National Disaster Medical System
On-line Response Team Training Program

Hazardous Materials Awareness for NDMS Teams

John K Gaffney
BBA, CEM, EMT-Flight Paramedic,
NDMS Office of the Director

Original post date: 05/20/2002
Last update: 08/09/2004

KEYWORDS:
Occupational Safety and Health Administration (OSHA)
Environmental Protection Agency (EPA)
Chemical, Biological, Radiological, Nuclear, Explosive (CBRNE)
Code of Federal Regulations (CFR),
Personal Protective Equipment (PPE)
Weapons of Mass Destruction (WMD)
Hot, Warm, Cold Zones
Non-fixed Location
Fixed Location
Placard
Material Safety Data Sheet
Contamination, Decontamination

Hazardous Materials Awareness for NDMS Teams

OBJECTIVES:
By the end of this module, the student should be able to:

- Recognize the function of OSHA, EPA, and CFR.
- Recall the Four levels of hazardous materials training.
- Recall the activities and purpose of each hazardous materials "zone."
- Identify the four key parts to a hazardous materials placard and the significance of each part.
- Recall the Four concepts of initial contaminated patient management.

INTRODUCTION:
Given the billions of tons of hazardous materials shipped[1] by today's society, it should come as no surprise that one area of concern for disaster responders is the recognition and management of hazardous material incidents. More specifically, it is critical that each disaster team member be able to recognize and make informed clinical and team-safety judgments involving patients contaminated by hazardous materials.

Both the Occupational Safety and Health Administration[2] (OSHA) and the Environmental Protection Agency[3] (EPA) have regulations in place that impact disaster medical programs. Primarily, OSHA and the EPA require employers to provide minimum training to personnel who "participate, or are expected to participate, in emergency response to a hazardous substance accidents."[4] It would be a difficult to argue that this regulation does not include disaster medical teams.

The first issue to address is "What is a hazardous material?" A material is categorized hazardous if it poses a risk to people, property or the environment, and if it is not properly controlled.[5] Although, this is a broad definition, it serves to illustrate that there are many hazardous materials, in many forms, which pose many different risks.

PROVIDER LEVELS:
The rest of the hazardous materials introduction primarily comes from the Code of Federal Regulations (CFR), which establishes the Occupational Safety and Health Administration (OSHA) and Environmental Protection Agency (EPA) regulations described above. The OSHA regulation is a critical document, in that it defines who needs hazardous material training and outlines what the training should entail. It requires that there be four levels of training: 1) awareness, 2) operations, 3) technician, and 4) specialist.

The first two levels, awareness and operations, are courses designed to teach the responder the initial actions to take at a hazardous materials scene. First and foremost, the responder should be able to recognize a hazardous material scene so that appropriate safety precautions can be taken and the proper response initiated. The awareness responder course introduces these responsibilities. Next, the awareness and operations providers should take defensive actions. The defensive steps include attempting to identify the hazardous material(s) involved in the incident and isolating the incident. Isolating the incident can mean preventing continued hazardous material leakage or stopping the access of non-essential persons or the exodus of contaminated persons.

The technician-level provider is trained to take offensive actions required to stop the spill. This level of approach requires that the provider wear appropriate personal protective equipment (PPE). Because there are different levels and types of PPE for different hazardous materials, simply deciding what to wear for a particular release is beyond the scope of the basic awareness-trained provider. For this reason, it is unlikely that any disaster medical team without a heavy investment in training and equipment would ever be expected to actually approach the hazardous material incident or perform initial decontamination on exposed patients.

The fourth training level is that of specialist. The specialist may or may not actually enter the hot zone in PPE, but it must have special training or experience pertinent to the event. In many cases, the specialist is someone thoroughly familiar with the hazardous material itself, or perhaps with the type of container from which the material is escaping. In addition, some systems train certain EMTs as hazardous material medical specialists.

Some jurisdictions include a fifth level of training, known as incident commander training. In addition to the incident command training and experience, this individual should have a minimum of awareness and operations level training. This ensures that the person in charge of the event's response, the incident commander, can not only manage a hazardous material incident but is able to manage the special needs of the event.

ZONE DESIGNATION

Hot Zone:

The technician-level provider is trained to manage activities within the inner perimeter of what is known as the “hot” zone. The hot zone is established by the hazardous materials response team and is the area where there is imminent danger of exposure from the released hazardous material. Its size and shape depend upon the released material’s physical properties, the size of the release, the weather, and the geography of the incident. Inside the hot zone are those victims who have not escaped the scene prior to its being contained, so there is a natural tendency of health care providers to g to the aid of these patients. Doing so is dangerous at best and can be potentially fatal.

When team member safety is at high risk, disaster responders should have policies in place allowing for variance from triage and treatment protocols.

Entry into the hot zone requires PPE, which necessitates that the rescuer undergo a physical assessment prior to donning the gear, and that a decontamination corridor be established prior to entry. Per OSHA requirements, rescuers who don PPE and enter the hot zone must be trained, fit tested for equipment, and have specialized annual physical exams. The response requires a trained and equipped hazardous materials team. Ad hoc responses would be hazardous and might even subject the would-be rescuers to legal action.

For every rescuer in PPE, inside the hot zone, there must be another rescuer outside the hot zone who is prepared to assist a rescue of the first if necessary. Performing on-scene pre-PPE physical exams for the large number of rescuers is a service a disaster medical team can assist with, but be advised that it is a time-consuming process.

Until the decontamination corridor is in place and a sufficient number of rescuers are available in PPE to enter the hot zone and perform extrication and decontamination of the victims, anyone inside the hot zone can expect to stay there.

Warm Zone:

Outside the hot zone is the warm zone. This area acts as a buffer between the hot zone and the cold zone and is where the decontamination corridor is located and other “dirty” duties are preformed. It is beyond the hazard of immediate exposure, but secondary contaminants may be present and contaminated equipment and supplies may be staged. The outer perimeter of the warm zone is the closest to the hazardous materials release that disaster medical personnel should be.

Cold Zone:

Beyond the warm zone perimeter is the cold zone, which is the buffer between the warm zone and the ‘rest of the world.’ In this area, personnel should be staged, ambulances prepared to receive patients for transports, and other such official “clean” functions performed. Since some hot zones can be thousands of feet in size,

the entire restricted area is potentially huge and will require tremendous personnel resources to contain. A final note on the organization of the hazardous material scene is that it must, per OSHA regulations, utilize an incident command system (ICS) and that the ICS must utilize a safety officer. One area for training and interface between the disaster team and the local public safety community therefore would be ICS.

RECOGNITION AND IDENTIFICATION:

Clues such as the involvement of hazardous material-carrying vehicles in the disaster area, location of the incident (such as a known chemical facility), or unexplained multiple casualties, should alert responders to be cautious when approaching the scene.

Upon approach to the scene, the disaster responders should be looking it over for further clues. The presences of facilities or containers, where hazardous materials might be found, or the more obvious presence of actual spills, are all clues. It should be kept in mind that hazardous materials could be in gaseous or particulate form and may not be visible.

In general terms, a hazardous material can only be found in one of two location types: non-fixed or fixed. Only the first of these location types, non-fixed, has specific regulations as to how the material must be packaged, shipped and labeled. Under 49 CFR 172, the Department of Transportation (DOT) adopts the nine United Nations (UN) hazard classes, quantity thresholds (describing when various hazardous materials must be labeled and placarded) and the specifics of the labels and placards. Figure 1 shows both the DOT placards and the basic hazard classes.

Non-fixed Locations:

Non-fixed locations include vehicles, containers, or trailers found at emergency scenes. Although it is possible to identify various hazardous materials based upon where they are found, this is, at best, a single clue. To better utilize this information requires training and experience. Reference materials are often misleading. This session will not go into further detail, but will refer disaster responders to more in-depth hazardous material literature.

Fixed Locations:

The second location type where hazardous materials may be found is known as a fixed facility. As the name implies, this is a location, such as a chemical depot or manufacturing site, where quantities of different chemicals are stored, either in preparation for transportation, for use in a manufacturing process, or as waste that is awaiting proper disposal. While there may be federal, state, and local regulations that determine how these facilities are managed, these regulations vary from locale to locale. Thus, the only effective way to prepare for fixed location responses is to do so in advance. This is best accomplished by an on-going program of training as well as by maintaining a close relationship with the local fire department(s) that have primary jurisdiction for hazardous material response.

Signage:
While the DOT labeling requirement is complex, the labels and placards themselves are standardized and easy to interpret. Labels are found directly on packages and containers containing hazardous materials and give information specific to the substance within. It is important to note that a single facility or vehicle may contain numerous different types and quantities of hazardous materials, so a high suspicion must be maintained that even small delivery vehicles may pose multiple risks. While more often encountered, placards may provide less information. These are the large, color-coded, diamond-shaped signs on the outside of vehicles transporting hazardous materials. Some hazardous materials require placards for any quantity, while some have threshold amounts below which no placard is required. In addition, if the conveyance is transporting multiple hazardous materials, the placard displayed may simply read “dangerous.” While alerting rescue personnel to the presence of hazardous materials, it provides no clue as to what the materials might be.

There are four key parts to a placard. The first part is the color, which is visible from a distance, and can convey hazard type. Red, for example, always means that there is a combustibility or flammability concern (combustible and flammable differ in the temperatures at which each burns). In the center of the placard, there is a symbol that indicates the general hazard (perhaps the best known of which is the purple propeller indicating radioactive materials).

Depending upon the placard, there may be a four-digit number as well. This number can be looked up in one of several sources, and it indicates the hazardous material in question, however only to a certain level of specificity. 1203, for example, could be any one of several types of flammable liquids and is seen daily on tanker trailers hauling gasoline to your neighborhood service station. Finally, in the center of the bottom of the placard, there is a number between one and nine. In many cases, this number will be a single digit but could also include a numeral in the “tenths” column. This refers to the UN Hazard Class shown on Figure 1.

There is one recognized national system for marking fixed facilities, which local governments may or may not adopt. Established by the National Fire Protection Agency, NFPA 704 requires the prominent display of a diamond shaped multi-colored sign (Figure 2) outside the location where the hazardous materials are located. The diamond is divided into four color-coded portions. The left-most section is blue, and indicates health hazards, the top of the diamond is red and indicates flammability and the right side is yellow and describes the reactivity of the building’s hazardous materials. The remaining section is white and describes – by symbol and/or lettering – special precautions to be taken by emergency responders.

Within the blue, red, and yellow sections is a number ranging from zero to four based on a hazard scale unique to the color. Zero indicates that the hazardous materials within the facility pose no risk for the color-coded category while four indicates the maximum possible risk. For example, a zero in the red means that

there is no flammability concern with the building's contents, while a four in the blue means an extreme health hazard exists.

SCENE RESPONSE:

Based upon pre-dispatch information, clues noted while approaching the scene, the location of the incident, and various markings, disaster response team members should have an awareness of the presence of a hazardous material release prior to approaching the incident. While some hazardous material courses teach the responder to be mindful of odors or other 'physical' clues on the scene, it should be apparent that any rescuer close enough to appreciate such clues is TOO CLOSE! If the disaster team suspects that they have arrived on a hazardous material scene, they should immediately move to a safe location, usually upwind, certainly not downhill, and at distances to be determined by the type of material involved. Appropriate agencies and personnel must be notified prior to any patient contact.

Notification of Appropriate Agencies and Personnel:
The agency(s) to be notified varies by jurisdiction and should be determined in advance. The local fire department is commonly the hazardous material response contact, but other agencies may need to be notified. For example, in New Mexico the State Police have statutory authority over all hazardous material incidents and must be contacted.

To the highest degree possible, all notifications should include information about the hazardous material. In addition to the labels and placards described above, additional sources of information are available. In general, start with the responsible party. In the case of a fixed facility release this may be a plant engineer or the leader of a corporate emergency response team, while in the case of a transported material it may be the truck's driver or train's engineer. These individuals should know what materials are present in their facility or conveyance and are required to have access to certain specific paperwork.

In the case of transported hazardous materials, the carrier has obligations and capabilities and should be notified promptly. They may not only have a response team available but are likely to be ultimately responsible for clean-up and recovery of the scene and will require lead time to assemble the necessary resources. The plant engineer, safety officer or shipping supervisor will also have access to the paperwork accompanying a hazardous material, generally a Material Safety Data Sheet (MSDS).

Depending upon the type of conveyance, the paperwork may be known as a waybill, bill of lading, consist, or other form which will also provide shipper contact information.

Both the MSDS and transportation paperwork provide general information about material, its chemical and/or physical properties, the nature of risk it poses, and suggestions on the management of a release. While the latter may prove useful, it is questionable as to whether health care providers should follow the form's medical

advice or simply use it as general guidance on the type of care that may be required.

Resource Information:
There are several excellent reference sources available by telephone that, again, must be determined in advance. These may include national firms such as CHEMTREC (800-424-9300) or local resources such as your regional poison information center.

Additional national numbers are shown at the bottom of Figure 1.
Other local resources are available under a series of federal laws designed to protect individuals and communities against hazardous materials emergencies.[6] Among these is your Local Emergency Planning Committee (LEPC). The LEPC is responsible for many facets of hazardous materials management, both in daily operations within the community as well as during emergencies, and is an excellent resource for disaster response teams.

Another excellent resource that is easy to carry on deployments is the DOT Emergency Response Guide (ERG, Figure 3). This small reference book starts with a flow chart similar to Figure 1 and then has four color-coded sections. The yellow section lists thousands of chemicals in the order of their four-digit DOT number while the blue section lists the same materials alphabetically. In both cases the material is referenced against a specific guide found in the orange section. This guide is specific to the general type of material, its properties and its prioritized risks. For example, if the material is more dangerous to 'health' than a 'fire or explosion' risk, then the health paragraph comes before the fire or explosion paragraph. Suggested emergency and personal protection procedures to be followed for each type of risk are then listed.

If, in either the yellow or blue sections the material is highlighted, it is cross-referenced to the final section, which is green. The materials listed in the green section are highly hazardous and have extensive evacuation requirements. The ERG is available in bulk quantities, free of charge, from the DOT or your local hazardous material response unit.

In addition to the resources described herein, there are many others that disaster teams may find useful to obtain in advance. Your local hazardous material response agency can recommend many of these as can your facility's industrial hygienist or safety and health professional.

WEAPONS OF MASS DESTRUCTION:
Although the bulk of this module has referred to hazardous materials as 'chemicals,' it should be recognized that biological agents and radiological agents can be hazardous materials as well. In general, this consideration is already included in the basic hazardous material response guidelines (e.g., there are labels and placards for biological agents) but differences may arise when making notifications involving biological emergencies.

This difference is necessitated not only by the differences between biological and chemical agents but also because of the growing concern about potential terrorist use of hazardous materials as weapons of mass destruction (WMD). Should a terrorist WMD event using chemical weapons occur, it would most likely be immediately obvious to the public safety and health care communities that something has happened, and responses will be mounted accordingly. An often-cited example of this would be the release of some type of nerve agent (a chemical hazardous material) in a high population venue such as a sporting event. In addition to being immediately obvious, if an explosive device disburses the chemical, the chemical itself will almost assuredly cause immediate symptoms.

A terrorist use of a biological agent will unfold quite differently than other HAZMAT incidents. Given the latency of biological agents, particularly agents that require several days of incubation, it is likely that there will be no 9-1-1-type of signal that something has occurred. Thus, a biological WMD event becomes more of a public health consideration than a public safety response. In turn, this means that EMS agencies, emergency departments and health departments need to be particularly alert to developing trends in their patient populations, so that epidemiological measures to find the source of the outbreak can begin as soon as possible. The notification of the proper agency(s) of a potential biological event requires determining a completely different set of resources and points of contact than would be utilized in a traditional hazardous material incident.

Additionally, terrorist use of a radiological agent would present differently than other HAZMAT incidents. Because radiation can not be sensed with out specialized equipment it is possible that a radiation incident might go initially unnoticed, thereby contaminating bystanders and rescue workers. An example would be the use of a “Dirty Bomb” where radiological materials might be packed around a conventional explosive. When the device is detonated it might be mistaken for a conventional explosive unless responders checked the area for radiation.

DECONTAMINATION AND TREATMENT:

Perhaps one of the medical community’s weakest areas, in terms of responding to hazardous materials events, is that of decontamination and PPE. Based on the above discussion, it is unlikely that disaster team members will be doing gross decontamination. It is important that they be able to determine the efficacy of the decontamination done on their behalf, if any. According to data from the Centers for Disease Control and Prevention’s Agency for Toxic Substance and Disease Registry, well over half of the patients presenting to hospital emergency departments for treatment have not gone through any organized triage or decontamination process.

In the event of a large hazardous material incident with numerous casualties, it should be anticipated that many of the ambulatory victims would self-refer from the scene to area emergency departments prior to formal decontamination processes being established. It is crucial that this be recognized and that these contaminated

victims not be allowed to enter the department, lest it become contaminated and thus removed from the community's available resources.

INITIAL MANAGEMENT OF CONTAMINATED PATIENTS:
There are four concepts to apply to the initial management of a contaminated patient.

First, disaster team members must protect themselves. This may mean not responding until the scene is safe, or refusing to accept patients whose decontamination status is questionable. If, however, the disaster team must become involved, their first consideration should be PPE. Unfortunately, adequate PPE (especially respiratory protection) is often not available to team members. However, much of the PPE available to health care workers is sufficient for the majority of hazardous materials. PPE used for universal precautions, particularly when designed for trauma or surgical use including waterproof clothing or gowns, goggles, and gloves is often adequate. If contamination is suspected, this level of protective clothing is the absolute minimum that must be worn.

The second consideration is found in the general concept of time, distance, and shielding. Although this set of concepts (time, distance and shielding) is generally associated with radioactive materials, it is of use with all chemical exposures. By maximizing the distance between the responder and the victim, minimizing the exposure time, and/or by providing some type of shielding (e.g., the aforementioned universal precautions) - or through some combination of all three - the rescuers are protecting themselves as much as is probably possible under the circumstances.

The third concept is simply recognizing what is contaminated. Usually the vast majority of contaminants can be removed simply by disrobing the victim, leaving only exposed surfaces to be decontaminated. These surfaces may include some difficult to- clean areas such as under the fingernails and in the hair. The most common solution for this problem is irrigation with copious quantities of water (and soap, if available). Realizing that the run-off may become a contaminant itself and should be contained, if possible, to minimize any environmental impact. During this process, also consider patient modesty and comfort issues. Decontamination of patients exposed to radiological agents would be handled in the same way as patients contaminated by chemicals. The use of radiation survey meters would greatly aid in the decontamination process, by allowing the detection of any remaining contaminate on the patient. Patients who have been exposed to gross biological agent such as a powder (as with the anthrax letters) or a liquid should be decontaminated in the same manner as used with chemical agents.

Finally, it may be possible to triage some victims by asking the question 'If the patient is truly contaminated with a highly lethal agent, will decontamination be of practical use, or should other patients be managed instead?' While this may seem callous, it forces the rescuer to evaluate if there is really a contamination issue. If there is in fact a hazardous materials spill and the patient is not dead or dying, there is probably minimal contamination, and gross decontamination (with available

PPE for the rescuer) may be sufficient. Please note that the disaster team must err on the side of safety and modify their triage and transport decisions accordingly. Once a patient is adequately decontaminated, management of the medical condition can occur. It may be worth asking, however, if clinical concerns should always be subordinate to decontamination issues. The answer may be 'no' in some cases, and thus, the treatment of the medical condition need not wait for complete patient decontamination. A good example of this might be a patient with alpha-particle radioactive contamination. The PPE described above, as that used for trauma victims, is more than adequate for protecting the health care provider from the alpha particles, which may not be as lethal as the underlying heart attack or injury requiring treatment.

As in all of medicine, the ultimate answer to many of these questions is in the judgment of the provider and medical control physician. After recognizing the hazardous materials incident, notifying the proper authorities, identifying the agent(s) involved and learning about them, and determining the decontamination status of the patient, the disaster medical team members can next begin to treat the patient. Unfortunately, the majority of hazardous materials have no antidote, and therefore, treatment is supportive and symptomatic. An advantage of identifying the hazardous material is that it can perhaps be put into some classification so that a specific therapeutic regimen can be determined.

For example, all currently known nerve agents are essentially organophosphates, the treatment for which is well known. Otherwise, the most common manifestations of chemical exposures must be anticipated and the team prepared for them. These include GI symptoms, airway/pulmonary complications, metabolic disturbances, cardiovascular symptoms – particularly cardiac dysrhythmias and cardiovascular collapse – and CNS effects. Disaster medical providers should be trained and equipped to deal with these syndromes as they present and not necessarily focus initially on definitive therapy. Once again, your local poison information center may be of great help, not only anticipating what symptoms may present but also in assisting in and finding definitive therapies with which the disaster medical team may otherwise be unaware. One of the therapies available in some areas utilizes an experimental chelating agent (DTPA) that can be administered after the inhalation or ingestion of certain radioactive elements.

SUMMARY:

While safety considerations make it unlikely that disaster medical teams will be solely responsible for the management of a hazardous material incident or the care of a contaminated patient, there are critical roles that they might play. Disaster medical teams should be able to:

1. Recognize the presence of a hazardous material incident based on clues, labels, placards, and other such evidence.
2. Provide for personal safety and know about appropriate PPE while involved in a hazardous material incident.
3. Safely interface with other agencies within the ICS at a hazardous materials incident.
4. Determine, to the degree possible, the hazardous material and its properties and effects on patients.
5. Know sources of information about the materials involved and notify the appropriate agencies.
6. Identify decontamination issues and determine the efficacy of decontamination processes, particularly prior to deciding whether or not to transport a patient.
7. Anticipate basic symptoms and therapies required for the hazardous material or its general chemical or biological class and provide appropriate treatment for the agent.

Works Cited

1. Borak, J; Callan, M; Abbott, W. Hazardous Materials Exposure: Emergency Response and Patient
2. Care; Brady Publishers, 1991
3. 29 CFR 1910.120
4. 40 CFR 112
5. Ibid.
6. U.S. Department Health and Human Services Managing Hazardous Materials Incidents, Volume III:
7. Medical. Management Guidelines for Acute Chemical Exposures
8. Title III, Superfund Amendments and Reauthorization Act