1. Regarding targeted temperature management TTM after cardiac arrest
    a) TTM should be implemented for at least 72 hours after arrest
    b) Target temperature should be between 32 and 36 degrees
    c) Rapid infusion of 60ml/kg of IV iced normal saline should be used after ROSC
    d) Once TTM period is finished, there is no guide on what temperatures should be kept at if a patient remains comatosed

2. Which of the following is **incorrect** in describing renal handling of acid base balance
    a) Renal tubular acidosis type 1 distal inhibits H+ extrusion and serum bicarb decreases to a steady state level
    b) 15% of bicarbonate reclamation occurs in the distal tubule
    c) If serum is acidotic, formation of new bicarbonate in the distal tubule to may take up to 4 -5 days to reach equilibrium
    d) Ammonia has no effect on acid excretion

3. Regarding acid and base compensation which is correct
    a) Correlation between venous and arterial pH is poor especially in DKA
    b) Compensation in chronic respiratory alkalosis may be efficient enough to normalize pH
    c) A patient cannot have a normal pH if there is a disease process causing metabolic acidosis
    d) In an ABG with a high pH, acidosis can be excluded

4. When calculating the anion gap
    a) Measured values of K is always needed to accurately calculate anion gap
    b) Anion gap > 12 is always abnormal
    c) Most of the normal anion gap in healthy individuals consists of albumin
    d) Anion gap cannot be normal if there is an elevated lactate

5. Which is **not** a cause for a high anion gap metabolic acidosis
    a) Renal tubular acidosis
    b) Methanol consumption
    c) Uremia
    d) Infections

6. Which is **not** a cause for a normal anion gap metabolic acidosis
    a) Addisons
    b) Hypochloraemia

c) Acetazolamide
d) High output stoma

7. Which is correct when calculating compensation for acid / base disturbances
   a) For metabolic acidosis expected pCO_2 = 1.5x bicarb – 8
   b) For chronic respiratory acidosis every 8mmHg rise in pCO_2 will result in a 4mmol rise in bicarb
   c) For metabolic alkalosis expected pCO_2 = 0.7x bicarb + 10
   d) pCO_2 usually cannot compensate below 12 in spontaneously respiration

8. Which is a cause of chloride sensitive metabolic alkalosis
   a) Renal artery stenosis
   b) Conn's syndrome
   c) Excess licorice consumption
   d) Cystic Fibrosis

9. Which is a cause of chloride insensitive metabolic alkalosis
   a) Cushings
   b) Diuretics
   c) Diarrhea
   d) Vomiting

10. What is a potential complication of metabolic alkalosis
    a) Shift in oxygen dissociation curve to the right
    b) Hyperventilation
    c) Seizures
    d) Hypercalcaemia

11. Which is **not** a treatment for severe metabolic alkalosis
    a) Frusemide
    b) Supportive care
    c) Acetazolamide
    d) Hydrochloric acid

12. Regarding delta ratio (AG-12)/(24-bicarb)
    a) <0.4 suggests a pure high anion gap metabolic acidosis
    b) 0.4 – 0.8 suggests a concurrent metabolic acidosis and alkalosis
    c) 1 – 2 suggests a pure high anion gap metabolic acidosis
    d) >2 suggests a combined high and normal anion gap metabolic acidosis

13. Which is true regarding A-a gradient and the alveolar gas equation
    a) Water vapour pressure is 37
    b) A-a gradient varies with age and FiO2
    c) An A-a gradient > 14 is always abnormal
    d) Respiratory quotient is 0.5

14. Regarding gas exchange in the alveolus which is correct
    a) CO2 is x20 more soluble than O2 so is unaffected by pulmonary oedema which increases diffusion distance
    b) Erythrocytes freely enter pulmonary capillaries sometimes many pass simultaneously to maximize O extraction
    c) When total surface area of the lung is half that of normal, significant impedance of gas exchange occurs
    d) If Hb is already saturated, increasing pressure gradient of O2 across the alveolar membrane will make no difference to oxygenation

15. Which of the following is true of VQ mismatch
    a) Pneumonia produces greater ventilation than perfusion
    b) Pulmonary embolism produces a vascular right to left shunt
    c) Pulmonary circulation will vasodilate in response to hypoxia
    d) Thebesian veins adds to right to left shunt

16. Which factor shifts oxygen dissociation curve to the right
    a) Acidosis
    b) Low pCO2
    c) Hypothermia
    d) Low 2,3 DPG

17. Which situation will increase ET CO2
    a) Decreased cardiac output
    b) Hyperthermia
    c) Hyperventilation
    d) Pulmonary Embolism

18. Which is **not** true of sepsis treatment as per 2015 guidelines
    a) Lactate > 4 infers a >40% mortality
    b) Blood products should only be given if Hb < 7 g/dl
    c) Administration of fluids if hypotensive and broad spectrum antibiotics should be done within the first 3 hours of presentation
    d) Aiming for a mixed venous oxygen saturation of >65% is no longer a critical step in treating sepsis

19. Which is **incorrect** regarding serum osmolality
    a) Normal serum osmolarity is between 275 – 295 mOsm/L
    b) The normal osmolar gap is 10
    c) Exogenous Alcohols, hyperlipidaemia, hyperproteinemia can increase the measured osmolality – calculated osmolarity
    d) The calculated osmolarity = (2 x Na) + K + glucose + urea

20. Which is correct about central pontine myelinolysis
    a) It is caused by rapid fluid shift into cells causing lysis
    b) Highest risk occurs if Na is corrected faster than 1 mmol/L/h in patients with hyponatraemia <120mmol/L that has lasted >48 h
    c) After rapid correction of Na, conscious state may improve then deteriorate after 3-5 days
    d) Symptoms include headache, vertigo, diplopia, hearing loss

21. What is the corrected sodium for hypertonic hyponatraemia if Na = 120 and glucose = 36
    a) 150
    b) 140
    c) 130
    d) 120

22. Which of the following conditions would result in a urine Na < 20 mmol/L in a hypovolaemic hyponatraemic patient
    a) Diuretic use
    b) Severe burns
    c) Salt wasting nephropathy
    d) Addisons

23. Which of the following characteristics is **not** typical of SIADH?
    a) Serum osmolarity > 275 mOsm/L
    b) Euvolaemia
    c) Urine Na > 20 mmol/L
    d) Urine osmolality > 200 mOsm/L

24. Regarding hypervolaemic hypotonic hyponatraemia which will have a urine Na >20mmol/L
    a) Renal failure
    b) Congestive cardiac failure
    c) Nephrotic syndrome
    d) Cirrhosis

25. A 50 yo male patient presents with true serum Na = 105, whilst in emergency he has a seizure, what fluid should be given to stop seizure activity?
    a) 3% saline 100ml over 8 hours
    b) 0.9% saline 1L over 8 hour
    c) 0.9% saline 100mL over 1 hour
    d) 3% saline 100ml over 1 hour

26. Which is **not** correct regarding hypernatraemia
    a) Initial fluid replacement for severe hypernatraemia should be 0.9% saline
    b) If plasma osmolality is >350 mOsm/kg mortality can be >50%
    c) May be associated with hypocalcaemia
    d) Severe cerebral cell shrinkage can occur in chronic hypernatraemia

27. Which of the following are **not** true about potassium
    a) Approximately 70-75% of potassium is in muscle tissue
    b) For every fall of 0.1 in pH from 7.4 the serum potassium increases by 0.5 mmol/L

c) 50% of potassium is excreted by the kidneys
d) Extracellular potassium accounts for 2% of total body potassium

28. What is an ECG change in hypokalaemia
    a) Short PR interval
    b) ST elevation
    c) T wave inversion
    d) Widened QRS

29. Which ECG change in hyperkalaemia corresponds with the K level
    a) K 5.6 = Flattened P wave
    b) K 6.0 = Sine wave appearance
    c) K 6.8 = Widened QRS
    d) K 8 = Sinus bradycardia

30. In the treatment of hyperkalaemia which is correct
    a) IV calcium gluconate will decrease K by 1 mmol/L
    b) If a patient is digoxin toxic, calcium gluconate should not be given
    c) Salbutamol will only decrease K for 30 minutes post administration
    d) Sodium polystyrene sulfonate will decrease QRS prolongation within 30 minutes

31. Which of the following would **not** be a cause of hypocalcaemia
    a) Alcoholism
    b) Acute pancreatitis
    c) Chronic renal failure
    d) Hypophosphatemia

32. Regarding hypocalcaemia which is correct
    a) Decreased levels reduces the strength of myocardial contractions primarily by inhibiting relaxation
    b) Symptoms occur when ionized levels fall < 0.7 mmol/L and are not related to rate of decrease
    c) Trousseau sign (carpal spasm post BP cuff inflated above systolic for 3 min) and Chovstek sign (twitch at corner of mouth when facial nerve is tapped) are weak signs for clinical diagnosis

d) Paresthesia around the mouth and fingertips, irritability and hyperactive deep tendon reflexes are late symptoms

33. What are the ECG changes in hypocalcaemia
    a) Dysrhythmias are common
    b) Prolonged QT
    c) T wave inversion
    d) Widened QRS

34. Regarding treatment of hypocalcaemia
    a) Ratio of calcium in mmol/10mL between CaCl: Ca gluconate = 1:2 (approx.)
    b) Magnesium should be replaced in conjunction with Ca replacement
    c) There is little interaction between Calcium replacement and anti-arrhythmics
    d) Calcium replacement is needed after every unit of blood during transfusions

35. Which is **not** a symptom of hypercalcaemia
    a) Renal calculi
    b) Skeletal deformities
    c) Hallucinations
    d) Diarrhea

36. Which is an ECG feature of hypercalcaemia
    a) Osborn J waves
    b) Prolonged QT
    c) Depressed T waves
    d) Widened QRS

37. Which is not an initial treatment of symptomatic hypercalcaemia
    a) IV fluid rehydration
    b) Correct other electrolytes
    c) Frusemide
    d) Bisphosphonate such as pamidronate

38. Regarding hypomagnesemia which is **not** true
    a) ECG changes include prolonged PR and QT, wide QRS, ST depression and inversion of T waves
    b) Hypokalaemia, hypocalcaemia and hypophosphatemia are often associated
    c) Symptoms include ataxia, tetany, hyper-reflexia and muscle weakness
    d) Causes include hypothyroid, renal failure and Rhabdomyolysis

39. Which of the following is correct about hypophosphatemia
    a) A very important finding in refeeding syndrome
    b) Symptoms can appear early and are easily recognized
    c) There is little cardiovascular effects of low phosphate
    d) Patients presenting with DKA can often have low phosphate

Answers

1. B (ANCOR guidelines 11.8 JAN 2016: TTM should be at least 24h, aim temp 32-36, infuse up to 30ml/kg and avoid larger volumes, if patient remains comatosed aim temp 32-36 degrees)
2. D ([H+] is trapped in lumen by ammonia and inorganic phosphate, glutamine generates bicarb and ammonia)
3. C (good correlation between venous and arterial pH and bicarb but pCO2 is more controversial, compensation cannot fully return pH to normal if a single acid / base disturbance is present except for chronic respiratory alkalosis, a normal pH can occur with concurrent metabolic acidosis and alkalosis, alkalemia does not exclude acidosis)
4. C (Anion gap = Na – Cl – bicarb, Anion gap 12+/- 4 although >15 is always high, every 1g/L decrease in albumin will decrease anion gap by 0.25 -> LITFL 9 September 2015 revision)
5. A (Acute tubular necrosis, Lactate Toxins Ketoacidosis Renal)
6. B (Hyperchloraemia, Addisions Bicarb loss Chloride excess Diuretics acetazolamide although top 2 most common causes are diarrhea and renal tubular acidosis)
7. D (metabolic acidosis expected pCO2 = 1.5 x bicarb + 8, chronic respiratory acidosis every 10 rise in CO2 = 4 rise in bicarb, metabolic alkalosis expected pCO2 = 0.7 x bicarb + 20 also pCO2 = 0.9 x bicarb + 9, from anaesthesiamcq.com and edexam.com.au)
8. D (causes of chloride sensitive ie hypochloraemic alkalosis: vomiting, diarrhea, diuretics, cystic fibrosis, chloride wasting enteropathy)
9. A (causes of chloride sensitive alkalosis: renal artery stenosis, renin secreting tumours, adrenal hyperplasia, hyperaldosteronism, Cushings, Liddle syndrome, Licorice excess, Fludocortisone excess)
10. C (tetany, neuromuscular instability, seizures, constriction of arterioles with reduced coronary and cerebral blood flow, low calcium potassium magnesium phosphate with refractory dysrhythmias, worsen COPD due to shift of oxygen dissociation curve to the left)

11. A (hydrochloric acid if acetazolamide does not help)
12. C (<0.4 pure normal anion gap metabolic acidosis, 0.4-0.8 high and normal AG met acidosis, 1-2 pure high anion gap met acidosis, >2 concurrent metabolic acidosis and alkalosis, all from anaesthesiamcq.com and LITFL)
13. B (pAO2 = [atm pressure 760 – water vapour 47] x FiO2 – pCO2 / [respiratory quotient 0.8], normal A-a gradient is <15 but varies with age and FiO2)
14. A (erythrocytes must squeeze through pulm capillaries, when total surface area is reduced to <1/3 to 1/4 normal then gas exchange is significantly impeded, increasing pressure gradient by 100% fiO2 or hyperbaric O2 facilitates O2 loading)
15. D (pneumonia is a right to left shunt where Q > V, PE is where V > Q, pulmonary circulation vasoconstricts in response to areas of low O2 tension)
16. A (low temp, 23DPG, CO2 shifts to the left; alkalosis, carboxy Hb, fetal Hb, methemoglobin shifts to the left)
17. B (increase ET CO2 = high cardiac output, hypoventilation, hyperthermia, bicarb admin, insufflation CO2 laparoscopy; decrease ET CO2 = low cardiac output, hyperventilation, hypothermia, PE, misplaced or kinked ETT)
18. A (lactate of >4 infers a 28% mortality)
19. D (osmolarity = 2 x Na + glucose + urea)
20. C (Caused by high plasma osmolality causing fluid shift out of cells, correction should be 0.5 mmol/L/hour especially in >48h of Na <120 mmol/L, symptoms: altered GCS; dysarthria; dysphagia; convulsions; pseudobulbar palsy; quadraparesis -> also see Cameron 4th edition page 540)
21. C (Tintinalli is American so calculations are difficult, for every 3mmol/L rise in glucose above normal adjust serum sodium upwards by 1 mmol/L -> Cameron 4th edition page 537, also corrected Na = Na + glucose/3 -> edexam.com.au)
22. B (hypovolaemic hyponatraemia with urine Na >20 = renal causes, urine Na < 20 = extra renal causes)
23. A (Hypotonic hyponatraemia, urine osmolality high > 200 mOsm/L, high urine Na > 20mmol/L, euvolaemic, normal adrenal; renal; cardiac; hepatic; thyroid functions, correctable with fluid restriction)
24. A (renal failure unable to excrete free water, only exception to renal condition causing high urine Na is nephrotic syndrome)
25. D (In cases where hyponatraemia <120 developes rapidly < 48 hours and is associated with coma or seizures, admin 3% saline at 25-100 ml/h, the rise in Na should be no greater than 0.5-1 mmol/L/h but can be increased to 1-2 mmol/L/h if seizures occur)
26. D (Although intracranial bleeds or thrombosis can occur, if hypernatraemia persists for more than a few days brain water contents may return to normal due to idiogenic osmoles)
27. C (90% excreted by kidneys)
28. C (increased amp of p wave, prolonged PR, T wave flat or inverted, ST depression, U wave, prolonged QT or QU)
29. D (K>5.5 = peaked T wave, K>6.5 = P wave flatten; prolonged PR, K>7 = prolonged QRS; sinus brady or slow AF; arrhythmias, K>9 = cardiac arrest, all from LITFL)

30. B (calcium: membrane stabilization onset 1 minute duration 30 min, insulin: shifts K into cells onset 30 min duration 4 hours, salbutamol: shifts K into cells onset 30 min duration 4 hours, Bicarbonate: shifts K into cells onset 10 min duration 2 hours, resonium: GI excretion of K onset 1-2 hours duration 6 hours. Giving Ca when dig toxic potentiates digoxin's toxic cardiac effects)
31. D (causes: VitD deficient, malabsorption, alcoholism, CRF, diuretics, hypoparathyroid, sepsis, pancreatitis, massive transfusion, hypomagnesemia, rhabdo, hyperphosphatemia)
32. A (symptom severity depends greatly on rate of decrease, Trousseau and Chovstek signs are good clinical indicators, initials symptoms are Paresthesia around the mouth and fingertips, irritability and hyperactive deep tendon reflexes)
33. B (dysrhythmias are uncommon except for AF as per LITFL)
34. B (CaCl 10% 10ml = 6.8mmol, CaGluconate 10% 10ml = 2.2mmol, Ca replacement can potentiate digoxin toxicity, massive transfusion replace Ca after every 4-6 unit)
35. D (Stones renal colic, bones osteolysis, moans psychiatric disorder, groans ulcer pancreatitis constipation)
36. A (Short QT, short ST, widened T waves, bundle branch blocks and heart blocks, Osborn J waves in severe cases -> LITFL)
37. C (loop diuretics no longer recommended, hypercalcaemia associated with hypokalaemia and hypomagnesaemia, other drug: calcitonin)
38. D (causes: Iv glucose, pancreatitis, cirrhosis, malnutrition, diuretics, hyperthyroid, diarrhea)
39. A (Symptoms are unlikely to appear until levels are quite low, can cause impaired myocardial function, treatment of DKA 12 - 24 hours later or alcoholic ketoacidosis can cause low phosphate)