8.4: Infusion of 8.4 Percent Sodium Bicarbonate Solution

As an example, consider the infusion of an 8.4% NaHCO$_3$ solution. This is a molar solution of NaHCO$_3$. Dissociation into two particles in solution results in a solution with an osmolality of 2,000 mOsm/kg. This is about 7 times the plasma osmolality!

Infusion of this solution has effects because it is:

- Hypertonic (2,000 mOsm/l) with a high [Na$^+$]
- Alkalinising (HCO$_3^-$ load).

The high sodium concentration restricts the distribution of the solution to the ECF. The hypertonic nature of the solution draws water out of cells until the ECF and ICF tonicities are equal. The increase in ECF volume will be greater than the volume of solution administered into it.

The ECF [Na$^+$] will increase dependent on the amount of solution administered but the water drawn out of the cells will tend to minimise this increase. Sodium bicarbonate solution has occasionally been recommended for emergency treatment of acute hyponatraemia particularly where there was also a perceived benefit of the alkalosis.

The ECF [HCO$_3^-$] will increase and this exogenous administration of base will cause a metabolic alkalosis. This causes intracellular movement of K$^+$ and ECF [K$^+$] will decrease. This is the basis of the use of NaHCO$_3$ solution for the emergency treatment of hyperkalaemia.

Under normal circumstances, if the plasma bicarbonate rises above about 27 mmol/l then HCO$_3^-$ is rapidly excreted in the urine. A metabolic alkalosis will rapidly correct unless there is some additional factor which maintains it. Because of the brief nature of the alkalosis, the compensatory hypoventilation is minimal.
There are conflicting influences on ADH levels:

- A rise in extracellular tonicity of 1 to 2% or more will increase ADH levels (effect via hypothalamic osmoreceptors).
- An increase in blood volume of 7 to 10% or more will decrease ADH levels (effect via low pressure baroreceptors).

A decrease in ADH will increase water excretion. An increase in blood volume due to NaHCO$_3$ infusion will cause a fall in plasma oncotic pressure and water reabsorption in the proximal tubule will decrease slightly due to glomerulotubular imbalance.

The increases in tonicity and blood volume can be estimated from a knowledge of the volume of solution administered.

[See similar calculations in Section 8.2.]