Acute Exposure Guideline Levels for Selected Airborne Chemicals: Volume 8
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The time required to eliminate half of the gas is 3-5 h (Landaw 1973), depending on the amount of respiration, which acts to wash it out of the body. Peterson and Stewart (1970) reported a range of 128-409 min for the elimination half-time in 39 experiments, with an average of 320 min in human subjects who breathed normal air after CO exposure. Increased oxygen pressure helps to dislodge it from the hemoglobin. One hundred percent oxygen given at atmospheric pressure reduces the elimination half-life rate to about 80 min (Peterson and Stewart 1970). Weaver et al. (2000) reported a half-life of 74 ± 25 min for COHb in CO-poisoned patients receiving 100% oxygen. Klasner et al. (1998) reported a half-life of 44 min for 26 children (4-12 years old) when given 100% oxygen via face mask. Hyperbaric oxygen at 3 bar pressure reduces the half-life to about 20-25 min (Landaw 1973; Beard 1982).

4.2. Mechanism of Toxicity

If not stated otherwise, the information on the mechanism of toxicity is taken from the extensive recent reviews of WHO (1999a) and EPA (2000). The best understood biologic effect of CO is its combination with hemoglobin (Hb) to form COHb, thereby rendering the hemoglobin molecule less able to bind with oxygen. Although the rate of CO binding with hemoglobin is about one-fifth slower and the rate of dissociation from hemoglobin is an order of magnitude slower than the respective rates for oxygen, the CO chemical affinity for hemoglobin (represented by the Haldane coefficient M) is about 245 times greater than that for oxygen. One part of CO and 245 parts of oxygen would form equal parts of oxyhemoglobin and COHb (50% each), which would be achieved by breathing air containing 21% oxygen and 570 ppm CO. The steady-state ratio of COHb to oxyhemoglobin is proportional to the ratio of their respective partial pressures:

$$COHb{:}O_2Hb = M\,(P_{CO}{:}P_{O2}).$$

Under dynamic conditions, competitive binding of oxygen and CO to hemoglobin is complex: the greater the number of heme groups bound to CO, the greater the affinity of free heme groups for oxygen. CO not only occupies oxygen-binding sites, molecule for molecule, thus reducing the amount of available oxygen, but also alters the characteristic relationship between oxyhemoglobin and the partial pressure of oxygen, which in normal blood is S shaped. The difference in the partial pressure of oxygen between freshly oxygenated arterial blood ($P(O_2)$ = 100 mm Hg) and mixed venous blood ($P(O_2)$ = 40 mm Hg) represents a release to the tissues of approximately 5 mL of O_2/100 mL of blood (NIOSH 1972). With increasing COHb in blood, the dissociation curve is shifted gradually to the left, and its shape is transformed into that of a rectangular hy-

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