Hill and Knowlton, Inc.

Article on Inhalation Injury

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"Warning: The Surgeon General Has Determined That Furniture Smoking Is Hazardous To Your Health."

Furniture smoking?

Yes, furniture smoking. Or, if you wish, put in your own substitute for cigarettes. Draperies. Carpets. Newspapers. Clothing. Lumber. Lampshades. Plastics. In fact, anything that will burn.

Except for the fact that the Surgeon General was dealing with what he then perceived to be a specific situation which needed urgent and special attention, he might well have be n counseled to extend the cigarette smoking warning label to every organic product in our environment. Because they all can burn. Anything that burns can represent a threat to life safety.

The direct threat to life is not so much from the flames themselves but, rather, what the flames produce. In 1973, the National Commission on Fire Prevention and Control produced a report titled "America Burning" [1] which contained this description of "How to Di in a Fire:"

"Most people, when they think of fire as a killer, think of flames. Those who have set fire safety standards for materials have emphasized flame resistance. Yet, in a list of the five ways in which fire can kill, when arranged in declining importance, flames rank last.

"Asphyxiation. Fire consumes oxygen from the surrounding atmosphere, thus reducing its concentration. If the oxygen concentration falls below 17 percent, thinking may be an effort and coordination difficult. Below 16 percent, attempts to escape the fire may be ineffective or irrational, wasting vital seconds. With further drops, a person loses his muscular coordination for skilled movements, and muscular effort leads rapidly to fatigue. His breathing ceases when the oxygen content falls below 6 percent. At normal temperatures, he would be dead in 6 to 8 minutes.

"Attack by superheated air or gases. With temperatures above 300°F., loss of consciousness or death can occur within several minutes. In addition, hot smoke with a high moisture content is a special danger since it destroys tissues deep in the lungs by burning.

"Smoke. Inhalation of smoke -- or, more correctly, of the products of incomplete combustion -- kills people who suffer no skin burns at all. In addition to carrying toxic products, such as carbon monoxide and hydrogen cyanide, thick smoke may be laden with organic irritants, such as acetic acid and formaldehyde. In the early stages of a fire, the irritants, which attack the mucous membranes of the respiratory tract, are often the more important danger. Smoke often blocks the visibility of exits.

"Toxic products. Many toxic components of smoke are responsible for the damage done -- including oxides of nitrogen, aldehydes, hydrogen cyanide, sulfur dioxide, and ammonia, to name only a few. There is ample evidence that the hazard of two or more toxic gases is greater than the sum of the hazards of each. Moreover, low oxygen and high temperatures increase the toxic effects. In addition to toxic gases that attack the lungs, there are irritants that attack the eyes with blinding effect, pr venting escape. Some fire gases dull the senses of the victim or his awareness of injury.

"Flames. Since the aforementioned factors can debilitate, confuse, blind, or kill without warning, the person who goes to sleep confident that advancing flames will provide sufficient warning for escape may be taking a fatal gamble.

"Until such time as all five of these hazards have been well-studied and controlled by materials standards, too little will have been done to control the built environment and thus reduce the gamble Americans take in their daily lives."

Five years after that report was published, the nation is making perceptible progress toward a fire safe environment.

To achieve this aim we, as a nation, have taken a number of steps. Possibly the most promising has been in the direction of automatic detection and warning. Very simply, this means installation of devices in our homes and other places of occupancy which will discover a fire in its early stages and signal human occupants to vacate the premises. There

may be no other more effective single step that can be taken to protect life in a structural fire.

A second step we have taken has been in the direction of fire testing of materials on a large scale that simulates, to a more accurate degree than laboratory tests, the behavior of materials and construction assemblies in actual fire situations.

Most people, ranging from those who have fought real fires to those who studied the chemistry of fire degredation in the laboratory, are quite ready to concede that the more we learn about fire, the more we need to learn about it. No two real world fires are identical. But we are beginning to be able to predict, within some broad parameters, how a certain material or a type of assembly will behave in certain real fire situations.

A third step -- directly stemming from step two -- has been the development of materials and assemblies and structural configurations which are designed to reduce hazards from unwant d fires.

A fourth has been in the development and dissemination of materials which are designed to inform and educate you and me in the fire hazards that may confront us and how to cope with them.

Finally, as a nation, we have taken significant steps in development of our techniques in treating fire injuries -- not just burns but inhalation damage.

This treatise mainly concerns steps four and five. Briefly, we will tell you, as a nurse, how to help save your own life and the lives of others caught in a structural fire. Next we will tell you what symptoms, other than external burns, you should be aware of in fire victims. Finally, we will provide a suggested range of treatment.

The one thing to remember in all of this discussion is that every victim of a fire, whether he or she has visible burns or not, has inhaled an alien atmosphere. As "America Burning" pointed out, it could be a reduced concentration of oxygen, super-heated air or gases, smoke, or toxic products of combustion. Or it could be a combination of any or all of them. That makes for a complicated diagnosis.

WHERE WILL THE FIRE OCCUR?

The National Fire Prevention and Control Administration has instituted an ambitious undertaking to determine, statistically, who are fire victims, how they become fire victims, where they are most likely to be exposed to a fire accident, and why. It is not an easy undertaking because so many fires go unreported, and others are inadequately reported. But a picture is beginning to emerge.

Most people, if asked where fire takes its greatest human toll, will cite mass human tragedies -- 602 dead in the Iriquois theater fire in Chicago in 1903, 492 killed in Boston's Cocoanut Grove fire in 1942, 145 victims in the Triangle Shirtwaist Factory fire in New York in 1911. Or they will mention some of the major transportation crashes and fires.

But the NFPCA has determined that if you are caught in a fire, you probably will not be in a factory or a nightclub r a theater or an office building or an airplane. You will be in your own home.

"Roughly two-thirds of fire deaths occur in ones and twos in the victims' own homes," says the NFPCA.[2] "Less than 4 percent of fire deaths occur in multiples of five or more at a time. The residental danger has been underappreciated, perhaps because of the publicity surrounding major fires. In fact, only a small fraction of deaths (for example, 7 percent in California and Ohio) are in commercial or institutional places such as nightclubs, schools, jails, offices, or nursing homes."

Based on limited data from Ohio and California, the NFPCA says the most frequently reported cause of residential fires leading to deaths and injuries is smoking, mostly cigarettes, and cooking. Together they account for about half of the deaths and a third of the injuries in residential fires.

One rather common characteristic of serious accidental residential fires is that ignition occurs when nobody is there to detect it. The human body is an extraordinarily good fire detection and alarm system. It can feel heat, hear combustion, see and smell smoke, and sound the alert.

Automatic fire detection and alarm systems represent man's efforts to duplicate that system. However imperfect in comparison, they have saved many lives and injuries by sensing fires and sounding the alert in early stages of combustion. Aside from prevention of ignition in the first place, early detection is the most important factor in life safety.

There are two critical concepts the layman -- well known by the professional firefighter -- should keep in mind about fire: (1) a seemingly innocuous fire can, under proper conditions grow to astounding proportions at a rapid rate, and (2) fire gases and smoke can incapacitate and kill at some distance from the fire source.

These two principles lead inevitably to the most crucial action the non-professional firefighter can take in case of fire: isolate yourself and others from the source of the hazard.

Ideally, this means leaving the structure quickly. If you have others in your care, your concern will be to get them out with you.

Beginning with our residences, where most of the fire problem lies, every household should be concerned with pre-planning in case of accidental fire. Such pre-planning should include means of alarm, alternate means of escape, and a central place of assemblage for all members of the household who reach s fety. There have been too many tragic instances of individuals going back into burning buildings in futile efforts to save a family member who already escaped.

Because of the unusual problems associated with fires in health care facilities -- such as nursing homes and hospitals -- pre-planning plays an even more important role.

As the National Fire Protection Association points out, movement of certain patients, even for short distances, can be accomplished only with great difficulty, and evacuation may be impossible without seriously jeopardizing a patient's survival.[3]

"In these respects, the hospital resembles a ship at sea or a high rise building," NFPA says. "It is far better to keep the fire from the patient than to remove the patient from the fire. Thus, hospital design and operation must incorporate methods by which fires may be detected early, contained, and fought rapidly and successfully. Early alarm, containment, horizontal evacuation, and rapid extinguishment are essential; they require careful consideration in hospital design as well as operation."

If we all lived and worked in ideal fire-safe environments, we would not have to worry. But we don't. Our surroundings are packed with organic materials which burn, and our fir detection, alarm and suppression systems have not yet reached the point of where we are totally protected.

As a nurse, you probably do not have a great deal to say about fire safety in design, either for residences or for health care facilities. That is a fact of life, not a criticism of the system. Comes the revolution, maybe things will be different.

However, you do have control over "operation," meaning the handling of yourself and others -- whether they be patients or members of your own family -- in fire situations.

On page____, you will find a list of things to do which may help save your own life and the lives of others in your care if caught in a structural fire. These are guidelines only, and not meant to replace your own good judgement. Every real fire situation is different, and each will require a slightly different priority for action. But if you firmly fix in your mind the

possible courses of action, you will be more likely to take the life saving measures most appropriate to those particular conditions.

AFTER THE FIRE

Every nurse, at some time in her career, has had to handle a burn patient. In extreme cases, there may be no more difficult or frustrating type of injury with which a nurse has to deal. Because of the highly visible nature of burns, medicine has made great progress in treatment of exterior burns. Not so with internal damage which may be caused by products of combustion other than flames.

In spite of its significance, inhalation problems associated with fire received little attention in the medical literature up to a dozen years ago. In 1967, three midwestern physicians reported case histories which demonstrated "the variable course of this entity and the need for individualized care of the victims."[4]

"Of particular importance," they wrote, "is recognition of the 6- to 48-hour latent period which may ensue before complications of acute bronchial obstruction, pneumonia, pulmonary edema, and eventual cardiopulmonary failure develop. Management may require tracheostomy, prolonged intermittent positive-pressure breathing with appropriate concentrations of oxygen and high humidity, and, when indicated, administration of systemic antibiotics and steroids. Frequent arterial blood gas measurements are essential for proper evaluation in these

cases, both to delineate the status of the patients and to guide and determine the effectiveness of therapy. If victims of smoke inhalation can be managed through the acute phases of their illness, they often make a complete recovery."

Perhaps coincidentally, the first major epidemiologic study to identify the lethal factor in fires was done by a team at Columbia Presbyterian Hospital in New York which conducted an extensive analysis of autopsy records of New York City fir victims during 1966 and 1967.[5] Carbon monoxide (CO) poisoning was noted in 70 percent of all victims with a primary diagnosis of smoke poisoning or asphyxia, and almost equally in the presence or absence of surface burns.

An ongoing epidemiologic study begun in 1971 by the Applied Physics Laboratory of Johns Hopkins University and the Maryland State Medical Examiner's office obtained data from more than 200 autopsies of victims who had died within 6 hours of fire exposure through 1974.[6,7] The study indicated that half the victims died from CO poisoning and 30 percent from CO poisoning plus contributory factors such as heart disease, alcohol or burns.

Other gases, such as hydrogen cyanide (HCN) and hydrogen chloride (HCL) associated with the thermal decomposition of some plastics and some natural materials, did not appear significant in these deaths.

It has been suggested by some investigators that with increasing uses of plastics -- and, consequently, increasing involvement of synthetic materials in fires -- HCN, HCL and, perhaps, other gases pose a significant new threat to life safety.

Terrill, et al,[9] report that such suggestions are open to question at present:

"Unequivocal data on the effects of HCN in fire victims are meager and open to question because HCN can be either generated or consumed in postmortem blood. The determination that death is due to HCl in fire smoke is difficult, but for different reasons; HCl cannot be measured directly in the blood. In the few cases where deaths due to HCl have been reported, the conclusions appeared to have been reached on the basis of the course of pulmonary injuries sustained, low COHb conc ntrations and the limited number and type of materials involved in the fire."

At the present time the evidence indicates that most fire victims brought to a health care facility for treatment will have been exposed to products of combustion of a variety of materials, both natural and synthetic, and that the primary inhalation problem will be some degree of carbon monoxide poisoning. This may be complicated by the patient having been exposed to an atmosphere of superheated air or gases, an oxygen deficiency, smoke, and other toxic gases.

Your focus on treating the problem might change if you knew that the victim -- a fireman, for example -- had been severely exposed to products of combustion of a concentration of a single type of material. For example, a storeroom full of burning wool clothing would emit large amounts of HCN or a vault jammed with PVC cables would emit large amounts of HCl. Even then, however, CO should be the prime suspect.

The current state of science requires us to conclude that the only uniform features in the toxicology of burning plastics are those of the toxicology of fire -- heat, carbon monoxide, deficiency of oxygen, other combustion gases, and smoke.[9]

It may be somewhat comforting to note that prompt and proper therapy can be very effective in handling inhalation cases. A report by five physicians on the treatment of firemen involved in a high-rise fire in Los Angeles in 1974 states:

"We recently studied 21 Los Angeles firemen, 19 of whom developed transient acute hypoxemia following exposure to a fire in a high-rise office building in which large amounts of PVC were combusted. These same firemen were re-evaluated one month following the fire to ascertain any possible effects on pulmonary function as a result of this episode of inhalation of smoke. In light of previous studies suggesting impairment in pulmonary function as a consequence of fighting fires, we were surprised to find that our group of Los Angeles firemen had relatively few respiratory symptoms, as well as remarkably normal pulmonary function, compared with published predict d values."

TREATMENT OF INHALATION VICTIMS

That experience will not always hold true for all cases, of course, particularly where there has been substantial and prolonged exposure to an alien fire atmosphere and where proper treatment has been delayed or ignored.

An important consideration to keep in mind is that symptoms of carboxyhemoglobinanemia (carbon monoxide poisoning) and hypoxia (deficient oxygenation of the blood) may not show up for hours after exposure.

Nurses should be aware of the need to administer oxygen routinely as soon as possible -- preferably humidified -- and to observe the patient closely for cerebral complications of CO[10] and respiratory insufficiency which may ensue after a deceptively tranquil interval.[11]

(copy on specific symptoms and treatment to be added)

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