# Metabolic and Acid Base Fellowship Session

**Question 1 (10 marks)** - VBG – Aspirin Toxicity

A 72 year old man presents with confusion. He is brought in by family who are concerned that he has worsening depression since his wife died 3 months ago. The patient is unable to give any clear history of the events. He has a history of atrial fibrillation and hypertension.

On full examination he has no abnormal physical examination findings aside from effortless tachypnoea and a GCS of 14 . ECG shows a sinus tachycardia only. CXR no abnormalities.

Results of FBC, EUC, LFT, Coags, CRP, Blood Cultures are all pending

**Observations**

P 116

BP 110/60

Sats 91% RA

RR 36

Temp 37.4

**VBG**

pH 7.21

pCO2 22

HCO3 16

Cl 98

Lact 3.4

Gluc 3.0

Na 130

K 5.0

Cr 134

Hb 137

1. List the two (2) key acid-base abnormalities on this VBG (2 marks)

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Primary uncompensated HAGMA

Primary respiratory alkalosis

1. List the three (3) most relevant differential diagnoses (3 marks)

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Salicylate Overdose

Overdose of any other toxin known to cause metabolic acidosis (e.g. toxic alcohol/ TCA)

PE

Sepsis e.g. from urine (as no signs) – need to specify a site that would be non detectable clinically i.e. can’t say cellulitis/LRTI as no clinical signs

Multiple other causes may be appropriate

1. List the five (5) MOST important additional investigations you will order (5 marks)

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Salicylate level

Panadol level

DDImer (or CTPA) – will depend upon risk assessment

Urine dip and MC&S

CT Brain

Osmolarity (to calc gap)

**Question 2 – (10 marks)** - Toxic Alcohol, Osmolar Gap

A 19 year old male has been brought in by police after being found confused, agitated and vomiting. A plastic bottle full of an unknown substance was found in his back pack. He appears intoxicated and is unable to give any further history.

He has no identification on his person and there is no collateral history

**Observations**

P 110

BP 90/70

Sats 100% RA

RR 30

Temp 36.5

**Venous Blood Gas**

pH 7.22

pCO2 32

HCO3 16

Lact 4.5

Gluc 4.0

**Bloods**

Na 134

K 4.0

Cl 100

Ur 6.0

Cr 140

Serum Osm 302

1. List the two (2) MOST important laboratory findings including the two (2) appropriate calculations used when determining those findings (4 marks)

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High Anion Gap Metabolic acidosis with appropriate respiratory compensatory efforts

e.g**. winters formula** for expected CO2 1.5 x 16 +8 = 32 or **AG calculation**= (Na) – (Cl + HCO3), ref range 4-12 (if use K 4-16)

**Osm Gap** = 302 – ((2x134) + 4 + 6.) = **24**

1. List the three (3) MOST important investigations you will order to confirm the nature of the ingested liquid (3 marks)

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Alcohol levels/BAL

Serum Calcium

Urine Microscopy for Calcium Oxalate Crystals (poor sens and spec however)

Levels for ethylene glycol/methanol/isopropyl alcohol

The patient is attempting leave the department and is becoming physically aggressive to staff. The decision to is made to intubate the patient for his own and the safety of staff.

1. List three (3) measures you will take, specifically related to this patients presentation, to avoid peri-intubation complications (3 marks)

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No apnoeic period – gentle bagging to prevent hypercarbia and worsening acidosis

Match the pre intubation resp rate when setting ventilator

Utilise push dose pressors/fluid loading to avoid hypotension

Reduced dose of induction agent/use ketamine

Double suction available to avoid aspiration if vomits on induction

DSI to prevent staff assault

**Question 3 – (11 marks)** - Resp Acidosis with hypoxia, needs BIPAP

A 71 year old man with a history of severe COPD presents with drowsiness, wheeze and a cough. He has had a recent ICU admission for pneumonia, during which he was ventilated for 3 weeks and had a lengthy stay in a rehabilitation ward on discharge.

He has hypertension but no other significant comorbidities.

Has been using Ventolin 12 puffs 3 hourly via spacer for 2 days, Spiriva 18mcg MDI mane, prednisolone 30mg daily for 3 days and his usual perindopril 5mg daily.

He has severe tachypnoea with use of all accessory muscles, tripod position and agitation. Continuous salbutamol nebulisation commenced 5 minutes ago. CXR shows only hyperinflated lungs.

**Observations**

P 130

BP 160/98

RR 40

Sats 82% 15L NRB

Temp 35.2

**VBG**

pH 7.2

pCO2 85

HCO3 20

Cl 105

Lact 6.2

Na 145

K 3.0

Cr 180

1. List the two (2) MOST important acid-base abnormalities (2 marks)

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Primary Respiratory Acidosis

Primary High Anion Gap Metabolic Acidosis

* Expected HCO3 if acute acidosis = +4
* Expected HCO3 if chronic = +16
* HCO3 is actually reduced therefore has a concomitant metabolic acidosis
* AG 145-105-20 = 20 ?due to lactate/secondary to ventolin

**The patient has documented advanced care plans that state he doesn’t wish to be intubated or have CPR. All other active treatment measures are to be taken in the event that he has a respiratory deterioration, including non-invasive ventilation and inotropes.**

1. List the five (5) MOST important instructions you will give to the bedside nurses regarding commencement and ongoing management of non-invasive ventilatory support for this patient (5 marks)

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Commence BIPAP mode

IPAP:EPAP 10-14/5-8 with appropriate instructions

Continue to deliver bronchodilators through the non invasive machine

Titrate FIO2 to saturations of 88-92%

Repeat VBG at 2-4 hour intervals

Pressure care area and breaks

**The patient has a repeat VBG 4 hours later when he appears to have significantly less work of breathing and a saturation of 92% on FIO2 0.4 on NIV. He has had Ventolin 5mg nebulised 1 hourly for the last 2 hrs**

**pH 7.18**

**pCO2 60**

**HCO3 14**

**Lact 9.2**

**Na 146**

**Cl 106**

**K 3.0**

1. List the findings and your interpretation of the cause of the repeat VBG result (4 marks)

|  |  |
| --- | --- |
| **Findings** | **Interpretation** |
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|  |  |

|  |  |
| --- | --- |
| **Findings** | **Interpretation** |
| Improvement in respiratory component of acidosis with downtrending pCO2 | Effective treatment of COPD exacerbation with NIV and bronchodilators |
| BUT worsening of HAGMA and lactataemia | Another cause for HAGMA – need to exclude sepsis, overdose, intraabdominal catastrophe, renal failure, DKA, bleeding etc  Not enough Ventolin given to cause such a significant lactateaemia |

**Question 4 – (9 marks)** - Respiratory Alkalosis

**A 70kg, 23 years old female present with a very sudden onset of shortness of breath and right sided chest discomfort 1 hour ago while sitting at her desk at work. She has a history of anxiety but reports no current stressors.**

**She has been placed on 15L NRB Oxygen by the paramedics and her VBG and observations are shown below.**

**pH 7.54**

**pCO2 20**

**HCO3 28**

**Lactate 2.3**

**P 110**

**BP 100/70**

**Sats 99% 15L NRB**

**RR 36**

**Temp 36.9**

1. Describe the primary acid base abnormality and compensatory response (2 marks)

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Primary respiratory alkalosis

Appropriate compensation for an ACUTE onset

1. List the three (3) MOST likely differential diagnoses (3 marks)

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Hyperventilation secondary to anxiety/panic attack

Pulmonary Embolus

Pneumothorax

Cardiac Arrhythmia ?SVT

**10 minutes later the patient has a sudden cardiac arrest in the resus bay. Standard ALS management is ongoing when you arrive with adequate CPR and ventilation in a 15:2 ratio. She has narrow complex PEA and has received 1mg of adrenaline and a bolus of 1000mls Normal Saline has been commenced.**

1. In the table list the two (2) MOST important specific interventions (out with the standard ALS algorithm) that you will that consider with details of each (4 marks)

|  |  |
| --- | --- |
| **Intervention** | **Details** |
|  |  |
|  |  |

|  |  |
| --- | --- |
| **Intervention** | **Details** |
| Chest decompression (right then left) | 2nd ICS needle decompression bilaterally  5th ICS finger thoracostomy |
| Thrombolysis | Alteplase 10mg bolus, then 90mg over 2 hrs  Allow weight based IVI of remainder of dose |

**Question 5 (14 marks) -** Hyponatramia with seizure/confusion

**An unknown man, who appears to be approximately 50 years old, is brought in by ambulance after a 10 minute tonic clonic seizure. The seizure was witnessed by paramedics and was terminated with intranasal midazolam. He has a GCS of 9 (M5V2E2) at 30 minutes post event. He appears malnourished and poorly kempt, there is no obvious sign of trauma. There is no available collateral history.**

**As you enter the resus bay he commences having a second tonic clonic seizure**

**Observations immediately prior to second seizure**

**BP 190/100**

**P 60**

**Sats 95% RA**

**RR 14**

**T 37.2**

**VBG**

**pH 7.21**

**pCO2 56**

**HCO3 16**

**Lact 9.0**

**Na 115**

**K 3.4**

**BSL 2.9**

**ECG shows no abnormality**

**FBC, EUC, LFT, Coags, CMP, urine and serum osmolalities have all been sent**

1. List the five (5) MOST important management priorities in the next hour in the table below (10 marks)

|  |  |
| --- | --- |
| **Treatment Priority** | **Brief Details/Doses/Agents** |
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| --- | --- |
| **Priority** | **Brief Details/Doses/Agents** |
| Termination of Seizure | 3% saline  Or appropriate Benzodiazepine |
| Slow correction of Na avoiding osmotic demyelination | Aim for 5mmol rise/up to max 125mmol/l  No greater than 10-12mmol/L rise per 24h |
| Correction of BSL | 50mls 50% dextrose  Regular BSL checks – every |
| Airway Management | Intubate – any appropriate doses of induction and paralysis |
| Neuroprotective strategies | Head up, oxygenation and control of CO2  Tape not tie etc |

Would not actively manage BP beyond hypertonic saline till know whether any intracranial lesion/bleed/watershed area

**A CT scan of the brain is performed**



1. Describe four (4) abnormal findings on this CT slice and state the diagnosis (4 marks)

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Diagnosis\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

FINDINGS:

Large right parietal crescentric extraaxial fluid collection - crosses coronal suture

Mixed density collection with hypo and hyperechoic elements

Midline shift

Effacement of the right lateral ventricle

Small hypoechoic (chronic) left sided crescentric collection

DIAGNOSIS: Acute on Chronic Subdural with significant mass effect

**Question 6 (marks)** - Refeeding syndrome in anorexic

A 14 year old female has been brought in by her parents due to concerns around weight loss and lethargy for 6 months duration. She has been seeing a psychologist for 6 months for anxiety that is related to school attendance.

Observations

BP 80/60

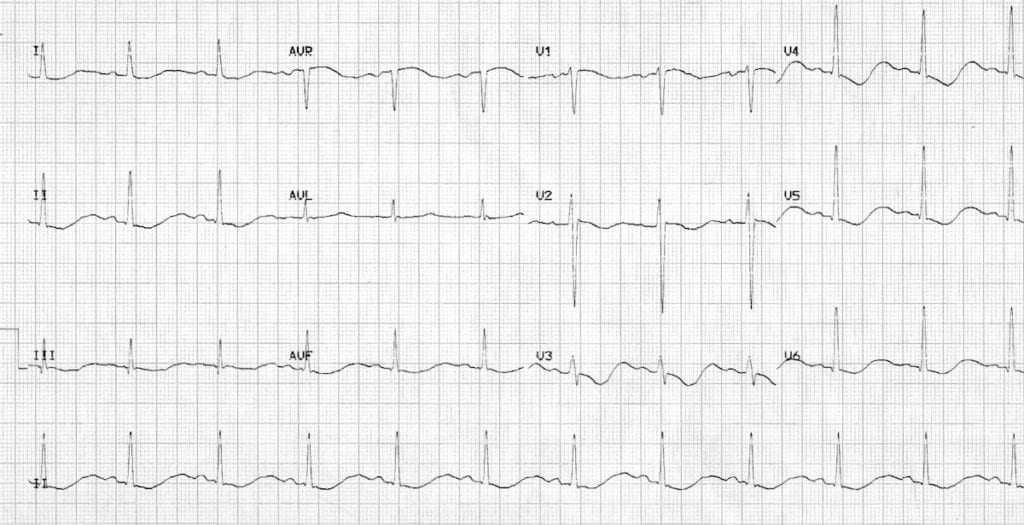
P 72

Sats 98% RA

RR 22

Temp 35.8

Her ECG is shown



1. List 3 abnormalities on the ECG and the likely cause of these abnormalities (4 marks)

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Cause\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

ST depression.

T wave inversion.

Prominent U waves.

Long QU interval.

CAUSE: Electrolyte abnormalities – HypoK/HypoMg +/- Hypocalcaemia/Phos

1. In the table below list the MOST important features you will seek specific to the assessment of this patient (10 marks)

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| --- | --- |
| **Historical Features** | **Clinical Examination Features** |
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|  |  |
| --- | --- |
| **Historical Features** | **Clinical Examination Features** |
| Intentional vs Unintentional weight loss  Purging/Binging/Exercise/laxatives/diuretics | Weight and height - BMI |
| Physical Sx that might suggest an underlying medical illness  Thyrotoxicosis/Malignancy/ | Purging signs – teeth/knuckles |
| Depression and suicidality Hx  e.g. HEADS assessment/SADPERSONS | Lanugo hair and other nutritional signs- tongue B12, nails, |
| Social Factors – school bullying, family issues etc | Signs of cardiac failure |
| History of eating disorders in the past/treatments in the past | ?Goitre/features of thyrotoxicosis e.g. tremor/eye signs |
| Symptoms related to dehydration/hypoglycaemia/nutritional deficiency e.g. dizziness/collapse/palpitations |  |

**The patient has the following blood results, she wants to go home and is threatening to run away**

**TSH/T4 normal**

**Hb 98**

**MCV 69**

**Phos 0.3**

**CCa 2.2**

**K 1.7**

**Mg 0.4**

**Cr 154**

**Ur 8.7**

**LFT normal**

1. List the five (5) MOST important management priorities in this patient (5 marks)

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Treatment against patient wishes if cannot convince to be a voluntary patient – common law or section appropriate, patient is a minor so cannot refuse treatment

Urgent correction of electrolyte abnormalities with IV KCl, MgSO4, NaH2PO4 on a monitor till K>2.5, PO4 normalised

Consideration of Refeeding Syndrome – dietician assessment and withholding of carbohydrate till appropriate feeding regime decided

Appropriate IV hydration for renal failure

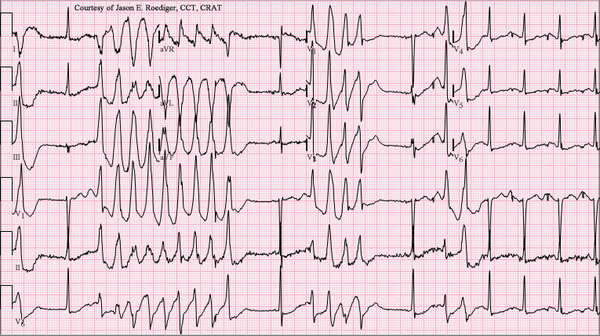
Psychiatric assessment/therapy ideally with eating disorder specialist involved

Admission to medical team/HDU – too unwell for

**Question 7 (13 marks) – HypoMg Torsdes**

**A 67 years old cachectic man presents with recurrent collapses. He is of no fixed abode and has a history of hazardous alcohol use, with frequent presentations to the Emergency Department for withdrawal seizures. Past history of IHD and hypertension.**

**An ECG was taken during a transient unconscious episode in ED**



**Observations post episode**

**P 56**

**BP 90/60**

**RR 22**

**Sats 96% RA**

**Temp 37.7**

1. Descrive the three (3) MOST important abnormalities on the ECG shown and state the ECG diagnosis (4 marks)

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Diagnosis\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Recurrent WCT approx. 300bpm

Twisting of the QRS around isoelectric baseline

Long QTc

R on T phenomenon

DIAGNOSIS: Torsades de Pointes

1. List four (4) likely causes or contributing factors for this arrhythmia in this patient (4 marks)

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**Causes likely in this man**

[Hypokalemia](https://www.wikiwand.com/en/Hypokalemia)

[Hypomagnesemia](https://www.wikiwand.com/en/Hypomagnesemia)

[Hypocalcemia](https://www.wikiwand.com/en/Hypocalcemia)

[Medications](https://www.wikiwand.com/en/Medications) – anything prolonging QTc

[Heart failure](https://www.wikiwand.com/en/Heart_failure)

[Left ventricular hypertrophy](https://www.wikiwand.com/en/Left_ventricular_hypertrophy)

**Other causes unlikely in this case**

[Hypothermia](https://www.wikiwand.com/en/Hypothermia)

[Subarachnoid hemorrhage](https://www.wikiwand.com/en/Subarachnoid_hemorrhage)

[Hypothyroidism](https://www.wikiwand.com/en/Hypothyroidism)

[Bradycardia](https://www.wikiwand.com/en/Bradycardia)

**The patient has 6 further unresponsive episodes due to the same arrhythmia.**

1. List five (5) specific treatment options for this arrhythmia in the table below (5 marks)

|  |  |
| --- | --- |
| **Treatment Option** | **Details** |
|  |  |
|  |  |
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| --- | --- |
| **Treatment Options** | **Details** |
| Atropine IV | 500mcg IV repeated q3-5mins up to max 3g  Appropriate |
| Magnesium sulfate | 50% solution 4 mL (2 g) by intravenous infusion, over 10 to 15 minutes followed, if required, by 1 to 1.5 mL (0.5 to 0.75 g) per hour by intravenous infusion for 12 to 24 hours |
| Correct other electrolyte abnormalities  Specifically K | KCL minibags 10mmol/30-60mins on monitor till K 4.5mmol/L acheived |
| Isoprenaline | 20 micrograms intravenously, repeated according to clinical response, followed by 1 to 4 micrograms/minute by intravenous infusion |
| DC Cardioversion | Syncronised shock at 200J if prolonged episode , but if unsuccessful as sync may need |
| Temporary transvenous pacing | At 90-100 bpm (overdrive) to prevent bradycardia |
| lignocaine | 75 to 100 mg intravenously, over 1 to 2 minutes followed, if successful, by 4 mg/minute by intravenous infusion for 1 hour, then reduce to 1 to 3 mg/minute. |

**Question 8 (14 marks)**

**A 90 year old man is sent in by his GP for investigation of has renal dysfunction. The triage information states that he has had several months of lethargy. He has no significant medical history aside from a hip replacement 10 years ago. He is independently living with his wife, takes no medications and not had any contact with his GP since his hip replacement.**

**A brief physical assessment reveals a well hydrated, but slender man who has no overt abnormalities on external physical examination.**

**Observations**

**P 90**

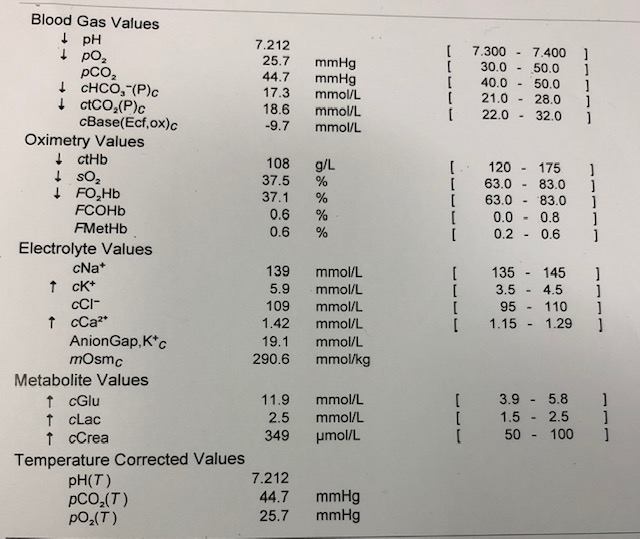
**BP 140/80**

**RR 24**

**Sats 96% RA**

**Temp 37.1**

**VBG**

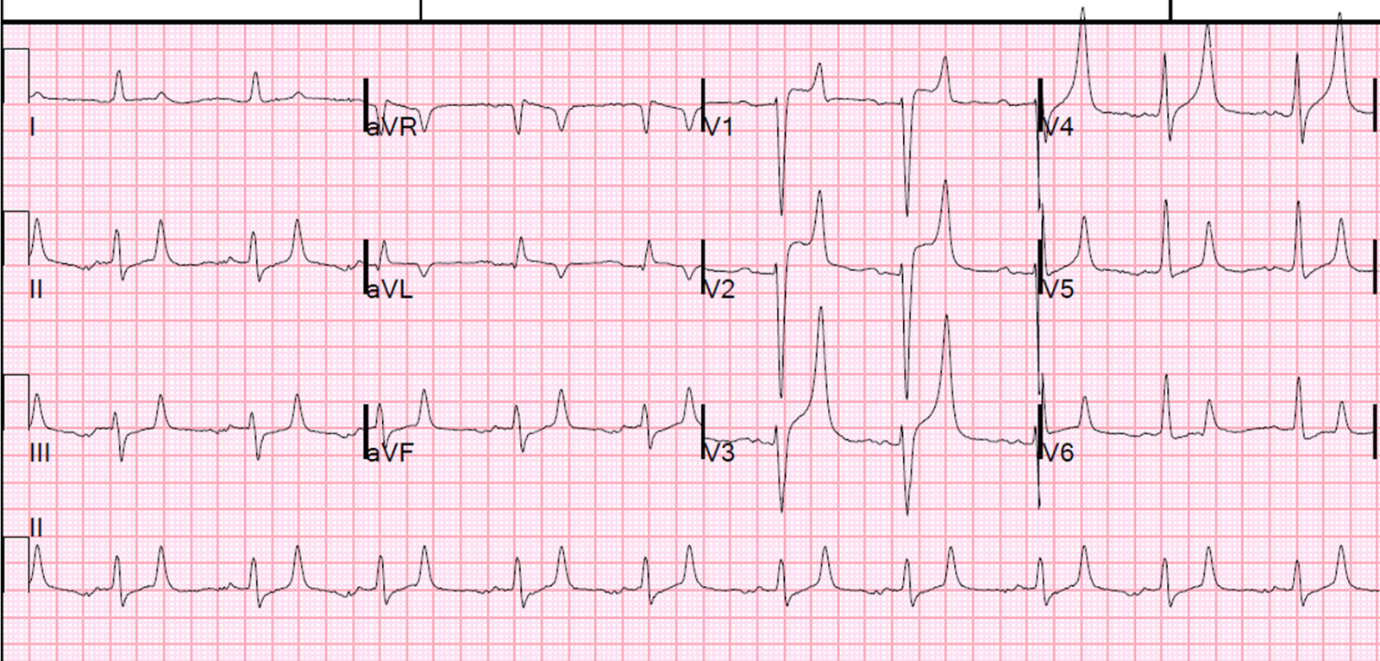


1. In the table below list the abnormalities seen in the blood gas shown and provide the most likely reasons for these abnormalities (10 marks)

|  |  |
| --- | --- |
| **Abnormality** | **Likely Explanation(s)** |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

|  |  |
| --- | --- |
| **Abnormality** | **Likely Explanation (s)** |
| HAGMA | Renal failure – potential intrinsic and post renal causes - |
| Renal Failure – unclear if acute or chronic | Possible causes include age related decline, renal parenchymal disease and post obstructive causes e.g. BPH/Prostate Ca |
| Hyperkalaemia | Secondary to renal failure, also due to acidosis. O.05 rise in K for every 0.1 drop in pH |
| Anaemia | Likely related to chronic renal dysfunction, lack of epo.  Need to exclude bleeding |
| Hyperglycaemia | ?undiagnosed T2DM vs stress response  Meets non fasting criteria for diagnosis of DM |
| Hypercalcaemia | ?due to renal disease, need to exclude malignancy with bony mets e.g. prostate |

**The formal serum potassium level is 6.4mmol/L and the patient has the following ECG. The nurses have performed a post void residual bladder scan that shows 400mls**



1. List the four (4) most important next actions you will take in managing this patient (4 marks)

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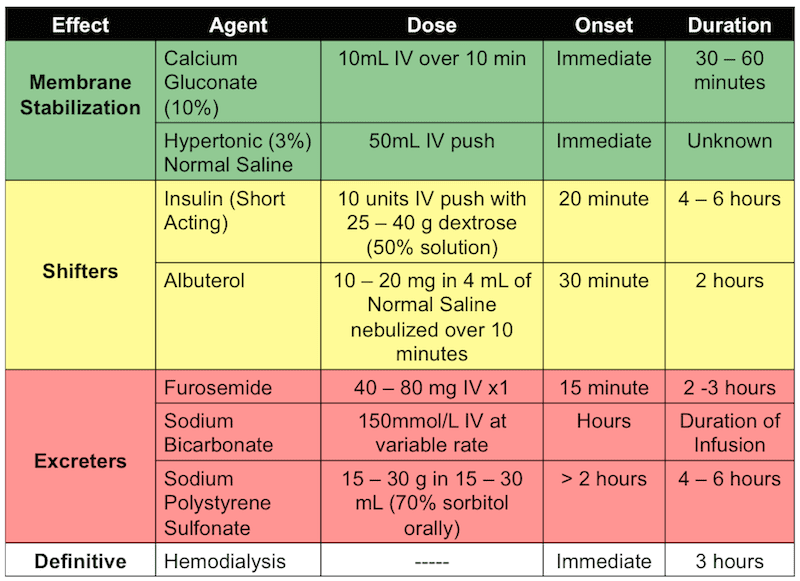
Calcium gluconate 10-20 10% IV – end point normalisation of ECG changes

20mg nebulised salbutamol stat

10units of actrapid with 50mls of 50% dextrose

Insert IDC carefully to relieve bladder obstruction

(Bicarbonate could be considered as a K excreter given acidosis)



**Question 9 (11 marks)**

You are called urgently to assist with a 9 week old baby who presents with 1 week of increasing lethargy, vomiting and poor feeding. The baby was born at term and had an uneventful neonatal period. The baby is exclusively breast fed.

The child appears dehydrated and hypotonic. Fontanelles are sunken, capillary return 4 seconds. No overt signs of focal infection, pulses feeble but equal in all limbs, no murmurs, chest clear with no increase in work of breathing. Abdomen non distended and soft.

The child is fully monitored with a patent IV line

**Observations**

P 190

BP 70/50

RR 40

T 36.5

Sats 91% RA

**VBG**

pH 7.21

pCO2 45

HCO3 12

Lact 4.5

K 6.5

Na 124

Gluc 3.0

Cl 100

Hb 140

Cr 110

1. What is the acid base abnormality (2 marks)

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Mixed HAGMA and Respiratory Acidosis

1. List the four (5) potential differential diagnoses (5 marks)

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Sepsis - ?UTI/Meningitis/pneumonia/skin etc

Adrenal Failure – classic VBG

Congenital Cardiac disease

Other metabolic disorder/Inborn errors of metabolism

Dehydration due to poor feeding

Consider NAI

RTA/renal disorders

Unlikely pyloric stenosis with this combination of Na/K/Cl/Acidosis – usually hypochloraemic metabolic alkalosis

1. List your five (5) immediate treatment steps for this child (5 marks)

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Oxygen via face mark or nasal prongs

Fluids bolus of 10 mls/kg – can be titrated depending on signs of cardiac failure

Calculate fluid defecit/maintainence and replace with 0.9%NS and 5% dextrose over 24-48hrs

2mls/kg 10% dextrose – repeat till BGL >4.0

Hydrocortisone (after taking metabolic bloods)

Calcium gluconate/Insulin and Dextrose (doses not required – would look up)

Antibiotics – per eTG

|  |  |  |
| --- | --- | --- |
|  | cefotaxime 50 mg/kg intravenously, 6-hourly |  |

OR

|  |  |  |
| --- | --- | --- |
|  | ceftriaxone 50 mg/kg intravenously, 12-hourly |  |

PLUS EITHER

|  |  |  |
| --- | --- | --- |
|  | amoxicillin 50 mg/kg intravenously, 6-hourly |  |

OR

|  |  |
| --- | --- |
|  | ampicillin 50 mg/kg intravenously, 6-hourly. |