WICM Data Supplement

This document is designed to supplement the recent WICM data quiz. It contains some of the techniques used, some of the patterns displayed and ***some*** of the questions. All answers are displayed at the end of the document.

The main aim of the quiz was to get you to learn from each other. This document is not designed to cover "data for CICM", but will hopefully act as a palate cleanser in your lifelong insatiable thirst for knowledge

Good luck.

Please email me any feedback david.knight@cdhb.health.nz

Question 1

1 – What is the Aa Gradient?

- FIO_2 – 0.21

Acid-base status			
pH	7.370		[7.340 - 7.440]
↑ pCO_2	53.6	mmHg	[40.0 - 52.0]
pO_2	29.4	mmHg	[25.0 - 40.0]
↑ $cHCO_3^-(P)_c$	31.0	mmol/L	[22.0 - 28.0]
↑ $cBase(B)_c$	4.9	mmol/L	[-3.0 - 3.0]

pCO2 = 7.14 kPa

PO2 = 3.92 kPa

Question 2

3- What would you estimate the SaO_2 to be with a normally positioned oxygen dissociation curve?

Acid-base status			
pH	7.370		[7.340 - 7.440]
↑ pCO_2	53.6	mmHg	[40.0 - 52.0]
pO_2	29.4	mmHg	[25.0 - 40.0]
↑ $cHCO_3^-(P)_c$	31.0	mmol/L	[22.0 - 28.0]
↑ $cBase(B)_c$	4.9	mmol/L	[-3.0 - 3.0]
Oximetry values			
Hct_c	44.3	%	[-]
ctHb	145	g/L	
sO_2	53.1	%	[-]
FO_2Hb	52.1	%	[-]
FCOHb	0.9	%	[-]
FMetHb	1.0	%	[-]
FHHb	46.0	%	[-]
Calculated values			
$AnionGap.K^+_c$	9.0	mmol/L	
$mOsm_c$	285.1	mmol/kg	
$p50(st)_c$	27.42	mmHg	

pCO2 = 7.14 kPa

PO2 = 3.92 kPa

P50 = 3.65 kPa

Question 3

13 Spot Diagnosis

Previously well 60 year old with lethargy

Parameter	Measured Value	Normal Ranges
FIO_2	0.21	
pH	7.25	7.35-7.45
$PaCO_2$	26 (3.5)	35-45 mmHg
PaO_2	95 (12.5)	80-100 mmHg
Bicarbonate	11	22-27 mmol/L
Base Excess	-15	-2 to +2 mmol/L
Sodium	140	135-145 mmol/L
Potassium	4.0	3.5-4.5 mmol/L
Chloride	112	100-110 mmol/L
Glucose	11	3.0-6.0 mmol/L
Urea	7	3.5-7.2 mmol/L
Creatinine	70	50-100 micromol/L
Lactate	1.0	< 2.0 mmol/L

Question 4

14 What "Chronic" Conditions Are Present?

1. Na 138, Cl 112, Bicarb 20, CO2 30
2. Na 138, Cl 120, Bicarb 20, CO2 30
3. Na 138, Cl 100, Bicarb 30, CO2 50
4. Na 138, Cl 72, Bicarb 55, CO2 55
5. Na 138, Cl 120, Bicarb 25, CO2 40

A. Pyloric stenosis
B. Lithium Therapy
C. Renal Tubular acidosis
D. Pregnancy
E. COPD

Question 5

16 Most Likely Diagnosis

Parameter	Measured Value	Normal Ranges
FIO_2	0.4	
pH	7.15	7.35-7.45
$PaCO_2$	20	35-45 mmHg
PaO_2	80	80-100 mmHg
Bicarbonate	7	22-27 mmol/L
Base Excess	-20	-2 to +2 mmol/L
Sodium	140	135-145 mmol/L
Potassium	4.8	3.5-4.5 mmol/L
Chloride	114	100-110 mmol/L
Glucose	7.9	3.0-6.0 mmol/L
Urea	8.2	3.5-7.2 mmol/L
Creatinine	97	50-100 micromol/L
Lactate	22.0	< 2.0 mmol/L

A. Compensated lactic acosis
B. Compensated NAGMA secondary to saline resucitation
C. Liver failure
D. Compensated mixed NAGMA and HAGMA – saline plus adrenaline
E. Metformin toxicity

Question 6

18 Most likely diagnosis?

Parameter	Measured Value	Normal Ranges
FIO_2	1.0	
pH	7.3	7.35-7.45
$PaCO_2$	65	35-45 mmHg
PaO_2	70	80-100 mmHg
Bicarbonate	31	22-27 mmol/L
Base Excess	+5	-2 to +2 mmol/L
Sodium	136	135-145 mmol/L
Potassium	3.2	3.5-4.5 mmol/L
Chloride	95	100-110 mmol/L
Glucose	11.2	3.0-6.0 mmol/L
Urea	12	3.5-7.2 mmol/L
Creatinine	120	50-100 micromol/L
Lactate	1.0	< 2.0 mmol/L

A. Compensated metabolic alkalosis
B. Aspiration and gastric outlet obstruction
C. ARDS with diuretics
D. COPD and steroids
E. Excess liquorice ingestion

Question 7

25 Match the following causes of hyponatraemia*

S=Serum, U=urinary

1. SNa 120, SOsmo 325, Glucose 65 pH 7.20, UNa 100, UOsm 320
2. SNa 120, SOsmo 257, Glucose 7 pH 7.30, UNa 40 Uosm 480
3. SNa 120, SOsmo 310, Glucose 8 pH 7.00, UNa 40 UOsm 300
4. SNa 120, SOsmo 257, Glucose 9 pH 7.20, UNa 5 UOsm 520
5. SNa 120, SOsmo 257, Glucose 8 pH 7.40, UNa 40 Uosm 80
6. SNa 120, SOsmo 257, Glucose 3, pH 7.10, UNa 40 UOsm 300

A. Hypoadrenalism
B. Psychogenic polydipsia
C. SIADH
D. Hyperosmolar hyperglycaemic syndrome
E. Diarrhoea
F. Ethylene Glycol Toxicity

*Need ***ALL*** correct for any marks

Question 8

27 Most Likely Diagnosis

Parameter	Measured Value	Normal Ranges
FIO_2	0.5	
pH	7.2	7.35-7.45
$PaCO_2$	40	35-45 mmHg
PaO_2	180	80-100 mmHg
Bicarbonate	15	22-27 mmol/L
Base Excess	-11	-2 to +2 mmol/L
Sodium	132	135-145 mmol/L
Potassium	2.2	3.5-4.5 mmol/L
Chloride	112	100-110 mmol/L
Glucose	5.8	3.0-6.0 mmol/L
Urea	8.5	3.5-7.2 mmol/L
Creatinine	102	50-100 micromol/L
Lactate	0.2	< 2.0 mmol/L
Urine Sodium	10	
Urine Potassium	3	
Urine Chloride	40	
Urine pH	5.0	

A. Pneumonia and acetazolamide therapy
B. Diarrhoea with aspiration
C. Pneumonia and amphotericin treatment
D. Pneumonia and type IV RTA
E. Pyroglutamic acid metabolic acidosis

Question 9

28 Match the following causes of polyuria*

S=Serum, U=urinary

1. SNa 140, SOsm 325, Glucose 3, UNa 40, UOsm 320
2. SNa 130, Sosmo 325, Glucose 7, UNa 40 UOsm 320
3. SNa 150, SOsmo 320, Glucose 7, UNa 100 UOsm 300
4. SNa 120, SOsmo 260, Glucose 7, UNa 200 UOsm 300
5. SNa 150, SOsmo 320, Glucose 8, UNa 50 UOsm 120
6. SNa 150, Sosmo 320, pH 7.50, UNa 80 UOsm 300

A. Diabetes Insipidus
B. Alcohol
C. Diuretics
D. Cerebral Salt Wasting
E. Hypertonic Saline
F. Mannitol

*Need ***ALL*** correct for any marks

Question 10

30
Which was processed in ABG machine

(Other went to Lab)

Parameter	Sample A	Sample B	Normal Ranges
FIO_2	0.3	0.3	
pH	6.9	6.9	7.35-7.45
$PaCO_2$	5	5	35-45 mmHg
PaO_2	150	150	80-100 mmHg
Bicarbonate	2	2	22-27 mmol/L
Base Excess	-28	-28	-2 to +2 mmol/L
Sodium	150	140	135-145 mmol/L
Potassium	4.7	4.7	3.5-4.5 mmol/L
Chloride	118	118	100-110 mmol/L
Glucose	6.0	6.0	3.0-6.0 mmol/L
Lactate	30	5	< 2.0 mmol/L
Albumin	40	40	35-50 g/L
Total protein	70	120	60-80 g/L
Calcium	2.0	2.0	2.1-2.55 mmol/L
iCa	0.9	0.9	1.11-1.25 mmol/L
Ethanol	0	0	

Question 11

31. Which is NOT true?

(NR = Normal Range)

- Patient
  - MAP 40
  - CI 2.2
  - SVV 22%
  - GEDI 800
  - SVRI 1010
- Normal Range
  - SVV < 10%
  - GEDI 680-800
  - CI 3-5
  - SVRI 1500-2500

A. Patient could be in AF
B. Patient could have femoral CVC
C. All the above values are dynamic measurements
D. System may need recalibrating
E. Patient may have PE

Question 12

37. Most likely diagnosis?

Parameter	Measured Value	Normal Ranges
FIO_2	0.21	
pH	7.22	7.35-7.45
$PaCO_2$	40	35-45 mmHg
PaO_2	95	80-100 mmHg
Bicarbonate	15	22-27 mmol/L
Base Excess	-11	-2 to +2 mmol/L
Sodium	139	135-145 mmol/L
Potassium	6.2	3.5-4.5 mmol/L
Chloride	102	100-110 mmol/L
Glucose	1.8	3.0-6.0 mmol/L
Urea	4.2	3.5-7.2 mmol/L
Creatinine	160	50-100 micromol/L
Lactate	6.5	< 2.0 mmol/L
AST	200	10-50 U/L

A. Alcoholic binge
B. Seizures
C. Insulin overdose
D. Simvastatin toxicity
E. Critical illness myopathy

Question 13

39. Most Likely Diagnosis

Parameter	Measured Value	Normal Ranges
Hb	95	115-155g/L
Haematocrit	0.32	0.35-0.45
MCV	107	80-99 fL
MCH	28	27-33 pg
WBC	14.0	4.0-11.0x 10^9/L
Neutrophils	10.5	1.9-7.5 x 10^9/L
Platelets	160	150-400 x 10^9/L
Sodium	120	135-145 mmol/L
Potassium	2.8	3.5-4.5 mmol/L
Chloride	85	100-110 mmol/L
Glucose	8.0	3.0-6.0 mmol/L
Urea	5.0	3.5-7.2 mmol/L
Creatinine	115	50-100 micromol/L
Lactate	1.2	< 2.0 mmol/L
Albumin	30	35-50 g/L
Total protein	60	60-80 g/L
Calcium	1.9	2.1-2.55 mmol/L
Phosphate	1.0	0.7-1.5 mmol/L
Magnesium	1.0	0.7-1.0 mmol/L
AST	80	< 45 U/L
ALT	40	< 45 U/L
Creatinine Kinase	500	50-300 U/L
Serum osmolality	280	275-295 mosm/kg

A. Diuretics
B. Malnutrition
C. Hypothyroidism
D. Alcoholism
E. B12 deficiency

Question 14

42. Most Likely Diagnosis

Parameter	Measured Value	Normal Ranges
FIO_2	0.21	
pH	7.55	7.35-7.45
$PaCO_2$	58	35-45 mmHg
PaO_2	75	80-100 mmHg
Bicarbonate	49	22-27 mmol/L
Base Excess	+25	-2 to +2 mmol/L
Sodium	142	135-145 mmol/L
Potassium	1.8	3.5-4.5 mmol/L
Urinary Potassium	20mmol/L	
Chloride	100	100-110 mmol/L
Glucose	12.3	3.0-6.0 mmol/L
Urea	3.6	3.5-7.2 mmol/L
Creatinine	125	50-100 micromol/L
Lactate	0.8	< 2.0 mmol/L
Magnesium	0.4	0.6-1.2 mmol/L
Phosphate	0.2	0.6-1.4 mmol/L

A. COPD and steroids
B. Diarrhoea
C. Diuretics
D. Conns syndrome
E. Periodic paralysis

Question 15

49. What is the most likely cause?

- 75 yo man post tissue AVR (AS).
  - Bleeding briskly from drains.
    - INR 1.2
    - APTT 45 s
    - Fibrinogen 1.6 g/L
    - TCT 17 s (12-18)
    - Pl 180 x 10^9/L

A. Heparin effect
B. Von Willebrand factor deficiency
C. Aspirin
D. Factor XII deficiency
E. Hypothermia

Question 16

50. Most likely diagnosis

Parameter	Measured Value	Normal Ranges
Hb	185	115-155g/L
Haematocrit	0.60	0.35-0.45
MCV	96	80-99 fL
MCH	31	27-33 pg
WBC	14.9	4.0-11.0 x 10(9)/L
Neutrophils	11.0	1.9-7.5 x 10(9)/L
Platelets	288	150-400 x 10(9)/L
Bicarbonate	20	22-27 mmol/L
Base Excess	-5	-2 to +2 mmol/L
Sodium	137	135-145 mmol/L
Potassium	4.8	3.5-4.5 mmol/L
Chloride	115	100-110 mmol/L
Glucose	8.2	3.0-6.0 mmol/L
Urea	12.0	3.5-7.2 mmol/L
Creatinine	130	50-100 micromol/L
Albumin	20	35-50 g/L
Erythropoietin	28	4-20mU/L

A. Haemochromatosis
B. Burns
C. Haematological malignancy
D. Chronic hypoxaemia
E. Excess erythropoietin

Question 17

53. Match cells to disease

1. Howell Jolly Bodies
2. Pappenheimer bodies
3. Basophilic stippling
4. Cabot rings
5. Target cells

A. Lead poisoning
B. Sickle cell disease
C. Liver disease
D. Alcohol
E. Sideroblastic anaemia

Question 18

61. Match One *Potential* Antibiotic

1. MRSA	A. Clindamycin
2. Enterococcus Faecalis	B. Penicillin
3. Acinetobacter	C. Teicoplanin
4. Streptococci	D. Amoxicillin
5. Anaerobes	E. Meropenem

Question 19

63. Match the Micro with the Bug

1. Gram positive cocci in chains	A. Klebsiella pneumoniae
2. Gram negative cocci	B. Clostridium perfringens
3. Gram positive cocci in clusters	C. Enterococcus faecalis
4. Gram positive rods	D. Staph aureus
5. Gram negative bacilli resistant to carbapenem	E. Neisseria meningitidis

Question 20

65. What antimicrobial treatment?

- WCC 90 x 10^6/L
  - 90% Neutrophils
- RBC 1 x 10^5/L
- Protien 0.6mg/L (0.15-0.4)
- Glucose 10 mmol/L
- Gram stain Nil
- PCR – HSV positive
- Blood Culture Gram-positive bacilli

Answers

NAGMA = normal anion gap metabolic acidosis

HAGMA = high anion gap metabolic acidosis

1. 53mmHg or 7.1kPa
    - Aa gradient = $P_IO_2 – (PaCO_2/0.8) –$ **PaO_2**
    - Room air $P_IO_2 = P_{ATM} – P_{H2O} \times F_IO_2 =$ (760- 47) x 0.21 = **150mmHg** (or 149.7 to be precise)
    - Note P_AO_2 influenced by F_IO_2, P_{ATM}, and $PaCO_2$ (and P_{H2O})

2. 56mmHg
    - Normal P50 is 26.6 mmHg or 3.5 kPa
    - Right shifted curve – increase CO_2, H^+, temperature or 2,3 DPG (low phosphate can cause a left shift)
    - The curve in the example is right shifted and therefore a vertical line from the x-axis (representing a constant PaO_2) would cross the relatively left positioned (compared to the pathological sample) normal curve at a higher O_2 saturation %.

3. DKA
    - If pH is abnormal and is within 5-10 of pCO2 (in mmHg) then it is a compensated metabolic problem
        - pH 7.1 and CO2 of 10mmHg = compensated metabolic acidosis
        - pH 7.5 and CO2 of 50mmHg = compensated metabolic alkalosis
    - Na – Cl screening test
        - Na – Cl < 30 = abnormal = NAGMA (+/- HAGMA) or very low albumin or rarely unmeasured cation (magnesium, lithium etc)
        - Na – Cl > 40 = abnormal = metabolic alkalosis (+/- other acid base issue)

pH	pCO2	Possibility 1	Possibility 2	Notes
Normal	Normal	Normal	Mixed metabolic alkalosis and high anion gap acidosis.	Na-Cl should be 30-40 If > 40 consider HAGMA plus alkalosis. AKI plus vomit
Normal	High	Compensated respiratory acidosis	Mixed respiratory acidosis and metabolic alkalosis	COPD
Normal	Low	Compensated respiratory alkalosis	Mixed respiratory alkalosis and metabolic acidosis	Pregnancy
Low	Low	Compensated metabolic acidosis		Does CO2 = last 2 digits of pH (see above)
High	Low	Uncompensated respiratory alkalosis		Hyperventilation
Low	Normal	Uncompensated metabolic acidosis		Can also be called mixed metabolic acidosis and respiratory acidosis

High	Normal	Uncompensated metabolic alkalosis		Can also be called mixed metabolic alkalosis and respiratory alkalosis
Low	High	Uncompensated respiratory acidosis		Opioid overdose
High	High	Compensated metabolic alkalosis		Does CO2 = last 2 digits of pH

4. 1D, 2C, 3E, 4A , 5B
    - Compensated respiratory alkalosis is pregnancy. Metabolic compensation here is chloride retention
    - Compensated NAGMA = RTA
    - Compensated respiratory acidosis = COPD (note that Na-Cl usually > 40)
    - Compensated metabolic alkalosis = pyloric stenosis (note Na-Cl > 40)
    - Low anion gap with normal metabolic state = unmeasured cation = Lithium

Please note that I haven't put these figures through an acid-base calculator (a cardinal sin) and so they may not work perfectly, but they are designed to outline the principles

5. D
    - pH = CO2 = compensated metabolic acidosis
    - Na – Cl < 30 = NAGMA +/- HAGMA
        - Delta gap = (21-12)/(24-7) = 0.5 = NAGMA + HAGMA

Note if absolute lactate figure (in mmol/L) > BE then likely to be Lactic acidosis HAGMA plus metabolic alkalosis

6. C
    - Large Aa gradient = 562
    - Partially compensated respiratory acidosis or mixed respiratory acidosis and metabolic alkalosis (note the ubiquitous low chloride of metabolic alkalosis)
    - Na-Cl = 41 = metabolic alkalosis

Could be B or D, so in quiz I modified B to aspiration and Conns (not common) and added NIV to "D" which would be pretty hypoxaemic for NIV

7. 1D, 2C, 3F, 4E, 5B, 6A
    - Hypotonic hyponatraemia
        - High glucose – HHS/HONK
        - Normal glucose but metabolic acidosis – toxic alcohol (if low calcium think ethylene glycol)
    - Isotonic hyponatraemia
        - Appropriate ADH inhibition= urine osmo < 100 = intravascular depletion = diarrhoea
        - Inappropriate ADH
            - SIADH
            - Low glucose – hypoadrenalism (may have eosinophilia)

8. B
    - Uncompensated metabolic acidosis or mixed metabolic and respiratory acidosis
    - Na-Cl = 20 = NAMA+/-HAGMA
        - Delta gap = (12-5)/(24-15) = 0.57 = HAGMA and NAGMA
    - Urine Na < 20 = dehydration
    - Urine anion gap
        - Na + K – Cl
        - Normally a negative number in acidosis
            - Represents unmeasured ammonia (traditional model)
            - Ensures relative loss of Cl and therefore trying to compensate with an alkalosis
        - *Urine anion gap negative therefore kidneys trying to help and so problem extrarenal*
        - If anion gap normal or positive then kidneys are exacerbation the problem = RTA
        - ***Simply negGUTive***

9. 1B, 2F, 3E, 4D, 5A, 6C
    - Big serum osmolar gap think diuretic
        - Low glucose – alcohol
        - Hyponatraemia – mannitol
    - Low serum sodium, ***polyuria*** and high urine sodium = CSW
    - High serum sodium low urine osmo (<300) = DI
    - High serum sodium metabolic alkalosis = diuretics

10. A
    - Sodium measured undiluted in ABG machine, often diluted in lab
    - High protein count in “B” fools the dilution method to give “pseudohyponatraemia” (yes it really exists)

    - Lactate gap – ethylene glycol toxicity produces glycolate which interferes and falsely elevates lactate in some ABG (and indeed lab) machines

11. C
    - SVV suggests volume GEDI suggests not
        - SVV not validated in AF (though software tries to compensate)
        - Right heart failure with pulmonary hypertension means the LV is under-filled and generates data supportive of this (think what the LV looks like on a classic PE ECHO)
    - GEDI is a static calculation done only when the machine is calibrated
    - Femoral CVC leads to a GEDI calculation about 50ml greater than the RIJ CVC equivalent

12. B
    - High lactate and low glucose = liver failure, seizures or alcohol binge
    - AST and Creatinine high = muscle (would check a CK if requested)

13. C
    - Macrocytosis, low sodium, high CK are all consistent with hypothyroidism
    - High cholesterol is also a hypothyroid “classic”

14. D
    - Compensated metabolic alkalosis
        i. Hypokalaemic metabolic alkalosis
    - Low Mg and PO also likely in Conns
    - Urine K
        i. Note urine K should be < 10 unless kidneys are part of the problem
        ii. Urine K > 10 = diuretics (in polyuric phase) conns
        iii. Urine K < 10 = diarrhoea

Note urine K is generally not that useful apart from the perfect CICM exam patient

15. B
    - Acquired type 2A Von Willebrand syndrome secondary to aortic stenosis is common
        i. Can lead to mild prolongation of APTT
    - TCT is a very sensitive marker of heparin
        i. It was historically use as a quality control measure for samples which may have been heparin-contaminated.
    - Whilst congenital factor XII deficiency is a common cause of APTT prolongation it is almost never associated with bleeding issues

16. B
    - Polycythaemia cause
        - Chronic hypoxaemia (no ABG here)
        - Haematological malignancy – other blood cells normal
        - Epo – not very raised and usually raised in critical illness, (realtive epo resistance)
        - Haemochromatosis does not normally cause polycythaemia
        - Low albumin suggestive of capillary leak = burns

17. 1B, 2E, 3D, 4A, 5C
    a. Sickle cell can cause asplenism = target cells
    b. Basophilc stippling = lead or alcohol
    c. Cabot rings = lead poisoning, megaloblastic anaemia, haematological malignancy

Just learn a list of what causes what

18. 1C, 2D, 3E, 4B, 5A
    a. Just learn what treats what

19. 1C, 2E, 3D, 4B, 5A
    a. As above

20. CSF, acyclovir and amoxicillin
    a. Blood brain barrier is disrupted in critical illness, so CSF protein often mildly raised in non-CNS disease
    b. Gram positive bacilli – Listeria (think *clostridia* species if clinically appropriate - skin or faeces)
    c. Listeria needs ampicillin/amoxicillin (many suggest adjunct gentamicin)