Carbon Monoxide Poisoning from Gas Water Heater Installed and Operated in the Bathroom

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Summary

Two cases of carbon monoxide poisoning involving 3 victims occurred in Cameron Highlands in the months of August and September 1995. Two of the victims were found dead in the bathrooms where they were taking a bath while the other one survived. Blood toxicology from the post mortems revealed high levels of carbon monoxide. The only significant source of carbon monoxide in both cases were the gas water heaters which were installed in the bathrooms. A multigas detector was used to monitor the level of carbon monoxide in one of the bathrooms and carbon monoxide was found to be produced to 1200ppm in 16 minutes during operation of the heater. Carbon monoxide poisoning from gas water heaters installed in bathroom is a significant hazard.

Key Words: Carbon monoxide, Gas water heater, Bathroom

Introduction

A MEDLINE search from 1984 to June 1995 revealed 22 citations on "Carbon Monoxide (CO) Poisoning at Home" of which 8 implicated gas water heaters or boilers. A one year study from 1978 to 1988 on CO poisoning in Brussels[1] revealed that among all the apparatuses that have been considered to be cause for the accident, around 2/3 were water heaters. The main cause being defective installation.

The gas used for these water heaters is liquefied petroleum gas (LPG). Domestic cooking gas is pressurized LPG in iron tanks. The main composition of LPG is propane and butane (also called hydrocarbon gases). Other naturally occurring gases such as CO and methane (CH_4) are also present. Sulphur dioxide ($S0_2$) is added to produce the pungent smell to ensure quick detention of LPG leakage. In the presence of adequate oxygen, hydrocarbon gases undergo complete combustion to form water and carbon dioxide. However, when oxygen is inadequate, CO and / or carbon is produced instead.

During operation of the heaters, CO can result from leakage of LPG tank or from partial combustion of the hydrocarbon gases of LPG. Causes of inadequate oxygen include defective devices, poor ventilation and defective installation. A study in Copenhagen[2] showed that most cases of CO poisoning from gas water heaters were due to sooted convectors and installed without a flue.

Gas water heaters are used extensively in Cameron Highlands compared to electric heaters because the water heats up faster and they are cheaper to operate. Users should be aware of the danger of CO poisoning when using gas water heaters.

Review of patients' records of Cameron Highlands Hospital from January 1988 to July 1995 showed 17 cases of CO poisoning in the bathrooms but no deaths. Presenting symtoms of these cases were usually giddiness or syncope.

In this report, we wish to document 2 fatal cases of CO poisoning with experiment carried out to identify the probable cause of the poisoning.

Case History

Case 1 : August, 1995:
2 girls, ages 5 and 10, took a bath together. 30 minutes later the mother found both of them unconscious in the bathroom. The younger sibling died on arrival at the hospital while the other was diagnosed by CAT Scan to have extensive cerebral ischaemia. She was subsequently discharged.

Case 2 : September, 1995: An Indian male, aged 33, was found unconscious in the bathroom 40 minutes after he went in to take a bath. He was rushed to the clinic but was pronounced dead on arrival.

The blood COHb% of the deceased Case 1 and Case 2 measured by the Chemistry Department in Ipoh were 59% and 70% respectively.

Materials & Methods

To investigate the likely cause of the CO poisoning, a portable multigas detector, the MX21 (Oldham France S.A), fitted with gas sensors to detect CH_4, SO_2 and CO was used to measure these 3 gases in the bathroom of the deceased in Case 2 before and during operation of the gas water heater. This investigation could not be done for the gas water heater in Case 1 because the heater was removed after the death of the daughter. Maximum level measurable by the MX21 was 1200ppm.

For comparison, the levels of CH_4, SO_2 and CO of a leaking LPG tank in a closed bathroom were also measured.

Measurements of the 3 gases were made by connecting an electric air pump to the MX21 via a vinyl hose. The air pump was placed on the floor of the bathroom while the MX21 was placed outside. The door of the bathroom was closed. Once started, air from the bathroom was pumped through the MX21 via the vinyl hose and readings of the gases were taken every 30 seconds. This procedure was done twice in the bathroom where the faulty heater of Case 1 was installed and twice in a bathroom of a similar size where a LPG tank was placed with the burner on but unlit.

Results

The gas levels of C0, CH_4 and SO_2 of a leaking LPG tank in a closed bathroom were:

At 0 minute: none of the 3 gases were detected.
At 16 minutes: the concentration of C0 was 75ppm, CH_4 was 53 LEL units and SO_2 was 1.1ppm.
At 30 minutes: the concentration of CO was 116ppm, CH_4 was 70 LEL units and SO_2 was 1.6ppm.

The gas levels of CO, CH_4 and SO_2 of the bathroom (closed) of Case 2 before and during operation of the gas water heater were:

At 0 minute: none of the gases were detected.
At 16 minutes: the concentration of CO was 1200ppm, CH_4 was 3 LEL unit and SO_2 was 1.6ppm.

A visual inspection of the heater in Case 2 revealed sooting over the ventilation slots.

Discussion

CO that was produced by the gas water heater in Case 2 was rapid and in large amount. The maximum measurable level of 1200ppm was reached in just 16 minutes. A leaking LPG tank only managed to release CO reaching 110ppm in 30 minutes. This means that the heater in Case 2 was not leaking LPG. Rather the CO was produced consequent to incomplete combustion of hydrocarbon gases.

Additional evidence that the high CO produced by the gas water heater tested was not due to a leakage was that the level of CH_4 attained in the bathroom of the deceased Case 2 was only 3 LEL units while in the bathroom of the leaking LPG tank CH_4 was found to be 53 LEL units at the end of 16 minutes;

the reason being CH_4 in a leaking LPG tank is not burnt. Supporting evidence of incomplete combustion of hydrocarbon gases is the sooting found around the convectors of the heater.

CO is a common pollutant found in the atmosphere. The major source being motor vehicles. Therefore, CO would be found in the blood of the average city and town dweller. Higher COHb% levels will be found in smokers. This level should not be more than 5.0% as higher levels will produce symptoms in the normal individual.

Accumulation of CO in human blood at various concentrations of atmospheric CO as published in the Encyclopedia of Occupational Health and Safety[3] showed that when the atmospheric concentration of CO was 1000 ppm, it took approximately 180 minutes for the blood COHb% to reach 50%. Since both Case 1 and Case 2 were only in the bathrooms for about 30 minutes, the atmospheric concentration of CO in the respective bathrooms was inferred to be very much higher as the post mortem blood COHb% levels were 59% and 70% respectively. The MX_2, however, can only measure CO to a maximum of 1200ppm.

In summary, CO produced by gas water heaters during mechanical malfunction is a significant hazard.

References

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