This article, the second in this series on homeostasis and its role in maintaining stable bodily conditions, discusses acid-base balance and explores blood gas analysis, related conditions and nursing care.

Blood acid-base balance is under homeostatic control through the nervous and endocrine systems, which maintain normal levels of components in the blood. This ensures that cellular processes are optimised and not life-threatening (Tortora and Grabowski, 2002). The normal components in the blood are shown in Table 1.

The pH of blood reflects the number of hydrogen ions in it – either too few or too many results in cellular dysfunction and inadequate oxygen transportation around the main body organs. This in turn leads to tissue hypoxia and results in tissue death if it is not reversed (Tortora and Grabowski, 2002; Adam and Osborne, 1997). Although carbon dioxide (CO₂) does not contain hydrogen ions it rapidly reacts with water to form carbonic acid (H₂CO₃), which further dissociates into hydrogen and bicarbonate ions (HCO₃⁻). This reaction is shown as CO₂ + H₂O ⇌ H₂CO₃ ⇌ HCO₃⁻ + H⁺ (Proehl, 1999; Adam and Osborne, 1997) (Fig 1).

Potential hydrogen concentration (pH)

Blood pH is monitored to ensure that when it deviates from the norm clinical care is adapted to resolve the underlying issue (Docherty, 2002b). A pH either less than 7.0 or above 7.8 is incompatible with cellular metabolism and is therefore life-threatening (Proehl, 1999). Low (acidic) pH is often considered to be acute, while more serious high (alkalotic) pH is often due to chronic medical conditions such as chronic renal failure and is less easy to resolve in the short term (Pruitt and Jacobs, 2004; Woodrow, 2004).

Homeostatic control

There are two main components of acid-base homeostatic control: respiratory and metabolic. Both work to correct imbalance. As a general rule, a respiratory abnormality will correct itself within hours, whereas a metabolic abnormality may take up to 2–3 days to correct (Resuscitation Council (UK), 2000; Proehl, 1999). In respiratory dysfunction CO₂ levels deviate from the norm. They are usually raised as a result of inadequate breathing, which leads to excess CO₂ combining with water to form carbonic acid. This in turn lowers the blood pH, resulting in blood acidosis (Docherty, 2002b).

The respiratory system alters CO₂ levels to counteract changes in blood pH. In low pH (acidosis) the medulla oblongata increases the respiratory rate and depth to correct the excessive CO₂ level in the
In acid-base balance other factors are involved in the homeostatic control of the vital components. These have their own homeostatic mechanisms, which should be considered when looking at the patient holistically. They include:

1. **Haemoglobin** – The amount of haemoglobin in the blood affects its oxygen-carrying capacity. When this is identified, for example, through cyanosis, action should be taken to restore the correct level, because the body’s own homeostatic mechanisms take several days to work. This may be too long in the acute setting (Proehl, 1999).

Haemoglobin also acts as a buffer to hydrogen ions in red blood cells, so in acidosis in low haemoglobin states the cells are less able to buffer the acidic effect as efficiently (Woodrow, 2004).

2. **Temperature** – Temperature will impact on the amount of oxygen dissociation from oxyhaemoglobin molecules in the circulating blood, and so this should also be considered and corrected where possible (Adam and Osborne, 1997).

3. **Blood Pressure** – The cardiovascular system should be sufficiently strong to circulate adequate volumes of blood around the body and if there is heart failure (for example low cardiac output) this will impact on the delivery of oxygen to tissues and the clearance of waste products such as carbon dioxide (Proehl, 1999; Smith, 2000).

Where possible, support should be given if the body’s own mechanisms are unable to cope with the demand. This might be in the form of fluid management (for example blood cells or crystalloid), drug therapy (for example inotropic support) or mechanical support (for example a pacemaker or intra-aortic balloon pump) (Docherty, 2002a; Smith, 2000).

**Other factors**

In some patients, especially those with underlying chronic airway conditions or those who are neurologically unstable, this change in respiratory function to correct the acid-base imbalance (Fig 2) can make them tire easily and respiratory support may be required, such as continuous positive airway pressure or mechanical ventilation (Docherty, 2002b). However, patients with chronic airways disease are able to live normally with a high CO2. In fact they require it as a stimulus to breathe. In these patients restoration of CO2 should initially but then worsens it if respiratory compensations are not effective (RCUK, 2000).

**REFERENCES**


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