DIABETES - CLINICAL CASES

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# Learning Objectives

1. To understand the acid/base abnormalities that occur in patients with type 1 diabetes.

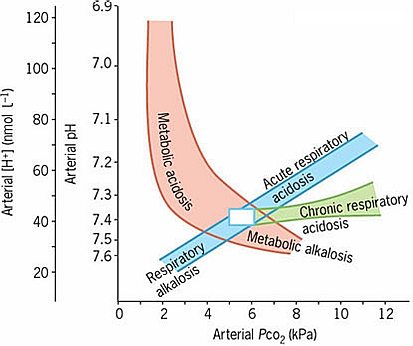
2. To understand the use of chemical pathology to determine the anion gap in patients with diabetes, and to be able to interpret this.

3. Know how to calculate the osmolality and interpret the results

4. Interpret data in from electrolyte results to give a differential diagnosis.

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Draw graph of CO2 versus pH in the space below.



**pH= - log 10 ([H+])**

**Case 1**

A 16-year-old arrives unconscious in casualty. His mother said that he had been very ill for the last few days, with vomiting and complaining of breathlessness. Investigation reveal:

pH 6.85. pCO2 = 2.3 kPa (NR 4-5) pO2 = 15 kPa (normal)

What is the acid-base abnormality?

Na: 145. K 5.5 Urea 10.0mM. Glucose 25 mM Chloride = 96mM Bicarb=4mM

Why is he unconscious?

**How to calculate the plasma osmolality:**

Formula: Osmolality = charged molecules + uncharged molecules

= cations + anions + urea + glucose

Cations (Na, K) = anions (Cl, HCO3, others), otherwise the blood would be charged!

Write down the final formula for calculating osmolality here:

What is the plasma osmolality?

**How to calculate the Anion Gap:**

Cations (Na + K) = anions (Cl, HCO3, **others**), otherwise the blood would be charged!

“Others” known as “anion gap”. They represent the usually unquantified anions, including phosphate, sulphate, lactate, ketones and any added anions.

Write down the final formula for calculating the anion gap here:

AG=

What is the normal anion gap?

What is the anion gap in this patient?

**Case 2**

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

pH 7.65. pCO2: 2.8 kPa. Bicarb 25mM (normal). pO2 15 kPA (normal)

What is the acid-base abnormality?

Further results:

Na=140, K=4.0, Bic = 24mM, Cl = 100, Glucose = 1.3 mM

What is the anion gap?

What is the diagnosis?

**Case 3**

A 60-year-old man presents unconscious to casualty with a long history of polyuria and polydipsia. Investigations reveal:

Na 160 mM, K 6.0 mM, U=50mM, Glucose = 60mM

What is the osmolality?

Why is he unconscious?

**Case 4**

A 60-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 = 4.0 mM

What is the osmolality?

What is the anion gap?

What is the acid-base disturbance?

Why is he unconscious?

**Definition of Diabetes**

This is only really relevant to type 2 diabetes, where patients only slowly become unwell. Patients with type 1 diabetes present with ketoacidosis, so there is no argument about whether or not they have diabetes. However type 2 diabetes can be more difficult because patients might have fasting plasma glucose values close to 7.0 mmol/l. To diagnose diabetes, it is important that the patient has symptoms of diabetes. If they have a random (i.e. not necessarily fasting) plasma glucose of >11.1 mmol/l then it is highly likely that they have diabetes.

If they have a fasting plasma glucose > 7.0 mmol/l, they have diabetes. If the fasting glucose is greater than 7.0 then the patient has diabetes, and no further testing is needed.

Normal fasting plasma glucose < 5.5 mmol/l according to the American Diabetes Association and <6.1 mmol/l according to the World Health Organisation. It is irritating for students that both values are widely used, but we will ensure that for exam purposes that this difference is not a problem. For the rest of this guide, we are going to use the ADA guidelines.

Thus, a glucose level between 5.5 mmol/l and 7.0 mmol is known as **“impaired fasting glucose (IFG)”.**

Alternatively, an oral glucose tolerance test (OGTT) can be performed. This is performed by giving 75 grams of glucose in approximately 300 ml of water and can be useful if patients are particularly obese or have impaired fasting glucose. Patients who have a glucose 2h after an OGTT that is greater than 11.1 also have diabetes. Thus, to have diabetes one needs to have **either** a fasting plasma glucose greater than 7.0mmol/l **or** a 2 hour value greater than 11.1 mmol/l.

Some patients who have a fasting glucose of less than 7.0 mmol/l will have a 2 hour value of between 7.8 and 11.1. These patients have “**impaired glucose tolerance (IGT)**”.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **NORMAL** | **IFG** | **IGT** | **Diabetes** |
| 0 mins | <5.5 | 5.5 – 7.0 |  | >7.0 mmol/l |
| 120 mins | <7.8 mmol/l |  | 7.8 – 11.1 mmol/l | >11.1 mmol/l |

All the values above apply to PLASMA glucose. To measure this, the blood sample needs to be collected in fluoride oxalate and centrifuged to remove the red cells. If this is not done, then you are measuring WHOLE BLOOD glucose. In this case, the values above need to be changed:

7.0 plasma is 6.1 whole blood.

7.8 plasma is 6.7 whole blood.

11.1 plasma is 10.0 whole blood.

This occurs because red cells occupy approximately 40% of blood volume, and the glucose within those cells is lower than outside the cells.

Occasionally, patients with type 2 diabetes who have a fasting glucose only just above 7.0 mM, might be able to lose weight (by strict dieting and exercise) so that they become “non diabetic”. This is definitely worth striving for, but unfortunately most patients aren’t motivated enough to keep the weight off, and so the diabetes returns shortly afterwards. However people forced to keep on diet and exercise can stay non diabetic. For evidence that type 2 diabetes is preventable with diet and exercise, see the landmark trial, the Diabetes Prevention Programme (New Engl J Med Feb 7th 2002 Vol 346 (6) pages 393 – 403.

