G84 Vehicular Emissions Systems and Their Effects on Suicides and Attempted Suicides by Carbon Monoxide

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After attending this presentation, attendees will understand the workings of vehicular emissions systems and their ability (and inability) to generate CO (Carbon Monoxide). As cars run cleaner, CO suicides in a closed space (garage) are more difficult to accomplish. The cleaner car allows for more time for a "victim" to alter his intentions. The attendee will understand these timing issues, as well as the possibility that death is brought on not by CO intoxication, but by hyperthermia.

This presentation will impact the forensic science community by showing how to properly investigate deaths associated with vehicles left running in confined spaces.

Concerns about automotive emissions, greenhouse gasses, and fuel economy have led car manufacturers to decrease CO emissions from vehicles. Over the last thirty years, CO emissions levels from tailpipes have dropped substantially. Corresponding with this drop in CO, the presenter has seen a substantial drop in his caseload of deaths brought about by acute CO intoxication (usually suicide) brought about by running cars in enclosed garages.

The modern automotive engine (gasoline) makes use of an oxygen sensor to determine how close the engine is running at ideal stoichiometry: - 14.75 parts air to one part fuel. The engine has one (or several) O2 sensors placed in the exhaust stream to measure free oxygen. In an open air atmosphere, the oxygen sensor and ECU (Engine Control Unit) work together to insure that CO emissions are kept low.

For a person attempting suicide, the effects of the emissions system can have three outcomes:

1. Non event – no fatal levels reached
2. Suicide – fatal COHb levels reached
3. Suicide – minor to moderate COHb levels reached, but death caused by hyperthermia

The non-event is perhaps the hardest for an medical examiner system to analyze, as there is neither a death or case report.

Empirically, testing of vehicles has shown that in some instances, a garage has enough "leakage" and infiltration (air changes per hour) that there is sufficient oxygen to keep the engine running clean and for CO levels to stay at a minimum. This "non-event" can manifest itself in one of three ways:

1. The emissions system 'slowed' down CO production so much that the would-be suicide candidate changed his/her mind.
2. A fatal COHb level was never achieved because the vehicle ran out of fuel, thwarting the suicide.
3. The vehicle had enough free O2 (leaky building) that under no circumstances would a fatal COHb level ever be achieved.

The fatal CO event is the easiest case to analyze. Grossly, the cherry red lividity is the telltale sign, along with supporting COHb levels at autopsy. But the fatal level raises the question: with modern cars running so clean, how does one ever achieve fatal results. Testing carried out shows the function of the O2 sensor in the exhaust stream. This sensor is a ratiometric device, comparing free O2 in the exhaust stream to free O2 in the atmosphere. The vehicle's ECU will keep CO production to remarkably low levels for some time, but there reaches a point (in a well sealed garage) that the design assumptions (IE, 20% free O2 in the atmosphere) are invalid and the vehicle become very dirty. Note that this fatal outcome is just an extension of one, above – CO production was slowed down, but the candidate's ardor was not inhibited; the death just took longer to achieve. Using empirical data, the presenter has been able to model the CO production/accumulation as a first order differential equation.

The fatal outcome with low CO is at first the most complex to analyze. The body presents with CO levels more associated with high levels of cigarette smoke: 5 to 10%, possibly higher, but never at levels associated with death. Testing done at our lab shows that temperatures can be reached in garages (closed spaces) that are untenable. The indicator that first led us to this area of inquiry was the existence of spray cans (paint, insecticides) that had bulged at their seams. It was known at what internal pressures the cans would expand, as well as the nature of the propellant gas inside. This data shows the increase in temperature over time within various garages, and the factors that work for and against this type of hyperthermic event are presented. In these cases the manner of death is still suicide, but causation has changed from acute CO intoxication to hyperthermia.

Suicide, Carbon Monoxide, Hyperthermia

 ** Presenting Author*