WE ARE ALL AWARE the leading cause of death on the fireground is heart attack and stroke; both diseases are attributable to heart disease, poor diet, lack of exercise and unhealthy lifestyle. The fire service has been addressing these issues through annual physicals, exercise, and nutrition programs. Despite all these preventative measures, the leading cause of death is still cardiovascular in nature. But is it really?

Firefighter Joe Smith, a healthy 10-year veteran of his department, is conducting overhaul in a structure. His mask is dangling off to the side; he is pulling down ceiling material, and he's telling jokes with his crew. Substances are smoldering around him as one of his members uses the thermal imaging camera to look for “hot spots.” After about 15 minutes, operations switches out the crews. Smith, while walking toward his apparatus, collapses to the ground. Despite heroic efforts by fellow firefighters and paramedics, Smith is pronounced dead a short time after arrival at the local emergency department.

Hydrogen cyanide (HCN) is a colorless, odorless gas. In the chemical world, it is a simple molecule, one atom of carbon, one atom of nitrogen and one atom of hydrogen. It is a relative dwarf in the world of organic chemistry. But this little guy packs one heck of a punch!

It is a highly toxic substance that interferes with energy production in our cells. It is capable of shutting down the energy production in the cell in a matter of seconds. HCN is 35 times more toxic than CO during acute exposure. Cells exposed to HCN cease to function and die quickly.

We have all seen the dramatized, but fairly accurate depictions in movies of spies biting on a cyanide capsule and dying quickly. Nazi Germany used cyanide crystals, known as “ZYKLON B,” in the gas chambers of concentration camps. Tuskegee Airmen, the black fighter pilots of World War II, were issued cyanide capsules as part of their escape kits. It was feared, due to their race, if captured they would be tortured mercilessly and the cyanide capsule offered a quick end to the torture.

Over the last two decades there has been a significant shift away from wood and natural materials toward lighter construction materials composed of synthetics, plastics, and petroleum-based products. These new materials are high sources of cyanide when they burn. In fact, the greatest amount of hydrogen cyanide produced in a fire occurs not during the fire itself, but during pyrolysis. Pyrolysis occurs at the beginning of a structure fire, before flashover, when oxygen levels are low. These conditions are favorable for massive formation of HCN. We should now consider HCN to be present in all structure fires and further consider every structure fire as a haz-mat type of incident!
The Swedish National Testing and Research Institute conducted tests assessing the emission of HCN and carbon monoxide (CO) under smoldering and flaming conditions during the burning of wool, nylon, synthetic rubber, plastic, and polyurethane foam; all materials present in current building construction. They concluded that every one of these substances emitted high quantities of HCN when burned, especially during smoldering conditions (pyrolysis). HCN is 35 times more toxic than CO during acute exposure.

On February 20, 2003, about 400 people were in The Station nightclub in Warwick, R.I. A fire started when pyrotechnics ignited polyurethane foam lining the walls of the stage area. The blaze quickly spread to the ceiling and wood paneling.

The emergency response was rapid and well executed. 911 calls were made about 35 seconds after ignition. The first engine arrived on the scene in less than five minutes after the initial 911 call, and began extinguishing the blaze one minute thereafter. Despite this rapid and coordinated response, 100 people died.

As part of the after investigation, the National Institute of Standards and Technology (NIST) conducted simulations of this fire. They measured temperature, CO, oxygen, and HCN 1.4 meters above the floor and 1.6 meters from the stage. Within 90 seconds, concentrations of CO and HCN soared as oxygen levels plummeted. This created conditions that were incompatible with sustaining life.

In a Paris study conducted in 1988 and 1989, blood was collected from patients treated by the first arriving EMS units to residential fires. A total of 109 fire victims were studied—66 who survived and 43 who died. The study showed many victims who died had blood levels of HCN in the lethal range while blood levels of CO were in the non-lethal range. These results were contrary to the thinking of the day, where emphasis had been placed on CO as the culprit in smoke inhalation mortality. Instead, the results of the study indicated HCN concentrations were directly related to the probability of death, and that HCN poisoning may be the leading cause of death in many smoke inhalation victims.

In early 2006, firefighters in Providence, R.I. were tested for HCN in smoke after structure fires. Eight of 27 firefighters had elevated levels of HCN that required treatment. One firefighter actually collapsed on scene and had to be immediately treated for HCN poisoning.

How does HCN work? HCN inhibits the production of adenosine triphosphate (ATP) in the mitochondria of the cell. The mitochondria are the powerhouse or engine of the cell. ATP provides the energy. It is almost as if ATP is gasoline and the mitochondria are the engines. Cut off the supply of gasoline, and the engine dies. Shut off the production of ATP in the mitochondria, and the cell dies. When the cells die, the body dies.

The immediate treatment of HCN poisoning is administration of intravenous hydroxocobalamin. It is related to vitamin B-12 and binds to the cyanide and neutralizes it, thereby rendering it no longer toxic.

Hydroxocobalamin is commercially available in a product called a Cyanokit®. The Cyanokit contains two 2.5-gram vials of hydroxocobalamin, each designed to be diluted with 100 milliliters of normal saline. Two vials (equal to five grams) of hydroxocobalamin are administered intravenously over 15 minutes, with the possibility of repeating it once, depending on response.

Here's the catch, the kit retails for anywhere from $700 to $800. That's right; you read it correctly, close to $800 per dose!

Earlier, I stated that HCN is released in high quantities during pyrolyzing, which tends to be in the early stages of a structure fire, when gases are emitted under high temperature and low oxygen. We also have to remember that during smoldering conditions,
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