



## Carbon monoxide – the silent killer

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In this issue of the journal there is a report in the Images in Forensics section of an accidental death due to exposure to carbon monoxide gas in the confines of an outdoor shower unit due to a defective, poorly maintained gas water heater [1]. The importance of establishing the cause of death in this case is clear as further deaths would almost certainly have occurred if this dangerous environment had not been identified by the examining pathologist. Once again the potential significance of promptly taking information from the morgue back to the community and relevant authorities has been demonstrated [2]. Accidental carbon monoxide poisoning has been increasingly recognized in association with defective heating devices and this has led to the issuing of public warnings [3]. There have also been a number of reports from a variety of countries on such deaths [4–7]. While the manner of death involving defective water heaters is usually accidental, rare cases of intentional deaths have been reported [8].

Carbon monoxide has been described as a “silent killer” as it does not smell or have any taste or color [9, 10]. Levels increase when organic fuels do not undergo complete combustion and in an Australian context most deaths are due to vehicle-related suicides or to accidental house fires. This, however, differs among communities, with a recent study on unnatural deaths from Tierra del Fuego showing that carbon monoxide toxicity from faulty heating was responsible for 11 times more deaths than suicides [Dr Ines Aparici, personal communication]. Accidental deaths not involving fires are unusual in South Australia and are most often caused by defective exhaust systems in older vehicles. In Hong Kong and parts of South East Asia there is a much higher rate of carbon monoxide suicides from the use of charcoal burners indoors [11].

Carbon monoxide toxicity is also something that should be considered in workplace or industrial deaths where machinery is operating in confined or poorly-ventilated spaces. For example, carbon monoxide toxicity was responsible for one third of deaths in a study of 523 fatal occupational inhalations the United States in the 1990’s. Mining had the highest fatality rate followed by firefighting [12]. It has also been identified as a cause of death in the fishing industry [13] and should prompt proper evaluation of equipment on fishing boats when looking for defects. Carbon monoxide exposure is something that should also be considered in commercial or recreational scuba diving at all ages, as toxic/lethal levels may accumulate in tubing and equipment [14, 15].

Carbon monoxide is dangerous because of its enhanced affinity for hemoglobin compared to oxygen, which results in displacement of significant amounts of oxygen from the hemoglobin molecule, causing reduction in blood oxygen levels. Carbon monoxide may also interfere with the function of mitochondria [16]. The clinical manifestations vary with the amount of carboxyhemoglobin in the blood, with low levels causing confusion, nausea, headaches, weakness, visual disturbances and nausea. As levels increase shortness of breath occurs, followed by fitting, loss of consciousness and death [17]. Death may, however, occur in the elderly and infirm at lower blood levels because of the synergistic effects of significant comorbidities. In cases where comorbidities are present a level of 25% may prove lethal, compared to the usual level of 50 to 60%, or greater [16], as in the reported case [1].

Carbon monoxide toxicity continues to account for a significant number of deaths that present for medicolegal evaluation in most countries. Apart from variable cherry pink discoloration of the skin autopsies are essentially negative for any definitive findings. The nature and manner of these deaths varies among communities. It is, however, something that should always be suspected and tested for by the examining pathologist when an unexpected death occurs in a confined space where there is a heating unit, such as a bathroom or caravan, at a commercial venue where machinery is being operated, during underwater diving, or when more than one unexpected death has occurred without obvious cause.

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## Compliance with ethical standards

**Ethical approval** Not required.

**Conflict of interest** The author declares that he has no conflicts of interest.

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