Pediatric Emergency Medicine Reports

The Practical Journal of Pediatric Emergency Medicine

Volume 18, Number 5 / May 2013 www.ahcmedia.com

Author:

Kristin M. Kim, MD, PhD, Pediatric Emergency Medicine Consultant, Clinical Instructor, Emergency Medicine and Pediatrics, Mayo Clinic, Rochester, MN.

Peer Reviewer:

Taryn R. Taylor, MD, FAAP, FACEP, Assistant Professor of Pediatrics and Emergency Medicine, Emory University School of Medicine, Atlanta, GA.

Statement of Financial Disclosure

To reveal any potential bias in this publication, and in accordance with Accreditation Council for Continuing Medical Education guidelines, we disclose that Dr. Dietrich (editor), Dr. Skrainka (CME question reviewer), Dr. Kim (author), Dr. Taylor (peer reviewer), Ms. Mark (executive editor), and Ms. Hamlin (managing editor) report no relationships with companies related to the field of study covered by this CME activity.

AHC Media

Disaster Planning in the Pediatric Emergency Department

No one wants to believe that a pediatric mass casualty incident will occur where they live and work, but, unfortunately, the recent events in Boston have shown that this is a very real possibility. In the event an incident occurs, preparation, response, and management of all of the victims, including the children, are critical and will define the future for each of the victims. The author reviews the basics for preparation and steps to recognize, prepare, and maximize the possibility of a good outcome in the event of a pediatric disaster.

— Ann M. Dietrich, MD, Editor

Introduction

The prospect of a pediatric mass casualty incident is one of the most horrifying possibilities emergency medicine faces. Unfortunately, pediatric disasters can and do occur around the world and in the United States. The earthquake in Sichuan, China, in 2008 caused the collapse of approximately 7,000 schools, injuring and killing thousands of people, including about 8,000 children.[1] Hurricane Katrina hit the U.S. gulf coast and caused chaos with a breakdown of public services and daily life, with approximately 400,000 people displaced. Five thousand children were separated from their families. The last child was reunited with family members 6 months later.[2] In Beslan, Russia, terrorists attacked a school, holding more than 1000 people hostage, 700 of whom were children. The rescue attempt failed and more than 330 people were killed, including more than 100 children. At least 400 people were hospitalized, including more than 200 children.[3] The recent mass shooting at an elementary school in Connecticut killed 26 people, 20 of whom were young children.[4]

The question is not whether another disaster involving children will occur, but when and where it will occur. No city or region is exempt from disasters, and they often come with little or no notice. Appropriate and adequate planning and preparation can mitigate further harm when a disaster occurs and ensure timely, organized delivery of medical care.

Many regulating bodies, including the Centers for Medicare and Medicaid Services (CMS) and The Joint Commission, require hospitals to have emergency plans and conduct disaster drills. Unfortunately, children have often been relegated to "special population" status in disaster planning. This minimizes the importance of the 24% of the U.S. population that is younger than 18 years of age.[5] Indeed, children are at higher risk of injury than adults, both from the disaster as well as from the response phase due to multiple physiologic, developmental, and social reasons. Disaster planning in emergency departments, hospitals, and local communities must include pediatric-specific plans.

This review seeks to provide an understanding of the basics of emergency medicine disaster planning, with a particular emphasis on planning for pediatric patients. The general principles of disaster planning regarding emergency medicine will be covered. Pediatric patients are at particular risk from mass casualty

Executive Summary

- Disaster planning can be divided into five phases: 1) planning; 2) preparation and practice; 3) disaster response; 4) recovery; and 5) review.
- Plans should be coordinated across local community resources, including Emergency Medical Services (EMS), fire, law enforcement, public health, and hospitals, as well as schools and other institutions.
- A more compliant thoracic wall and less developed abdominal musculature place children at higher risk for intrathoracic and abdominal injuries from blast or blunt trauma.
- In a mass casualty situation with mass exposure to weaponized chemicals such as nerve gases, combined auto-injectors are likely the best method to distribute antidotes but are unavailable in pediatric sizes.

incidents because they have different physiology, developmental stages, and social roles. This article will discuss responses and planning for specific threats, including hazardous chemical exposures, radiation and radioactive exposures, and biologic warfare agents. Children are at risk both at the time of the incident as well as in the aftermath and recovery phase. This article will offer strategies to mitigate this danger. At the end of this review, the reader should have a good understanding of the basics of disaster planning for mass casualty incidents affecting the one-quarter of the population younger than 18 years of age.

Disaster Planning Basics

Most experts recommend an all-hazards approach to disaster planning.[4,6] This allows for preparation for a wide range of events and the flexibility to respond when the disaster changes. Disaster planning can be divided into five phases: 1) planning; 2) preparation and practice; 3) disaster response; 4) recovery; and 5) review. The planning phase should include a careful assessment of risks faced in the local community and region. Risk assessment should guide planning but not limit it. Plans should be coordinated across local community resources, including Emergency Medical Services (EMS), fire, law enforcement, public health, and hospitals, as well as schools and other institutions. For non-pediatric hospitals, local resources for pediatric expertise, transfer agreements, and plans to shelter in place should be identified.

The preparation phase should include training for staff, testing of procedures and the plan, and obtaining needed supplies. Ongoing procurement plans should be included to allow re-supply during any prolonged disaster. Pediatric materials must be included, such as diapers, formula, clean water, child-friendly meals, and safe bedding, including cribs or toddler cots. Drills must occur to ensure that the plans will meet the needs of the community during diverse disasters. It is crucial that routine drills assess pediatric-specific responses with inclusion of pediatric "victims."

The response phase begins when a disaster actually occurs. The initial response to the disaster employs pre-existing procedures and plans. As the incident develops, these existing procedures may need to be modified to respond to the specific threat and situation. Use of the Incident Command System (ICS) will aid coordination between fire, EMS, law enforcement, and health care responders. ICS allows a unified and coordinated response from diverse agencies. The ICS command structure should be delineated in the planning and preparation stage. The response will likely require flexibility, and additional outside resources from state or regional sources may be needed. The delay in outside resources may be considerable, and communities should plan to stand alone for at least 24-48 hours.

The recovery phase involves returning the community to normal status and a re-assessment of current resources. This is typically the longest phase of most disasters and may require diverse tasks, including rebuilding infrastructure for both basic community needs and medical facilities. It likely will require ongoing medical, psychiatric, and social care of victims and survivors. Timely completion of an After Action Report (AAR) gathers information and lessons learned. The AAR can help the local community to plan for the next event as well as allow others to learn from the experience. After a disaster actually happens and recovery and response phases are over, review of the efficacy of the previous procedures and plans is useful. This data can be used to prepare more effectively for the next disaster, both locally as well as to provide valuable "lessons learned" for others as they improve their response plans. (*See Table 1.*)

Pediatric Considerations

Children are affected by both natural disasters and mass casualty incidents. Indeed, they are at particularly high risk of injury from hazardous materials exposures, bioterrorism, chemical warfare agents, and mass casualty incidents. Differences in children's physiology, size, developmental stages, and social roles impact how they are affected in both the acute phase of a disaster and in the recovery from such an event. These differences should guide the planning and preparation phases of emergency planning.

The simple fact that children are smaller and shorter than adults puts them at higher risk from many disasters. Many toxic gases are dangerous

precisely because they are heavier than air and remain near the ground. Children may receive a larger dose of such gases, as they are located closer to the ground than adults. Their increased surface area to weight ratio means that they may absorb an increased dose per weight of toxic substances through their skin. This is particularly exacerbated by increased absorption per surface area because of the thinner epidermis in children.[7,8] Thinner skin may also place children at increased risk of both thermal and chemical burns.

Because young children are crawling on the ground and often pick up objects from the ground, they are at higher risk of ingesting and contacting particulate contaminants or radioactive particles. In blast or projectile injuries, their smaller size means that vital organs are spatially closer together and they are more likely to have multiple organs injured.[9] A more compliant thoracic wall and less developed abdominal musculature also place children at higher risk of intrathoracic and abdominal injuries from blast or blunt trauma. Because of their relatively larger heads, in a blast or projectile mass casualty incident, children are more likely to present with head injuries.

Even small doses of a toxin may be dangerous to children, as they receive a proportionally larger dose per body weight. Antidote dosing and administration in smaller children can be difficult for responders who are uncomfortable with pediatric weight-based dosing.[10,11] In a mass casualty situation with mass exposure to weaponized chemicals such as nerve gases, combined auto-injectors are likely the best method to distribute antidotes but are unavailable in pediatric sizes.[12] Atropine auto-injectors do exist in pediatric sizes; however, they do not include the 2-PAM agent needed to prevent the "aging" of the agent. Hypovolemia and shock may occur earlier due to bleeding or fluid losses from diarrhea or vomiting.[10,11] Children also may have more difficulty regulating body temperature if left exposed to the elements during recovery or search periods.

Table 1. Five Phases of Disaster Planning

1. Planning: Careful assessment of the risks faced in the local community and region
2. Preparation: Training for staff, testing of procedures and plan, obtaining needed supplies
3. Response: Initial response to a disaster that employs existing procedures and plans
4. Recovery: Returning the community to normal status and re-assessment of current resources
5. Review: Evaluate how well the preparations and plans worked during the actual disaster. Revise if needed and share lessons learned with others.

Increased metabolic rates and demands place children at risk in mass casualty incident situations. Children's increased respiratory rate can cause increased absorption and deposition of vaporized or gas phase toxins or caustic substances. Many toxins and biologic weapons affect children more quickly due to increased metabolic demands compared to adults. Asphyxiants can quickly impair children who have significantly lower oxygen reserves. Increased secretions from cholinergics, caustics, or biologic weapons cause increased respiratory distress due to smaller airways and decreased respiratory reserve.[11,13,14] Children's ability to maintain blood pressure until impending circulatory collapse may lead to inappropriate under-triage if medics and caregivers are not cognizant of pediatric signs of shock such as behavioral changes, tachycardia, and perfusion.

Developmental differences can be challenging to caregivers and can place children at increased risk of injury. Infants and toddlers cannot move themselves to avoid injury or to seek shelter. They often cannot feed themselves and are completely dependent upon adults to keep them safe. Older toddlers and preschool children may be mobile but are often unable to localize and appropriately respond to dangers (i.e., hiding under the bed in a fire). Older children may still have inappropriate or ineffective responses to danger. Teens are likely able to remove themselves from danger, but often have inappropriate risk assessments and are at high risk of unrecognized psychological trauma.[15] Children's natural fear responses may make caring for them particularly challenging.

An important factor that should not be minimized is that injury to children causes emotional stress for caregivers and medical personnel, even in non-disaster situations. In a mass casualty incident, this stress may become overwhelming or even incapacitating for some staff. Monitoring and responding to this source of stress should be addressed in the planning and drill stages to decrease impairment in an actual response.

Social and educational structure places children at risk of harm, particularly due to intentional acts of harm. Children spend much of their waking hours gathered in groups, away from their families. Children attend schools, ride buses, and are in large daycare settings. A mass casualty incident that impacts a large group of children separated from their parents leads to significant challenges, including reunification of families, delivering appropriate care, and identification of pre-existing medical conditions or allergies to medications.

Table 2. Needs of Children in a Disaster

In a disaster, children need:
• To be kept with or reunited with their family or caregivers
• To receive appropriate and timely medical care
• To be kept safe from further harm
• To be kept warm, fed, and clean
• To return to normal as soon as possible

Disaster Planning for Pediatrics

Disaster planning for children encompasses instituting plans that will provide children with the things they need to be safe and cared for after a disaster strikes. In a disaster, children need:

- To be kept with or reunited with their family (or caregiver);
- To receive appropriate and timely medical care;
- To be kept safe from further harm;
- To be kept warm, fed, and clean;
- To return to normal as soon as possible. (*See Table 2.*)

Keeping children with their families or caregivers provides many benefits, both in daily life as well as after a disaster. Unless it is medically absolutely necessary to remove a child from his or her family, children should be kept with their parents or caregivers. If a child arrives with a teacher, babysitter, or other familiar adult, keep the child with this caregiver until a parent or guardian can be identified. This will decrease the child's fear and allow easier assessment and treatment of injuries and illness. Prevention of secondary injury and illness is much simpler if parents (or caregivers) are with the child to provide appropriate supervision and care. Psychological trauma can be lessened by keeping children with their families or known caregivers. It is well established that perception of pain increases with anxiety and fear; allaying fear and anxiety by keeping them with their parents or familiar adults will help children to deal with pain from injury or illness. Keeping children with families helps to prevent further need for increased reunification efforts after treatment, which are costly and time-consuming.

Children need to receive medical care in a timely and appropriate fashion after a disaster. Care may be initiated at a community or local hospital rather than at a designated pediatric specialty hospital. All hospitals and clinics should be prepared to care for children until transfer is feasible and safe. Disaster medical plans at all facilities should contain provisions to evaluate, stabilize, and treat injured or ill children. In the planning stages of emergency preparedness, non-pediatric facilities should identify local pediatric resources and personnel who can provide pediatric expertise in a disaster. These local resources may include family physicians, pediatricians, and nurses with prior pediatric expertise. Plans must allow for both transfer and shelter in place for children in non-pediatric-specific hospitals. Conversely, stand-alone pediatric facilities should prepare to receive adult patients as well. An excellent resource for protocols and equipment needed is included in the *Joint Policy Statement: Guidelines for the Care of Children in the Emergency Department.*[16] Particularly for non-pediatric providers, fear of causing pain should not prevent treatment of severe or life-threatening injuries. The pain should be managed or alleviated but should not significantly delay the treatment. Consider use of intranasal medications such as intranasal fentanyl protocols for quick pain control without IV access.

Hypothermia or heat illnesses pose particular challenges in a disaster involving children. Environmental exposure can occur during the disaster, during search and rescue, or as part of the initial triage procedures. Children are very vulnerable to environmental injury, and particular attention should be paid to preventing and treating hypothermia or heat illness. Decontamination, in particular, poses significant risks of hypothermia, even in warm weather.

In a disaster, one of the non-medical challenges faced by hospitals and clinics will be to keep children safe from further harm. Children (particularly unaccompanied children) will require a safe area to wait for medical care, including areas for toileting, playing, and feeding. After care is received, they will likely require an area to wait, as parents and caregivers may be receiving treatment, dead, or missing. Areas must be "childproofed" as well as have appropriate adult supervision. Supervision may be provided by non-clinical staff, including child-life specialists, social workers, and chaplains. Children will require food, including formula or baby foods. Diapers and wipes, as well as child-friendly toilets, must be available. Any unaccompanied child must be kept safe from exploitation or abuse as well. Unfortunately, there are criminals who prey on vulnerable children and may seek to remove children from the hospital. Reunification of children with parents poses challenges to safety as well.

Psychological trauma after a disaster can be widespread and debilitating in adults as well as in children. For children, returning to normal activities of childhood can be protective. Experience with the aftermath of the Japanese earthquake, tsunami, and Fukushima disaster reinforces the need for children to return to play and normal activities.[1] Return to play and school as early as possible (including in shelters or even hospitals) is essential. Schedules and structure are comforting to children, particularly in chaotic environments and should be instituted if possible.

Table 3. Hazardous Materials Toxidromes[12,31]

Toxidrome	Symptoms	Examples	Pediatric Considerations
Irritant gas	Mucous membrane irritation Bronchospasm Pulmonary edema	Ammonia Formaldehyde Chlorine Phosgene	Difficult to differentiate bronchospasm and irritation from asthma exacerbation in mass casualty incident
Asphyxiant	Hypoxemia Central nervous system (CNS) effects Cardiovascular effects	Carbon monoxide Methemoglobin-forming compounds Cyanides, sulfides, azides	Children's increased metabolism → increased effects of smaller doses/ exposures
Corrosives	Chemical burns Coagulative necrosis Liquifactive necrosis	Acids Bases	Children at are at high risk of accidental ingestion
Hydrocarbon & Halogenated Hydrocarbons	Hypoxemia, skin burns CNS and cardiovascular effects	Gasoline, methane, hexane Butane, turpentine, toluene	Commonly encountered
Cholinergic	Muscarinic effects (DUMBELLS) Nicotinic effects (tachycardia, weakness, hypertension, fasciculations)	Insecticides (malathion, parathion, chlorpyrifos) Nerve agents (sarin, soman)	2-PAM 20-50 mg/kg IV or IM (suggested dosing) – repeat Q1 hour Atropine 0.05-0.1 mg/kg IV, IM – repeat Q2-5 minutes for symptoms MCI triage level Red[12] < 1 y: 1 pediatric atropine auto-injector (0.5 mg) Q3 mins prn 1-8 y: 1 atropine auto-injector (2 mg) repeat Q3 mins prn; 1 2-PAM auto-injector (600 mg)*
* Alternate dosing plans are available. This plan balances risk of lack of anti-aging antidote with risk of overdose of atropine and/or 2PAM. Risk-benefit is based on lack of evidence of harm in atropine overdoses from accidental injections in Israel as well as need for simplicity in stocking pediatric and adult auto-injectors.			

Disaster Triage for Children

Triage in disasters is designed to provide scarce resources to patients most likely to benefit from those resources. Multiple systems have been designed to rapidly determine the priority of patients in a mass casualty incident. Most use color systems to identify priority. Typically, red/immediate denotes a patient who is seriously injured but with immediate attention is likely to survive. Yellow/delayed indicates a patient who is seriously injured and requires urgent but not immediate intervention for survival. Green/minor describes a patient who has minimal injury that likely requires treatment but has no life-threatening injuries. Black/blue/expectant patients are those unlikely to survive even with immediate intervention.

Unfortunately, most triage systems were designed primarily for acute trauma in adults. There are several triage systems for pediatrics, but they have not been extensively validated, and performance of EMS personnel has been variable in implementing them.[17] Options include a pediatric modification of the adult START triage system[18] called JumpSTART,[19]

which adds vital signs ranges for children and allows two rescue breaths to be given prior to declaring expectant/dead status. Other options include the Pediatric Triage Tape,[20] Careflight,[21] and expert opinion. Detailed exploration of these is not included here; however, there are inherent advantages and drawbacks to each system and at this time there is no perfect pediatric triage tool in practical settings. Wallis et al discusses the merits of several systems.[17]

Another factor that should be considered and planned for in procedures as well as drills is the emotional difficulty of assigning a child to the expectant category. Many experienced EMS providers have balked at leaving a child without treatment, even when injuries are obviously incompatible with survival in a resource-poor environment.[22] This may lead to inappropriate triage and use of scarce resources in a disaster and could lead to increased mortality for other patients. This must be anticipated in the planning and training phases to prevent further harm during actual mass casualty incidents.

Pediatric Considerations in Specific Disaster Scenarios

Chemical Exposures and Hazardous Materials Exposures. The same basic principles of hazardous materials (hazmat) treatment are applicable to children, with several important caveats. Use of toxidromes to suspect and then identify hazmat exposure is the key to early identification and treatment. (*See Table 3.*) Typical toxidromes seen in hazmat or weapons of mass destruction exposure include irritant gases, asphyxiants, cholinergics, corrosives, and hydrocarbons. These toxidromes may overlap, and several have symptoms similar to pediatric viral illnesses.

Once a hazmat exposure is suspected, the need for decontamination must be determined quickly. Immediate decontamination is required in chemical or biologic contamination if there is a hazmat or biologic infectious agent contamination *and* it poses a risk to the patient *and* it poses a risk to others. If there is no risk to surrounding caregivers or others, the need for decontamination of the patient can be prioritized based on the injuries of the patient; otherwise, decontamination takes priority over all other interventions. In general, decontamination should start with disrobing the patient and removing loose particulate matter from the skin or hair with a dry, soft washcloth. This will remove 80-90% of most contaminants.[23,24] Then water decontamination should include copious amounts of water with the addition of gentle soap and use of a washcloth.[25] For patients who are not able to fully decontaminate themselves, staff should be prepared to aid with decontamination. Staff must be protected with appropriate personal protective equipment (PPE)/suits. For in-hospital mass decontamination, level C suits are likely a reasonable compromise for ease of donning and maneuverability with protection from toxic exposure.[23] Typical splash guards and examination gloves provide almost no protection from hazmat exposure. The literature is full of cases of caregivers and medical personnel who became ill or injured from secondary exposure. It is imperative that staff be protected prior to aiding with decontamination. Secondary contamination of caregivers is a serious threat that has resulted in illnesses and injury to caregivers, as well as emergency department shutdowns.[26,27] Several excellent references are available for selection of PPE.[23,24]

Due to the risks of hypothermia and dermal damage, as well as the frightening nature of decontamination, pediatric decontamination must be planned in advance. As with most treatments for pediatrics, it is essential to keep children with their parents or caregivers. Both parent and child can be decontaminated together; however, the parent may need additional assistance while caring for the child. Water temperature should be monitored to prevent both hypothermia and thermal burns. Water temperature should be between 98 and 105 degrees F.[24] Water flow should be high volume but low pressure (< 60 PSI), as dermal injury can occur with high-pressure water decontamination. Care should be taken to avoid dropping or otherwise injuring infants or toddlers when washing them. Possible solutions include placing the child into a laundry basket to prevent accidental falls while allowing water to flow out, or using a car seat without the padding.

Before and after water decontamination, care must be taken to avoid hypothermia. Use blankets and portable heaters to ensure that the disrobing and robing areas are warm. Older children may be modest, and this modesty must be honored unless the medical condition precludes this. For children who arrive at the hospital unaccompanied by adult caregivers, allow them to remain with peers if at all possible. For most contaminants, copious water decontamination aided with a washcloth is likely sufficient;[25] however, baby shampoo is a useful adjunct for oily or adherent materials and will be safer than standard soaps for children. See Freyberg et al[24] for an excellent sample protocol for pediatric mass decontamination.

Biologic Weapons. The infectious agents are classified by the CDC into categories based on the level of threat they pose as biological weapons.[28] Category A are easily disseminated and pose a high risk of mortality and threat to public health. Diseases in this category include anthrax, smallpox, botulism, plague, tularemia, and viral hemorrhagic fevers. See Table 4 for disease-specific information as well as pediatric treatment recommendations. The early symptoms of many of these illnesses are non-specific, with fever and respiratory symptoms. These may be missed early in the course or confused with more common pediatric illnesses. Diseases may present differently in young

Table 4. Infectious Diseases Concerning for Intentional Mass Casualty Incident (Category A)[8,13,14,33]

Disease	Symptoms	Incubation	Treatment
Anthrax	Inhalation: Fever, mediastinitis, widened mediastinum on CXR, sepsis Cutaneous: Papule, vesicle, ulcer, then black eschar	1-60 days	Ciprofloxacin 10-15 mg/kg IV Q12h (max 400 mg/dose) Doxycyline 2.2 mg/kg IV Q12h (max 100 mg/dose) (combine at least 2 agents unless cutaneous)
Plague	Febrile prodrome evolves into fulminant pneumonia, bloody sputum, sepsis, and DIC	2-4 days	Gentamycin 2.5 mg/kg Q8h Doxycycline 2.2 mg/kg IV Q12h Ciprofloxacin 10-15 mg/kg IV Q12h (max 400 mg/dose)
Smallpox	Febrile prodrome evolves into synchronous vesicopustular eruption, including face and extremities	7-17 days	Supportive care Prophylactic vaccination within 4 days
Tularemia	Pneumonic: Fever, fulminant pneumonia, CXR shows hilar adenopathy	2-10 days	Gentamycin 2.5 mg/kg Q8h Doxycycline 2.2 mg/kg IV Q12h Ciprofloxacin 10-15 mg/kg IV Q12h (max 400 mg/dose)
Botulism	Afebrile, descending flaccid paralysis. CN palsy with intact sensation and mentation	1-5 days	CDC trivalent antitoxin, 1 vial
Viral hemorrhagic fevers	Febrile prodrome evolves to rapid onset of shock and DIC with purpura and fulminant bleeding	4-21 days	Supportive care Lassa fever: Ribavirin 30 mg/kg then 15 mg/kg Q6h

CXR = Chest radiograph

children than in adults. Influenza pandemics have been illustrative of this point, with the fever and cough being essentially diagnostic in adults with flu but only seen in 64% of children with influenza-positive specimens.[29] Children may be less resistant to these illnesses due to a lack of multiple exposures to common pathogens. Because children maintain blood pressure until near cardiovascular collapse, early signs of shock may be missed, particularly in a large-scale incident.

Treatment of these diseases is also fraught with difficulty because the antibiotic of choice may not be approved for children. When treating diseases such as anthrax, concern about the severity of the illness outweighs concerns about antibiotic side effects. Suggested possible doses are listed in the table, but dosing should be checked prior to administration, as recommendations may change.

Radiation Concerns. Mass casualty radiation events typically are thought of as thermonuclear blast events, a "dirty bomb" with radioactive contamination of a conventional explosive device, a radiation accident such as Chernobyl, or radiation exposure from a concealed source. The last example likely would involve many patients exposed to ionizing radiation, but with little concern of ongoing radioactive contamination. A nuclear blast would involve widespread radiation, but the contamination would be reasonably obvious. A radiation accident such as Fukushima or Chernobyl could present an ongoing radiation exposure as well as a radioactive contaminant disaster. The most insidious radiation disaster or mass casualty incident is likely the dirty bomb. This can present with widespread radiation exposure as well as radioactive contamination of wounded patients.

External radioactive particle contamination can be removed in a similar fashion to the method used to remove chemical contamination. Decontamination begins with removing the patient's clothing and then removing the rest of the dust or particles with water decontamination. The same principles for

Figure 1. Sample Form for Unaccompanied Minor Identification and Tracking

MASS CASUALTY / DISASTER PEDIATRIC RESOURCES

Unaccompanied Child Information Tracking Document:

Tracking band # _____

Apply sticker here

Source of information: **(if more than 1 source please number, then use to document below)**

___ child	___ friend	___medical record
___ school personnel	___ daycare/babysitter	___school records
___ EMS	___ parent	___ daycare records
___ bystander	___ guardian	___ state immunization
___ sibling		

(give as much information as possible, please document source by including number of source as given above)

Child's name: _____
(if child does not know full name, give as much as possible)

Parent(s) name(s): _____
_____

Child's home address:_____
(or description) _____
_____

Child's location prior to transport to ED: _____

Name of person(s) who brought child to ED:
_____

Child's age / DOB: _____

Other identifying information:
Siblings (name/age):_____
_____
School attended: _____
Daycare attended: _____
Name of pet: _____
Family names/locations (ie grandparents, aunts, uncles):
_____

pediatric decontamination apply as for hazmat decontamination except for priority of decontamination. Lifesaving interventions can (and should) be performed first, after which decontamination of the patient should occur.[30] Adequate decontamination can be determined with a simple Geiger counter. Decontamination is complete when the level is at two times the background level.[30] Persistent radioactivity after initial decontamination may indicate internal penetration of radioactive fragments. In a mass

casualty incident with radioactive contamination of multiple casualties, individual removal of penetrating contaminated fragments may place too high a radiation burden on treatment teams.[31] Some experts suggest placing injured patients with persistent high levels of radioactivity after adequate water decontamination into the expectant category in a true mass casualty incident with radioactive contamination.[31]

Unaccompanied Children and Reunification Concerns

In a mass casualty incident affecting children, it is likely that there will be children who are separated from their families because of the child's initial location (i.e., child at school, parent at work) and/or injuries or death of the parent or caregiver. Identification of these children may be extraordinarily difficult if they are very young, injured, or have developmental delays. Efforts at identification should start immediately with written descriptions of all identifying information as well as with a digital (ideal) or instant photograph of the child. Multiple resources exist for templates. A suggested template is included in Figure 1.

Difficulties in establishing reunification are extensive and include (but are not limited to) establishing the legal relationship of the child and adult, identifying other family members if the parent is incapacitated or dead, preventing a non-custodial parent from taking the child, and keeping child predators from masquerading as the child's caregiver. Social workers, child life specialists, local child protection and social services officials, chaplains, and law enforcement may be needed to assist in reunification efforts. In all cases, detailed written records must be kept of who, where, and how children are released into a caregiver's custody.

Given the complexity of this issue, early planning for possible disaster-related reunification should be done before a disaster occurs and should involve the local agencies that are likely to be called upon in the case of a mass casualty incident.

Conclusion

Children will continue to be affected by natural disasters as well as intentional mass casualty incidents. To mitigate the damage these disasters inflict, emergency physicians must plan for and practice a response. Pediatric planning should be part of every hospital's disaster plan, even in a non-pediatric hospital, to ensure that children receive adequate and timely delivery of high-quality emergency medical care. Just as plans must include children, drills and practice of these procedures must include children to ensure that the plans work as expected. With advance planning and preparation, emergency care providers will be able to provide excellent medical care to children in the worst possible scenario.

References

1. Kikuchi S, Kikuchi T. The medical association activity and pediatric care after the earthquake disaster in Fukushima. *Keio J Med* 2012;61(1):23-27.
2. Weiner D, et al. Response to challenges and lessons learned from Hurricanes Katrina and Rita: A national perspective. *Pediatrics* 2011;128(S1):S31-S33.
3. Wikipedia. Beslan school hostage crisis. 2013 [cited 2013 January 22].
4. Quality A.f.H.R.a. *Pediatric Terrorism and Disaster Preparedness: A Resource for Pediatricians.* Available 2006 [cited 2013 Jan 22].
5. U.S. Census Bureau. Profile of General Population and Housing Characteristics: 2010; 2010 Demographic Profile Data. 2010 February 2, 2013.
6. AAP Policy Statement: Committee on Pediatric Emergency Medicine, A., The Pediatrician and Disaster Preparedness. *Pediatrics* 2006;117(2):560-565.
7. Markenson D, Redlener I. Pediatric terrorism preparedness national guidelines and recommendations: Findings of an evidence-based consensus process. *Biosecur Bioterror* 2004;2(4):301-319.
8. American Academy of Pediatrics Committee on Environmental Health and Committee on Infectious Disease, A., Chemical-biological terrorism and its impact on children: A subject review. *Pediatrics* 2000;105:662-670.
9. Gausche-Hill M. Pediatric disaster preparedness: Are we really prepared? *J Trauma* 2009;67(2):S73-S76.
10. Scalzo A, et al. Disaster preparedness and toxic exposures in children. *Clin Ped Emerg Med* 2008;9:47-60.
11. Lynch E, Thomas T. Pediatric considerations in chemical exposures: Are we prepared? *Pediatr Emerg Care* 2004;20(3):198-208.
12. Foltin G, et al. Pediatric nerve agent poisoning: Medical and operational considerations for emergency medical services in a large American city. *Pediatr Emerg Care* 2006;22(4):239-244.
13. Henreitig F, Cieslak T, Eitzen E. Biological and chemical terrorism. *J Pediatrics* 2002;141(3):311-326.
14. Bernardo L, Kapsar P. Pediatric implications in bioterrorism: Education for healthcare providers. *Disaster Management and Response* 2003;1(2): 52-53.
15. Markenson D, Reynolds S. The pediatrician and disaster preparedness. *Pediatrics* 2006;117(2):e340-e362.
16. American Academy of Pediatrics, Committee on Pediatric Emergency Medicine. American College of Emergency Physicians — Pediatric Committee, and Emergency Nurses Association, Pediatric Committee, Joint Policy Statement — Guidelines for the care of children in the emergency department. *Pediatrics* 2009:1233-1243.
17. Wallis L, Carley S. Comparison of paediatric major incident primary triage tools. *Emerg Med J* 2006;23:475-478.
18. Benson M, Koenig K, Schultz C. Disaster Triage: START then SAVE — a new method of dynamic triage for victims of a catastrophic earthquake. *Prehospital and Disaster Med* 1996;11:117-124.
19. Romig L. Pediatric triage. A system to JumpSTART your triage of young patients at MCI. *JEMS* 2002;27:52-58, 60-63.
20. Hodgetts T, et al. Paediatric triage tape. *Pre-Hospital Immed Care* 1998;2: 155-159.
21. Nocera A, Garner A. An Australian mass casualty incident triage system for the future based upon triage mistakes of the past, the Homebush Triage Standard. *Aust N Z J Surg* 1999;69:603-608.
22. Personal communication with M. Lozon, 2009, Ann Arbor, MI.
23. Scarfone R, Sullivan F, Henretig F. Decontamination and the use of personal protective equipment. *Pediatr Emerg Care* 2006;22(6):445-452.
24. Freyberg C, et al. Disaster preparedness: Hospital decontamination and the pediatric patient — guidelines for hospitals and emergency planners. *Prehospital and Disaster Med* 2008;23(2):166-173.
25. Levitin H, et al.,Decontamination of mass casualties — Re-evaluating existing dogma. *Prehospital and Disaster Med* 2003;18(3):200-207.
26. Okumura S, et al. Clinical review: Tokyo — protecting the health care worker during a chemical mass casualty event: An

important issue of continuing relevance. *Crit Care* 2005;9(4):397-400.

27. Okumura T, et al. The Tokyo subway sarin attack: Disaster management. Part II. Hospital response. *Acad Emerg Med* 1998;5:618-624.
28. Centers for Disease Control and Prevention, C. Bioterrorism Agents/Diseases — By category. Emergency Preparedness and Response 2013 [cited 2013 February 15, 2013].
29. Poehling K, et al. The under-recognized burden of influenza in young children. *N Engl J Med* 2006;355:31-40.
30. Wolbarst A, et al. Medical response to a major radiologic emergency: A primer for medical and public health practitioners. *Radiology* 2010;254(3):660-677.
31. Williams G, O'Malley M, Nocera A. Ensuring the safety of surgical teams when managing casualties of a radiological dirty bomb. *Injury* 2010;41:938-942.
32. D M, Reynolds S. The pediatrician and disaster preparedness. *Pediatrics* 2006;117(2):e340-e362.
33. Pickering L, ed. *AAP Red Book*, 2003 Report of the Committee on Infectious Diseases, 26th ed., ed. A.A.o. Pediatrics. Vol. Section 2, Biological Terrorism. 2003, American Academy of Pediatrics: Elk Grove Village, IL.

CME Questions

1. In the case of contamination with organophosphate of a 2-year-old boy and his mother, initial steps should include:
   A. Remove the child from his mother to decrease further contamination, give oral atropine, and then decontaminate with high-pressure water to remove remaining contamination.
   B. Keep the child with his mother, have both remove all clothing, shower with high-volume but low-pressure warm water and baby shampoo, and treat with atropine and 2-PAM as needed.
   C. Keep the child with the mother, have staff don examination gloves and N-95 masks, fully assess with history and physical, and decontaminate only if there are significant symptoms.

2. In order to safely decontaminate an infant after chemical exposure:
   A. Place the child into a plastic laundry basket, maintain airway and heat.
   B. Have a nurse not wearing PPE hold the baby in his arms so that the PPE does not interfere with ability to safely hold the baby.
   C. Use cold water to decrease burns caused by exothermic reactions of the chemical with the water.
   D. Separate the child from his parents immediately.

3. Children are at high risk from mass casualty events for many reasons, *except*:
   A. Children have a larger body surface area to volume ratio.
   B. Children have thinner skin.
   C. People who appear after a mass casualty incident to care for children will always have the best intentions.
   D. Children may be separated from their caregivers at the time of the mass casualty incident.

4. In the case of a mass casualty incident, community hospitals without an inpatient pediatric floor should:
   A. plan to transfer all pediatric patients prior to definitive treatment
   B. plan to shelter in place and initially care for children and adults until transfer is safe and available
   C. not perform any invasive procedures in children, as this may cause more pain
   D. plan to separate children from adults to allow for easier transfer to other hospitals

5. Which of the following statements is true?
   A. Pediatric hospitals do not need to include adults in mass casualty incident drills, as all adults will be cared for at other hospitals.
   B. Separating children from their classmates following a mass casualty incident will allow for easier identification of injuries and triage of patients.
   C. No special supplies are needed in planning to care for children in a disaster, as their parents will supply these if needed.
   D. All hospitals should include pediatric patients in plans as well as in disaster drills.

6. Radioactive particle contamination is different from chemical contamination in that:
   A. Radioactive particle contamination does not pose a threat to caregivers.
   B. Lifesaving interventions can be performed first, then decontamination carried out for radioactive contamination.
   C. Radioactive contamination is easily noticed even in a dirty bomb scenario.
   D. Radioactive contamination is very unlikely after a terrorist mass casualty incident.

7. The CDC categorizes diseases as biologic threat Category A because they:

Pediatric Emergency Medicine Reports

CME Objectives

Upon completion of this educational activity, participants should be able to:

- recognize specific conditions in pediatric patients presenting to the emergency department;
- describe the epidemiology, etiology, pathophysiology, historical and examination findings associated with conditions in pediatric patients presenting to the emergency department;
- formulate a differential diagnosis and perform necessary diagnostic tests;
- apply up-to-date therapeutic techniques to address conditions discussed in the publication;
- discuss any discharge or follow-up instructions with patients.

CME Instructions

HERE ARE THE STEPS YOU NEED TO TAKE TO EARN CREDIT FOR THIS ACTIVITY:

1. Read and study the activity, using the provided references for further research.
2. Log on to **www.cmecity.com** to take a post-test; tests can be taken after each issue or collectively at the end of the semester. *First-time users will have to register on the site using the 8-digit subscriber number printed on their mailing label, invoice, or renewal notice.*
3. Pass the online tests with a score of 100%; you will be allowed to answer the questions as many times as needed to achieve a score of 100%.
4. After successfully completing the last test of the semester, your browser will be automatically directed to the activity evaluation form, which you will submit online.
5. **Once the completed evaluation is received, a credit letter will be e-mailed to you instantly.**

A. have no known treatments
B. are the easiest to prepare to defend against
C. likely to cause widespread disease and are relatively easy to disseminate as a weapon
D. they have been used as weapons in the past 10 years

8. In a large casualty motor vehicle accident, the most likely chemical contaminant encountered is:
   A. hydrocarbon fuel; however, no attention should be paid as it is much less dangerous than any trauma sustained
   B. hydrocarbon fuel including gasoline; this can cause significant CNS and cardiovascular impairment as well as chemical burns to skin
   C. chemical fertilizers from transport trucks
   D. sulfuric acid from cargo train vs. car accidents

9. In a mass casualty incident blast (explosive injury) scenario, which of the following is true?
   A. Children are less likely than their parents to be injured because they are closer to the ground.
   B. Parents can be counted on to care for their children in the initial chaos.
   C. Ambulatory children will be able to move to a safer place without assistance.
   D. Children's more compliant chest/abdominal walls provide less protection to the encompassed organs and they at are higher risk of intrathoracic and intra-abdominal injury.

10. An unaccompanied minor tracking form should include:
   A. identifying details about the child, location child was initially found, to whom the child is eventually released
   B. only the most important details of medical care to keep the form simple
   C. only information about the child that can be verified with accompanying documentation
   D. no photograph of the child to prevent the images from being misused by child predators

Pediatric Emergency Medicine Reports™
(ISSN 1082-3344) is published monthly by AHC Media, a division of Thompson Media Group LLC, 3525 Piedmont Road, N.E., Six Piedmont Center, Suite 400, Atlanta, GA 30305. Telephone: (800) 688-2421 or (404) 262-7436.

Senior Vice President/Group Publisher:
Donald R. Johnston
Executive Editor: Shelly Morrow Mark
Managing Editor: Leslie Hamlin

GST Registration No.: R128870672
Periodicals Postage Paid at Atlanta, GA 30304 and at additional mailing offices.

POSTMASTER: Send address changes to ***Pediatric Emergency Medicine Reports***, P.O. Box 105109, Atlanta, GA 30348.

Back issues: $65. Missing issues will be fulfilled by customer service free of charge when contacted within one month of the missing issue's date.

Subscriber Information

Customer Service: 1-800-688-2421

Customer Service E-Mail Address:
customerservice@ahcmedia.com
Editorial E-Mail Address: shelly.mark@ahcmedia.com
World-Wide Web page: http://www.ahcmedia.com

Subscription Prices

1 year with 30 ACEP, AMA, or AAP Category 1 credits: $439;
1 year without credit: $389;
Add $17.95 for shipping & handling
Multiple copies:
Discounts are available for group subscriptions, multiple copies, site-licenses or electronic distribution. For pricing information, call Tria Kreutzer at 404-262-5482.
One to nine additional copies: **$350 each;**
10 or more additional copies: **$311 each.**
Resident's Rate: **$194.50**
All prices U.S. only. U.S. possessions and Canada, add $30 postage plus applicable GST.

Accreditation

AHC Media is accredited by the Accreditation Council for Continuing Medical Education to provide continuing medical education for physicians.

AHC Media designates this enduring material for a maximum of 30 *AMA PRA Category 1 Credits™*. Physicians should claim only credit commensurate with the extent of their participation in the activity.

Approved by the American College of Emergency Physicians for a maximum of 30.00 hour(s) of ACEP Category I credit.

This continuing medical education activity has been reviewed by the American Academy of Pediatrics and is acceptable for a maximum of 30.0 AAP credits. These credits can be applied toward the AAP CME/CPD Award available to Fellows and Candidate Members of the American Academy of Pediatrics.

This CME activity is intended for emergency and pediatric physicians. It is in effect for 36 months from the date of the publication.

AHC Media

Exclusive to our subscribers

Rapid Access Management Guidelines

Pediatric Emergency Medicine Reports

The Practical Journal of Pediatric Emergency Medicine

Disaster Planning in the Pediatric Emergency Department

Hazardous Materials Toxidromes

Toxidrome	Symptoms	Examples	Pediatric Considerations
Irritant gas	Mucous membrane irritation Bronchospasm Pulmonary edema	Ammonia Formaldehyde Chlorine Phosgene	Difficult to differentiate bronchospasm and irritation from asthma exacerbation in mass casualty incident
Asphyxiant	Hypoxemia Central nervous system (CNS) effects Cardiovascular effects	Carbon monoxide Methemoglobin-forming compounds Cyanides, sulfides, azides	Children's increased metabolism → increased effects of smaller doses/ exposures
Corrosives	Chemical burns Coagulative necrosis Liquifactive necrosis	Acids Bases	Children at are at high risk of accidental ingestion
Hydrocarbon & Halogenated Hydrocarbons	Hypoxemia, skin burns CNS and cardiovascular effects	Gasoline, methane, hexane Butane, turpentine, toluene	Commonly encountered
Cholinergic	Muscarinic effects (DUMBELLS) Nicotinic effects (tachycardia, weakness, hypertension, fasciculations)	Insecticides (malathion, parathion, chlorpyrifos) Nerve agents (sarin, soman)	2-PAM 20-50 mg/kg IV or IM (suggested dosing) – repeat Q1 hour Atropine 0.05-0.1 mg/kg IV, IM – repeat Q2-5 minutes for symptoms MCI triage level Red[12] < 1 y: 1 pediatric atropine auto-injector (0.5 mg) Q3 mins prn 1-8 y: 1 atropine auto-injector (2 mg) repeat Q3 mins prn; 1 2-PAM auto-injector (600 mg)*

* Alternate dosing plans are available. This plan balances risk of lack of anti-aging antidote with risk of overdose of atropine and/or 2PAM. Risk-benefit is based on lack of evidence of harm in atropine overdoses from accidental injections in Israel as well as need for simplicity in stocking pediatric and adult auto-injectors.

Infectious Diseases Concerning for Intentional Mass Casualty Incident (Category A)

Disease	Symptoms	Incubation	Treatment
Anthrax	Inhalation: Fever, mediastinitis, widened mediastinum on CXR, sepsis Cutaneous: Papule, vesicle, ulcer, then black eschar	1-60 days	Ciprofloxacin 10-15 mg/kg IV Q12h (max 400 mg/dose) Doxycyline 2.2 mg/kg IV Q12h (max 100 mg/dose) (combine at least 2 agents unless cutaneous)
Plague	Febrile prodrome evolves into fulminant pneumonia, bloody sputum, sepsis, and DIC	2-4 days	Gentamycin 2.5 mg/kg Q8h Doxycycline 2.2 mg/kg IV Q12h Ciprofloxacin 10-15 mg/kg IV Q12h (max 400 mg/dose)
Smallpox	Febrile prodrome evolves into synchronous vesicopustular eruption, including face and extremities	7-17 days	Supportive care Prophylactic vaccination within 4 days
Tularemia	Pneumonic: Fever, fulminant pneumonia, CXR shows hilar adenopathy	2-10 days	Gentamycin 2.5 mg/kg Q8h Doxycycline 2.2 mg/kg IV Q12h Ciprofloxacin 10-15 mg/kg IV Q12h (max 400 mg/dose)
Botulism	Afebrile, descending flaccid paralysis. CN palsy with intact sensation and mentation	1-5 days	CDC trivalent antitoxin, 1 vial
Viral hemorrhagic fevers	Febrile prodrome evolves to rapid onset of shock and DIC with purpura and fulminant bleeding	4-21 days	Supportive care Lassa fever: Ribavirin 30 mg/kg then 15 mg/kg Q6h

CXR = Chest radiograph

Sample Form for Unaccompanied Minor Identification and Tracking

MASS CASUALTY / DISASTER PEDIATRIC RESOURCES

Unaccompanied Child Information Tracking Document:

Tracking band # _____

Apply sticker here

Source of information: (if more than 1 source please number, then use to document below)

___ child
___ school personnel
___ EMS
___ bystander
___ sibling
___ friend
___ daycare/babysitter
___ parent
___ guardian
___medical record
___school records
___ daycare records
___ state immunization

(give as much information as possible, please document source by including number of source as given above)

Child's name: _____
(if child does not know full name, give as much as possible)

Parent(s) name(s): _____
_____

Child's home address:_____
(or description) _____
_____

Child's location prior to transport to ED: _____

Name of person(s) who brought child to ED:
_____

Child's age / DOB: _____

Other identifying information:
Siblings (name/age):_____
_____
School attended: _____
Daycare attended: _____
Name of pet: _____
Family names/locations (ie grandparents, aunts, uncles):
_____

Five Phases of Disaster Planning

1. Planning: Careful assessment of the risks faced in the local community and region
2. Preparation: Training for staff, testing of procedures and plan, obtaining needed supplies
3. Response: Initial response to a disaster that employs existing procedures and plans
4. Recovery: Returning the community to normal status and re-assessment of current resources
5. Review: Evaluate how well the preparations and plans worked during the actual disaster. Revise if needed and share lessons learned with others.

Needs of Children in a Disaster

In a disaster, children need:

- To be kept with or reunited with their family or caregivers
- To receive appropriate and timely medical care
- To be kept safe from further harm
- To be kept warm, fed, and clean
- To return to normal as soon as possible

Supplement to *Pediatric Emergency Medicine Reports*, May 2013: "Disaster Planning in the Pediatric Emergency Department." *Author:* **Kristin M. Kim, MD, PhD,** Pediatric Emergency Medicine Consultant, Clinical Instructor, Emergency Medicine and Pediatrics, Mayo Clinic, Rochester, MN.