# Blood Gas SAQs

Emergency Medicine Fellowship Program

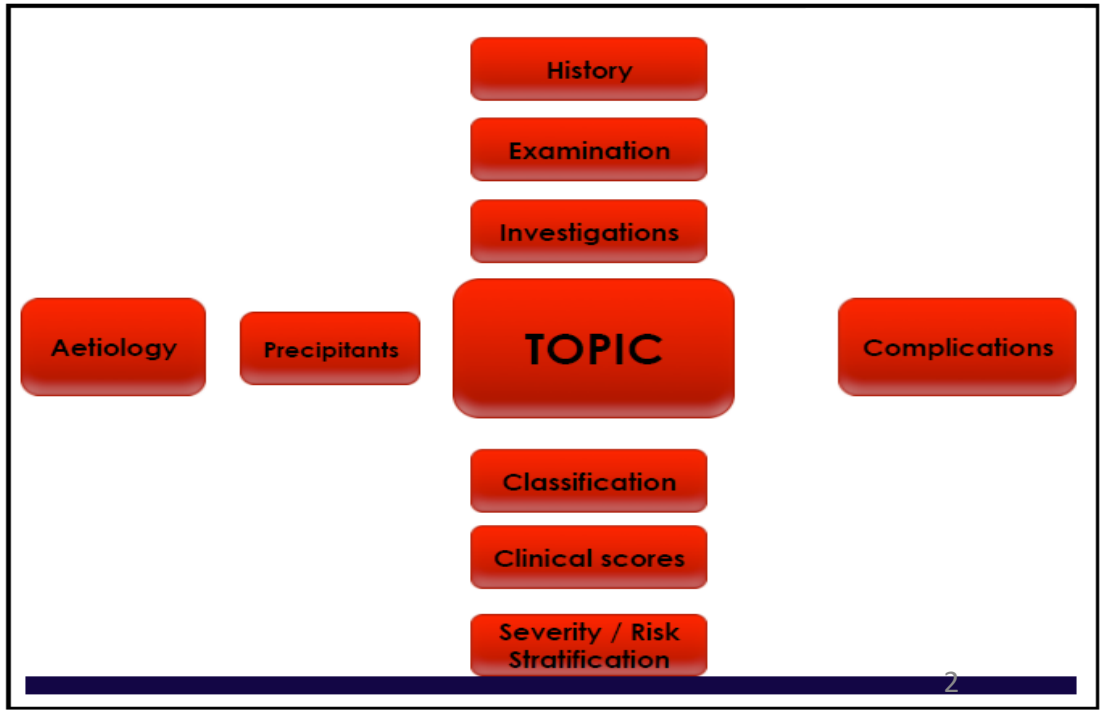
How to use this book:

1) Complete SAQs
- < 3 months until exam: Exam conditions – focus on clear answers ‘to time’
- 3-6 months until exam: Transition towards exam conditions
- > 6 months until exam: Open book is ok, ‘focus on good answers and developing knowledge acquisition

2) Read and study around SAQ
- Use each SAQ as motivation to study around the individual topic
- Think about the different ways the topic could come up in the SAQ exam (use the topic structure provided by APEM course)

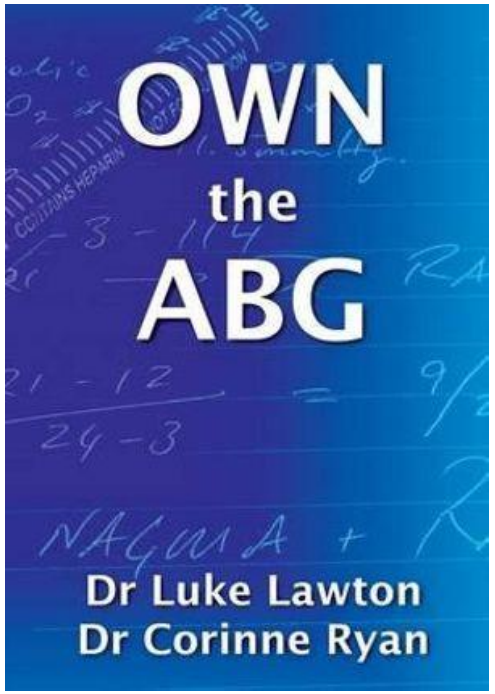
3) Write SAQs to further develop this program
- Review syllabus of medical expertise
- Create SAQs relating to topics not covered in this book, please format to be in exam-format, include answers
- This will help further develop this program as well as help you think like an examiner
- Return to ben.shepherd86@gmail.com

ALL THE BEST!



### 3.14 Acid Base Disorders

a) Interpretation of arterial blood gases I Ex
   i) Alveolar gas equation I H
   ii) A-a gradient I H
b) Metabolic acidosis I H
c) Metabolic alkalosis I H
d) Respiratory acidosis I H
e) Respiratory alkalosis I H
f) Anion gap I Ex
g) Osmolar gap I H
h) Indications for the administration of sodium bicarbonate D H




**Expectation of Answer of Blood Gas Question**

1) State primary disturbance
   - Discuss provisional and DDx
2) Identify other disturbances
   - Discuss provisional and DDx
3) Assess for compensation
4) Assess/correct electrolytes
5) Assess Oxygenation

**Finally**

Summarise issues and management priorities

| Column "LO" – Categories of Learning Objectives | | | Column "LP" – Levels of Practice |
|---|---|---|---|
| DIS - Diseases/Injuries/Symptoms | D - Pharmacological & toxicological agents | | Ex - Expert |
| E - Physical Examination | P - Procedures | S - Systems | H - High |
| I - Investigations | Eq - Equipment | NCI - Non-clinical/clinical interface | G - General |
| M - Medical Interventions | T - Theories | | |

## DDx Lactaemia

| Type A (↓O2 delivery) | Type B |
|---|---|
| Shock<br>Other:<br>-Severe hypoxia<br>-Severe anaemia<br>-CO/CN poisoning | B1 (medical problems)<br>-sepsis<br>-liver failure<br>-thiamine deficiency<br>-diabetes<br>B2 (drugs)<br>-metformin / iron / salicylates and many more<br>B3 (inborn errors) |

**Delta Ratio** = $\frac{AG - 12}{24 - HCO3}$

< 0.4 = Isolated NAGMA

0.4-0.8 = Mixed NAGMA + HAGMA

1-2 = Isolated HAGMA

>2 = HAGMA + metabolic alkalosis

## DDx HAGMA

K: Ketones [Diabetic / Starvation / Alcoholic]
U: Uraemia
L: Lactate
D: Drugs [not directly via lactate]
-toxic alcohols: methanol / ethylene glycol
-salicylates
-toluene

**pH 7.4**

**HCO3 24**

**pCO2 40**

**pO2 100**

**Lactate 2**

## DDx NAGMA

Hyperchloraemia [e.g. NaCl]
GI loss of HCO3 [diarrhoea / fistulas]
Renal Loss [Acetazolamide, Spironolactone, RTA]
Adrenal Insufficiency
Early Uraemia /Recovering DKA etc

**Expected HCO3 (1-2-4-5 rule)**

1: Acute Resp Acidosis CO2 ↑ 10mmHg = HCO3 ↑ by 1mmol/L

2: Acute Resp Alkalosis CO2 ↓ 10mmHg = HCO3 ↓ by 2mmol/L

4: Chronic Resp Acidosis: every CO2 ↑10mmHg = HCO3 ↑ by 4mmol/L

5 Chronic Resp Alkalosis CO2 ↓ 10mmHg = HCO3 ↓ by 5mmol/L

**DDx Metabolic Alkalosis**

| **Chloride Sensitive**<br>**U Cl < 20** | **Chloride Resistant**<br>**U Cl >20** |
|---|---|
| GI Loss [Vomiting / Diarrhoea / NG suction]<br>Diuretic use<br>Exogenous Alklali (Mild Alkali, NaHCO3)<br>Contraction Alkalosis (volume depletion) | Mineralocorticoid Excess [Cushings / Conns / Adrenal Hyperplasia] |

**Aa gradient** (normal = 4 + age/4)

A-a gradient = PAO2 – paO2

PAO2 = fiO2 x 713 – pCO2/0.8

**P/f ratio:** paO2 / fiO2 ratio

Clinical indicator of hypoxia

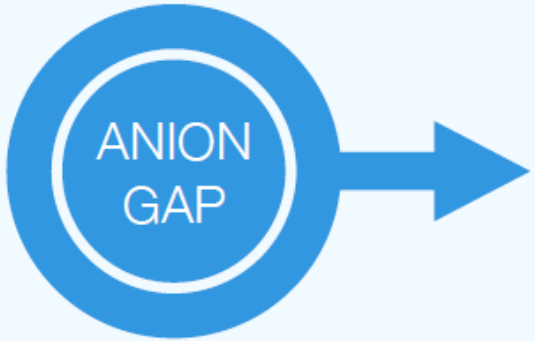
Normal > 500 (at sea level)

**Corrected Values**

K+ for pH: every 0.1 away from pH 7.4, K+ changes by 0.5mmol/L in opposite direction

Na+ for BSL: Na + (BSL-5) /3

# THE 3 ACIDOSIS EXAM RULES

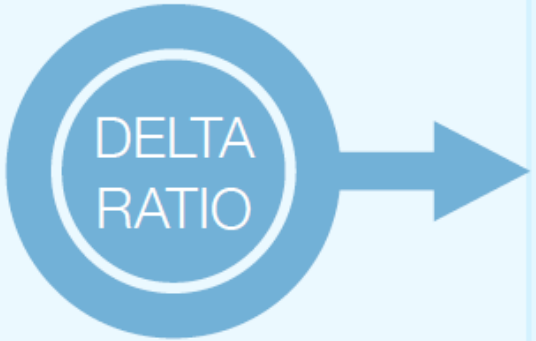



## Rule 1

If you see a metabolic acidosis, you **must** calculate the **anion gap**

$$\text{ANION GAP} = [Na]-[HCO_3]-[Cl]$$

Normal 12 (range 6-15)
Albumin correction = AG +¼(44-albumin)




## Rule 2

If the anion gap is elevated, you should calculate the **delta ratio**

$$\text{DELTA RATIO} = \frac{\uparrow \text{ in AG}}{\downarrow \text{in } [HCO_3]}$$

$$\text{DELTA RATIO} = \frac{\text{AG - 12}}{\text{24 - } [HCO_3]}$$

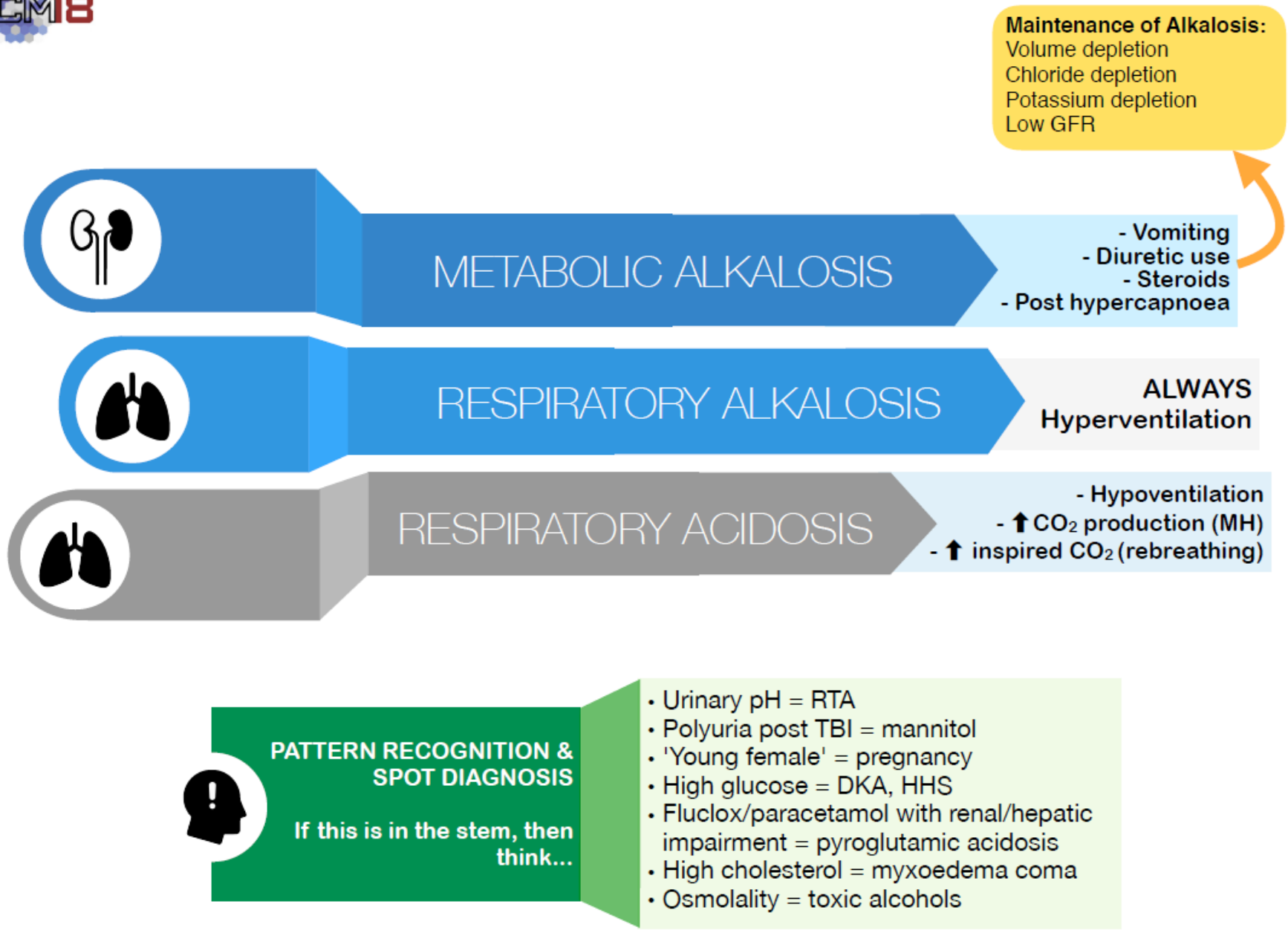
<0.8 = combined HAGMA & NAGMA
1-2 = uncomplicated HAGMA
>2 = pre-existing metabolic alkalosis

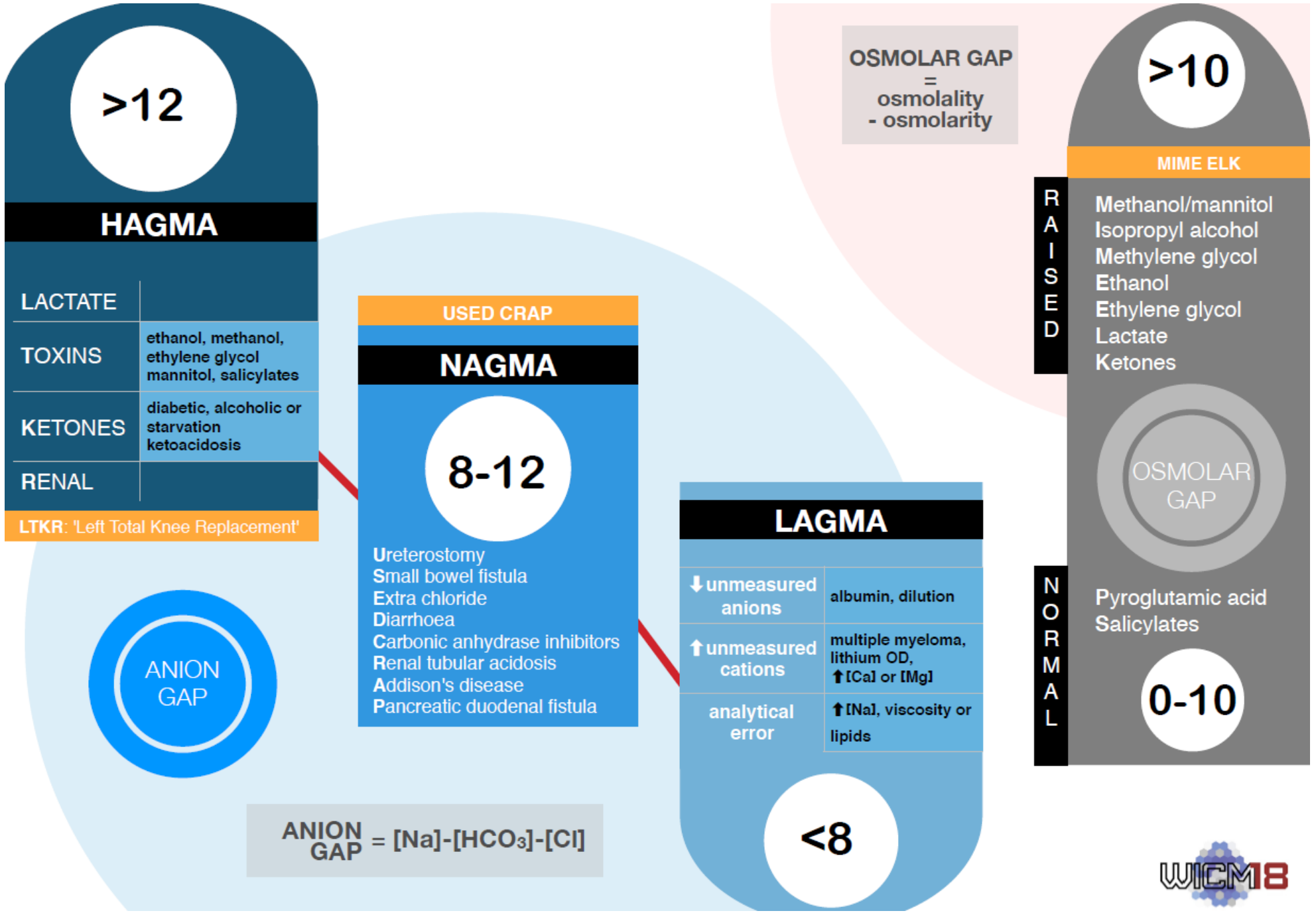

## Rule 3

If you see a measured osmolality, you **must** calculate the **osmolar gap**

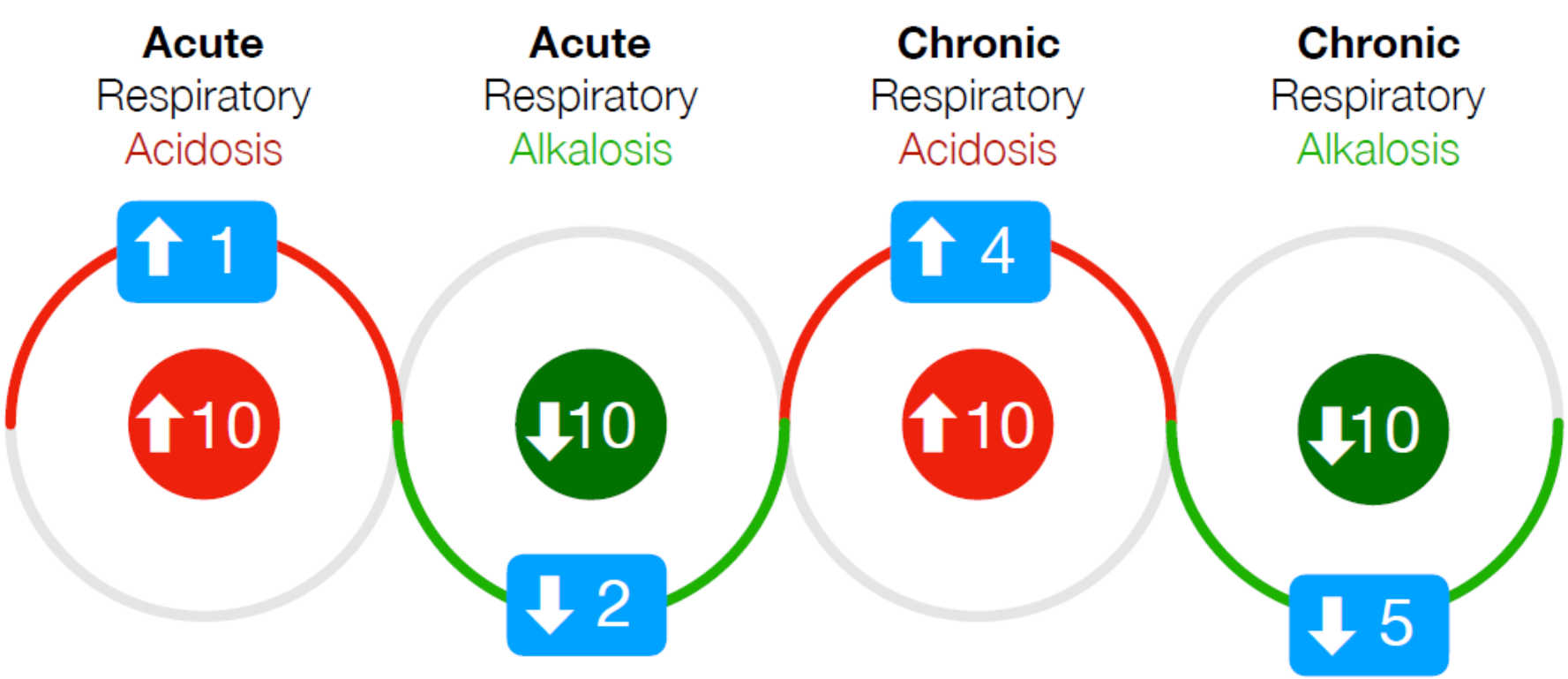
$$\text{OSMOLAR GAP} = \text{osmolality - osmolarity}$$

osmolality is *measured*
osmolarity is *calculated*
**calc osmolarity = 2[Na]+urea+glucose**


Maintenance of Alkalosis:
Volume depletion
Chloride depletion
Potassium depletion
Low GFR
METABOLIC ALKALOSIS
- Vomiting
- Diuretic use
- Steroids
- Post hypercapnoea
RESPIRATORY ALKALOSIS
ALWAYS
Hyperventilation
RESPIRATORY ACIDOSIS
- Hypoventilation
- ⬆ $CO_2$ production (MH)
- ⬆ inspired $CO_2$ (rebreathing)
PATTERN RECOGNITION & SPOT DIAGNOSIS
If this is in the stem, then think...
• Urinary pH = RTA
• Polyuria post TBI = mannitol
• 'Young female' = pregnancy
• High glucose = DKA, HHS
• Fluclox/paracetamol with renal/hepatic impairment = pyroglutamic acidosis
• High cholesterol = myxoedema coma
• Osmolality = toxic alcohols


>12
HAGMA
LACTATE
TOXINS
ethanol, methanol, ethylene glycol mannitol, salicylates
KETONES
diabetic, alcoholic or starvation ketoacidosis
RENAL
LTKR: 'Left Total Knee Replacement'
ANION GAP
USED CRAP
NAGMA
8-12
Ureterostomy
Small bowel fistula
Extra chloride
Diarrhoea
Carbonic anhydrase inhibitors
Renal tubular acidosis
Addison's disease
Pancreatic duodenal fistula
LAGMA
⬇unmeasured anions
albumin, dilution
⬆unmeasured cations
multiple myeloma, lithium OD, ⬆[Ca] or [Mg]
analytical error
⬆[Na], viscosity or lipids
<8
ANION GAP = [Na]-[HCO3]-[Cl]
OSMOLAR GAP = osmolality - osmolarity
>10
MIME ELK
RAISED
Methanol/mannitol
Isopropyl alcohol
Methylene glycol
Ethanol
Ethylene glycol
Lactate
Ketones
OSMOLAR GAP
NORMAL
Pyroglutamic acid
Salicylates
0-10

# COMPENSATION RULES




$HCO_3^-$ ⬆1 mmol for every

10mmHg⬆in $CO_2$>40

**A**cute A**C**idosis

***1** for 10*

$HCO_3^-$ ⬇2 mmol for every

10mmHg ⬇in $CO_2$<40

**A**cute A**L**kalosis

***2** for 10*

$HCO_3^-$ ⬆4 mmol for every

10mmHg⬆in $CO_2$>40

**C**hronic A**C**idosis

***4** for 10*

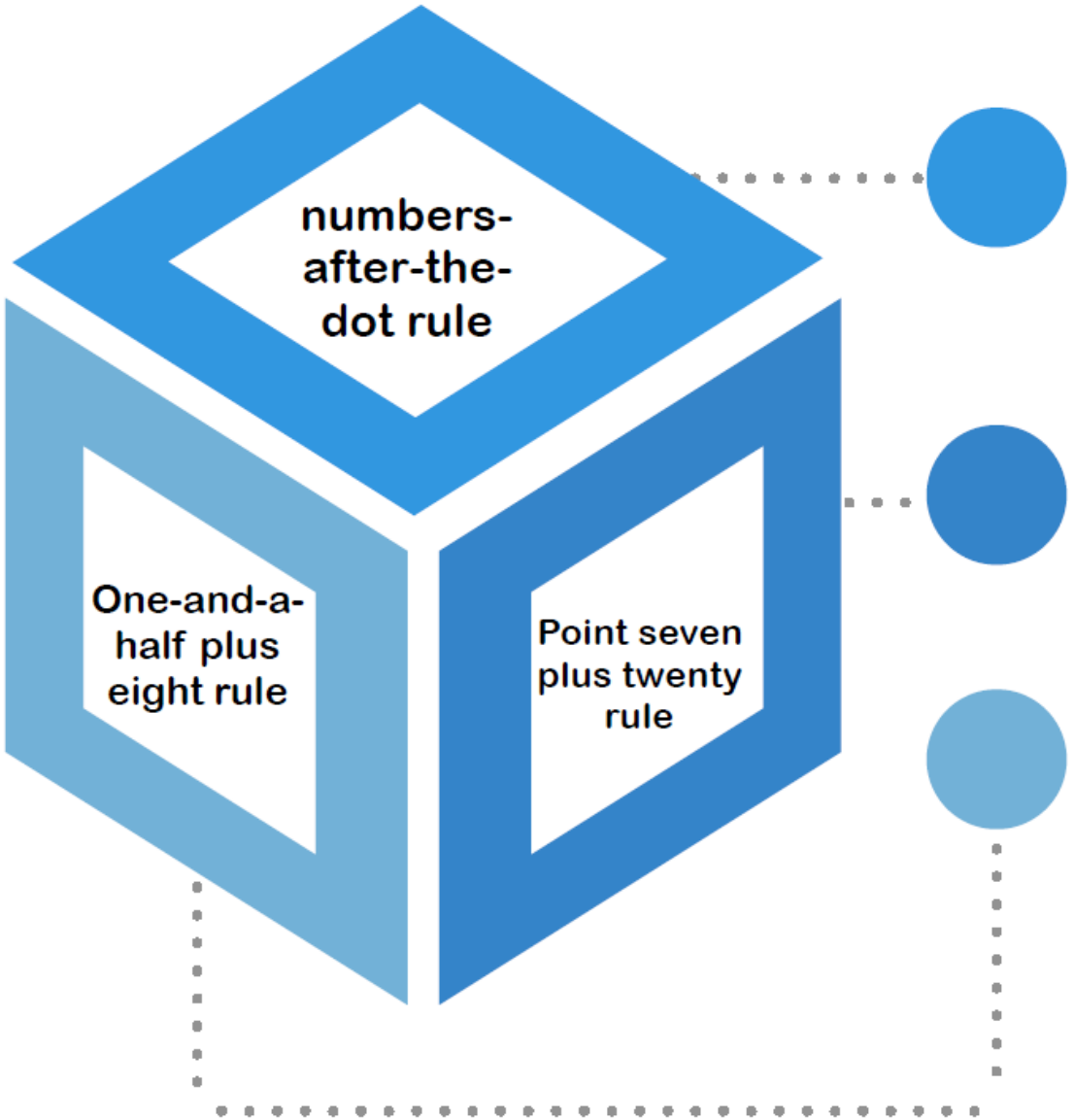
$HCO_3^-$ ⬇5 mmol for every

10mmHg ⬇in $CO_2$<40

**C**hronic A**L**kalosis

***5** for 10*

# ACID BASE CHEATS




## ANY METABOLIC DISORDER

**expected $CO_2$ = digits after the pH decimal point**

only works where there is a single process

## METABOLIC ALKALOSIS

**expected $CO_2 = 0.7 \times [HCO_3] + 20$**

## METABOLIC ACIDOSIS

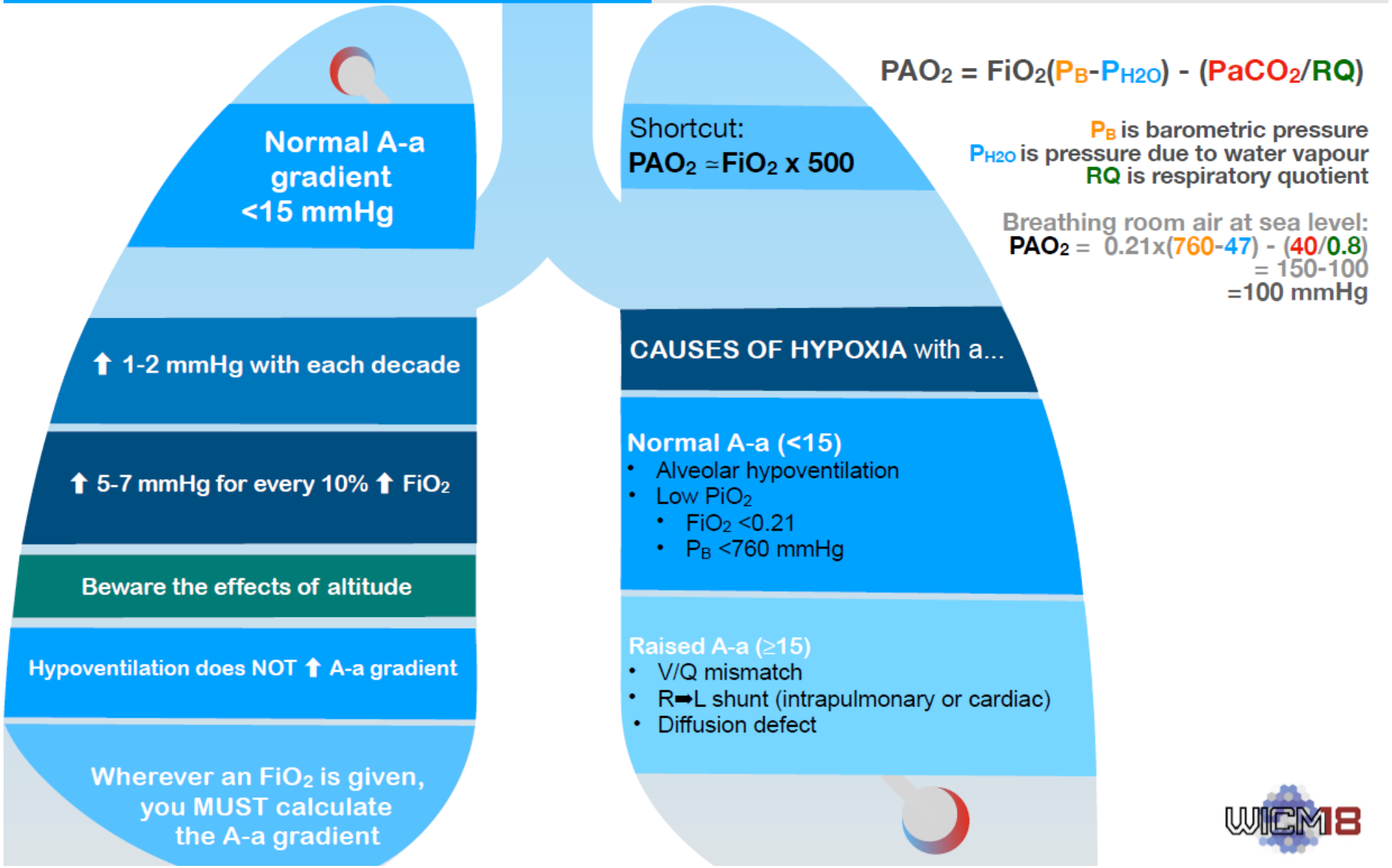
**expected $CO_2 = 1.5 \times [HCO_3] + 8$**

If the pH is normal, there must be

- 2 or more problems *(mixed picture)*
- no problem *(never in the exam)*
- pregnant patient *(compensated respiratory alkalosis)*

# A-a GRADIENT

= $PAO_2$ - $PaO_2$
= alveolar (calc) - arterial (measured)



A 20 year old male presents with a 3 day history of lethargy and generalised malaise. He is confused and looks unwell. The following venous blood tests are obtained.

| | | | |
|---|---|---|---|
| pH | 7.08 | | |
| pCO2 | 20 | mmHg | (35-45) |
| HCO3 | 16 | mmol/L | (22-28) |
| BE | -22 | mmol/L | (-3-3) |
| Lactate | 9 | mmol/L | (<2.2) |
| Glucose | 44 | mmol/L | (3.9-5.8) |
| | | | |
| K | 2.7 | mmol/L | (3.5-4.2) |
| Na | 160 | mmol/L | (135-145) |
| Cl | 124 | mmol/L | (95-110) |
| | | | |
| Creatinine | 70 | micromol/L | (60-110) |
| Urea | 5.3 | mmol/L | (3-8) |

i. Interpret the above results, and show any relevant calculations (5 marks)

ii. Outline your immediate management priorities (5 marks)

A 2 year old boy is brought to your emergency department by his grandparents having found him unresponsive at their home. He has no significant past medical history.

On examination he is very drowsy with a GCS of 7 (E2, V1, M4) and has the following observations:

| | | |
|---|---|---|
| HR | 140 | /min |
| BP | 80/50 | mmHg |
| RR | 18 | /min |
| O2 saturation | 100% | on 2L/min O2 via nasal cannulae |
| Temperature | 36.5 | oC |

His initial blood results are shown:

**Venous blood gas**

| | | | Reference Range |
|---|---|---|---|
| pH | 7.1 | | 7.35 – 7.45 |
| pO2 | 50 | mmHg | |
| pCO2 | 37 | mmHg | 40 – 52 |
| HCO3- | 11 | mmol/L | 24 – 32 |
| Lactate | 8.8 | mmol/L | 0.5 – 2.0 |
| Na+ | 143 | mmol/L | 135 – 145 |
| K+ | 3.8 | mmol/L | 3.5 – 4.8 |
| Cl- | 110 | mmol/L | 95 – 110 |
| Glucose | 1.8 | mmol/L | 3.0 – 6.0 |

1. List five (5) significant abnormalities on the blood gas

2. What is the acid/base disturbance? Show your calculations.

3. List five (5) relevant differential diagnoses.

A 20 year old woman with a history of diabetes mellitus presents to your emergency department with fever, acute respiratory distress and chest pain.
Her observations on arrival (pre treatment) are:

| | | |
|---|---|---|
| GCS | 14 | (E4, V4, M6) |
| HR | 128 | beats/min |
| BP | 85/45 | mmHg |
| $SaO_2$ | 90% | on 10L $O_2$ via Hudson mask |

Arterial blood gases and serum biochemistry are taken after 20 minutes of supplemental oxygen therapy. Results are given below.

| | | | |
|---|---|---|---|
| $FiO_2$ | 100% | | |
| pH | 7.20 | mmHg | (7.36 - 7.44) |
| $pCO_2$ | 28 | mmHg | (35 - 45) |
| $pO_2$ | 150 | mmHg | (85 - 110) |
| $HCO_3$ | 15 | mmol/L | (21 - 28) |
| Na+ | 140 | mmol/L | (135 - 145) |
| K+ | 6.0 | mmol/L | (3.2 - 4.3) |
| Cl- | 95 | mmol/L | (99 - 109) |

**i.** Calculate this patients alveolar $pO_2$ ($pAO_2$), using the alveolar gas equation. Show your calculations and results.

**ii.** Using your answer from question 1, calculate this patients alveolar-arterial (A-a gradient) for oxygen.

**iii.** List two (2) possible causes of your findings and justify your answer.

| | Cause | Justification |
|---|---|---|
| 1 | | |
| 2 | | |

**iv.** Calculate the anion gap from these results.

**v.** List two (2) likely causes of the anion gap finding.

1

2

**vi.** Calculate the predicted serum K+ if the patient's pH was corrected to 7.40, assuming no other factors affect it.

A 32 year-old male smoker is BIBA to the Emergency Department of a tertiary hospital following a fire at his metal cleaning and reclaiming shop. He has a fluctuating level of consciousness. His current examination shows :

| | | |
|---|---|---|
| GCS | 13 | (E4 M5 V4) |
| Temperature | 36.5 | degrees Celsius |
| RR | 10 | /min |
| BP | 88/55 | mmHg |
| HR | 130 | /min |
| O2 Saturation | 96% | on $O_2$ 6 L/minute via face mask |

He has no evidence of airway compromise, burns or other significant injury.

**The venous blood gas is taken and is available in the props booklet on page 5**

i. List three (3) important abnormalities. State the significance of each abnormality (6 marks)

| | Abnormality (3 marks) | Significance (3 marks) |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |

| | | | |
|---|---|---|---|
| PH | 7.18 | | (7.35 - 7.45) |
| $PO_2$ | 100 | mmHg | |
| $PCO_2$ | 45 | mmHg | (40 - 52) |
| $HCO_3^-$ | 12 | mmol/L | (24 - 32) |
| COHb | 18 | % | |
| $Na^+$ | 145 | mmol/L | (135 - 145) |
| $K^+$ | 4.8 | mmol/L | (3.5 - 4.8) |
| $Cl^-$ | 107 | mmol/L | (95 - 110) |
| Glucose | 10.8 | mmol/L | (3.0 - 6.0) |
| Lactate | 16 | mmol/L | (0.5 - 2.0) |

ii. Provide two (2) calculations that will assist your diagnostic process. State how each calculation will contribute to the diagnosis (4 marks)

| Calculation (2 marks) | Contribution to diagnosis (2 marks) |
|---|---|
| | |
| | |

iii. List the two (2) most clinically important differential diagnoses. (2 marks)

1 _____

2 _____

iv. List two (2) specific treatments that you would commence. Provide details for each treatment including doses and routes where applicable. (4 marks)

| | Specific treatment (2 marks) | Details (2 marks) |
|---|---|---|
| 1 | | |
| 2 | | |

A previously well 55 year old woman presents with a complaint of severe vomiting for 5 days. Her observations are as follows:

| | | |
|---|---|---|
| HR | 110 | /min |
| BP | 100/60 | mmHg |
| Temp | 36.8 | oC |

A venous blood gas is performed and is shown below:

| | | | |
|---|---|---|---|
| pH | 7.23 | | (7.35 - 7.45) |
| pO2 | 40 | mmHg | |
| pCO2 | 22 | mmHg | (40 - 52) |
| HCO3 | 9 | mmol/L | (24 - 32) |
| Na | 140 | mmol/L | (135 - 145) |
| K | 3.4 | mmol/L | (3.5 - 4.8) |
| Cl | 77 | mmol/L | (95 - 110) |

i. What is the primary acid/base disturbance? (1 mark)

ii. Calculate the anion gap - show your calculation. (2 marks)

iii. Is there adequate compensation? - show your calculation. (2 marks)

iv. What is the delta ratio? - show your calculation. (2 marks)

v. What does this delta ratio result tell us in this clinical setting? (2 marks)

vi. Provide a unifying explanation for these gas results. (2 marks)

A 75 year old male is brought to your ED via ambulance, with Respiratory Distress, fever and confusion. On assessment the patient is confused and combative. His vital signs on arrival are:

| | | |
|---|---|---|
| Temp | 38.7 | °C |
| HR | 120 | bpm, irregular |
| BP | 110/60 | mm Hg |
| RR | 32 | /min |
| O2 sats | 91% | on High flow Nasal prong O2 |

The patients arterial blood gas is reprinted below

| | | | |
|---|---|---|---|
| PH | 7.21 | | ( 7.32 - 7.42 ) |
| PCO2 | 64 | mmHg | ( 41 - 51 ) |
| PO2 | 75 | mmHg | |
| HCO3 | 21 | mmol/L | ( 20 - 40 ) |
| BE | -6 | mmol/L | ( -3.0 - +3.0 ) |
| Na | 148 | mmol/L | (135-145 ) |
| Cl | 105 | mmol/L | ( 95 - 107 ) |

a ) Assuming the patients K is normally 4.0, based on these acid base abnormalities Calculate the following Parameters showing your calculations. (2 marks)

| Expected potassium (K) | Delta Ratio |
|---|---|
| | |

b ) What is the acid base abnormality on these results? Justify your answer ( 2 marks)

_____

_____

c ) List Three (3) key differential diagnosis in this case; For each differential list Two (2) investigations you would perform, with a justification for each (15 marks)

| | DDx | Investigation | Justification |
|---|---|---|---|
| 1 | | a. | |
| | | b. | |
| 2 | | a. | |
| | | b. | |
| 3 | | a. | |
| | | b. | |

A 48 year old woman with shortness of breath for 2 days. She has a history of diabetes and depression. Her LMO has been treating her for an URTI without improvement.
On assessment she is awake and oriented. Her vital signs are:

| | | |
|---|---|---|
| BP | 150/90 mmHg | |
| HR | 120 | /min |
| Sats | 99% | RA |
| Temp | 36.8°C | |

**Her arterial blood gas is shown in PROPS BOOKLET ; Page 12 .**

a) What is the acid base abnormality? (1 mark)

_____

b) Complete the table below showing requested calculations ( 4 marks)

| | **Calculations and results** |
|---|---|
| **A-a gradient** | |
| **Delta gap** | |
| **Expected K**<br>**(Normal = 4)** | |
| **Corrected Na** | |

| | | | |
|---|---|---|---|
| PH | 7.10 | | ( 7.32 - 7.42 ) |
| PCO2 | 39 | mmHg | ( 41 - 51 ) |
| PO2 | 94 | mmHg | |
| HCO3 | 12 | mmol/L | ( 20 - 40 ) |
| BE | -16 | mmol/L | ( -3.0 - +3.0 ) |
| Na | 128 | mmol/L | (135 - 145 ) |
| K | 5.2 | mmol/L | ( 3 - 5 ) |
| Cl | 97 | mmol/L | ( 95 - 107 ) |
| Glu | 47 | mmol/L | (3.0 - 10.0) |
| Cr | 125 | mmol/L | ( 50 - 120) |

c) List three (3) essential treatments for this patient including dosage. (6 marks)

| | Treatment | Dosage |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |

Four hours after commencement of treatment the patient becomes drowsy and responsive to only painful stimuli.

d) List three (3) essential investigations that should urgently be performed with one justification for each. (6 marks)

| | Investigation | Justification |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |

A 30 year old man presents to the emergency department with new onset bilateral lower leg weakness. He denies any past medical history. His venous blood gas is reproduced here.

| | | |
|---|---|---|
| pH | 7.399 | (7.320-7.420) |
| $pCO_2$ | 32.8 mmHg | (41.0-51.0) |
| $pO_2$ | 56.0 mmHg | (20-40) |
| $HCO_3^-$ | 19.9 mmol/L | (21.0-30.0) |
| Base Excess | -4.1 mmol/L | (-3.0-3.0) |
| $Na^+$ | 143 mmol/L | (135-145) |
| $K^+$ | 1.5 mmol/L | (3.5-5.0) |
| $Cl^-$ | 113 mmol/L | (95-107) |
| Glucose | 8.3 mmol/L | (3.0-10.0) |
| Lactate | 2.3 mmol/L | |
| Creatinine | 51 µmol/L | (50-120) |

**i.** List three (3) abnormalities and explain their significance.

| | **Abnormalities** | **Significance** |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |

**ii.** Calculate two (2) values and state how they contribute to your diagnosis.

1. _____

2. _____

_____ / 4

**iii.** List four (4) differential diagnoses for this patient's presentation.

1. _____

2. _____

3. _____

4. _____

_____ / 4

**iv.** List three (3) changes on an ECG that could be expected for this patient based on his blood results.

1. _____

2. _____

3. _____

An 84 year old man is brought to your emergency department following a high speed car accident. He has signs of multiple left rib fractures. Two hours after arriving in the emergency department he becomes more breathless and distressed.

His observations are:

- GCS 14
- HR 75 bpm
- BP 100/60
- RR 24

An arterial blood gas is performed

| | | | Reference Range |
|---|---|---|---|
| pH | 7.14 | | (7.35-7.45) |
| $pCO_2$ | 60 | mmHg | (35-45) |
| $pO_2$ | 114 | | |
| $HCO_3^-$ | 17 | mmol/L | (21-28) |
| Lactate | 1.4 | mmol/L | (< 2.0) |
| $FiO_2$ | 50 | % | |
| $Na^+$ | 139 | mmol/L | (135-145) |
| $K^+$ | 4.8 | mmol/L | (3.2-4.3) |
| $Cl^-$ | 116 | mmol/L | (99-109) |
| Glucose | 11.3 | mmol/L | (3.0-6.0) |

a. Calculate the patient's A-a gradient and show the formula/s used in the calculation (3 Marks)

b. Calculate the patient's expected $pCO_2$ and show the formula/s used (2 Marks)

c. Calculate the patient's expected $HCO_3^-$ increase assuming all changes are acute show the formula/s used (2 Marks)

d. List 6 potential causes of the patient's ABG results (3 Marks)

1.

2.

3.

4.

5.

6.

A 23 year old male with a decreased level of consciousness is being assessed in your ED. His arterial blood gas results with reference ranges are:

| | | | Reference Range |
|---|---|---|---|
| $FIO_2$ | 0.3 | | |
| pH | 6.9 | | (7.35-7.45) |
| $pCO_2$ | 10 | mmHg | (37-45) |
| $pO_2$ | 147 | mmHg | (80-95) |
| Bicarbonate | 2 | mmol/L | (22-28) |
| Base excess | -30 | | (-3 - +3) |
| $O_2$ saturation | 98 | % | (> 95) |
| Lactate | 7.1 | mmol/L | (< 1.3) |
| | | | |
| $Na^+$ | 140 | mmol/L | (134-146) |
| $K^+$ | 6.0 | mmol/L | (3.4-5.0) |
| $Cl^-$ | 105 | mmol/L | (98-106) |
| Creatinine | 0.1 | mmol/L | (0.06–0.12) |
| Urea | 4.8 | mmol/L | (3.0-8.0) |
| Glucose | 5.2 | mmol/L | (3.5-5.5) |
| Osmolality | 360 | mOsm/L | (275–295) |

a. List 4 key abnormalities on this patient's gas (2 Marks)

1. _____

2. _____

3. _____

4. _____

b. Calculate the patient's anion gap and write the formula/s used (2 Marks)

_____

_____

_____

_____

_____

_____

_____

_____

c. Calculate the patient's osmolar gap and write the formula/s used (3 Marks)

_____

_____

_____

_____

_____

_____

_____

_____

d. List 6 causes for a raised osmolar gap (3 Marks)

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

A 55 year old Female with PMH of CCF and DM, is brought to your emergency department by ambulance with vomiting and drowsiness.here is no clinical signs to suggest trauma. Her Vital signs are :

| | | |
|---|---|---|
| BP | 95/60 | mmHg |
| HR | 110 | bpm |
| RR | 28 | bpm |
| O2Sat | 94% | RA |
| T | 37 | deg celsius |
| GCS | 14 | (E3V5M6) |

Her venous blood gas is shown in **PROPS BOOKLET; PAGE 6**.

a) What is the likely explanation for these gas results in this patient (2 marks)

1. _____

2. _____

3. _____

4. _____

5. _____

b) Is anion gap normal or abnormal? show your calculation. (2 mark)

_____

_____

Venous blood gas

| | | | |
|---|---|---|---|
| PH | 7.41 | | ( 7.32 - 7.42 ) |
| PCO2 | 32 | mmHg | ( 41 - 51 ) |
| HCO3 | 19 | mmol/L | |
| Na | 144 | mmol/L | (135 - 145) |
| K | 2.7 | mmol/L | ( 3 - 5 ) |
| Cl | 90 | mmol/L | ( 95 - 107 ) |
| Glu | 25 | mmol/L | (3.0 - 10.0) |
| Lactate | 1.8 | mmol/L | ( 0.5 - 2) |

c) Calculate the Approximate Delta Gap and show your calculation. (2 marks)

_____

_____

d) What acid base disturbances does the Delta gap suggest? (1 mark)

_____

_____

e) List Four (4) expected changes with the ECG for Hypokalaemia.(4 marks)

1. _____

2. _____

3. _____

4. _____

A 32 year-old male smoker is BIBA to the Emergency Department of a tertiary hospital following a fire at his metal cleaning and reclaiming shop. He has a fluctuating level of consciousness. His current examination shows:

| | | |
|---|---|---|
| GCS | 13 | (E4 M5 V4) |
| BP | 88/55 | mmHg |
| HR | 130 | bpm |
| Temperature | 36.5 | deg Celsius |
| RR | 10 | bpm |
| O2 Saturation | 96% | on O2 6 L/minute via face mask |

He has no evidence of airway compromise, burns or other significant injury.
The venous blood gas is taken and is available in **PROPS BOOKLET; PAGE 13**.

a) List three (3) important abnormalities. State One significance for each abnormality (6 marks)

1. _____

_____

2. _____

_____

3. _____

_____

Venous blood gas

| | | | |
|---|---|---|---|
| PH | 7.18 | | ( 7.32 - 7.42 ) |
| PCO2 | 45 | mmHg | ( 41 - 51 ) |
| PO2 | 90 | mmHg | |
| COHb | 18 % | | |
| HCO3 | 12 | mmol/L | (24 - 32) |
| Na | 145 | mmol/L | (135 - 145) |
| K | 4.8 | mmol/L | ( 3 - 5 ) |
| Cl | 107 | mmol/L | ( 95 - 107 ) |
| Glu | 10.8 | mmol/L | (3 - 10) |
| Lactate | 16 | mmol/L | ( 0.5 - 2) |

b) Provide two (2) calculations that will assist your diagnostic process. State how each calculation will contribute to the diagnosis (4 marks)

1. _____

_____

2. _____

_____

c) List the two (2) most clinically important differential diagnoses. (2 marks)

1. _____

2. _____

A 62-year-old male with a history of chronic pancreatitis presents to the Emergency Department with several days of nausea and vomiting.

His biochemistry profile is attached:

| Parameter | Patient Value | Normal Adult Range |
|---|---|---|
| **Arterial Blood Gas** | | |
| $FiO_2$ | 0.4 | |
| pH | 7.62* | 7.35 – 7.45 |
| $PCO_2$ | 62 mmHg* (8.2 kPa)* | 36 – 45 (4.6 – 6.0) |
| $PO_2$ | 133 mmHg (17.5 kPa) | |
| Bicarbonate | 65 mmol/L* | 21 – 28 |
| Base Excess | > 30 mmol/L* | -3 – +3 |
| Sodium | 149 mmol/L* | 135 – 145 |
| Potassium | 3.3 mmol/L* | 3.5 – 5.2 |
| Chloride | 53 mmol/L* | 95 – 110 |
| Calcium ionised | 0.74 mmol/L* | 1.12 – 1.32 |
| Lactate | 2.7 mmol/L* | < 1.3 |
| | | |
| **Venous biochemistry** | | |
| Urea | 34.9 mmol/L* | 3.0 – 8.0 |
| Creatinine | 431 micromol/L* | 60 – 110 |

1. Interpret the abnormalities in the results. (3 marks)

2. Give likely underlying causes for the main metabolic acid-base disturbances. (3 marks)

3. Describe the clinical features of severe hypocalcaemia. (2 marks)

4. Outline your management of symptomatic hypocalcaemia. (2 marks)

A 32-year-old Aboriginal woman presents to the ED with lethargy. She is previously well, and has not been seen by medical services for the previous 10 years.

Her VBG is attached:

| | |
|---|---|
| pH | 7.25 |
| pCO2 | 24.4 |
| HCO3 | 11.7 |
| Hb | 81 |
| Na | 140 |
| K | 5.1 |
| Ca++ | 0.81 |
| Cl | 98 |
| Gluc | 9.6 |
| Lact | 0.9 |

1. What is the most likely cause for the abnormalities on the VBG? Describe and interpret the abnormalities. (5 marks)

Her creatinine is 1842 with a urea of 62.

2. List **4** possible causes for these findings in a 32-year-old Aboriginal woman, with the most common cause first. (3 marks)

(1) _____

(2) _____

(3) _____

(4) _____

She becomes agitated and appears to be getting ready to leave the ED.

3. What would be some strategies to stop her leaving? (4 marks)

An 89 year old lady presents with generalised weakness, nausea and diarrhoea. She had a fall 3 days earlier and had broken her humerus. She was discharged for orthopaedic follow up as an outpatient. She appears dehydrated, BP 140/80, pulse 80 regular, and is afebrile.

Her venous blood gas is below :

| | |
|---|---|
| Venous Blood pH POCT | 7.073 |
| Venous Blood pO2 POCT | 23.8 mmHg |
| Venous Blood pCO2 POCT | 48.2 mmHg |
| Venous Blood O2 Saturation POCT | 33.2 % |
| Venous Blood HCO3 POCT | 13.4 mmol/L |
| Venous Blood Base Excess POCT | -14.8 mmol/L |
| Venous Blood Oxyhaemoglobin POCT | 32.8 % |
| Venous Blood Inspired Oxygen POCT | 21 % |
| Venous Blood Haemoglobin POCT | 97 g/L |
| Venous Blood Reduced Haemoglobin POCT | 66.0 % |
| Venous Blood Methaemoglobin POCT | 0.4 % |
| Venous Blood Carboxyhaemoglobin POCT | 0.8 % |
| Venous Blood Creatinine POCT | 179 umol/L |
| Venous Blood Sodium POCT | 126 mmol/L |
| Venous Blood Potassium POCT | 3.2 mmol/L |
| Venous Blood Chloride POCT | 100 mmol/L |
| Venous Blood Calcium Ionised POCT | 1.25 mmol/L |
| Venous Blood Glucose POCT | 5.6 mmol/L |
| Venous Blood Lactate POCT | 1.1 mmol/L |

1. Interpret the blood gas results - what are the likely causes of her acidosis? (5 marks).

2. List 5 further investigations you feel are indicated. Justify your responses (5 marks).

i. _____

ii. _____

iii. _____

iv. _____

v. _____

A 30 year old man presents to your ED with a 24 hour history of increasing weakness.

An ABG and electrolytes are performed.

**ABG**

| | | |
|---|---|---|
| FiO2 | 21% | |
| pH | 7.26 mmHg | (7.35-7.45) |
| pCO2 | 29 mmHg | (35-48) |
| pO2 | 101 mmHg | (83-108) |
| HCO3 | 13 mmol/L | (21-28) |
| BE | -13 mmol/L | (-1.5-3.0) |

**ELECTROLYTES**

| | | |
|---|---|---|
| Na | 137 mmol/L | (136-146) |
| K | 1.8 mmol/L | (3.9-5.2) |
| CL | 116 mmol/L | (95-110) |
| Urea | 7.8 mmol/L | (3.1-8.1) |
| Creat | 86 mmol/L | (60-110) |
| Glc | 4.0 mmol/L | (3.9-5.8) |
| CK | 1975 U/L | (29-168) |
| Trop T | 20 ng/L | (<30) |

i. Describe and interpret his blood results (8 marks)

ii. List your 3 immediate management priorities (3 marks)

iii. An internal jugular central venous catheter is placed to facilitate potassium replacement. List 4 early and 4 late complications of internal jugular central venous catheter placement (8 marks)

A previously well 2 year old boy presents acutely unwell with tachypnoea and abdominal pain. VBG results are shown below.

PH 7.20
PC02 25
BIC 10
BASE EXCESS -16.4
K 4.5
NA 138
CL 96

a) List the further investigations you request at this time with justification for each. (7 marks)

b) What are the 3 most concerning potential diagnoses for this child. (3 marks)

An 84 year old man is brought to your emergency department following a high speed car accident. He has signs of multiple left rib fractures. Two hours after arriving in the emergency department he becomes more breathless and distressed.

His observations are:

- GCS 14
- HR 75 bpm
- BP 100/60
- RR 24

An arterial blood gas is performed

| | | | Reference Range |
|---|---|---|---|
| pH | 7.14 | | (7.35-7.45) |
| $pCO_2$ | 60 | mmHg | (35-45) |
| $pO_2$ | 114 | | |
| $HCO_3^-$ | 17 | mmol/L | (21-28) |
| Lactate | 1.4 | mmol/L | (< 2.0) |
| $FiO_2$ | 50 | % | |
| $Na^+$ | 139 | mmol/L | (135-145) |
| $K^+$ | 4.8 | mmol/L | (3.2-4.3) |
| $Cl^-$ | 116 | mmol/L | (99-109) |
| Glucose | 11.3 | mmol/L | (3.0-6.0) |

a. Calculate the patient's A-a gradient and show the formula/s used in the calculation (3 Marks)

b. Calculate the patient's expected $pCO_2$ and show the formula/s used (2 Marks)

c. Calculate the patient's expected $HCO_3^-$ increase assuming all changes are acute show the formula/s used (2 Marks)

d. List 6 potential causes of the patient's ABG results (3 Marks)

1.

2.

3.

4.

5.

6.

A 23 year old male with a decreased level of consciousness is being assessed in your ED. His arterial blood gas results with reference ranges are:

| | | | Reference Range |
|---|---|---|---|
| $FIO_2$ | 0.3 | | |
| pH | 6.9 | | (7.35-7.45) |
| $pCO_2$ | 10 | mmHg | (37-45) |
| $pO_2$ | 147 | mmHg | (80-95) |
| Bicarbonate | 2 | mmol/L | (22-28) |
| Base excess | -30 | | (-3 - +3) |
| $O_2$ saturation | 98 | % | (> 95) |
| Lactate | 7.1 | mmol/L | (< 1.3) |
| | | | |
| $Na^+$ | 140 | mmol/L | (134-146) |
| $K^+$ | 6.0 | mmol/L | (3.4-5.0) |
| $Cl^-$ | 105 | mmol/L | (98-106) |
| Creatinine | 0.1 | mmol/L | (0.06–0.12) |
| Urea | 4.8 | mmol/L | (3.0-8.0) |
| Glucose | 5.2 | mmol/L | (3.5-5.5) |
| Osmolality | 360 | mOsm/L | (275–295) |

a. List 4 key abnormalities on this patient's gas (2 Marks)

1. _____

2. _____

3. _____

4. _____

b. Calculate the patient's anion gap and write the formula/s used (2 Marks)

_____

_____

_____

_____

_____

_____

_____

_____

c. Calculate the patient's osmolar gap and write the formula/s used (3 Marks)

_____

_____

_____

_____

_____

_____

_____

_____

d. List 6 causes for a raised osmolar gap (3 Marks)

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____