PPE Considerations for Hospital Based Decon Following a NBC Incident

William H. Ruting, Sr. ***SEM***

Assessing the appropriate level of PPE for hospital workers performing decon in a location that is away from the incident scene is a concern for many hospitals.

Background

The major considerations in the selection of personal protective equipment (PPE) revolve around statutory requirements, the need for adequate protection, the actual level of the threat, and the cost of the protective equipment. Once a the conditions are evaluated, it is generally found that the major area of concern is the level and type of respiratory protection necessary. We state this for the following reasons:

1. Body protection is both easily selected and affordable. A disposable suit which is suitable for the expose costs less than $25.00[1].

2. Hand protection is also very reasonable, under $4.00 for a suitable glove.[2]

3. Adequate foot protection is also available for an affordable cost.

This leaves respiratory protection, then as the major issue. The respiratory protection that is typically recommended powered-air-purifying-respirator (PAPR) can have costs per unit as high as $700.00 for a hood system with NBC cartridges.

The question which needs to be answered is whether this level of protection is necessary and if it affords a significantly higher level of protection to the user that some alternatives. This question should be resolved based on the nature of the event rather than the nature of the protection.

Protection Assessment

Using the B-NICE algorithm for biological, nuclear, incendiary, chemical, and explosive, it is possible to explore the conditions presented by each type of event and make some realistic assertions as to the type of protection which would be necessary.

In the case of simple incendiary and explosive, events, other than a typical hospital surgical mask or simple nuisance dust mask to filter out dust and surface contamination, there is little needed in respiratory protection. (We do add the caveat that a "simple" explosive device may contain radioactive material – a "dirty" bomb – which would require the appropriate type of respiratory protection.

Protection against biological and nuclear agents is simply a filtration process designed to stop the passage of particles in the micron range. Therefor, unless there is so much particulate contamination that it either clogs the filter, or builds up enough material on the filter media to create to a dangerous level of radiation, the requirements are fairly

[1] For a Tychem SL® suit with integral hood and booties.

[2] Based on Silvershield 4H® gloves

straightforward and easily met. This leaves chemical agents as the real issue to be resolved.

Chemical Protection

Most decisions on the selection of respiratory protection are based on the OSHA Respiratory Protection Standards (29CFR1910.134) which are the controlling standards. The following is the actual content of the applicable sections:

General requirements.
1910.134(d)(1)(I)
The employer shall select and provide an appropriate respirator based on the respiratory hazard(s) to which the worker is exposed and workplace and user factors that affect respirator performance and reliability.

1910.134(d)(1)(ii)
The employer shall select a NIOSH-certified respirator. The respirator shall be used in compliance with the conditions of its certification.

1910.134(d)(1)(iii)
The employer shall identify and evaluate the respiratory hazard(s) in the workplace; this evaluation shall include a reasonable estimate of employee exposures to respiratory hazard(s) and an identification of the contaminant's chemical state and physical form. Where the employer cannot identify or reasonably estimate the employee exposure, the employer shall consider the atmosphere to be IDLH.

Interpreting this section is relatively direct - identify the hazard, select the appropriate respirator, and make sure the respirator is NIOSH certified for the hazard. The most important item in this standard may be the citation in section 1910.134(d)(l)(iii): *"Where the employer cannot identify or reasonably estimate the employee exposure, the employer shall consider the atmosphere to be IDLH."*

Based on this section, if the atmosphere may be IDLH, then a much higher level of protection, as well as escape provisions are required.

Assessing the Atmosphere

Assuming a chemical agent is used the victims arriving at any hospital will fall into the following categories:

1. Deceased
2. Expectant
3. Moderately exposed
4. Lightly exposed
5. "Worried well"

Groups 1 & 5 pose no threat - they are either directed to a holding area for the morgue, or decontaminated even though they have no contamination[3]. This leaves the victims in categories 2 – 4 as the ones about which to be concerned. It is necessary, therefor, to determine the potential for persons in these categories to create a significant threat - whether by contact or through the off-gassing of the agent – to hospital workers.

A detailed review of literature on this subject produced a wide range of answers, with the recommendations weighing heavily on the side of fully encapsulated level A or level B suits with approved chem-bio masks. The masks most commonly cited include both traditional style "gas masks" with fitted

[3] In the typical projections, these "worried well" will outnumber the actual victims by a ratio of 4:1.

facepieces or hood style PAPR with appropriate filter cartridges. While these two options offer a high level of protection, the literature uniformly fails to deal with the issues of annual fit-testing, training, storing enough of the different sizes, and particularly in the case of the PAPR, the cost per unit.

Citing a reference from the CDC:

> *"Personnel caring for contaminated patients should be properly outfitted in PPE. Specific data to determine the appropriate level of hospital worker protection remains limited, and a recent extensive review on chemical and biological terrorism published by the Institute of Medicine is inconclusive on this issue.*

Further, even those references which are available do not discuss the actual conditions which limit the potential for significant exposure to hospital personnel from those patients who are contaminated, but at levels well below the LD threshold. After all, given the extreme toxicity of the nerve agents, any patient who arrives at the hospital in a viable condition cannot be heavily exposed or contaminated[4].

This is particularly true for Sarin which, because of its low viscosity – it is very close in physical properties to water – would rapidly pass through ordinary clothing. This may be less true of the "persistent" agents such as VX, which use thickening agents to decrease their evaporation rate, make them less soluble in water and increase the period of time during which they remain active. Even under conditions which would cause people to be heavily clothed, and even in the coldest climate, people still do not cover all of their skin completely, and would have exposure to the agent on unprotected skin.

The other aspect is that the nerve agent may produce vapors which van become entrained in clothing. Obviously, in the case of the heavily clothed victim, the more clothing, the more vapors might be entrained. These vapors do not adsorb on the clothing fibers and are readily released back into the atmosphere, exposing the victim to continued vapors even after they have been removed or fled from the scene. It is indicated that the vapors (provided there was no liquid contamination) would be entirely dissipated in approximately 30 minutes. Obviously, factors such as clothing bulk and fiber content, the level of the agent, conditions of temperature and humidity, and the activity of the victim would have an effect on this. Still, since the victim is continuously exposed to the vapors until they completely dissipate, ambulatory victims who self-present will very likely have clothing contamination levels which are far below any lethal or incapacitating threshold.

The lesson in this is that if a victim arrives at the hospital in a viable condition – especially if the victim is ambulatory – the level of contamination on the victim's clothing and/or skin would not be high enough to create an atmosphere which would be IDLH either through the evaporation of any residual liquid or from the release of residual vapors which might be entrained in the clothing. Making this possibility even more remote would be for receiving personnel to make certain that the victims' clothing is collected and contained in separate plastic bags and sealed to preclude a concentration of agent from a large number of small amounts, and that the bags are then

---

[4] It must be noted that the effects of exposure to sub-lethal levels of nerve agent vapors is not without risk and/or consequence.

removed to a location which is remote from the decontamination operations. Significantly, it is reasonable to assume that this would apply to sarin, the most volatile of the agents and, therefore, given the lower vapor pressure of other nerve agents and the blister/mustard agents, it would be even less likely for these to pose a significant respiratory hazard due to off-gassing.

Decisions

This still leaves the administrator with a question as to what level of respiratory protection to select. We offer the following guidelines for consideration:

1. First, consider where the decontamination would be taking place. If it is in an outside location, with relatively free - even if somewhat restricted air movement - the rate of air exchange will reduce the levels through mixing, dilution, and dissemination.

2. How close is the hospital to the site of the incident? If the victims would require more than 15 minutes to arrive by walking directly from the scene to the hospital, the level of entrained gaseous contamination will be significantly reduced, if not completely eliminated. Similarly, any liquid contamination will either evaporate, or will have penetrated the victim's clothing, rendering the person incapacitated or dead.

3. It may be assumed that victims transported by ambulance will have been field deconned before transport, as the ambulance personnel may not have PPE to protect themselves from contamination.

Taking these conditions into consideration there are several possibilities which might be considered.

First, the hospital may opt for the "traditional" approach using a full-face respirator or PAPR – either in a hood configuration or a face-piece design. The difficulty with any full-facepiece respirator is that the employee must be fit tested and given a respiratory fitness exam on an annual basis. The PAPR hood design does eliminate the fit-testing requirement, but can be a very expensive option (as previously state, a single unit may cost over $600.00), and requires regular maintenance and careful charging and cycling of batteries to insure it will work for a reasonable period when needed. On the positive side, these choices provide full freedom of movement and a high level of protection.

A second option, and one which may be far less costly, is the use of an airline supplied hood type respirator. If a supply of medical breathing air can be provided in or close to the decontamination area this would be a viable option. This system uses a chemical resistant hood connected to a low-pressure air hose fed by the hospital's breathing air compressor. The flow of air into the hood keeps and hazardous materials out, and helps to cool the worker. These system, provided the air supply is secure, provide the highest level of protection as the hood is always at a pressure higher than ambient, and even if a slight tear or puncture occurs, no material could infiltrate. The cost of these hoods is about $65.00 per unit, plus the cost of the air line, which might add an additional $100 - $125. In addition, the air supply from the hospital will most likely need to be piped to the area and connections for the desired number of workers provided. Even with all these costs,

it would be possible to protect 4 - 6 workers for the cost of only 2 PAPR units.

The third option is the use of a hood style respirator with a filtration system. These units as marketed as "escape" devices and designed primarily for emergency use to allow personnel to escape from a sudden attack or release of a chemical. *We must state that these hoods have not been evaluated for use in a response setting.*

Two manufacturers currently produce hoods which might be useable in the hospital decontamination setting - Mine Safety Appliances (MSA) and Draeger. Both units use essentially the same basic design, a hood which seals against the face and around the neck with an all-hazard filtration canister. At least one of these masks[5] has service times which indicate it would be more that adequate for use in a hospital response setting. The one consideration in the selection of these units is that they are more costly than the airline option (the MSA unit lists at $169.00, the Draeger at $190.00) and are non-reusable.

Conclusions

Because every aspect of a potential terrorist act can never be fully anticipated, it is difficult to make any absolute conclusions. We can only suggest that administrators consider the options given, consult with their suppliers, and decide what will provide a level of protection they are comfortable with. Of course, it is always prudent to err on the side of caution.

[5] MSA Response® Escape Hood canister mask MSA-10022208. NOTE as of the date of this report, this mask **had not** received NIOSH approval.