it has a disadvantage of a high thrombosis and infection rates. The axillary vein placement requires an experienced operator. The transhepatic approach, is technically difficult and reserved for advance cases.

Question 25:

In Uremia (Choose one)?
A) PTT is prolonged, PT is normal, and Platelet count is normal, but bleeding time is prolonged.
B) PTT is prolonged, PT is normal, Platelet count is decreased, and bleeding time is normal
C) PTT is normal, PT is normal, Platelet count is decreased, and bleeding time is prolonged
D) PTT is prolonged, PT is prolonged, Platelet count is decreased, and bleeding time is normal
E) PTT is normal, PT is normal, Platelet count is normal, and bleeding time is prolonged

Answer:
E: PTT is normal, PT is normal, Platelet count is normal, and bleeding time is prolonged

Rationale:
Uremia causes dysfunction of platelet but there is no decrease in numbers. Uremia does not affect PT and PTT - so only bleeding time is prolonged.

Question 26:

Indomethacin makes nephrogenic Diabetes Insipidus (choose one):
A) Worse
B) Better
C) No response

Answer:
B: Better

Rationale:
Indomethacin has been shown to help in nephrogenic diabetes insipidus particularly in drug-induced diabetes insipidus associated with lithium. Most of the literature and case reports in this regard are 20-25 years old but recently there has been renewed interest with this phenomenon.

Reference(s):
1. Indomethacin in streptozocin-induced nephrogenic diabetes insipidus - American Journal of Kidney Diseases Volume 9, Issue 1, Pages 79-83, January 1987
2. Indomethacin in the treatment of lithium-induced nephrogenic diabetes insipidus, Arch Intern Med. 1989 May; 149(5): 1123-6.
3. Pharmacologic Treatment of Congenital Nephrogenic Diabetes Insipidus - clinicaltrials.gov

Question 27:

Claviprex (clevidipine butyrate) is a continuous infusion IV medication for acute hypertension control. It is relatively contraindicated in patients with:
A) Allergies to soybeans, soy products, eggs, or egg products
B) Defective lipid metabolism such as pathologic hyperlipemia, lipoid nephrosis
C) Acute pancreatitis, if it is accompanied by hyperlipidemia
D) Severe aortic stenosis
E) All of the above

Answer:
E: All of the above

Rationale:
It is a lipid-based drug. It is almost a look alike of propofol, and at bedside, care should be taken in titrating this agent, due to accidental confusion. It contains phospholipids and can support microbial growth. Once the stopper is punctured, it should be used and discarded within 4 hours.
It has an extremely short half-life of 90 seconds and desirable for close titration of hypertension.

Question 28:

Cardiac output is the volume of blood being pumped by the heart, (left or right ventricle), in the time interval of?

A) One minute
B) One second
C) Each beat
D) One respiratory cycle

Answer:
A: Per minute

Rationale:
Cardiac output is the volume of blood pumped by the heart per minute (mL blood/min). Cardiac output is heart rate X stroke volume. An average resting cardiac output is 5.6 L/min for a human male and 4.9 L/min for a female.

Question 29:

The half-life of cisatracurium (Nimbex) is prolonged in?
A) Hepatic failure
B) Renal failure
C) Geriatric patients
D) Hypothermia
E) Both C and D

Answer:
E : (Both C and D)

Rationale:
The half-life of Nimbex is approximately 22 to 29 minutes, following administration of a single intravenous dose. The half-life is not substantially affected by the duration of administration (approximately 26 ± 11 minutes in ICU patients receiving cisatracurium via intravenous infusion), type of anesthesia, hepatic or renal function impairment, but is slightly longer in geriatric patients than in younger adults. In individuals undergoing induced hypothermia (body temperature of 25 to 28 °C), the half-life is prolonged as compared with the half-life during normothermia.

Question 30:

You have been called to manage a 32-year-old asthmatic patient who is suspected of having theophylline toxicity. The paramedics administrated lorazepam for seizure in the ambulance but you still see some bouts of seizure. What would be your next drug of choice in this probable theophylline induced seizure?
A) Phenytoin
B) Phosphenytoin
C) Keppra (levetiracetam)
D) Tegretol (carbamazepine)
E) phenobarbital

Answer:
E: phenobarbital

Rationale:
The objective of this question is to emphasize that phenytoin is usually not effective in these patients. Ativan or diazepam (benzodiazepines) is first line of drugs to be used here. If seizure activity continues, phenobarbital is indicated. Phenobarbital also enhances the hepatic metabolism of theophylline.
If phenobarbital therapy fails, then general anesthesia is indicated.

Question 31:

A 52-year-old diabetic male with now resolving sepsis (off vasopressors) was found to developed severe right upper quadrant (RUQ) tenderness around 7 PM. STAT ultrasound

showed distended acalculous gallbladder with thickened walls (4 mm). Diagnosis of Acalculous cholecystitis was made. The time now is now 10 PM. Your next step should be:
A) Place patient on NPO status. Follow-up with LFT (Conservative approach)
B) Place patient on NPO status. Start antibiotics and call surgery in the morning
C) Place patient on NPO status. Start antibiotics and call for a STAT surgical consult
D) Call interventional radiology to perform percutaneous cholecystostomy
E) Call GI service to perform endoscopic gallbladder stent placement

Answer:
C: Place patient on NPO status. Start antibiotics and call for a STAT surgical consult

Rationale:
When the diagnosis of acalculous cholecystitis is established, immediate intervention is indicated because of the high risk of rapid deterioration and gallbladder perforation. The definitive treatment of acalculous cholecystitis is cholecystectomy (open or laparoscopic).

In patients who are not surgical candidates, percutaneous cholecystostomy may be performed in interventional radiology as an alternative. Catheters are usually removed after approximately 3 weeks in critically ill patients with acalculous cholecystitis who have undergone percutaneous cholecystostomy. This allows for the development of a mature track from the skin to the gallbladder.

In patients who get declared non-surgical candidates, endoscopic gallbladder stent placement has been reported as an effective palliative treatment. This involves placement of a double pigtail stent between the gallbladder and the duodenum during endoscopic retrograde cholangiopancreatography (ERCP).

Question 32:
Sotalol
A) prolongs the PR interval
B) prolongs the QT interval
C) is a non-selective β blocker
D) may increase risk of death with decreased ejection fraction.
E) All of the above

Answer:
E: All of the above

Rationale:
Sotalol is non-selective competitive β-adrenergic receptor blockers that also have Class III antiarrhythmic properties by acting and inhibiting the potassium channels.
Though it can be used to treat hypertension, it is mostly used to treat ventricular tachycardias and atrial fibrillation, it should be avoided in the setting of low ejection fraction due to higher mortality.

Question 33:

Hypotension secondary to milrinone therapy can be managed more efficiently with which vasopressor?
A) Norepinehrine
B) Dopamine
C) Vasopressin
D) Phenylephrine
E) Epinephrine

Answer:
C: Vasopressin

Rationale:
Certainly any vasopressor can be used for hypotension but the literature point towards vasopressin as better choice of vasopressor in milrinone- induced hypotension. Low-dose vasopressin can decrease PVR/SVR ratio that was increased by milrinone. Milrinone–vasopressin can provide better hemodynamics than milrinone–norephinephrine in the management of right heart failure. Combination of Milrinone-vasopressin can maintain systemic perfusion pressure in addition to decrease in right heart afterload.

Reference(s):
Comparative hemodynamic effects of vasopressin and norepinephrine after milrinone-induced hypotension in off-pump coronary artery bypass surgical patients - Eur J Cardiothorac Surg 2006; 29:952-956

Question 34:

Out of following agents, which can be used as treatment in refractory cases of PSVT (paroxysmal supraventricular tachycardia)?
A) Dopamine
B) Dobutamine
C) Phenylephrine
D) Vasopressin
E) Norepinephrine

Answer:
C: Phenylephrine

Rationale:
Besides its role as a vasopressor, phenylephrine can be an effective in the treatment of PSVT, particularly in patients with PWP (Wolff-Parkinson-White syndrome), including refractory cases. Phenylephrine stimulates the baroreceptors and therefore decreases vagal output.
The dose of phenylephrine in PSVT is 0.5 mg, administered by rapid IV push. Subsequent doses may be given thereafter.

Reference(s):
Waxman MB, Wald RB, Sharma AD, et al: Vagal techniques for termination of paroxysmal supraventricular tachycardia. Am J Cardiol 1980; 46:655-664?

Question 35:

A 52-year-old diabetic male with now resolving sepsis (off of vasopressors) was found to have develop severe right upper quadrant (RUQ) tenderness around 7 PM. STAT ultrasound showed distended acalculous gallbladder with thickened walls (4 mm). Diagnosis of Acalculous Cholecystitis made. Time is now 10 PM. Your next step should be:
A) Make the patient NPO. Follow-up with LFT (Conservative approach)
B) Make the patient NPO. Start antibiotics and call surgery in the morning
C) Make the patient NPO. Start antibiotics and call STAT surgical consult
D) Call interventional radiology to perform percutaneous cholecystostomy
E) Call GI service to perform endoscopic gallbladder stent placement

Answer:
C: Make the patient NPO. Start antibiotics and call STAT surgical consult

Rationale:
When the diagnosis of acalculous cholecystitis is established, immediate intervention is indicated because of the high risk for rapid deterioration and gallbladder perforation. The definitive treatment of acalculous cholecystitis is cholecystectomy (open or laparoscopic).

In patients who are not surgical candidates, percutaneous cholecystostomy may be performed in interventional radiology as an alternative. Catheters are usually removed after approximately 3 weeks in critically ill patients with acalculous cholecystitis who have undergone percutaneous cholecystostomy. This allows for the development of a mature track from the skin to the gallbladder.
In patients who get declared non-surgical candidates, endoscopic gallbladder stent placement has been reported as an effective palliative treatment. This involves placement of a double pigtail stent between the gallbladder and the duodenum during endoscopic retrograde cholangiopancreatography (ERCP).

Question 36:

The Model for End-Stage Liver Disease, or MELD, is a scoring system now used by the United Network for Organ Sharing (UNOS) for prioritizing allocation of liver transplants. It takes into account all of the following EXCEPT?
A) Serum bilirubin
B) Serum creatinine
C) INR
D) Stage of (hepatic) encephalopathy

Answer:

D: Stage of encephalopathy

Rationale:
The calculation for MELD = 3.8 x log (e) (bilirubin mg/dL) + 11.2 x log (e) (INR) + 9.6 log (e) (creatinine mg/dL).

The following modifications has been made to the score by UNOS:
A) For those patients who have been dialyzed two times within 7 days, the value for serum creatinine used, should be 4.0 mg/dl
B) Any value less than 1 mg/dl, should be given the value of 1 mg/dl.
In interpreting MELD Score in hospitalized patients, the 3-month mortality is:
71.3% mortality for score >40
52.6%, mortality for score of 30–39
19.6% mortality for score of 20–29
6.0% mortality for score of 10–19
1.9% mortality, for core <9

Question 37:
Tumor lysis syndrome may cause all except? (Choose one)
A) Hyperkalemia
B) Hyperphosphatemia
C) Hypercalcemia
D) Hyperuricemia
E) Lactic acidosis

Answer:
C: Hypercalcemia

Rationale:
Tumor lysis syndrome causes hypocalcemia. As with hyperphosphatemia, calcium precipitates to form calcium phosphate, leading to hypocalcemia. Hypocalcemia may lead to tetany, and seizures.
Patients receiving chemotherapy for a cancer with a high cell turnover rate, such as lymphomas and leukemias, should receive prophylactic allopurinol as well as intravenous hydration to a target urine output > 2.5 L/day. Rasburicase is an alternative agent to allopurinol. Alkalization of the urine is controversial and has shown no difference.

Question 38:
Out of following, which treatment would not work in active bleeding from Uremia?
A) Desmopressin (DDAVP)
B) Hemodialysis
C) IV Estrogen
D) PO Estrogen
E) Cryoprecipitate

Answer:
B: Hemodialysis

Rationale:
Interestingly, dialysis is very effective in preventing uremic bleeding but has no role in active bleeding from uremia. DDAVP is the most potent remedy in such situations followed by cryoprecipitate. Estrogen (IV or PO) has also shown some effectiveness.

Reference(s):
Nature clinical practice nephrology, March 2007 vol 3 no 3

Question 39:

A 58-year-male patient was brought to ED with high fever along with mental status changes. In ED the patient had a witnessed seizure. Urine output was marginal. You received the following laboratory values:
Hb 7 gm/dl, Platelets 14 /µL, Cr 2.6 mg/dl.

Your next line of action along with treating rescuing airway and treating seizure is: (choose one)
A) Initiate Sepsis protocol
B) Perform lumbar puncture (to rule out meningitis)
C) Transfuse platelets
D) Call for plasmapheresis
E) Initiate dialysis

Answer:
D: Call for plasmapheresis

Rationale:
This patient most probably has thrombotic thrombocytopenic purpura (TTP). It has 5 basic criteria

1. Thrombocytopenia
2. Microangiopathic hemolytic anemia
3. CNS dysfunction
4. Fever
5. Renal failure

Plasmapheresis is very effective and has a rapid therapeutic response in the critically ill patients with TTP. Severe neurologic manifestations may disappear, and laboratory abnormalities may diminish within a few hours. Platelet transfusions should be avoided since this has been associated with marked decline in either renal or neurologic status. The treatment of seizures in TTP is the same as for seizures with other complicated hematologic disorders.
Splenectomy is another treatment option for TTP patients refractory to standard TPE or who have experienced recurrence or complications.

Question 40:

Which component of coagulation profile is part of Sequential Organ Failure Assessment (SOFA) score?
A) PT
B) PTT
C) Platelets
D) D-Dimer
E) Fibrinogen level

Answer:
C: Platelets

Rationale:
SOFA score is one of the many scoring systems used to calculate a patient's status during their stay in an intensive care unit (ICU). The SOFA score is based on six different scores:

Respiratory
Cardiovascular
Hepatic
Coagulation
Renal
Neurological

Scores less than 9, are associated with mortality rates of approximately 33% while scores greater than 11, are linked with rates >95%

Question 41:

Which finding in CBC is highly suggestive of adrenal crisis? (Select one)
A) Neutrophilia
B) Eosinophilia
C) Thrombocytopenia
D) Neutropenia
E) Polycythemia

Answer:
B: Eosinophilia

Rationale:
Hyponatremia, hyperkalemia, metabolic acidosis, and hypoglycemia may be present along with anemia and lymphocytosis, but eosinophilia with the above serum chemistry findings is highly suggestive of adrenal crisis.

Question 42:

A 58-year-old male with a mechanical mitral valve replacement has 'little rocky course' post operatively in ICU. The patient was managed with IV heparin. The patient is initiated on Warfarin. The last known INR was 3.8. Heparin is discontinued but the laboratory called this morning with positive OD of 2.4 for 'HIT' (Heparin Induced Thrombocytopenia). Your next action would be?
A) Continue the present management with warfarin
B) Continue warfarin but increase the INR target
C) Discontinue warfarin
D) Discontinue warfarin and start argatroban
E) Discontinue warfarin, administer vitamin K and start argatroban

Answer:
E: Discontinue warfarin, administer vitamin K and start argatroban

Rationale:
Warfarin may cause microthrombosis in patients HIT. These patients typically have severe protein C depletion. If warfarin has already been started, vitamin K should be given. Warfarin should not started before the platelet count is above 150.
In the above question A and B is wrong as warfarin should be discontinued. C and D are right but not completely accurate. E is the complete answer.

Question 43:

A-52-year-old female was started on LMWH (low molecular weight heparin) after right knee replacement. Prior to, discharge the patient complained of left calf pain and was diagnosed with DVT. It was also noted, the patient had dropped her platelet counts from 256 K/uL to 52 K/ul- and there was a high suspicion of HIT (Heparin induced thrombocytopenia). The patient was started on argatroban. Your next step would be to:
A) Continue enoxaparin (Lovenox) until the laboratory confirms the diagnosis of HIT
B) Start warfarin for oral transition to anticoagulation
C) Insert IVC filter to prevent PE
D) Discharge patient home on fondaparinux (Arixtra)
E) Continue argatroban with monitoring of PTT

Answer:
E: Continue argatroban with monitoring of PTT

Rationale:
HIT is a clinical diagnosis. If clinical suspicion is high, management should be started without waiting for laboratory results. All heparin related agents should be discontinued immediately (A is wrong).
Warfarin should not be started until the platelet count is 150 k/ul, to prevent warfarin related necrosis. (B is wrong)
IVC filter is not indicated and usually should not be inserted to avoid further complications with thrombus. In argatroban therapy, the patient is already protected for PE (C is wrong)
The patient is too sick to send home with diagnosis of HIT (D is wrong)

Question 44:

In which of the following cases, is only bleeding time prolonged (with PT, PTT and Platelet count all normal)?
A) Uremia
B) DIC
C) Aspirin?
D) Hemophillia
E) Von Willebrand disease

Answer:
Both A and C: Uremia and Aspirin

Rationale:
In uremia and in ASA intake, only the bleeding Time (BT) is prolonged but PT, PTT and Platelet counts all remain normal.
In DIC, PT, PTT and bleeding time - all become prolonged and platelet counts decrease.
In Hemophilia, only PTT gets prolonged but PT, BT and Platelet counts remain normal.
In Von Willebrand disease, PTT and BT gets prolonged but PT and Platelet counts remain normal.

Question 45:

Ciprofloxacin associated seizure can occur with:
A) thyrotoxicosis
B) high doses of the drug, old age,
C) renal insufficiency,
D) drug interactions
E) electrolyte abnormalities,
F) history of seizure
G) All of the above

Answer:
G: All of the above

Rationale:
The objective of this question is to enhance the relatively less known risk factor of seizure associated with ciropfloxacin intake i.e., thyrotoxicosis. Unrelated to it, ciprofloxacin itself can cause unexplained hypothyroidism.

Question 46:

What organism is most frequently involved in vertebral osteomyelitis? What is the antibiotic of choice for treating this organism? (Choose one)
A- *Pseudomonas aeruginosa*
B- *Klebsiella*

C- *Bacteroides fragilis*
D- *Staphylococcus aureus*
E- *E. Coli*

Answer:
D: Staphylococcus aureus

Rationale:
The most common microorganism in vertebral osteomyelitis is *Staphylococcus aureus*, followed by *E. Coli*. The antibiotic of choice for vertebral osteomyelitis (without implant) is beta-lactam at high doses (e.g., nafcillin or oxacillin 2 g IV every 6 hours or cefazolin 1-2 g IV every 8 hours).

Question 47:

CMV retinitis can be treated by ganciclovir or foscarnet,
A) orally
B) intravenously
C) intravitreal injection
D) intravitreal implant
E) All of the above

Answer:
E: All of the above

Rationale:
Besides the regular route of administration it is interesting to note that the Vitrasert (ganciclovir) implant is a sustained-release intravitreal implant that is used for the treatment of cytomegalovirus (CMV) retinitis. Each implant is designed to release drug over a 5 to 8 month period.

Question 48:

A 14-year-old male teenager is admitted to ICU with fever, vomiting and confusion. On examination you noticed rash on palms and feet. The patient has no past medical history, except recent viral infection for which he took aspirin as well as Tylenol (acetaminophen). You are suspecting Reye's syndrome. Which of these agents could be responsible?
A) Aspirin
B) Tylenol
C) Both

Answers:
C: Both

Rationale:
Although aspirin is well described in Reye's syndrome, similarly acetaminophen has been

described in Reye's syndrome studies, when taken in viral infections. Although this almost exclusively occurs in children adult cases has been reported as well.

Question 49:

Which of the following medicines can cause "Red Man Syndrome"?
A) Ciprofloxacin
B) Amphotericin B
C) Rifampicin
D) Vancomycin
E) All of the above

Answer:
E: All of the above

Rationale:
Antibiotics such as ciprofloxacin, amphotericin B and rifampicin can also potentially cause Red Man Syndrome, besides vancomycin. Like vancomycin, they are capable of causing direct degranulation of mast cells and basophils. Red Man Syndrome is amplified if these antibiotics are combined with vancomycin or with each other. Red man syndrome is also magnified in patients receiving vancomycin and opioid analgesics, muscle relaxants, or contrast dye because these drugs can also stimulate histamine release.

Question 50:

Vancomycin can be given as?
A) Intravenous infusion
B) via oral route (PO)
C) Via inhaled Nebulizer
D) via topical application
E) via drops in eye/ears
F) All of the above

Answer:
F: All of the above

Rationale:
Vancomycin can be given via all routes stated above. The objective of the above question is to emphasize inhaled administration of vancomycin, as other routes are fairly known to ICU physicians.
Lately, there have been various reports where inhaled vancomycin has been used successfully to treat MRSA particularly in cystic Fibrosis patients.

Question 51:

Which of the following are side effects of selective serotonin reuptake inhibitors (SSRIs)?
a. Anhedonia (inability to experience pleasure)

b. Apathy
c. Bruxism
d. Strange dreams
e. Mydriasis
f. Increased risk of bone fractures
g. Autonomic dysfunction
h. Syndrome of inappropriate antidiuretic hormone hypersecretion
I. All of the above

Answer:
I: All of the above

Rationale:
Many of these side effects disappear after 6-8 weeks however, their durations and extent of effects, are highly variable, from one individual to another and drug-specific.

Question 52:

Dose adjustment may be required for dexmedetomidine (Precedex) in
A) Renal failure
B) liver failure
C) ARDS
D) Thrombocytopenia
E) Seizure disorder

Answer:
B: Liver failure

Rationale:
Dexmedetomidine wears off clinically in approximately 6 minutes in adults, but it is extensively distributed with high protein binding. It is mostly metabolized through both the cytochrome P450 enzyme system and direct glucuronidation. It has a terminal elimination half-life of approximately 2 hours. Dose reduction may be needed in patients with hepatic dysfunction.

Question 53:

Bone marrow suppression, characterized particularly by thrombocytopenia (low platelet count), may occur during linezolid treatment but is reversible. Less frequent side effects of linezolid are peripheral neuropathy and optic neuropathy. Are they?
A) Reversible
B) Irreversible

Answer:
B: Irreversible

Rationale:
Long-term use of linezolid has also been associated with peripheral neuropathy and optic neuropathy, which is most common after several months of treatment and may be irreversible. Although the mechanism of injury is still poorly understood, mitochondrial toxicity has been proposed as a cause, linezolid is toxic to mitochondria, probably because of the similarity between mitochondrial and bacterial ribosomes.
A more extensive monitoring protocol for early detection of toxicity in seriously ill patients receiving linezolid has been developed and proposed by a team of researchers in Melbourne, Australia. The protocol includes twice-weekly blood tests and liver function tests; measurement of serum lactate levels, for early detection of lactic acidosis; a review of all medications taken by the patient, interrupting the use of those that may interact with linezolid; and periodic eye and neurological exams in patients set to receive linezolid for longer than four weeks.

Question 54:
All of the following can be used as treatment of hyponatremia in cerebral salt wasting (CSW) after subarachnoid hemorrhage except:
A) Hypertonic saline (3%)
B) Normal Saline or Salt tablets
C) Conivaptan (Vaprisol)
D) Fluid restriction
E) Fludrocortisone (Florinef)

Answer:
D: Fluid restriction

Rationale:
In CSW, treatment is aimed to restore normovolemia with normalization of serum sodium. If patient is asymptomatic, then aggressive treatment may not be needed

Patients with CSW may be given, hypertonic 3% saline at an initial rate of 25-50 ml/hour, 325 mg salt tablets, and/or 1-2 mg daily of oral fludrocortisone (Florinef) depending on the sodium level.
SIADH, on the other hand is treated with fluid restriction. In patients with aneurysmal subarachnoid hemorrhage (SAH) however, one should be very cautious because of the risk of vasospasm. It carries risk of increased incidence of infarction in patients treated for supposed SIADH with fluid restriction. Other types of treatment include infusion of hypertonic saline in conjunction with loop diuretics or the arginine vasopressin antagonist (Conivaptan).

Question 55:
Which of the following may be used in treatment of massive "Fire Ants" exposure on human body?

A) Immediate application of urine
B) Application of aloe vera gel
C) Topical anesthetic benzocaine,
D) Antihistamines
E) Corticosteroid
F) All of the above

Answer:
F

Rationale:
Exposure to colony of fire ants may be fatal if it causes severe allergic anaphylactic reactions to fire ant stings, but immediate and overall treatment is usually supportive. There is no specific antidote. If no immediate help is needed, human urine can be used for irrigation and to kill fire ants!!

Question 56:

Treatment of steroid psychosis is?
A) Thioridazine (Mellaril)
B) Chlorpromazine (Thorazine)
C) Haloperidol (Haldol)
D) All of the above

Answer:
D

Rationale:
Steroid psychosis is very common in ICUs but unfortunately often go undiagnosed. It occurs in about 5% of patients receiving steroids for other medical reasons. Physicians usually have a window of 1-3 days to abort the full-blown picture of steroid psychosis. Discontinuation of steroids, supportive treatment and psychotropic medications are needed.

Treatment includes Thioridazine (Mellaril) 50 to 200mg q.d. Chlorpromazine (Thorazine) 50 to 200mg p.o., q.d. or haloperidol (Haldol) 2 to 10mg po. q.d.
Symptoms of steroid psychosis sits on a wide range of spectrum including: anxiety, disturbances of body image, profound distractibility, pressured speech, emotional labiality, severe insomnia, sensory flooding, apathy, perplexity, hallucinations, agitation, mutism, delusions, depression, hypomania, and intermittent memory impairment.

Reference(s):
1. Corticosteroid-Induced Psychotic and Mood Disorders - Psychosomatics 42:461-466, December 2001
2. Psychiatric Adverse Drug Reactions: Steroid Psychosis - lecture of Richard C.W. Hall, M.D.

Question 58:

Which of the following is the immediate drug of choice to treatment of ventricular tachycardia (V.Tach.) induced by digitalis toxicity? - Choose one
A) B-blocker
B) Calcium Channel Blocker
C) Amiodarone
D) Phenytoin
E) Quinidine

Answer:
Phenytoin

Rationale:
Actually - Beta-blocker, calcium channel blocker, quindine and amiodarone should be avoided in digitalis-induced ventricular tachyarrhythmias as they may exacerbate it.
In the above situation either phenytoin or lidocaine should be the drug of choice for treatment.

Question 59:

Which corticosteroid has the highest Relative Sodium Retention (RSR)?
- Choose one
A) Prednisone
B) Methylprednisone
C) Hydrocortisone
D) Dexamethasone

Answer:
C: Hydrocortisone

Rationale:
Hydrocortisone has Relative Sodium Retention of "20" in comparison to other steroids
Prednisone's RSR is 1
Methylprednisone RSR is 0.5
Dexamethasone RSR is 0

Question 60:

You have a patient admitted with confirmed HIT (Heparin-Induced Thrombocytopenia). The patient was started on a non-heparin anticoagulant (argatroban). Once platelet counts reached a stable plateau and the INR (international normalized ratio) reached the intended target range, how many days overlap with non-heparin anticoagulation and warfarin should be continued? - Choose one
A) Switch immediately
B) 2 days
C) 3 days
D) 5 days

Answer:
D: 5 days

Rationale:
According to new (June 2008) American College of Chest Physicians Evidence-Based Clinical Practice Guidelines (8th Edition) on Treatment and Prevention of Heparin-Induced Thrombocytopenia.

"For patients with strongly suspected or confirmed HIT, we recommend against the use of vitamin K antagonist (VKA) [coumarin] therapy until after the platelet count has substantially recovered (usually, to at least 150 x 109/L) over starting VKA therapy at a lower platelet count (Grade 1B); that VKA therapy be started only with low maintenance doses (maximum, 5 mg of warfarin or 6 mg of phenprocoumon) over higher initial doses (Grade 1B); and that the nonheparin anticoagulant (e.g., lepirudin, Argatroban, danaparoid) be continued until the platelet count has reached a stable plateau, the international normalized ratio (INR) has reached the intended target range, and after a minimum overlap of at least 5 days between nonheparin anticoagulation and VKA therapy rather than a shorter overlap (Grade 1B)".

Question 61:
A 30-year female presented with complain of mild shortness of breath. The patient's electrolyte levels were: sodium 139 meq/l, potassium 3.5 meq/l, chloride 107 meq/l, and bicarbonate 20 meq/l. The patient pH on arterial blood gas revealed pCO_2 of 25 and pH of 7.45. What are the underlying acid base disturbances?

A) Metabolic acidosis
B) Metabolic alkalosis
C) Respiratory acidosis
D) Respiratory alkalosis

***Answer*:**
D: Respiratory Alkalosis

***Rationale*:**
The patient pH is 7.45 making it alkalosis, and the bicarbonate is not high, whereas the pCO_2 on arterial blood gas is low suggestive of respiratory alkalosis, as seen in a pregnant patient or in severe acute anxiety.

Question 62:
The patient underwent serum chemistry and arterial blood gas. Patient was found to have Na of 139 mEq/l, K 3 mEq/l, CL 93 mEq/L and HCO_3 of 35 mEq/L. The Patient's pH was 7.49 and pCO_2 was 41. What is the underlying acid base disturbance?

A) Mixed respiratory and metabolic alkalosis
B) Respiratory alkalosis

C) Hyperchloremic non-anion gap metabolic acidosis

D) Metabolic alkalosis

Answer:
D: Metabolic alkalosis

***Rationale*:**
The patient has pH of 7.49 suggestive of alkalosis. PCO_2 is within normal range excluding respiratory alkalosis. The pH is high and chloride is 93 mEq/L showing no indication of hyperchoremic metabolic acidosis. HCO_3 is high and expected pCO_2 is within normal range (Expected CO_2=0.9 x HCO_3+9; .9X35+9=40.5) suggestive of simple compensated metabolic alkalosis as seen with diuretic therapy.

Question 63:
A 30-year old patient with history of diabetes, presented to the hospital with complaint of nausea and vomiting. The patient's sodium was 140meq/l, potassium was 4meq/l, chloride was 105meq/l, and HCO_3 was 5meq/l. On ABG pCO_2 was 16 and pH was 7.11. What is the acid base disturbance?

A) Metabolic acidosis
B) Respiratory acidosis
C) Mixed metabolic and respiratory acidosis
D) Triple acid-base disturbance

Answer:
A: Metabolic acidosis

***Rationale*:**
Patient anion gap is high (30) suggestive of metabolic acidosis. Patient CO_2 is low, not supporting the notion of respiratory acidosis. Expected CO_2 is (pCO_2=1.5(HCO_3) +8 +/- 2; 1.5x5+8+/-2=13.5-17.5) within normal range.

Question 64:
A 60-year old patient presented with the compliant of shortness of breath. The patient has a 60-pack-year history of smoking. The patient's electrolyte levels are: sodium 140 meq/l, potassium 4 meq/l, chloride 94 meq/l, and HCO_3 36 meq/l. The patient's ABG revealed pCO_2 of 70 and pH of 7.31. What is the acid base disturbance?

A) Metabolic acidosis

B) Acute respiratory acidosis

C) Chronic respiratory acidosis

D) Mixed metabolic and respiratory acidosis

***Answer*:**
C: Chronic Respiratory acidosis

***Rationale*:**

The patient's anion gap is 10 that rules out metabolic acidosis. For every 10 Torr change in CO_2 change in pH is 0.3 for chronic and 0.8 for acute. Since the change in torr of CO_2 in this case is 30, and pH are 7.31 that make it chronic respiratory acidosis. If it would have been acute then the pH should have been 7.16 (0.08x3=0.24; 7.4-.24=7.16)

Question 65:
A 65-year old patient presented to the emergency department with respiratory distress. The patient's blood pressure was 84/60 mm Hg. The patient's electrolyte levels were: sodium 140meq/l, potassium 5 mEq/l, chloride 103 mEq/l and HCO_3 17. On arterial blood gas patient pCO_2 was 50 and pH was 7.15. What is the acid base disturbance?

A) Metabolic acidosis
B) Mixed respiratory and metabolic acidosis
C) Acute Respiratory acidosis
D) Triple Acid Base disturbance

***Answer*:**
B: Mixed respiratory and metabolic acidosis

***Rationale*:**
The patient's anion gap of 20 is suggestive of metabolic acidosis. In acute respiratory acidosis with a 10 torr change in pCO_2 the pH should be 7.32. Since pH is much lower, that of 7.32 is consistent with mixed respiratory and metabolic acidosis.

Question 66:
A non-compliant diabetic patient presented with the complaint of elevated blood sugar and vomiting. The patient's electrolyte levels were: sodium 140meq/l, potassium 3.5meq/l, chloride 95meq/l, and HCO_3 25. The patient's arterial blood gas values were: pH 7.4 and pCO_2 40. What is the acid base disturbance?

A) Metabolic acidosis
B) No acid base abnormality
C) Metabolic alkalosis
D) Metabolic acidosis and metabolic alkalosis

Answer:
D: Metabolic acidosis and metabolic alkalosis

Rationale:
The patient anion gap of 20 is suggestive of metabolic acidosis, though the pH and the HCO_3 were within normal limit, suggestive of concurrent metabolic alkalosis. Since there is no change in pH, due to combined metabolic acidosis and alkalosis the PCO_2 typically remains within normal limit.

Question 67:
A 25-year old female with a history of depression presented to the emergency department with complaint of tachypnea. She is not offering a good history. The patient's electrolyte levels were: sodium 140meq/l, potassium 3.5 mEq/l, chloride 107meq/l, and

HCO_3 13. On arterial blood gas the patient's pH was 7.56 and pCO_2 15. What is the underlying acid base disturbance?

A) Respiratory alkalosis
B) Metabolic alkalosis
C) Metabolic acidosis
D) Metabolic acidosis and respiratory alkalosis

Answer:
D: Metabolic acidosis and respiratory alkalosis

Rationale:
The patient's anion gap was 20, thus consistent with metabolic acidosis. The patient's pH is alkalotic suggestive of an alkalotic process, but since the bicarbonate is low, that goes against metabolic alkalosis. The patient's CO_2 is low consistent with respiratory alkalosis. If this low CO_2 should be due to metabolic acidosis, then compensatory CO_2 should be (pCO_2=1.5(HCO_3) +8 +/-2; 1.5x13+8+/-2=25.5-29.5). Since CO_2 is 15, it is suggestive of respiratory alkalosis. This can be seen with salicylate poisoning, as patient does have history of depression.

Question 68:
A 62-year male with a history of uretero-ileal conduit presented to the hospital with a history of not feeling well. The patient's electrolyte levels were: sodium 140meq/l, potassium 5meq/l, chloride 115meq/l, and HCO_3 were 15. Arterial blood gas results were: pH 7.3 and pCO_2 was 31. What is the acid base disturbance?

A) Metabolic acidosis
B) Hyperchloremic non-anion gap metabolic acidosis
C) Respiratory alkalosis
D) Mixed respiratory alkalosis and metabolic acidosis

***Answer*:**
B: Hyperchloremic non-anion gap metabolic acidosis

Rationale:
The patient anion gap of 10, goes against anion gap metabolic acidosis. CO_2 is low, but HCO_3 is 15 (pCO_2=1.5(HCO_3) +8 +/-2; 1.5x15+8+/-2=28.5-32.5), so the CO_2 is compensated. The patient's chloride is high, giving normal anion gap and low pH, consistent with hyperchloremic non-anion gap metabolic acidosis.

Question 69:

A patient with history of hypertension and anxiety presented to the hospital with tachypnea. The patient's electrolyte levels were: sodium 140meq/l, potassium 3meq/l, chloride 94meq/l and HCO_3 of 34. On arterial blood gas, the pH was 7.67 and pCO2 was 30. What is the acid base disturbance?

A) Respiratory alkalosis
B) Metabolic alkalosis

C) Respiratory and metabolic alkalosis
D) Hyperchloremic non-anion gap metabolic acidosis

***Answer*:**
C: Respiratory and metabolic alkalosis

***Rationale*:**
The patient's HCO_3 is high suggestive of metabolic alkalosis. The patient's expected CO_2 should be (pCO_2=HCO_3x0.9+9; 34x0.9+9=39.6); CO_2 is 30, which is lower than expected pCO_2, suggestive of mixed respiratory and metabolic alkalosis.

Question 70:
A patient presented to ED with complaint of vomiting and was found to be hypotensive. The patient's electrolyte levels were: sodium 140meq/l, potassium 3meq/l, chloride 92meq/l and HCO_3 of 29. Results of the arterial blood gas were: patient pH 7.61 and pCO_2 30. What is the underlying acid-base disturbance?

A) Mixed respiratory and metabolic alkalosis
B) Mixed respiratory alkalosis and metabolic acidosis
C) Respiratory alkalosis, metabolic acidosis and metabolic alkalosis
D) Respiratory acidosis and Respiratory alkalosis

Answer:
C: Respiratory alkalosis, metabolic acidosis and metabolic alkalosis

Rationale:
The patient's pH is high suggestive of alkalosis. The patient's HCO_3 is high suggestive of metabolic alkalosis, the PCO_2 should be high to compensate, but it is low, suggestive of concurrent respiratory alkalosis. The patient's anion gap of 19 is suggestive of metabolic acidosis. Hence the picture is consistent with metabolic acidosis, metabolic alkalosis and respiratory alkalosis. The patient cannot have respiratory acidosis and respiratory alkalosis together, as one cannot breathe slowly and fast at the same time.

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