5a. Carbon Dioxide and the Aircraft Cabin Environment

On the ground at sea level, the carbon dioxide concentration in the atmosphere is three hundred parts per million (0.03 percent). It is this atmospheric concentration of carbon dioxide that establishes the normal pressure-concentration gradient between the lungs and the atmosphere. It is reported that people who travel in modern aircraft may become ill as a consequence of the aircraft cabin environment. In a modern aircraft about fifty percent of cabin air is recycled. As a consequence, carbon dioxide concentrations may reach between one thousand and five thousand parts per million (one percent). This concentration of carbon dioxide is approximately three to fifteen times higher than the human body breathes at sea level. Accordingly, the concentration gradient of carbon dioxide from the lungs to the atmosphere is decreased by three to fifteen times. This increases the tissue concentrations of carbon dioxide in the body. In addition, the pressurised cabin of modern aircraft is pressurised to an equivalent altitude of two thousand to three thousand metres. At this altitude, the oxygen saturation of non-acclimatised blood is less than ninety percent of sea level values.

This occurs because at two to three thousand metres the partial pressure of oxygen in the atmosphere is only seventy percent of that of sea level values. At two to three thousand metres, in people who have not acclimatised to this height, the Haldane effect is diminished. The Haldane effect describes the fact that oxygen concentrations displace carbon dioxide concentrations from haemoglobin in red blood cells. The Haldane effect is vitally important for the normal elimination of carbon dioxide from the body. Indeed at sea level, the Haldane effect approximately doubles the amount of carbon dioxide released from the blood in the lungs and approximately doubles the pickup of carbon dioxide in the tissues. When the Haldane effect is diminished, carbon dioxide concentrations build up in the tissues. The Haldane effect is diminished in an aircraft cabin where normal physiological adaptation to high altitude has not had time to occur.

Normal human adaptation to high altitude takes several days to weeks. The build up of carbon dioxide in body tissues in an aircraft cabin is exacerbated by low aircraft cabin humidity, which leads to dehydration, and by lack of muscle movement which decreases capillary blood flow in the tissues. In addition, excess alcohol and food consumption on board an aircraft increases the metabolic carbon dioxide concentrations in the tissues of the body.