Abstract:
Although the principles of pediatric decontamination are similar as those for adults, the actual practice is much more challenging. The unique needs and vulnerabilities of children will require health care personnel to be sensitive to developmental stages of the victims and physiological hazards during decontamination. Unless medically indicated, families should undergo decontamination together. This article provides an overview of the need for decontamination and the process of decontamination for hospitals. Practical guidance on decontamination methods for children of different ages is presented. Recommendations for training and communication during decontamination are also reviewed.

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Principles of Pediatric Decontamination

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Since the 9-11 attack, there has been increased attention on disaster preparedness. First responders and first providers are now being trained to respond to disaster scenarios; however, there is little to no standardization in this training.[1] Although there has been much effort to consider children's needs during decontamination, best practices for pediatric decontamination have not been established. Even though children comprise 22% of the US population, there are few published reports detailing the appropriate medical needs, care, and decontamination of a child, of which none are based on scientifically rigorous studies.[2-4]

NEED FOR DECONTAMINATION

Chemical

The need for decontamination from chemical incidents or chemical terrorism has been well documented.[5] Decontamination is an essential early step in the mitigation of victim exposure to chemical and certain forms of radiological exposure. Proper training in decontamination will decrease the risk of secondary contamination to medical personnel, transport vehicles, and hospitals, in addition to improving the outcome of exposed victims.[6] If appropriate plans are not in place, the ability of the medical care system to remain effective during these events can be compromised when personnel, ambulances, and hospital emergency departments become contaminated. Although large-scale industrial incidents such as the methyl isocyanate toxicity[7] in Bhopal India in 1982 are rare, smaller scale incidents are common. Large-scale terrorist attacks have also occurred such as the Tokyo subway Sarin gas attack in 1995[8] and a nicotine-containing insecticide that was placed in ground beef in Grand

Rapids, Mich, in 2002. The latter affected more than 40 children, making this the largest chemical terrorism attack on children in the United States [9]. Children are a vulnerable population for a future attack because they regularly congregate together in schools and camps. Most of these locations have little to no security and are categorized by emergency planners as soft targets.[10] In addition, in the event of a mass casualty incident, children will be more vulnerable to psychosocial sequelae.

Radiological

Although decontamination is not useful for radioactive fallout from a nuclear bomb, decontamination will be necessary after exposure from a dirty bomb and the resultant spread of dust and other solid debris. Disrobing the patient will remove most of the dust, and thorough showering with water should remove all of the contamination. If the patient has a life-threatening injury, some authors believe that decontamination should be done after the patient has been stabilized;[11] however, this approach puts the trauma team at risk for radiation exposure. Depending on the radioactive substance, the time, and distance from the radioactive source, this exposure can be significant.[12] Currently, most institutions, to ensure the safety of hospital personnel and the hospital structure itself, recommend that all patients undergo decontamination before entering the facility regardless of the delay in definitive treatment. The only exception is if a specific and well-drilled strategy for victims of a dirty bomb exposure has been implemented before the incident.

Biological

In contrast to the previous sections, the role for decontamination from biological agents is minimal. This is due to the incubation period of many of the potential pathogens. Most patients will not present to a health care facility until days after the attack making decontamination unnecessary.[13] A possible exception might be acute aerosolized anthrax exposure in which the patient will be contaminated with spores.

PROCESS OF DECONTAMINATION

Decontamination is the removal or reduction of harmful substances from the victim's body. The goal of decontamination is to ensure that the toxic substance, whether chemical, biological, or radiological, is no longer in direct contact with the patient. This prevents further absorption by the patient and will decrease the possibility of transfer of the toxin to health care workers.[14] The military model of 3 zones—hot, warm, and cold—is now used throughout the country by local emergency medical services and HAZMAT (hazardous materials) teams.[15] The hot zone is where the incident occurred and therefore poses the greatest risk for coming into contact with dangerous toxins solid, liquid, or gaseous. Rescuers entering the hot zone typically need the highest level of personal protective equipment (PPE) available—level A. Level A protection includes a chemical-resistant splash proof suit combined with a self-contained oxygen supply. Level A apparatus will protect the rescuer against all solids, liquids, vapors, aerosols, and gases. A list of all levels of PPE is shown in Table 1.

There is little dexterity for rescuers wearing these suits. In the United States, only the most basic lifesaving treatments such as airway opening, hemorrhage control, and antidote therapy (eg, Mark 1 kits) may be performed in a hot zone.[14] Many disaster response systems will not provide even this level of care until the victim has been removed from the hot zone and decontaminated. Other countries, such as Israel, regularly practice and perform more extensive rescue tasks in full PPE.[16]

The only prehospital multicasualty triage system that incorporates the unique differences of children is the JumpSTART algorithm.[17,18] JumpSTART's objectives are 3-fold: to optimize the triage of injured children in a multicasualty setting, to improve resource allocation for all victims, and to decrease the emotional burden of triage personnel. Neither JumpSTART nor any other mass casualty incident triage system has been clinically or scientifically validated; however, this is the system in use in most areas of the country today. The JumpSTART algorithm is shown in Figure 1.

In theory, all patients should be decontaminated on scene; however, it is well described in the literature that many victims will bypass decontamination at the scene and self-present to hospitals.[19] Therefore, each hospital must have their own system for decontamination of potential victims.

In planning for such an event, it is generally assumed that the hospital will not be the site of the initial incident. Although victims may present to the hospital within minutes of the incident occurrence, they will have traveled some distance from the primary site. Whatever exposure the patient received, the hospital health care worker in theory should receive far less.[20] The hospital “hot zone” is in reality a “warm zone” with a lower risk of secondary contamination than that of the site of the primary incident. Thus, recommendations for PPE for

TABLE 1. Levels of PPE.

Level	Description	Types of Materials Protection Against	Advantages	Disadvantages	Possible Scenarios
	Fully encapsulated suit with self-contained breathing apparatus	Gases, vapors, aerosols, liquids, solids	Highest level of protection for inhaled and contact toxins	High-training requirements, expensive, physical demands, poor mobility, limited air supply	Prehospital hot zone that has toxic gas or vapor, oxygen poor environment
	Encapsulated suit with seams sealed, self-contained breathing apparatus outside suit or supplied air respirator	Vapors, aerosols, liquids, solids	High level of protection, supplied air improves mobility, fit testing needed	High-training requirements, expensive, physical demands, dependence on air line or limited air supply	Prehospital warm zone that has toxic solids and liquids and may have toxic gases
	Chemical-resistant splash suit with PAPR	Vapors, aerosols, liquids, solids	High level of protection, improved mobility, decreased expense and training requirements lower physical demands, no fit testing needed	Not adequate for high concentrations of toxic gases or high levels of splash	Hospital hot zone where toxins are liquid, solid, or low concentrations of vapors
	Normal work clothes, gowns, gloves, eye/face shields	Minimal for solids	Full mobility, full operational time , low physical stress, low training level and expense	Little to no protection against chemical or other toxins	Hospital cold zone after patient fully decontaminated

Pictures from www.wnysmart.org.

hospital-based decontamination are less restrictive—level C.[21] Level C includes a chemically resistant suit, boots, and gloves as well as a powered air-purifying respirator (PAPR). The PAPR is battery powered and contains 3 double-layer filters—one high efficiency particulate air (HEPA) and one chemical. Because there is no oxygen tank, the PAPR weighs much less than a level A breathing apparatus.

Patients will be decontaminated to lessen the severity of their symptoms. By the JumpSTART triage system, red victims should be decontaminated first, followed by yellow victims and, lastly, green victims. Black-tagged patients should not be decontaminated until all survivors have been treated. Families should not be separated unless there is a medical necessity. Keeping a parent or regular caregiver with children during an mass casualty incident will help to reduce the psychological stress for children and will also decrease the resources the hospital would otherwise have to deploy for decontamination and postdecontamination care. Simply having the patient undress will remove up to 85% of the contaminants.[5] Children will be hesitant to disrobe in the presence of strangers. Even with a parent, the process of disrobing a frightened, unwilling child may take longer than expected, particularly toddlers.[22] Using a hospital worker of the same sex as the child during the undressing process may make the child more comfortable and decrease the time the task takes to accomplish.[23] The clothes and any valuables (wallets, cell phones, iPods, and jewelry) should be placed in labeled bags, so they can be returned to the patients if the contamination is unfounded or the agent is not dangerous.

Once the patients have disrobed, they should immediately enter a decontamination shower. Water is the decontamination solution of choice due to its ease of availability. Some exceptions are contamination with sodium, potassium, cesium, lithium, and certain concentrated acids;[14] however, it is rare that the agent is identified before decontamination will

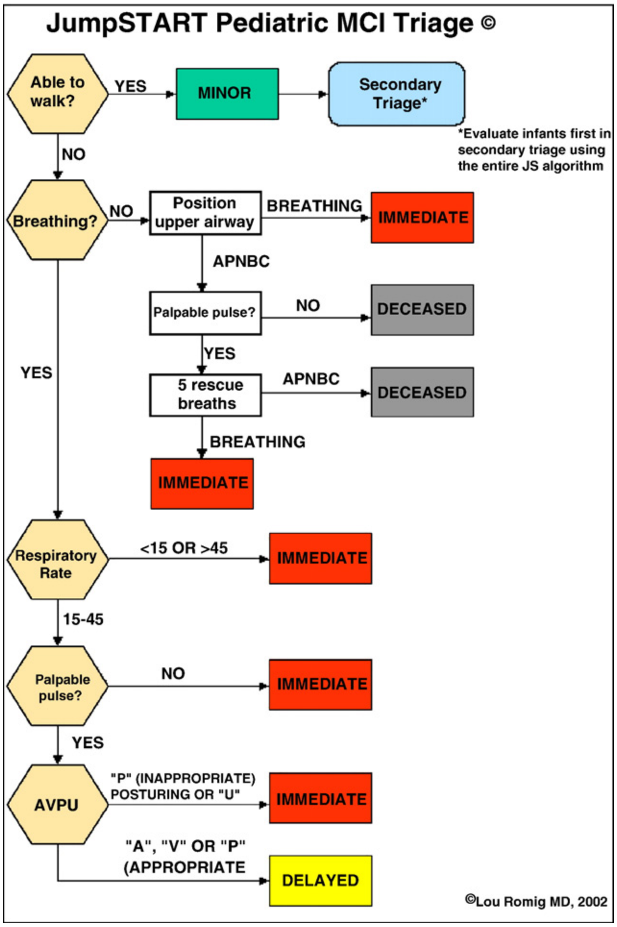

FIGURE 1. JumpSTART prehospital pediatric mass casualty triage algorithm.[39]

take place. Alkali soap has been suggested to improve removal of some toxins from the skin; however, its efficacy has not been proven.[15] A potential advantage of using soap is that the suds will remind the patient to rinse all areas of their body and hair. A disadvantage of soap is that it can get in the patient's eyes or cause mild skin reactions. There is no clear consensus on whether soap and water are superior to water alone. Dilute bleach has also been suggested to aid in the removal of certain skin contaminants; however, bleach cannot be used near the eyes or on mucous membranes; it may irritate the skin and be systemically absorbed if the skin barrier is compromised significantly.[24]

The recommendation for the duration of showering was set by Occupational Safety and Health Administration in 2004.[25] They suggest a 5- to 6-minute shower; however, this recommendation was based on opinion of experts and not on actual data. A retrospective, hospital-based decontamination protocol demonstrated that a 3-minute shower was adequate for external decontamination.[26] Symptomatic patients should have a longer shower than asymptomatic patients do because they may have been exposed to a higher dose of the toxin. Ideally, water temperature should be 98°F.[22] Although colder temperatures may cause peripheral vasoconstriction, thereby decreasing absorption of toxins, it may also induce hypothermia in pediatric patients.[27] The risk of hypothermia is exacerbated in children due to their increased surface area to body mass ratio. Another variable is water pressure. The water pressure in most showers is sufficient to clean the skin without being painful. Very high-volume showers should have adjustable flow handheld sprayers to decrease the water pressure to no more than 60 psi (413 kPa) so as not to injure children.[5] Young children, infants, or any child that cannot protect their own airway will need to be hand sprayed or have their airway closely monitored and protected.

Some hospital centers may have different options on shower devices. The decision to “set up the tent” or just use hoses with hand sprayers or preexisting regular shower rooms will be determined by the overall patient volume. Including extra time to disrobe, one should plan on a minimum of 10 minutes per child. This estimate includes the 5 minutes spent in the decontamination shower. Ideally, wait time should be no more than 1 hour to minimize ongoing exposure and confusion in the crowd. If the ambient temperature is warm and there are privacy ponchos available, children may disrobe in advance of entering the shower to increase throughput time.

Children who need to undergo decontamination should be categorized into nonambulatory or ambulatory groups. Nonambulatory children of any age will be disrobed by “hot zone” staff, placed on a stretcher, and escorted through the shower or hand sprayed. Hospital personnel should ensure the child's airway remains patent during decontamination because the child will be unable to protect his or her own airway. This is a particular concern for immobilized children in a cervical collar.

The ambulatory children should be further broken down by age groups: 8-18, 2-8, and 0-2 years.[22] The 8- to 18-year age group should be able to self-disrobe and function independently through the shower. They should also be grouped by sex for modesty issues. The 2- to 8-year olds will likely need assistance in disrobing (this should be done by caregivers if at all possible) and will need supervision from hot zone workers to thoroughly decontaminate themselves. This age group will often need extra time to disrobe and be coaxed into the shower. Children younger than 2 years should be disrobed by a caregiver or, if none present, by hot zone hospital personnel. They should then be placed on a stretcher or a container with apertures to allow fluid drainage. This prevents the potential risk of dropping them during the process. It also allows caregivers to adequately decontaminate themselves without holding the child. A hot zone worker should accompany this age group through the shower to ensure that the infants' airway remains secure and that they are completely washed. Developmentally delayed children are another subgroup that will require extra time to disrobe and may be fearful of the decontamination process. If a caregiver is present and able, they should assist the child through the entire process of decontamination. If no caregiver is present and there are multiple developmentally delayed victims, additional staff will be needed in the hot zone to assist these children. An algorithm for decontamination of pediatric patients is shown in Figure 2.

For small-scale disasters, everyone should be able to be decontaminated without a considerable wait. It is likely that the hot zone team will not need relief before they complete their task for small scale

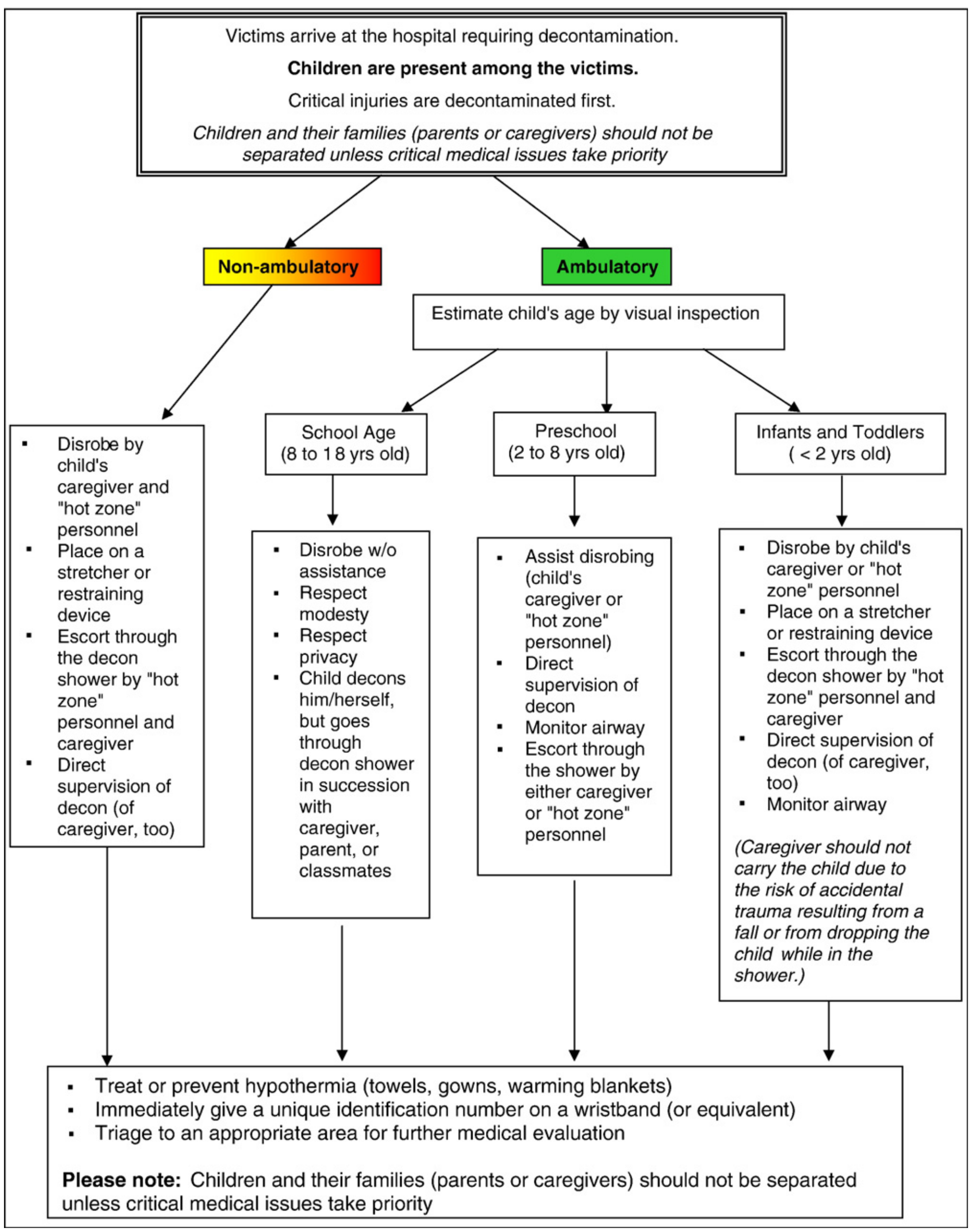

FIGURE 2. Algorithm for decontamination of pediatric patients.

events. For larger scale disasters, issues of crowd control and waiting time until decontamination become important concerns. At the recommended duration of 5 minutes per patient, that translates to 12 patients per hour for each shower head available.

For a disaster involving several hundred victims, this process may take hours to complete. Children may become impatient and disrupt the process. Also, rescuer fatigue and heat exhaustion will become evident necessitating switches in hot zone hospital personnel.[25] Personnel relief recommendations vary between 30 minutes to 2 hours depending on ambient temperature, physical fitness of rescuer, and the amount of exertion required. Because most contamination will be on clothing, if there will be a prolonged wait for the decontamination, children should be given a privacy poncho in the hot zone and encouraged to disrobe ahead of time, weather factors permitting. This will minimize the child's risk while they wait and speed overall throughput through the showers.

Decontamination of children who are equipment dependent, such as ventilators, pose an additional problem because these devices are not designed for excessive contact with water. If the patient is asymptomatic, there is little likelihood that the ventilator is significantly contaminated. It should be visually inspected for solid or liquid foreign bodies. A Geiger counter can be used to assess for radioactivity. If no visible contamination is found, it is safe to use. This may be helpful if there is a shortage of ventilators during a crisis. If there is doubt about the device, it is best to leave it in the hot zone and use a hospital ventilator. If the patient is symptomatic, the device should be assumed to be contaminated and remain in the hot zone. Other devices such as hearing aides or insulin pumps should follow a similar strategy. Eye glasses may be washed in the shower with the patient. Most prosthetic limbs are able to get wet and thus can be removed, thoroughly decontaminated along with the patient, and returned in the cold zone.

The physical layout of the hospital decontamination area should be optimized to maximize the overall speed of patient decontamination while taking into account a number of considerations:

- There should be a separate entrance and exit, so "hot" patients do not recontaminate patients who have already gone through the shower.
- The shower should be as close as possible to the resuscitation area of the hospital (the patients will be unclothed and wet making hypothermia a concern in cold weather environments).
- Male and female patients should be grouped separately through the shower to afford modesty and minimize embarrassment with the exception of keeping a caregiver with a child.
- Antechamber rooms where the patient can undress with some privacy prior to showering and be covered with a sheet, blanket, or towel upon exiting the shower, are useful but not mandatory.

For best results, hospitals should try to follow the above guidelines as closely as possible, understanding that most decontamination areas are retrofitted to an existing hospital footprint.

Once victims are decontaminated by hospital hot zone personnel, they must be retriaged in the hospital because their condition may have changed. This triage must be quick and accurate. There is a tendency to overtriage children, which can potentially misallocate already strained hospital resources.[28] Hospitals can either use the 3-tiered jumpstart algorithm or a 2-tiered system.[29] The 2-tiered system incorporates 2 forms of triage: a rapid visual assessment to quickly identify the sickest patients, followed by a more detailed triage assessment.[30] These detailed assessments will include a more involved physical examination and pertinent history taking. There will always be changes in triage status of patients because of triage error (mostly overtriage but some undertriage) and progression of disease state. Awareness of changes is vital to utilization of emergency department resources.[30]

Challenges and Recommendations

During mass casualty scenarios, it is optimal that at least 1 member of the hot zone team have pediatric clinical experience. A physician or nurse capable of recognizing respiratory distress, shock, or an evolving toxicological syndrome in a child is best.[21] The rest of the decontamination personnel can be nonclinical hospital staff who have received the necessary training. Unless the event is a large, ongoing disaster, the use of trained volunteers will be impractical because patients will start arriving before volunteers can be called.

Hot zone workers should be replaced frequently because working in a PPE suit is tiring and exposes the individual to heat exhaustion, particularly in warm climates. Recommendations vary depending on the exertion level, ambient temperature, and physical fitness of the hot zone worker. Most recommendations for hospital hot zone workers wearing level C protection are between 20 to 60 minutes.[21] A designated person in the cold zone triage area should be monitoring the amount of time each worker has spent in a decontamination suit, switching personnel as needed.

Planning for large-scale disasters is challenging and generally impractical. It would have been difficult to drill to evacuate the entire city of New Orleans before Hurricane Katrina. There are guidelines for smaller scale disasters. The Joint Commission has set emergency preparedness standards for hospitals throughout the United States, including the expectation that they hold disaster drills for the benefit of the community.[31] Hospitals must test their emergency management plans at least twice per year including 1 drill per year.[32] Despite this mandate, there is no set curriculum that hospitals use to train for disasters and no mandate by Joint Commission to conduct and include a pediatric mass casualty drill. Different training formats include disaster drills, tabletop sessions, technology-based sessions, skills sessions, and classroom lectures. A meta-analysis by Hsu et al[33] in 2004 evaluated different training methods. Hsu et al were able to demonstrate that drills were useful for finding flaws in hospital disaster plans. These areas included incident command, communications, triage, patient flow, materials/resources, and hospital security. There were insufficient data to make valid recommendations on other training methods. In a later study, Hsu et al[34] created a list of 7 core competencies for disaster training derived from an expert panel. The core competencies are as follows:

1. Recognize a potential critical event and implement initial action.
2. Apply the principles of critical event management.
3. Demonstrate critical event safety principles.
4. Understand the institutional emergency operations plan.
5. Demonstrate critical event communications.
6. Understand the incident command system and your role in it.
7. Demonstrate the knowledge and skills needed to fulfill your role during a critical event.

Despite having identified these core competencies, a meta-analysis by Williams et al[35] found that there is insufficient evidence to determine effective training interventions for hospital-based health care providers.

Some hospitals have used multimodality course training. Participants in these courses had increased knowledge on a posttest compared with a pretest; however, there are no data on knowledge retention or if this translates into improved performance during an actual disaster.[36] A smaller study on training for pediatric disaster victims used lectures and table top exercises[37] These investigators demonstrated increased retention of knowledge during a 6-month period.[37] In view of the previous discussion, all emergency department personnel (physicians, nurses, ancillary workers) should receive training in decontamination. The training should be both knowledge based (reasons for decontamination) and practice based (how to prepare for the hot zone). A minimum of 2 hours of training time is needed to assess risks and become familiar with the equipment. This training should be repeated every 6 months. There is often little to no warning before disaster events, so “just in time” training is impractical in this setting and may endanger the health care provider because they will be entering a potentially dangerous area (hot zone) with little training and no practice.

Communication during a disaster is vital to assure optimal outcomes. Although there are data on the effectiveness of telephone chains to alert physicians about a disaster,[38] there are few published data on communication strategies for pediatric decontamination. For provider-to-provider communication from hot zone to cold zone, there are 2 possible modalities. The first is by radio signal. There are many different models and manufacturers for these devises. The most efficient, but perhaps the most expensive, is a voice-activated throat microphone with an earpiece receiver. This has the least likelihood of becoming displaced while wearing a PAPR hood. The next best setup is a microphone connected to an earpiece that is worn under the PAPR. The microphone is activated by a large button that is worn on the chest under the splash suit. The relative disadvantages with this device type are that users will need to use their hands to talk and the headset can get displaced under the PAPR. This type of setup can be secured to the rescuer's head with an additional strap to decrease the chance of displacement. The second modality of communication is through the use of simple hand signals. For example, a palm held up vertically would mean stop. The advantage of this technique is that there is no dependence on technology that can potentially malfunction. The disadvantage is that it requires the use of one or both hands, thereby limiting communication to simple commands.

Patient communication with a rescuer wearing a PAPR is quite difficult. Powered air-purifying respirators–deaden sound, making all communication challenging. This is further exacerbated by the noisy, chaotic environment. In addition, children will not always get to see the rescuer's face, which may increase their anxiety. A bullhorn may be used to amplify one's voice over a wider area. Whenever possible, the rescuer should kneel down to the patient's eye level to maximize a verbal exchange.

A summary of key points is as follows:

- The smaller the child, the bigger the problem. Many children will be fearful of a shower and resist disrobing. Extra personnel and time will be needed to effectively manage a large group of children.
- Separation of families should be avoided, but medical issues take priority (eg, red parent and green child).
- Do not assume that parents or caregivers can decontaminate both themselves and their children at the same time. They will need assistance by hot zone personnel.
- It is recommended to have both male and female hot zone personnel to assist older children who may have modesty issues.
- Airway management through the shower is a priority. To help prevent asphyxia or drowning, handheld hose sprayers (large volume, low pressure) should be incorporated into hospital decontamination showers. These child-friendly devices may also decrease young children's fear of the process.
- Children are especially prone to hypothermia. Ensure that the shower temperature is at least 98°F. Once they are through the decontamination shower, they must be immediately covered with sheets, blankets, or a Mylar wrap and brought into the hospital.
- As soon as the patients exit the decontamination shower, a band with a unique hospital identification number must be placed on the patients to facilitate tracking during their hospital stay.
- As patients are medically cleared, they must be kept in a child-friendly environment (pediatric safe area) that is supervised by staff knowledgeable about pediatric issues such as social workers or child life specialists. Reunion of unaccompanied children with family members should occur here. Strict documentation is required to ensure that pediatric victims are released to the appropriate legal caregiver. Depending on the scale of the disaster, this process may take hours or days.
- After the event, pediatric victims will need to be evaluated for long-term psychological issues such as posttraumatic stress disorder. At the time of discharge, a list (with telephone numbers) of practitioners or hospital clinics should be given to each family because psychological trauma may not manifest itself immediately but may become a significant issue for the patient and family in the future.

REFERENCES

1. Phelps S, Doering G. The performance-level model of hospital decontamination preparedness. Am J Disast Med 2008;3: 157-63.
2. National Center for Disaster Preparedness. Pediatric preparedness for disasters and terrorism: a national consensus conference. Executive Summary 2003. Available at: http://www.bt.cdc.gov/children/pdf/working/execsumm03.pdf Accessed 1 March 1, 2009.
3. American Academy of Pediatrics. Academy testimony on children and terrorism, before the Senate Committee on Health, Education, Labor, and Pensions, presented by Joseph L. Wright, MD. Available at http://www.aap.org/advocacy/washing/Dr._Wright.htm Accessed March 1, 2009.
4. Institute of Medicine Committee on the Future of Emergency Care in the United States Health System. Emergency care for children: growing pains. Washington, DC: The National Academies Press; 2007.
5. American Academy of Pediatrics. Chemical-biological terrorism and its impact on children. Pediatrics 2006;118: 1267-78.
6. Horton DK, Orr M, Tsongas T, et al. Secondary contamination of medical personnel, equipment, and facilities resulting from hazardous materials events, 2003-2006. Disast Med Pub Health Prepared 2008;2:104-13.
7. Mehta PS, Mehta AS, Mehta SJ, et al. Bhopal tragedy's health effects. A review of methyl isocyanate toxicity. JAMA 1990; 264:2781-7.
8. Okumara T, Takasu N, Ishimatsu S, et al. Report on 640 victims of the Tokyo subway Sarin attack. Ann Emerg Med 1996;28:129-35.
9. Center for Disease Control and Prevention. Nicotine poisoning after ingestion of contaminated ground beef: Michigan, 2003. MMWR 2003;52:413-6.
10. Graham J, Shirm S, Liggin R, et al. Mass-casualty events at schools: a national preparedness survey. Pediatrics 2006;117: e8-e15.
11. Mettler FA, Voelz GL. Major radiation exposure—what to expect and how to respond. N Engl J Med 2002;346: 1554-61.
12. Smith JM, Ansari A, Harper FT. Hospital management of mass radiological casualties: reassessing exposures from contaminated victims of an exploded radiological dispersal device. Health Phys 2005;89:513-20.
13. USAMRIID. Medical management of biological casualties handbook, 6th ed.; 2005, Available at http://www.usamriid.army.mil/education/instruct.htm. Accessed March 1, 2009.
14. Houston M, Hendrickson RG. Decontamination. Crit Care Clin 2005;21:653-72.
15. Brennan R, Waeckerle J, Sharp T, et al. Chemical warfare agents: emergency medical and emergency public health issues. Ann Emerg Med 1999;34:191-204.

16. Adini B, Goldberg A, Laor D, et al. Assessing levels of hospital emergency preparedness. Prehosp Disast Med 2006;21:451-7.

17. Romig LE. Pediatric triage. A system to JumpSTART your triage of young patients at MCIs. J Emerg Med Serv 2002; 27 (7): 52-8, 60-3.

18. The JumpSTART pediatric MCI triage tool. Available at http://www.jumpstarttriage.com Accessed March 2, 2009.

19. Greenberg MI, Hendrickson RG. Report of the CIMERC/Drexel University emergency department terrorism preparedness consensus panel. Acad Emerg Med 2003;10:783-8.

20. Levitin HW, Siegelson HJ, Dickinson S, et al. Decontamination of mass casualties—re-evaluating existing dogma. Prehosp Disast Med 2003;18:200-7.

21. Hick JL, Hanfling D, Burnstein JL, et al. Protective equipment for healthcare facility decontamination personnel: regulations, risks, and recommendations. Ann Emerg Med 2003;42: 370-80.

22. Freyberg CW, Arquilla B, et al. Disaster preparedness: hospital decontamination and the pediatric patient—guidelines for hospitals and emergency planners. Prehosp Disast Med 2008;23:166-73.

23. Chur-Hansen A. Preferences for female and male nurses: the role of age, gender and previous experience—year 2000 compared with 1984. J Adv Nurs 2002;37:1928.

24. Decontamination. Medical management of chemical casualties handbook. 3rd edition. Aberdeen Proving Ground (MD)7 Chemical Casualty Care Division, US Army Medical Research Institute of Chemical Defense (USAMRICD); p. 175– 193, 2000.

25. Occupational Safety and Administration (OSHA). Best practices for hospital-based first receivers of victims from mass casualty incidents involving the release of hazardous substances. Washington DC7 Occupational Safety and Health Administration (OSHA); 2004. p. 1-32. http://www.osha.gov/dts/osta/bestpractices/firstreceivers_hospital.html.

26. Torngren S, Persson S, Ljungquist A, et al. Personal decontamination after exposure to simulated liquid phase contaminants: functional assessment of a new unit. J Toxicol Clin Toxicol 1998;36:567-73.

27. Clarke SF, Chilcott RP, et al. Decontamination of multiple casualties who are chemically contaminated: a challenge for acute hospitals. Prehosp Disast Med 2008;23:175-81.

28. Maldonado T, Avner JR. Triage of the pediatric patient in the emergency department: are we all in agreement? Pediatrics 2004;114:356-60.

29. Triage "Pediatric Terrorism and Disaster Preparedness: A Resource for Pediatricians." American Academy of Pediatrics AHRQ Publication No. 06-0056-EF. Rockville (Md): Agency for Healthcare Research and Quality; 2006.

30. NYC DOHMH Pediatric Disaster Advisory Group. Pediatric tool kit: hospital guidelines for pediatrics in disasters. NYC DOHMH Bioterrorism Hospital Preparedness Program Centers for Bioterrorism Preparedness. Pediatric Task Force, 2nd ed.; 2006.

31. Joint Commission on Accreditation of Healthcare Organizations. Comprehensive accreditation manual for hospitals: the official handbook. Oakbrook Terrace (Ill): Joint Commission Resources; 2003. p. EC-9.

32. Joint Commission on Accreditation of Healthcare Organizations. Comprehensive accreditation manual for hospitals: the official handbook. Oakbrook Terrace (Ill): Joint Commission Resources; 2003. p. EC-21.

33. Hsu EB, Jenckes MW, Catlett CL, et al. Effectiveness of hospital staff mass-casualty incident training methods: a systematic literature review. Prehosp Disast Med 2004;19:191-9.

34. Hsu EB, Thomas TL, Bass EB, et al. Healthcare worker competencies for disaster training. BMC Med Educ 2006;6: 19-28.

35. Williams J, Nocera M, Casteel C, et al. The effectiveness of disaster training for health care workers: a systematic review. Ann Emerg Med 2008;52:211-22.

36. Collander B, Green B, Millo Y, et al. Development of an "all-hazards" hospital disaster preparedness training course utilizing multi-modality teaching. Prehosp Disast Med 2008; 23:63-7.

37. Behar S, Upperman JS, Ramirez M, et al. Training medical staff for pediatric disaster victims: a comparison of different teaching methods. Am J Disast Med 2008;3:189-99.

38. Goldman M, Anderson T, Zehtabchi S, et al. Testing hospital disaster communication plan has immense value. Disast Manage Resp 2007;5:27.

39. Pediatric Disaster Toolkit. Hospital Guidelines for Pediatrics during Disasters 2nd ed. 2006. p. 69. http://www.nyc.gov/html/doh/html/bhpp/bhpp-focus-ped-toolkit.shtml.