THE ACIDOTIC MAN

Professor Karim Meeran

Learning Objectives

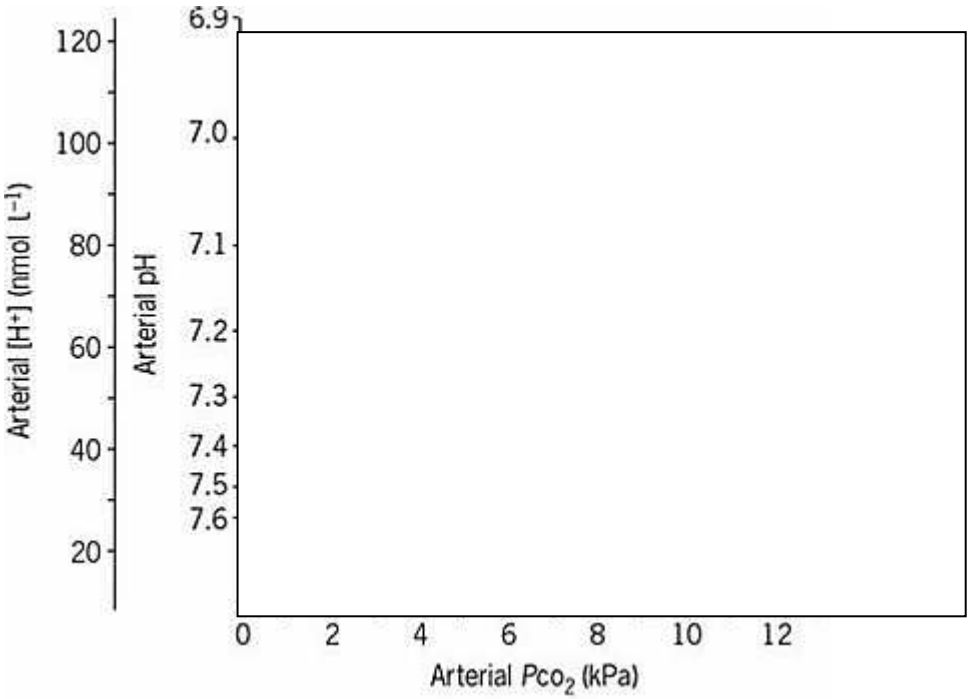
1. To understand the acid/base abnormalities listed below
2. To recognise common acid base scenarios and be able to recognise patterns immediately and without any clinical information.
3. Putting together the blood gas results with the acute medical context to work out the diagnosis.

Preliminary question:
pH 6.90. PCO_2 = 2.5 kPa (NR 4-5) PO_2 = 15 kPa (normal)

What is the acid-base abnormality?

1) Normal
2) Metabolic Acidosis
3) Metabolic Alkalosis
4) Acute Respiratory Acidosis
5) Acute Respiratory Alkalosis
6) Chronic respiratory acidosis with metabolic compensation.
7) Metabolic acidosis with respiratory compensation .
8) There is not enough information here to be sure

Draw graph of CO_2 versus pH in the space below.



$pH = - \log_{10} ([H^+])$

Typical values are calculated in the table:

pH	power (10,pH) (mol/l)	x 10 power 9	[H+] nM
6.9	1.26E-07	126	126
7.0	1E-07	100	100
7.1	7.94E-08	79.43282	80
7.2	6.31E-08	63.09573	63
7.3	5.01E-08	50.11872	50
7.4	3.98E-08	39.81072	40
7.5	3.16E-08	31.62278	32
7.6	2.51E-08	25.11886	25
7.7	2E-08	19.95262	20
7.8	1.58E-08	15.84893	16
7.9	1.26E-08	12.58925	12
8.0	1E-08	10	10

The only things that are measured in a blood gas sample are the pH, the PaCO2 and PaO2. All other parameters are calculated by the machine using the Henderson-Hasselbach equation.

You do NOT need to know the actual equation, just know of its existence, and that this explains that the bicarbonate is calculated from the pH and the PaCO2.

The Henderson Hasselbach equation: $[H^+] = \frac{k \times [CO_2]}{[HCO_3^-]}$

If PaCO2 is measured in kPA, then k = 180

Thus if pH = 6.90, [H+]=126 nM

$$: \quad [HCO_3^-] = \frac{180 \times [CO_2]}{[H^+]} = \frac{180 \times 2.5}{126} = 3.6 \text{ mM}$$

Definition of compensation:
Improving the pH (essential for survival) by using an alternative mechanism to the one that has caused the abnormality. Compensation therefore improves the pH but makes the PaCO2 or the bicarbonate worse.

Case 1. A 40-year-old arrives unconscious in casualty. His friend said that he had been very ill for the last few days, with vomiting and complaining of breathlessness. Investigation reveals:

pH 6.85. PCO_2 = 3.0 kPa (NR 4-5) PO_2 = 15 kPa (normal)
What is the acid-base abnormality?

Case 2
A 19-year-old who is known to have had type 1 diabetes for two years, presents unconscious to casualty.

pH 7.22. pCO_2: 1.6 kPa. pO_2 15 kPA (normal)

What is the acid-base abnormality?

Case 3
A 19-year-old who is known to have had type 1 diabetes for two years, presents unconscious to casualty.

pH 7.60. pCO_2: 3.0 kPa. pO_2 15 kPA (normal)

What is the acid-base abnormality?

Why is he unconscious?

Case 4
A 19-year-old who is known to have had a duodenal ulcer.
pH 7.60. pCO_2: 6.5 kPa. pO_2 15 kPA (normal)

What is the acid-base abnormality?

Case 5
A 24-year-old who drug addict arrives in A and E unconscious. He has had a mixture of heroin, methadone and temazepam.

pH 7.10. pCO_2: 9.5 kPa. pO_2 8.0 kPA

What is the acid-base abnormality?

Case 6
A 69-year-old who is known to have had COPD

pH 7.28. pCO_2: 9.5 kPa. pO_2 7.5 kPA

What is the acid-base abnormality?

Case 7
A 40-year-old who has taken an overdose

pH 7.41. pCO_2: 2.1 kPa. pO_2 17.5 kPA (normal)

What is the acid-base abnormality?

Case 8
A 59-year-old man, know to have had type 2 diabetes for several years who is on a good diet and metformin, presents to casualty unconscious. His urine is negative for ketones.
Investigations reveal:
Na: 140 mM, K=4.0mM, U=4.0 mM, pH=7.10, Glucose = 4.0 mM
PCO2 = 1.3 kPa, Cl = 90 mM, Bicarb = 3.0 mM

What is the acid-base disturbance?

Case 9
A 60-year-old who has a cardiac arrest

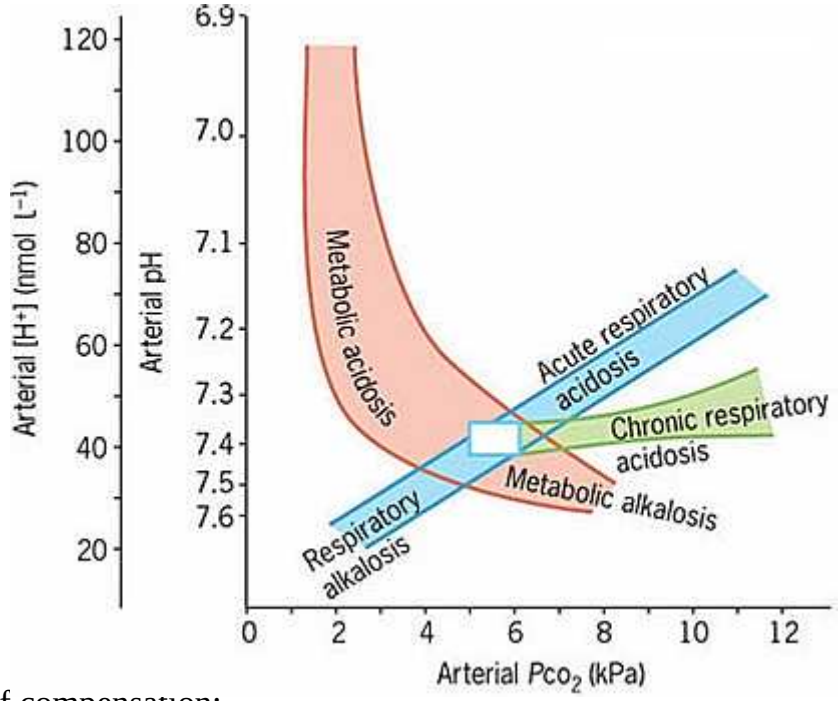
pH 6.61. pCO_2: 7.1 kPa. pO_2 17.5 kPA (normal)

What is the acid-base abnormality?

How will you manage this patient?

Correction of an acidosis.
There is only one treatment for a respiratory acidosis. Get them breathing. Ventilation is the key, and failure to ventilate is the commonest cause of death.

The treatment of a metabolic acidosis is more subtle.



Definition of compensatıon:
Improving the pH (essential for survival) by using an alternative mechanism to the one that has caused the abnormality.

Metabolic acidosis compensated with Kussmaul respiration

Respiratory acidosis compensates after some time with metabolic alkalosis in the kidney with the retention of bicarbonate to improve the pH but make the PCO2 even higher.

Generally:

- Compensation does not occur for an alkalosis.
- Resp alkalosis is too short lived
- Metabolic alkalosis would be compensated for by breathing slower, but hypoxia prevents this.

Causes of a metabolic acidosis:

- Drinking bicarbonate for your ulcer
- Losing potassium in the urine chronically causes a hypokalaemic alkalosis
- Diuretics
- Cushings
- Conns
- Any other cause of hypokalaemia.