OVERVIEW

The urban/wildland interface is the area where the private citizen meets wildland, and it is the zone of greatest concern for contemporary firefighters. Attendance at US parks and recreational areas has been steadily increasing for many years. Wilderness areas lack highly developed urban emergency medical services. In attempting to escape the dangers and troubles of an urban lifestyle, many place themselves at greater risk for loss of life and property through wildland fire.

In the United States, about 70,000 wildland fires per year burn almost 2 million acres and require the efforts of approximately 80,000 firefighters. Nearly every state has experienced fires in the urban/wildland interface that have resulted in significant losses. The National Fire Protection Agency (NFPA) estimated that, from 1985 to 1995, wildfires destroyed more than 9,000 homes and resulted in many deaths of firefighters, as well as civilians, with untold numbers of injuries. From 1990 to 1998, 133 fatalities were associated with wildland fire activities. While California had the highest number of fatalities, wildland fire fatalities occurred in 33 different states spanning every region of the country.

The most common cause of death from fighting wildland fires from 1990 to 1998 was burnover. This occurs when a firestorm burns over an individual in the path of the advancing front. Other causes include aircraft accidents, followed by heart attack and vehicle accidents. Lastly, falling snags, which refer to dead trees that have begun to burn, account for 5% of reported fatalities.

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Physical Principles of Heat Transfer

Heat energy is transferred by conduction, convection, radiation, and spotting, but generally only the latter three processes are significant in a wildland setting. Convection, or the movement of hot masses of air, accounts for most of the heat transfer outward from the fire. Convective currents usually move vertically unless a wind or slope generates lateral movement. Convection preheats fuels upslope and in shrub and tree canopies, further contributing to a fire’s spread and the onset of crown fires. Radiant energy is emitted in direct lines or rays and decreases inversely in proportion to the square of the distance from the source. Radiant heat does not penetrate solid objects and is easily reflected. Spotting is a mass transfer mechanism by which wind currents carry burning or glowing embers beyond the main fire to start new, often unpredictable and unexpected, fires.

FIRE-RELATED INJURIES AND FATALITIES

While no comprehensive data are available concerning wildfire injury, clearly, many more injuries than fatalities are seen in each event. Those with underlying medical conditions and poor physical conditioning are at higher risk of death or disability while fighting or escaping from a wildland fire. All the potentially injurious events that one normally associates with the outdoors are magnified for those closely associated with wildland fires. The most serious injuries from wildland fires are smoke exposure, respiratory problems, heat illness, burns, and thermal injury. Wildland firefighters generally do not wear the same level of protective equipment as their urban counterparts. It is rarely feasible for a wildland firefighter to wear a self-contained breathing apparatus or fireproof clothing. The risks of burning and smoke inhalation are magnified for those fighting wildfires. However, due to the nature of the open environment, the risk of injury from heat stress is decreased.

Thermal Injury

The most common cause of thermal injury is direct contact with flames. While the temperatures created by a forest fire can be extreme, they are often of short duration. The most severe burns typically involve civilians who are inexperienced with wildland fire behavior or with rapid, unanticipated changes in fire behavior. Burns can be partial thickness or full thickness. Immediate death is due primarily to hypovolemia or frank incineration.

Airway Injury

Contact with superheated air brings the risk of respiratory tract injury. Respiratory tract injury should be suspected with burns around the face, neck, or upper body, and with nasal hair singing, facial edema, stridor, and early respiratory distress. The level of injury is directly correlated with the amount of time spent in the burning area and the actual temperature of the air breathed. Air is a poor conductor of heat, and the upper airway is very efficient in thermal exchange. Thermal injuries
to the respiratory tract can be insidious, with respiratory distress presenting as late as 24 hours after exposure to superheated air.

**Heat Stress**

All persons involved with a wildland fire are at increased risk for heat-related illness. Wildland fire suppression is usually prolonged and extremely strenuous. Individuals working in the heat rarely replace fluids at the same level of that lost through exertion. For more information on heat-related disorders, see chapter 18 on Hyperthermia.

**Smoke Inhalation**

Asphyxia is always a risk when an individual is exposed to smoke. While many wildland firefighters use particulate masks, private citizens may be unprepared and have no form of airway protection. Wildland firefighters are not as likely to experience the extreme, acute exposures that structural firefighters encounter. However, they are more likely to have prolonged exposure to smoke. Common compounds found in the air of wildland fires include carbon monoxide, sulfur dioxide, particulate carbon and silica, polyaromatic hydrocarbons, aldehydes, and benzene. Of greatest concern are aldehydes and carbon monoxide. Aldehyde exposure results in local irritation, while carbon monoxide exposure is associated with nonspecific warning signs such as headache, and high levels can be potential fatal. While the long-term effects of respiratory contaminants are not fully known, studies have shown decreased short-term pulmonary function in wildland firefighters. Also of concern are exacerbations of underlying pulmonary conditions, like asthma, emphysema, and COPD.

**SYSTEMS PLANNING: FIRE SAFETY AND EMERGENCY MEDICAL SERVICES**

For wildland fires, as in almost all disasters, planning is essential for reducing loss of life and property. Proper planning begins and ends with education. The National Fire Protection Association has produced a wildfire training course that helps both volunteer and professional fire departments plan for and safely fight wildland fires. Instruction in entrapment procedures, wildfire behavior, communications, and escape protocols should be given. Minimum safety equipment for the wildland firefighter should include a hard hat, safety goggles, brightly colored clothing, long sleeves and pants, boots, and gloves. A personal fire shelter should also be carried to deploy in the event of imminent burnover.

**Collaborative Planning**

As almost all wildland fires are fought with the help of several municipal, state, and federal agencies, mutual aid agreements are vital in combating wilderness fires. Planning should take into account the expected extended nature of wildland fire sup-
pression efforts. Communication and chain of command should be addressed in advance. Rescue protocols, equipment needs, personnel needs, and evacuation procedures must be addressed as well.

EMS

A wildland fire is an ongoing disaster that may last for days to weeks. Emergency Medical Services can play a critical role in wildland fire safety. Typically at or near the fire front, EMS can play a critical role in triage and field treatment of those injured in these events. A mobile command post with the capabilities to treat several patients simultaneously for heat-related illness, trivial trauma, and respiratory complaints is able to reduce morbidity and the emergency department visits for fire personnel. Triage and treatment may occur simultaneously with stabilization, and the units must have the capacity to move from the area rapidly if this is required by the changing fire environment.

Emergency Department Preparedness

During a wildland fire, the emergency departments should maintain close contact with medical support at the scene of the fire. This will help assess civilian risk and guide resource utilization. The most common injuries seen are respiratory complaints, heat stress, burns, and minor trauma. However, serious trauma associated with involvement or responses to these events, as well as heart attack and stroke, are also seen. Emergency visits increase during these events, but hospitalization rates do not appear to be significantly increased.

PUBLIC EDUCATION

The general public tends to underestimate existing fire hazards and is usually not experienced in avoiding fire threats. Civilians entering the wilderness or building homes in the wilderness must be educated and informed about fire safety. Individuals should carry personal safety equipment and be familiar with safety and suppression procedures. Structures should be erected with attention to adequate ingress and egress routes, preferably multiple. Structures should be constructed with cognizance of possible fire hazard, built accordingly, and have a safe perimeter. Adequate resources for personal suppression efforts should be available. Such education and preparation is essential prior to entering the wilderness or building in the wilderness or urban/wildland interface. The general public must share responsibility with suppression organizations to minimize fire hazards created by humans. Care with fire, proper cleanup of debris, fuel reduction efforts on wildland property, fire-safe construction guidelines, and the application of survival skills will minimize fire threats.
REFERENCES


