Scene Assessment and Personal Safety

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INTRODUCTION

The emergency scene is a very dynamic environment, requiring emergency personnel to react rapidly and adapt to changing situations. Patients’ injuries may be complicated by their physical position and location, and medical care is often difficult to render in the uncontrolled environment. Many external factors, such as climate, scene hazards, and additional resources required can dictate immediate actions. Specific knowledge and resources must be obtained to meet the particular demands of the environment.

DISPATCH INFORMATION

Much insight can be gained into the nature of a call upon initial dispatch. Information obtained for a highway accident, such as the type of vehicle and number of patients, can indicate the resources needed to handle an incident. Certainly rescuers will think very differently about a collision involving a school bus as opposed to an accident involving a single motorcycle. Proper call screening will match the response to the type of emergency in order to increase the safety of personnel, such as dispatching law enforcement with EMS to violent scenes.

Obtaining useful call information depends on the presence of trained emergency telecommunicators (TCs). Telecommunicator competency can affect the survival of the patient as well as the safety of the emergency personnel. Many states have established guidelines for telecommunicator performance, strengthening their role as a valuable link in the chain of survival.
"Size-up" is the initial quick analysis of the scene upon arrival. The scene size-up is vital to safe and efficient operations. A rapid and accurate evaluation is required, especially when hazards are present. This provides for the safety of the emergency crew and validates the information provided during dispatch for other arriving rescuers.

There are several key items to look for when approaching the scene. Any immediate hazards, such as fuel, downed power lines, or a person with a weapon should be noted. These hazards should be mitigated prior to operating at the scene. Next, the mechanism of injury or illness should be noted. Mechanism of injury refers to how the injury occurred, such as a broken windshield associated with a laceration to the head. If time allows, take a quick look at the actual site of the incident. Remember that patients are frequently moved from the accident area. Viewing the area where the injury actually occurred may provide valuable insight into the patient’s injuries.

Calculate the total number of patients and the types of injuries. Both will dictate the number and type of ambulances needed and any specialty resources required, such as hazardous materials (hazmat) teams or utility companies. Remember that the emergency scene is dynamic; a safety officer who constantly observes for hazards as the scene changes will ensure continued scene safety.

Observing the environment during response provides information about the scene prior to arrival. The simple fact that traffic lights are not operating or lights are off in stores may be a good indication of downed power lines. A lack of oncoming traffic while en route to a motor vehicle crash (MVC) scene may indicate that the road is blocked.
Once on the scene, take a few seconds to look around. Is the scene consistent with the dispatch information? Looking into a window as you approach a patient’s home may allow observation of activity in the home without alerting those inside to your presence. When knocking on a door, stand to one side, away from view as the door is opened. This places you out of the “blast zone” if someone shoots through the door, and prevents people from easily viewing your position if the door is cracked open. Be observant of the overall scene. Is the front door kicked in? A telephone torn from the wall is usually done to prevent someone from calling for help.

Hazardous Materials

A hazardous material is any substance that poses an unreasonable risk to health and/or safety. Four billion tons of hazardous materials are carried by surface, air, rail, and water annually. The Superfund Amendments and Reauthorization Act of 1986 (SARA), the Environmental Protection Agency (EPA), and the Occupational Safety and Health Administration (OSHA) have demanded greater responsibility for incidents involving hazardous materials. These demands have set the stage for standardized hazardous materials training across the United States.

Hazardous materials are indiscriminate in causing harm. Protection of emergency personnel is vital to the successful mitigation of the hazard. Due to the common use of chemicals in today’s society, virtually any incident may involve hazardous materials. These scenes may require eye, ear, skin, and respiratory protection, as well as special techniques to identify the involved substances. Specialized protection requires training in the use of the protective equipment. Identification of hazardous substances is a priority because this knowledge dictates
what actions are appropriate. Do not overlook an on-site supervisor or safety team member who may be a valuable resource.

NFPA 473 (1997) outlines competencies for EMS personnel who respond to hazardous materials (hazmat) incidents as part of their duties. Hazmat training for the EMS responder is based on awareness of the potential harm that may be caused by operating blindly at an incident. Presence of mind and self-discipline are paramount in preventing complication of the situation. It is important for the paramedic to be able to recognize a hazmat incident through the use of placards, labels, shipping papers, and any other identification methods.

Once the scene has been identified as involving hazardous materials, the following agencies can provide valuable information for handling the incident:

**CHEMTREC** (800-424-9300): A private service that provides information specific to chemicals involved in transportation accidents. More information on CHEMTREC can be found at [www.cmahg.com](http://www.cmahg.com) and [www.chemtrec.org](http://www.chemtrec.org).

**ATSDR** (888-422-8737 or [www.atsdrcdc.gov](http://www.atsdrcdc.gov)) Agency for Toxic Substances and Disease Registry: Provides toxicological information and hazmat guidance

**CDC** (800-311-3435 or [www.cdc.gov](http://www.cdc.gov)) Centers for Disease Control and Prevention: Provides information related to biologic and disease hazards

**NPTN** (800-858-7378 or [http://ace.ornl.gov/info/nptn](http://ace.ornl.gov/info/nptn)) National Pesticide Telecommunications Network: Provides information related to pesticide exposures and accidents

**NRC** (301-415-7000 or [www.nrc.gov](http://www.nrc.gov)) Nuclear Regulatory Commission: Provides assistance regarding radioactive materials
**POISON CONTROL CENTERS:** Centers are regionally based, providing immediate information on toxicity and treatment of poisoning incidents.

**Conduct on Scene**

Although there is a degree of urgency on the emergency scene, running to the patient is ill-advised. The few seconds saved in rapidly arriving by the patient's side may result in too little time to “absorb” the scene. A prompt walk while observing for the mechanism of injury and various hazards will get you to the patient’s side safely. Traffic control and lane closure is usually a duty of law enforcement officers. If immediate hazards are not controlled, most emergency agencies are authorized under state law to take appropriate actions.

While on the scene, “authorized bystanders” need to be controlled. Unnecessary personnel at the scene can be needlessly exposed to scene hazards. In addition, the privacy and dignity of victims should be protected from curious onlookers, including extraneous rescue workers.

**Scene Illumination**

Proper illumination of a nighttime scene is vital to safe and efficient operations. Vehicle-mounted or portable lights powered by a generator or 12-volt vehicle supply are common. Special care should be taken to avoid the use of lights or other appliances that produce high heat near patients or flammables. Small, handheld, 12-volt mechanic-style lights are available that give excellent light output, yet produce very little heat. Portable fluorescent lights, powered by a 120-volt source, are available and provide ample light with minimal heat output. A ground fault circuit interrupter should be incorporated on all alternating-current systems utilized on emergency vehicles. These devices are electrically sensitive such that the circuit is broken if there
is enough stray current to cause harm, in contrast to conventional circuit breakers, which are designed to protect the actual electrical wiring. These systems should be engineered following appropriate electrical code and be assembled with waterproof hardware. With properly waterproofed equipment, there should be no hesitation to incorporate scene lighting in inclement weather. Remember that some tools are not engineered for wet location operation or hazardous atmospheres, so knowledge of your equipment is advised.

**Vehicle Positioning**

Vehicle positioning on the scene not only dictates the efficiency of patient care, but can directly affect scene safety. Unless there is some extenuating circumstance, positioning an emergency vehicle in a lane already blocked or on the same side as the incident affords several advantages. First, because the lane is already blocked, the emergency vehicles occupy little additional road space. Second, it prevents personnel from having to cross active lanes of travel, risking injury to personnel from passing vehicles. Third, because the emergency vehicles have left the other lanes open, traffic can still move at a slow pace. This may prevent a secondary collision and may allow additional emergency units quicker access to the scene. Fourth, in the case of a fire or rescue unit equipped with rescue tools and preconnected service lines, bringing these lines across the road would effectively block all traffic, including the departure of emergency units from the scene.

When parking on the side of the road, always leave one front and one rear wheel on solid pavement. Most emergency vehicles are equipped with positive traction differentials that allow the drive wheels with the most traction to propel the vehicle. This provides adequate traction for pulling away as well as turning the vehicle. Depending on traffic conditions, special
consideration should be given to utilizing the vehicle as a barricade to protect personnel operating at an accident scene. Preferably, this would be a large vehicle, and one that would remain on the scene for the duration of the operation, such as fire apparatus. The steering wheel should be turned in such a way that the emergency vehicle would move away from operating personnel should it be struck by oncoming traffic. Working between vehicles in close proximity to moving traffic is extremely hazardous. Some elements of patient care may be reprioritized to allow the removal of all concerned to a safer area.

Vehicle positioning at the scene should also include consideration of the vehicle’s exhaust gases. If vehicles are positioned too close to the scene, there is a possibility of contaminating the scene with exhaust by-products, among them carbon monoxide. This is harmful to emergency personnel and patients.

It must be remembered that vehicles are injured as well as their occupants. Generally, 50 feet is a good distance to allow between damaged vehicles and emergency apparatus. Just as patients may deteriorate, so may the structural integrity of damaged vehicles as paramedics incorporate various extrication techniques to effect patient removal.

Headlights should be turned off at nighttime highway collision scenes to avoid blinding oncoming traffic. A crash scene is already a dangerous place; imagine how hazardous it becomes when the headlights of stationary emergency vehicles blind drivers of oncoming vehicles. If the headlights are absolutely necessary to illuminate the scene, aim them directly where they are needed, and use low beams only. Some states now allow the use of alternating headlights as part of the emergency-vehicle warning package. While these are very effective, cautious use is indicated at night. Alternation to the high-beam mode while meeting traffic at night should be
avoided. If a motorist has a collision secondary to being blinded by high beams, fault for the crash may be placed on the emergency vehicle operator.

**Evidence Preservation**

It is possible for a law enforcement investigation to be compromised by careless acts of emergency responders. If the disturbance of the scene is necessary to effect patient care, then so be it. However, needlessly disturbing articles only serves to complicate the investigation. What appears unimportant to emergency responders may be, to a trained investigator, a pivotal clue in an investigation. Paramedics may be summoned to court to testify that a particular item of interest was moved or handled. Law enforcement investigators must properly identify, follow, and document evidence. If you become part of the “chain” of evidence, you may be required to testify in court.

Upon arrival of emergency personnel to a crime scene, a decision should be made concerning the most efficient method to render emergency care while minimizing alteration of the scene. Often two members can enter the crime scene and remove the victim to an intermediate area for treatment, thus removing the chance of unnecessary personnel altering the scene. Follow the same route to and from the patient, and avoid any items of investigative value, such as blood. Physically tracking through blood and items of evidence is one of the most damaging mistakes made on a crime scene (Stuart, 1996). In latent evidence collection, it is possible for law enforcement personnel to collect footwear impressions from blood or dirt. With current technology, even the smallest dustprints from the sole of a shoe on a piece of carpet can be recovered by electrostatic means. In a crucial criminal case such as homicide, these details may prove valuable.
Move only enough material that is absolutely necessary to care for the patient. If a patient's clothing must be cut, do so in a manner that will preserve points of injury, such as knife cuts, gunshot wounds, or powder burns. Label and seal this clothing in a suitable container for investigators.

Many law enforcement agencies now document personnel who enter a crime scene, including times and type of business. Law enforcement officials may also require a statement from emergency personnel as to specific activities on the scene. This is known as a statement of events and is separate from patient care information.

Clean up and carry with you any trash generated on the scene. When it is necessary to alter the scene, such as leaving trash, make notes of such activity and notify law enforcement investigators. Investigators may request copies of call reports, so be aware of local policy regarding the release of patient information. The use of a sterile burn sheet to cover a homicide victim will provide for a degree of privacy and allows you to assure investigators that the sterile sheet introduced no contamination. Law enforcement officials may find it a nice gesture to leave a biohazard bag if they are required to handle contaminated evidence.

If the scene involves motor vehicles, park as far away as practical to preserve skid marks, tire prints, or vehicle debris. The location of oil, tire marks, debris from the vehicle, and even dirt turned up by the vehicle can all be important clues to the investigator. To assist in motor vehicle accident investigations, mark the location of accident vehicles if rescue efforts dictate their movement. If bodies must be moved to effect the rescue of live patients or to protect the remains, likewise mark and document their position. Some agencies have made effective use instant cameras. This is an excellent avenue for documentation and the investigation is not delayed
pending the development of film. Proper scene security should be maintained as people may unknowingly disturb evidence, as well as seek “souvenirs,” which commonly happens on the scene of aircraft accidents.

If you leave the scene in a vehicle, pay special attention to any tire tracks that may be of value to the investigators. This may dictate driving the vehicle outside of the common “wheel ruts.” If possible, avoid taking the emergency vehicle off the paved road.

**Unsecured Scenes**

Emergency personnel may arrive on what appears to be a crime scene that was not detected as such by the telecommunicator. If this should happen, immediately notify the telecommunications center so that the proper authorities can be notified. If people on the scene require medical attention and the perpetrator is still present, emergency personnel should leave the scene if they believe they are in danger. Make all attempts to take the patient with you; however, do not delay egress if it poses a personal threat. The situation does not need to be complicated by injured emergency personnel.

If there are no medical needs on the scene, then retreat the same way you entered, leaving nothing behind, and stand by at a safe location. Careful attention should be given to dead-end streets by turning the vehicle around, headed in the direction of departure. If possible, take note of people in the area and vehicles that leave the scene. Reduce the volume of radios to avoid interference with other communications and to prevent revealing your location. Cutting off the ambulance's warning devices, headlights, and interior lights may eliminate you as a target.

A training program with law enforcement personnel will foster a close working relationship and provide a degree of knowledge about law enforcement operations. An
ambulance arriving blindly at a night standoff could send law enforcement officers scrambling
for cover as headlights illuminate what previously were several good hiding positions. The
perpetrator may take advantage of this mistake. Do not block entrances and exits to an unsecured
scene. Doing so may prevent additional resources from reaching the scene and could get you hurt
if someone is really intent on leaving the scene.

Firearms

If a firearm is located at the scene, assume it is loaded. Secure the area, notify the proper
authorities, and leave the weapon alone. This will preserve the chain of evidence and allow
someone with experience in firearms to render the weapon safe. If the weapon must be handled,
note the position and location of the weapon. Do not pick up the weapon with a cloth or pencil
through the trigger guard. Pick the weapon up by the grips, between your fingers. This may
destroy fingerprints, but it is the safe way to handle a gun. Lifting on a checked area of the handle
may be best, since fingerprints are difficult to lift from these surfaces. Take care to point the gun
away from harm. Avoid allowing an on-scene firearms “expert” to take care of the weapon if you
are not knowledgeable about their credentials. Any attempts to clear the weapon, changing the
position of rounds, or failure to note the condition of the chambered round may complicate an
investigation. If necessary, secure the weapon in a safe location until it can be turned over to the
proper authorities. New concealed-weapon laws may increase the frequency of finding weapons
on patients, so be aware of local laws regarding firearms on ambulances. Many states have
specific laws governing the transport of weapons on ambulances. If a firearm is located on a
patient, enlist the assistance of law enforcement personnel if possible.

Consider the emergency scene as you would an emergency patient; the patient's condition
is dynamic, so paramedics continually reassess and adjust therapy. The emergency scene is
dynamic also, so paramedics must continually reassess the physical site and environment.

**Motor Vehicle Hazards**

**Stabilization**

Unstable vehicles present a serious hazard to emergency personnel and patients. Vehicle
stability is considered part of the initial scene survey for hazards and demands prompt attention.
Vehicles should be secured in the position found, not moved to make stabilization easy.
Stabilization may be as simple as turning off the ignition switch, placing the transmission in a
secure gear, and setting the parking brake. Other scenes may require the use of a crane to
stabilize an overturned truck. Ultimately, the scene should be rendered safe for effective patient
care to take place.

Stabilization techniques are based on the principle of increasing contact points with a
secure object. For vehicles on their wheels, this usually involves preventing the vehicle from
rolling. This can be accomplished by use of vehicle controls and equipment, such as the parking
brake, spare tire, or jack. The wheels can be secured with wood blocks or, if on a steep incline,
with rated chains or cables. Preventing motion inherent in the suspension system is normally
accomplished by the use of wood cribbing. Cribs are built up between the vehicle chassis and the
ground in at least a three-point contact. Three-point contact will prevent both lateral and
longitudinal movement. Vehicles on their side or roof usually require more creative techniques,
such as filling in voids between the vehicle and ground and perhaps using rated chains and
cables. **Fire**

Virtually all motor vehicles rely on some type of hazardous fuel for propulsion. The fuel
itself is usually flammable and requires special knowledge and equipment to mitigate the hazard.

The burning vehicle presents many hazards. Tires, plastics, fabrics, and composite vehicle body panels contribute to the heavy fire load. When exposed to fire, the drive shaft of a rear-wheel drive vehicle can fail as entrapped air expands. The same holds true for the small hydraulic piston units designed to support the hood and trunk of modern vehicles. The energy-absorbing feature of bumpers poses a risk to personnel standing directly in front of or behind a burning automobile. When exposed to the forces of a crash or during certain extrication techniques, these sealed, pressurized cylinders can rapidly extend, causing injury. Keep in mind that people use their vehicles for utility purposes as well as travel. It is a good policy to inspect the trunk of any vehicle for propane or other chemicals transported in the trunk.

If the vehicle can be safely approached, turning off the ignition is the first step to ensuring the safety of the electrical system. Disconnecting the battery cables at the battery post will remove the electrical supply to most other accessories. This may prevent the ignition of fuel from a spark, the inadvertent activation of a supplemental restraint system, or a battery explosion. With a burning vehicle, the starter poses a great hazard. As the vehicle burns, the insulation surrounding the wires to the starter may begin to burn, creating a short circuit. This causes the starter to engage and, if the vehicle is in gear, could result in serious consequences. The vehicle's electrical system can also be used to your advantage. Prior to disconnecting electrical power, windows can be rolled down, sunroofs opened, or seats repositioned.

**Airbags**

Airbags are part of the supplemental restraint system, intended to augment the use of safety belts. As airbags have been phased in since the late 1980s, they have established an
impressive record of reducing death and injury. One study has illustrated a 28 percent reduction in driver fatalities in crashes with airbag deployment compared to crashes in which drivers were protected by seatbelts alone (Zador and Ciccone, 1993). Though the original airbag was designed to protect occupants in frontal impacts, several manufacturers have begun equipping cars with side impact systems.

Most vehicles with an airbag system can be identified by the large bolster in the center of the steering hub that houses the bag and inflation unit. These are often marked with initials such as "SRS." If installed on the passenger side, the dashboard must be designed to contain the unit. Close examination will usually identify panels that expand and split upon activation of the airbag system. Warning labels may alert you to the airbag's existence. Some manufacturers are adding “SRS” or “AIRBAG” labels to the vehicle identification numbers. Vehicles are now being equipped with deactivation switches for passenger-side airbags so that child safety seats can be safely used in the front seat.

Generally, there are two types of airbag firing mechanisms: mechanical and electrical. The mechanical unit activates on inertia, much like a hammer firing a bullet from a gun. The electrical units have several sensors located throughout the vehicle. These sensors are inertia-activated and serve to complete an electrical circuit. Nearly all of the electrically activated systems have a backup electrical supply provided by a capacitor. It stores electrical energy like a small battery, activating the airbag if the vehicle’s main electrical supply is interrupted. The capacitor’s electrical energy will eventually self-drain, but the length of time for this to occur is dependent on several factors, such as the manufacturer and the ambient temperature. This is why disconnecting the vehicle battery does not instantly render the airbag system safe. Caution is
advised when working in the proximity of inactivated bags, and the most reliable protection
against inadvertent deployment is to avoid working in the airbag's path.

The actual airbag is made of a neoprene-coated nylon or vinyl material. Contact with the
bag may cause minor abrasions. Electrically activated bags use sodium azide, a flammable solid
that reacts to create nitrogen gas, which inflates the airbag. The sodium azide is well protected
and contained within the gas generator module, so the likelihood of contacting the raw material is
minimal. Virtually no sodium azide exists after airbag deployment, though a white powder can be
found on the bag. This nontoxic powder is slightly alkaline and acts as a lubricant for smooth
deployment of the airbag. The alkalinity of the powder requires proper hand, body, and eye
protection. Any residue that contacts the skin can be easily washed away with water.

An additional hazard is the airbag system that has not deployed. Sodium azide has an
auto-ignition temperature of 600 degrees F. Temperatures of this magnitude usually mean the
vehicle is on fire, and the sodium azide would rapidly burn, creating nitrogen gas. Personnel
should exercise great caution when working in the proximity of an active airbag system. Sudden
inflation could cause additional injury to patients as well as rescuers. Remember that these
systems are not designed to activate in rear or rollover collisions.

Side airbags were first introduced by Volvo in 1995 to provide side-impact protection to
occupants. Side impacts account for about 30 percent of all passenger-vehicle occupant deaths,
second only to frontal crashes. Tests conducted by authorities have indicated that side-impact
bags provide a 40 to 60 percent reduction in the dummy-injury criteria for the head and chest.
Side-impact bags are currently being installed in seats, doors, and pillar assemblies, and are
activated by electrical accelerometers or mechanical sensors (Insurance Institute for Highway
The newest airbag development is an inflatable head protection system designed to protect occupants’ heads in serious side-impact crashes. The currently available units deploy from the area of the roof rails and, according to the National Highway Traffic Safety Administration, could prevent about 600 head-injury deaths a year. A 1993 to 1995 Insurance Institute for Highway Safety analysis of crashes recorded by the National Automotive Sampling System showed that head injuries were the cause of death in at least 44 percent of single-vehicle side impacts, and between 26 and 52 percent of multiple-vehicle side impacts. In 39 percent of the fatal single-vehicle, side-impact crashes that were studied, the vehicle struck a tree or pole on the side where the fatally injured occupant was seated. One auto manufacturer has engineered a knee-bolster inflatable restraint to protect the legs and pelvis, as well as an inflatable restraint to help prevent common whiplash-type injuries.

**PROTECTIVE EQUIPMENT**

Protective gear must be comfortable, light, safe, and affordable and still provide protection. The first priority is to choose the protective gear that fits the job. Certainly, emergency personnel have suffered injury or been killed due to lack of protective equipment. Unfortunately, some suffer harm because they wear equipment that falls under the generalized umbrella of protective gear. You should not enter a burning house expecting a water-rescue life vest to protect you, and it likewise would be poor judgment to attempt a water rescue wearing turnout gear. Emergency services personnel need to escape the generic definition of protection as that of “turnout gear,” and select protective gear suited for the environment. Remember, protective clothing is your first and last line of defense from a hostile environment.
Turnout Gear

Also commonly referred to as bunker gear, this equipment is intended to protect firefighters. There are three major components to the turnout-gear package: the shell, moisture barrier, and thermal liner.

The shell is the first line of defense for the wearer. It also serves to protect the thermal liner and moisture barrier. It must be flame-resistant and tough enough to endure heavy abrasion. It must be flexible, and manufacturers strive for a fabric that is lightweight. Most outer shells are manufactured of 6.0- or 7.5-ounce-per-square-yard Nomex® or PBI®/Kevlar® fabric.

The moisture barrier is designed to prevent water penetration inside the suit, particularly steam. A neoprene-coated fabric is very common, but this design does not “breathe.” This means that any internal moisture, such as perspiration, is trapped within the suit. This causes an uncomfortable clammy feeling and difficulty in movement as the suit sticks at the inner surface. Many manufacturers now utilize a “breathable” moisture barrier that allows perspiration to escape while preventing water passage from the outside, acting as a one-way valve. This newer-style moisture barrier has an additional benefit in that it is usually lighter than the conventional moisture barrier.

The thermal liner is designed to provide insulating qualities to the garment. This accounts for much of the bulk in firefighting gear, because a certain degree of thickness is necessary for proper insulation from heat. Currently, the NFPA uses a Thermal Protective Performance test to determine insulative qualities regardless of thickness, which has lead to the design of lighter, more efficient thermal liners.

Protective Hoods
The NFPA requires the use of a hood as part of the firefighter's protective ensemble. Like the outer shell, hoods are constructed of Nomex® or PBI® and help protect the skin on the face and neck. To attain a proper facepiece seal, the hood is normally worn over the facepiece straps of the breathing apparatus, with the helmet completing the ensemble. If the helmet is displaced, the hood provides a degree of protection to the head and reduces damage to the facepiece straps.

**Footwear**

Firefighting duties require the use of approved footwear. Although there are leather boots approved for firefighting use, the rubber boot is the most common. Most boots are shin-length height to protect the shin area. A flexible steel mid-sole and steel shank give the boot strength while providing resistance to punctures. Boots are available with various grades and levels of insulation and have a deep-cleated sole for traction on soft, slick surfaces. Although many of these boots have passed a dielectric test for insulative properties against incidental electrical hazards, they should not be relied on for such protection.

**Helmet**

Helmets are very specialized to the particular environment and the specific kind of protection needed. The type of head protection required in a burning structure, for example, is very different than that warranted for swift water rescue. Unfortunately, fiscal constraints prevent many agencies from equipping each rescuer with a “specialty” helmet for each type of rescue they encounter. Some of the current models have ratcheting headbands that allow rapid adjustment. This design lends itself to sharing among personnel.

Although an overall helmet standard does not exist, there are several industry-specific standards. OSHA, for example, has established protective equipment industry standards. The
Union of International Alpine Associations (UIAA) sets standards for climbing and mountaineering and has a specific testing procedure for helmets.

When searching for a helmet, certainly purchase a model that meets an industry standard if applicable. The outer shell should be rigid to resist impact and penetration and should be able to withstand temperature extremes. A suspension system with a smooth, shock-absorbing inner liner will allow the helmet to absorb impacts. A secure, quick-release chin strap with a four-point attachment to the helmet will keep it secured to the head, even through multiple impacts. Last, consider the ease of maintenance and the attachment of any accessories, such as a headlamp. Make sure you follow the manufacturer’s recommendations if altering the gear.

**Respiratory Protection**

In dust-filled environments, a high-efficiency particulate-style mask may afford some protection if no other mask is available. Remember that this is a particulate mask only; it provides no inherent protection for toxic or oxygen-deficient atmospheres. Different atmospheres require specific filters to remove particulates. Therefore, exact knowledge of the atmosphere’s composition is needed to determine the style of respirator required. In areas where the atmosphere is hazardous to humans, a fresh-air supply must be provided in some form.

Generally, there are four hazardous environments that are of concern to emergency personnel. Smoke-filled environments obscure vision, causing disorientation. The smoke particles—a combination of carbon, tar, and dust—contaminate the air. The physical condition of the airway and the size of the particles dictate how far the particles may be ingested. If inhaled, these particles range from mildly irritating to lethal.

Heat can cause damage to the airway in the same manner it does the skin. However, burns
involving the airway have several grave implications. First, the patient's airway may be compromised due to the burns, and conventional airway control techniques such as intubation may prove fruitless. Circumferential swelling will generally be present because the total inner surface of the airway is exposed to the heat. This drastically reduces the diameter of the airway. The airway is moist, which aids in rapid transfer of heat, and the inhalation of moist air can worsen the injury. The associated swelling can also be accompanied by pulmonary edema.

The process of combustion consumes oxygen. In a closed environment with a limited supply of fresh air, this results in an oxygen-deficient atmosphere.

Toxic gases can displace or dilute the content of oxygen, making a very deadly space appear totally innocent. OSHA requires the use of protective respiratory equipment if the oxygen concentration is less than 19.5 percent. When chemicals combine in an uncontrolled manner, the result may be unpredictable. This can result in toxic atmospheres with compound effects. Toxic gases may affect the lungs directly, or pass into the bloodstream where organs or body systems sustain damage.

Two main types of breathing apparatus are currently used by emergency personnel. The self-contained breathing apparatus (SCBA) is fully contained by the user, with a pressurized air tank mounted on a backpack. Air is supplied through a regulator to a facemask held to the head by straps.

Certain rescue operations in confined areas prove a backpack-mounted tank to be too cumbersome. In such cases, a supplied-air breathing apparatus (SABA) can be utilized. This type of unit consists of a facemask supplied with air through a hose. The compressed air source stays outside the rescue area, thus avoiding the bulk of an air cylinder. However, a small 5- or 10-
minute "escape bottle" is required should the main air supply be interrupted.

A personal alerting system is a standard part of the breathing-apparatus ensemble. These are small, battery-powered units that activate after a lack of movement for a period of time. Some are designed with heat-sensing capability. If rescue personnel are incapacitated or exposed to high-heat conditions, the monitor would activate, alerting others that personnel are in trouble. The units can also be manually activated.

**UNIVERSAL PRECAUTIONS AND INFECTION CONTROL**

In the 1800s, an obstetrician discovered that medical students were completing study in the anatomy lab, then reporting to the hospital to care for patients. Patients attended by the medical students experienced a higher death rate, and this was attributed to the medical students not washing their hands. This early discovery paved the road for the field of infection control and emphasized the effect handwashing could have on disease control.

In 1890, surgeon William Halstead introduced rubber gloves into medical practice to prevent the spread of disease. His associate, Dr. Joseph Bloodgood, illustrated a marked reduction in postoperative infection rates when the surgical team used gloves. However, these practices fell by the wayside as antibiotics were discovered and came into use (Duffy, 1992).

When antibiotic-resistant bacteria began to surface, infection control procedures reappeared, and now there is a strong emphasis on protection from hepatitis B and human immunodeficiency virus. For example, due to the seriousness of hepatitis B, OSHA has mandated that vaccination be available to all employees within 10 working days of assignment. OSHA estimates this can prevent from 244,000 to 274,000 cases of HBV infection over 45 years, saving approximately 6000 lives in the process.


**Legislation**

OSHA developed federal legislation designed to protect health care personnel (OSHA). Many of these procedures were written in the context of hospital practices and posed logistical problems when applied to the uncontrolled environment of EMS. To remedy this, several organizations have written specific guidelines for prehospital care providers. Among these are a manual written by the Centers for Disease Control and Prevention (CDC), a written standard and course by the National Fire Academy, and an administrative guide offered by the United States Fire Administration (CDC, 1988; National Fire Academy, 1988; USFA, 1992). First adopted in 1992 and revised in 1997, the National Fire Protection Association published NFPA 1999, which outlined rules for the performance of protective gear.

**Disease Transmission**

The paramedic's primary concern is protection from communicable disease, microorganisms that can be transmitted from person to person. Several conditions must be present for disease transmission to be successful. Elimination of any one of these links will break the “chain” and help prevent disease transmission. First, a pathogen must be present in sufficient dosage. For example, one milliliter of human blood may contain one to 100 human immunodeficiency viruses, whereas the same volume of blood may contain 100,000 to one billion hepatitis B viruses. Second, the infecting organism must have virulence, or the ability to survive and infect. The hepatitis B virus can remain infectious for weeks on smooth, dry surfaces. Third, the pathogen must locate a host susceptible to this particular disease. Fourth, the pathogen must travel by an appropriate route, whether air, blood, or food. Fifth, the organism must gain entry to the host. Interrupting the disease process at any of these points can prevent infection.

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This can be accomplished by following good infection-control practices and by understanding diseases and their transmission.

**Standard Precautions and Body Substance Isolation**

Standard precautions originated as precautions against exposure to blood and body fluids when a patient had a suspected or known blood-borne disease. Because many infected individuals remain asymptomatic, the CDC extended precautions against exposure to blood to include all patients in 1987. According to the concept of standard precautions, all human blood and certain body fluids are treated as if known to be infectious. In 1988, the list of fluids was expanded to include seminal, vaginal, synovial, cerebrospinal, pleural, pericardial, peritoneal, and amniotic fluids, as well as human tissue. Standard precautions do not apply to any other body fluids unless the fluid is blood-contaminated or the differentiation of body fluids is impossible to discern. Unfortunately, this is the exact case in most emergency situations.

Body substance isolation (BSI) is often confused with standard precautions. Whereas standard precautions apply to blood-borne pathogens, BSI extends the protective umbrella to include enteric and airborne pathogens. Adhering to BSI precautions encompasses acceptable coverage of standard precautions as required by OSHA. In the field, it is safest to initiate the highest level of protection available because any blood or body fluid must be considered infectious.

Remember that the use of protective equipment may "depersonalize" contact with patients. If faces are covered, many nonverbal cues are concealed. Alternative techniques must be incorporated to enhance communication.

**Prevention of Infection**
Proper discipline concerning the use of protective equipment is important to the safety of emergency personnel. Operating procedures can be written and enforced in every way possible, yet the success of controlling infection rests with the professionals at the end of the delivery chain.

All health care providers should be in a good state of health, both physically and emotionally. The rigors of providing care in an uncontrolled environment can be demanding. The basis of a good infection-control program is easier to build on a strong foundation of initial good health. All applicable immunizations should be current, including measles, mumps, rubella, polio, and tetanus. OSHA requires that the hepatitis B vaccine be available to all employees but does not mandate vaccination. Tuberculosis testing is required at the time of initial employment, serving as a baseline for any future exposures. Specialized fields may have requirements specific to the particular environment, such as baseline hearing tests for flight paramedics.

An infection-control program should also strive to protect patients, many of whom are already in a weakened state of health. Certain employee illnesses may result in the employee being placed on work restrictions. These requirements actually complement the basic infection control policy because they extend to protecting the employee who may be more susceptible to contracting disease. Some examples would be the employee with a fever, a communicable disease, or open skin lesions that cannot be adequately covered. Many employers follow this activity closely, based on concerns for limiting disease transmission and preventing abuse of the policy.

Personal protective equipment (PPE) is designed to protect the wearer from contact with body fluids, providing a complete and impenetrable barrier. A generic PPE ensemble does not
exist, and selecting protection specific to the disease is difficult in the field because often the disease threat is undetermined. Generally, emergency personnel must select protection based on the potential for transmission of disease. The CDC and the U.S. Fire Administration have published guidelines for the use of PPE (Duffy, 1992; CDC, 1988).

If leather gloves are required for hand protection while rendering patient care, latex gloves should be worn under the leather to act as a barrier to pathogens. If leather gloves are worn in the course of firefighting or fire protection duties, barrier protection gloves should be avoided to reduce the risk of steam burns.

Gowns are designed to protect the wearer from gross contamination of clothing. An alternative means of protection should be selected if wearing a gown is potentially harmful (loose ends may become entangled; material flammability is a concern, etc.).

If work clothing becomes contaminated, the employee should change into a clean uniform after completing the call. Depending on the level of contamination, a shower should be considered for substantial exposure. This requirement has changed the operations of EMS. Rescue units with "contaminated" employees may now have to be considered out-of-service while they return to quarters, shower, and change into fresh uniforms. Some agencies require employees to carry a change of uniform on the unit, where it is readily available. Contaminated clothing should not be taken home for laundering because this may extend the contamination along the route of transportation to a private residence. OSHA requires the employer to maintain the uniform if used as PPE. In short, contaminated material should stay on-site. Many agencies have developed agreements and contracts for the cleaning of contaminated material, and some have installed washers and dryers at base locations.
A fresh set of linen should be available for each patient. Linen should not be sorted or rinsed in preparation for cleaning, and grossly contaminated linen should be placed in a leakproof container and properly labeled. In keeping with this requirement, many ambulances now have a designated "contaminated" compartment where soiled linen and supplies are transported back to the base station.

Contaminated needles should not be recapped, bent, or removed to effect their disposal. Needle recapping results in a very common, preventable source of exposure to blood-borne pathogens. A common site of an unintentional needle stick is the index finger of the nondominant hand. Infection control concerns have resulted in the introduction of shielded IV catheters and needle-less connection systems. A disposable sharps container should be readily available for immediate sharps disposal at the site of use. This prevents the hazard of intermediate transport, then rehandling or perhaps forgetting about it. Remember that needle sticks are easily preventable, and a high frequency of occurrence should result in examination of engineering controls and employee training.

The use of disposable equipment has quickly gained merit in the field of EMS. Single-use devices do not have to be transported in a contaminated state and do not consume valuable time spent cleaning. Many disposable items that were initially avoided due to poor quality have now been re-engineered. This allows continued quality in patient care without requiring personnel to risk exposure cleaning contaminated equipment. For nondisposable equipment, the manufacturer’s recommendations should be followed, and personnel must wear proper protective equipment while conducting cleaning procedures.

Finally, regular handwashing should be considered the foundation of infection control
awareness. Hands should be washed after removal of PPE, after patient care, and after any other activities where contamination may be present, such as wiping the patient compartment. There are several sources of hand cleaners formulated for use without water that are suitable for use in the ambulance. These are fine for intermediate washing but should be followed with soap and water as soon as they are available.

**Cleaning the Ambulance**

Ambulances should have one compartment dedicated to contaminated or soiled materials. Even with the increased use of disposable articles, certain soiled materials will have to be transported in the vehicle. Considering this compartment to be contaminated will serve in keeping the remainder of the vehicle clean and free from cross-contamination.

Because the ambulance often spends considerable time away from quarters, cleaning supplies should be kept on the unit. Utility-type gloves are more durable than latex medical gloves and provide greater protection. A spray bottle with a general cleaning agent and another with a disinfectant or concentrated bleach solution should be handy. Disposable wipes should also be included. The collection of cleaning equipment can be stored in an easily accessible basket.

Carefully observe for areas of hidden contamination, such as radio microphones, handrails, the underside of stretchers, medbag handles, and compartment latches. Do not forget that the driver's compartment can easily become soiled, and the controls in the cab need similar attention. First, remove any grossly contaminated materials such as gauze or bandages, and dispose of them properly. Next, remove any equipment that must be cleaned prior to patient reuse, such as laryngoscope blades. Using the top-down theory, clean upper surfaces first,
beginning with the ceiling and working to the walls. Clean all surfaces that came into contact with the patient, as well as any surfaces contaminated in the course of patient care. Last, cleaning the floor is best done with a mop and water with disinfectant solution.

SUMMARY

The emergency scene is very dynamic, requiring emergency personnel to respond and adapt to the uncontrolled environment. Personnel must be prepared to provide for their own personal protection as well as the patient’s. By gaining specific knowledge about particular demands of the uncontrolled environment, the paramedic will be able to deliver the most effective patient care possible.

BIBLIOGRAPHY


Stuart, D: Personal communication, August 1996.


USFA: Guide to developing and managing an emergency medical service infection control program (FA 112), FEMA, 1992.


