Abstract:
Infants and children are common victims of disaster or mass casualty situations. Prehospital providers provide the initial care and stabilization at the scene of a mass casualty event. There are a number of challenges the prehospital provider faces when caring for children in a mass casualty event, among them are the following: the physiology of children differs from adults, children are particularly vulnerable in a disaster, separation from parents or caregivers may occur, and protocols developed for adults may not work well for children. This article reviews the planning and triage considerations for prehospital providers caring for children in a mass casualty event.

Keywords:
disaster; triage; pediatrics; emergency medical services; planning; mass casualty; prehospital

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Pediatric Mass Casualty: Triage and Planning for the Prehospital Provider

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A mass casualty event (MCE) involving a large number of children is a prospect that many prehospital providers might consider to be their worst nightmare. Unfortunately, children may be involved in any mass casualty response. In one recent study of Disaster Medical Assistance Team (DMAT) deployment, almost one third of the patients seen in DMAT field clinics were children.[1] Some disasters have a disproportionate number of pediatric victims, such as school shootings. Children have higher morbidity and mortality during a disaster than adults. Age is inversely related to increased morbidity and mortality in disaster scenarios.[2] The needs and, henceforth, the care required by children in an MCE are different. Therefore, consideration and planning for the needs of children in the event of a MCE are imperative.

Difficulties in the prehospital care of children in non–mass casualty emergency situations have been well documented, including the lack of proper equipment, the relative lack of practice for technical skills, and lack of pediatric-specific continuing education.[3-5] These pediatric-specific shortcomings in our day-to-day emergency care system are likely to be exacerbated in an MCE.

Several recent studies have demonstrated deficiencies in the preparedness of the emergency medical system for the care of children in disaster or mass casualty situations. One study noted significant deficiencies in pediatric training and equipment among DMATs.[6] A recent study of pediatricians in Michigan found that 38% had never attended a lecture on bioterrorism and 85% had never participated in a bioterrorism drill. The authors concluded that pediatricians are "overwhelmingly underprepared to deal with an event" of bioterrorism.[7] A national survey of ambulance services found deficiencies in the preparedness of many services for the care of children in MCEs.[8]

PREHOSPITAL CHALLENGES IN THE CARE OF CHILDREN

There are several physiologic vulnerabilities in children that pose a challenge in an MCE.[9-11] Figure 1 gives a partial list of the physiologic differences between children and adults that are important in the management of mass casualties. Children are physiologically and psychologically less fit than adults to survive the acute, subacute, and chronic stresses of a disaster. Children have a larger body surface/mass ratio than adults; predisposing them to heat loss and increased vulnerability to contact toxins. Infants have a particularly larger head to body ratio predisposing to head injury. Depending on the developmental stage of the child, there may be limited communication and self-protection abilities. For example, a young child may not have the motor skills to escape a dangerous situation. Even if they have the motor ability, they may lack the cognitive ability to recognize the danger.

Because children are typically dependent on their parents or caregivers, identification and separation are important difficulties during a disaster. There may be children whose adult caregivers have been incapacitated or injured. Reunification of children and parents can take months or years or may not be possible at all in some cases. Patient tracking of pediatric victims who require transport is especially important to ensure future reunification of those children with their families.[12-14]

First responders and emergency medical services (EMS) providers are faced with the additional challenge of securing the scene of a disaster and ensuring the safety of the victims as well as their own staff. Protecting unsupervised or orphaned children at a disaster scene can be more of a challenge than adults but should be given a high priority.

One of the biggest pediatric care challenges facing prehospital care providers is airway management. There are several anatomic factors that impact the maintenance of a pediatric airway. The child's head is disproportionately large, with a prominent occiput. When lying in a supine position, the chin is tucked and the head is pitched forward, making proper positioning of the airway difficult to achieve and maintain. A child's airway is smaller and more anterior, making it more difficult to visualize and intubate. The smaller diameter makes the airway more prone to occlusion, with secretions or small amounts of debris.

It is important for the prehospital provider to be aware that the most common cause of cardiac arrest in a child is the inability to establish or maintain a patent airway or the inability to oxygenate or ventilate a child. In a child with a depressed level of consciousness, the airway may simply become occluded from malpositioning of the head. Studies have shown that attempts at intubation by EMS providers in the pediatric patient are often unsuccessful, even in a relatively controlled setting.[15] Given the difficulties of pediatric field intubation in controlled circumstances, successful intubation in an MCE may be even less likely. The focus for prehospital airway management in the disaster situation should be on positioning and bag valve mask ventilation rather than on invasive

Thinner skin	More pliable skeletons
Higher surface area to mass ratio	Developmentally reliant on adults
Higher minute ventilation	Immune systems less mature
Larger heads in proportion to body size	Dehydrate more easily than adults
Fontanelles may still be open	Short stature (live closer to the ground)
Airway is floppy and more difficult to maintain	Poor hygiene habits = spread of disease
Greater physiologic compensation mechanisms than adults	Internal organs in closer proximity and not as fixed
Higher baseline pulse and respiratory rates	Interventions are weight-based, in kilograms
	Baseline mental status may not include following commands

FIGURE 1. Physiologic differences in children in disasters.

techniques. Positioning the child's airway appropriately can be a lifesaving intervention. Another important intervention that is often overlooked in the prehospital setting is appropriate suctioning of the child's airway. Because of the smaller diameter of the airway, it can easily be compromised (or even occluded) by secretions, especially in the event of chemical exposure.

Blast injury can be seen in certain MCEs. Injury patterns in children after a blast injury also differ from their adult counterparts and from nonblast pediatric injuries.[16,17] These different injury patterns must be recognized by the prehospital provider because explosives remain a weapon of choice among terrorist organizations. Because the head of a child is proportionately larger, there is a higher frequency of blunt traumatic brain injuries.[17] Children's smaller body mass, less subcutaneous fat, more pliable skeletons, and close proximity of organs mean that the energy imparted from the blast or flying debris can result in a greater force applied per unit of body area. Children are more likely to sustain multisystem injury rather than isolated injuries. Because of the pliability of the pediatric skeleton, there may be internal organ injury without overlying bony fracture. Identification of shock in a pediatric victim of a blast injury can be difficult for the prehospital provider. The child's ability to maintain blood pressure and cardiac output with increasing heart rate can be an important protective mechanism; but these mechanisms mean that the signs of early shock differ in children and adults. Tachycardia, poor distal pulse quality, and poor skin perfusion are early signs of shock in children, which must be recognized in the field.

Any incident involving a toxic chemical exposure poses special challenges to the EMS provider.[9] Children live closer to the ground, and therefore, are often the first to become symptomatic from a chemical agent. They have higher baseline respiratory rates and are at higher risk for airborne toxin exposure. Nerve gas antidote kits available for adults are not yet available for children in the United States. Management of the airway is still of utmost importance in the chemically exposed child and can be even more challenging due to increased airway secretions that may be caused by the chemical. Children are at increased risk for dermal absorption of toxins due to their thinner skin. Children have a greater body surface/mass ratio, so a smaller total amount of exposed skin can still provide significant absorption.[9,18]

One of the most important steps in the initial management of any victim of a chemical exposure is decontamination. The thin skin and large surface area/mass ratio of pediatric patients also places them at risk for hypothermia during the decontamination process. Warm water decontamination may prevent hypothermia in children but may not be available to the prehospital provider in the field. The ideal pediatric decontamination system would use large-volume, low-pressure warm water. In addition, infants and children may need a parent or adult to accompany them in the decontamination process, requiring even more warm water and a facility large enough to accommodate family units. Prehospital providers should plan for active rewarming measures after decontamination. These measures might include blankets, radiant warmers, and warm postdecontamination clothing.[19,20]

Biological agent exposure in children also poses special challenges.[9,21,22] Children have a relatively immature immune system and therefore may have a higher mortality rate than adults from any serious infection. Children dehydrate more easily than adults from any toxin producing gastroenteritis. Most young children have poor hygiene habits, so transmission rates of biological agents among children can be very rapid. This rapid transmission means that outbreaks of infectious agents may be first detected in daycare or school settings.

Unfortunately, some of the recommended treatments for biological terrorism agents have been poorly studied, rarely used, or are relatively contraindicated in children.[14,22]

Nuclear and radiologic exposures in children will also produce higher levels of morbidity and mortality than in adults.[23,24] Again, the greater surface area/mass ratio and thinner skin leave children more susceptible to these exposures. Likewise, their short stature and higher baseline respiratory rate leads them to receive higher particulate exposure of inhaled radioactive fallout. Lower total intravascular volume reserves in children leave them more susceptible to dehydration from the gastrointestinal losses encountered from acute radiation syndrome.[23,24]

In addition to the anatomic and physiologic vulnerabilities, there are several pediatric treatment considerations that may pose special challenges in an MCE.[8-11,25] For many medications, a single adult dosage form is adequate. There is no “one size fits all” dosing of medications or fluids in children—most medications involve kilogram dosing and calculations. Medication calculation and administration for children can be problematic in routine clinical prehospital situations but especially so for providers faced with multiple pediatric victims. Children require a broad range of equipment sizes, and maintaining adequate stocks of this equipment is a preparedness challenge.

Children, and particularly infants, are especially vulnerable to heat loss. Thus, temperature control is particularly important and may be a substantial challenge in shelter situations. Because children may not be able to effectively communicate their medical history and needs, separation from parents or caregivers presents a special treatment problem, which is exacerbated in the MCE situation.[12]

The other treatment dimension that becomes a challenge in a mass casualty situation is the relatively limited availability of pediatric specialty care and lack of pediatric surge capacity.[25] In comparison to adult care, the care of critically ill or injured children occurs in a smaller number of specialized centers, and some general hospitals lack the resources necessary for the care of ill or injured children. A study by the Centers for Disease Control found that only 5.5% of US hospital emergency departments had all the pediatric equipment recommended by the American Academy of Pediatrics and American College of Emergency Physicians and that only half had 85% or more of the recommended equipment.[26] Another study of emergency department preparedness found substantial deficiencies in necessary pediatric equipment and medications.[27] Thus, the availability of pediatric specialty care or even pediatric inpatient beds in an MCE may be limited in a given area. Transport of such children to other centers away from the disaster site may be necessary, and planning for such mass pediatric transport is important.

PLANNING CONSIDERATIONS FOR PEDIATRIC PREHOSPITAL CARE IN MCES

Most MCEs involve children. Table 1 includes a list of several sentinel events from around the globe that have included children over the past 2 decades.[28-58] Lessons learned from these events emphasize the challenges faced at the scene by prehospital providers. These lessons help focus efforts and priorities in the planning stages for future MCEs. Managing an MCE in the field requires a systematic approach that encompasses elements of command structure, scene safety, communication, assessment and triage of patients, and finally treatment, transport to local or tertiary facilities, and disposition.[59]

Command Structure

The most important management aspect of any MCE is the presence of a unified and organized command structure. The type and composition of this command structure should be organized in the preplanning stage. The Oklahoma City bombing provides an example of the need for preplanned coordination among local, community, state, and federal agencies as well as nontraditional agencies such as public utilities. This MCE involved the coordination of more than 75 fire departments and more than 100 law enforcement agencies. The Federal Emergency Management Agency dispatched 11 urban search and rescue task forces. Telephone and electric utilities were involved in the response. The incident command was coordinated by the Oklahoma City Fire Department.[37] Problems faced by the incident command included a flood of volunteers who came to the site of the explosion. Although well intentioned, this became a logistical problem.[60] One of the advantages the responding agencies had was previous participation in a course at the Emergency Management Institute.[37] Multiagency preplanning and coordination help establish a coordinated incident command structure during an MCE.

Incident command should be flexible and ready to respond to any type of disaster in the "all-hazard mode." Tactical decisions made by first arriving commanders should be flexible, tempered by incoming and frequently changing information. The need for flexibility and altering the response to changing information were vividly demonstrated in the World Trade Center attacks of September 11, 2001.[61] Responding personnel to the 9/11 attacks initially assumed that a small plane or light aircraft had veered off course and struck the building. Therefore, initial decision making planned for the triage area to be established on the first floor of Tower 1. Before the area could be established, the second tower was hit and subsequently collapsed. Incident command was then reestablished at a nearby undamaged hotel, and the search and rescue operation continued.[61] This event illustrates the scope of planning needed, for example, to prepare for the possibility that the established Incident Command itself may be in jeopardy and that alternate sites and contingency plans need to be secured.

Scene Safety and Control

Disaster scene safety and control are important to prevent further injury to victims or initial injury to rescue workers. The importance of scene safety is dramatically demonstrated in recent terrorist bombings, where secondary devices were set to explode after the arrival of prehospital providers. This situation is well illustrated by the Columbine High School shooting events in Littleton, CO, on

TABLE 1. Involvement of pediatric patients in major MCEs.

Event	Location	Year	Peds Casualties	All Casualties	% Peds	Fatalities
Organophospahte Gas Leak[28]	Arizona	1987	67	67+	100	?
Avianca 52 Plane Crash[29]	New York	1990	25	135	18.52	65 adults, 3 children
Pittsburgh Three Rivers Regatta Incident[30]	Pensylvania	1990	13	24	54.17	0
Hurricane Andrew[31,32]	Florida	1992	196	687	28.52	17
ATF/Branch Davidian Massacre[33]	Waco	1993	34	111	30.63	76 adults, 35 children
West Street Bus Crash[34]	Glasgow	1994	33	35	94	2 adults, 3 children
Northridge Earthquake[35]	California	1994	259	596	44.30	57
Sarin Gas in Tokyo Subway[36]	Japan	1995	Unknown	1034	Unknown	12
Oklahoma Federal Building Bombing[37]	Oklahoma	1995	61	759	8.03	168
Dunblane Shooting[38]	Scotland	1996	27	31	87.10	1 adult, 16 children
Manchester Bombing[39]	England	1996	30	217	13.80	0
Baclofen Overdose[40]	Maine	1997	14	14	100	0
Jonesboro School Shooting[41]	Arkansas	1998	14	15	93.30	4 children, 1 adult
Columbine School Shooting[42]	Colorado	1999	142	160	88.70	12 children, 1 adult
Tropical Storm Allison Flooding[1]	Texas	2001	126	575	21.90	43
World Trade Center Terrorist Attacks[43,44]	New York	2001	8+	6291+	0.01+	2604 killed (24 missing)
Erfurt Massacre[45]	Germany	2002	2	22	9	16 adults, 2 students
Hurricane Isabel[46]	North Carolina	2003	Unknown	>4000	Unknown	50
Toronto SARS Outbreak[47,48]	Canada	2003	25	438	5.70	33
Hurricane Ivan[49]	Alabama	2004	Unknown	>3000	Unknown	92
Hurricane Katrina[50]	Louisiana	2005	Unknown	5698	Unknown	1833 (6644 missing)
Cincinnati School Bus Chemical Exposure[51]	Ohio	2005	53	56	94.60	0
Platte Canyon High School Shooting[52]	Colorado	2006	6	7	85.71	1 adult, 1 child
Nickel Mines Amish School Shooting[53]	Pennsylvania	2006	10	11	90.90	1 adult, 5 children
Montreal Dawson College Shooting[54]	Quebec	2006	19	21	90.47	1 adult, 1 child
Virginia Tech Shooting[55]	Virginia	2007	22	50	44.00	33
Hyderabad Bombings[56]	India	2007	10	96	10.42	33 adults, 10 children
Hurricane Gustav[57]	Louisianna	2008	Unknown	Unknown	Unknown	153
Hurricane Ike[58]	Texas	2008	Unknown	Unknown	Unknown	103

April 20, 1999.[42,62] This was a complex incident with the threat of continued violence at the scene. Two students attacked their school using multiple homemade bombs, incendiary devices, and automatic weapons. Many of the devices were designed to injure fleeing students and rescue personnel.[63] The perpetrators also fired out a cafeteria window at paramedics attempting to rescue victims lying just outside. Because of the circuitous route taken by the gunmen through the school, there was a great deal of confusion as to the number of perpetrators (as many as 8 from initial reports) and their current location inside the school. Because of the size of the school and the difficulty in knowing how many assailants were involved, initial medical care for some victims was delayed for more than 3 hours while the school was secured by SWAT teams.[62]

Planning considerations for scene control should also include a universal identification (ID) system for rescuers. Although time consuming, an ID system will help limit scene access to those individuals involved in the rescue/recovery operation. Shortly after the Oklahoma City bombing, the Federal Bureau of Investigation set up a photo ID system for rescue workers who needed access to the scene.[37,60] The procedure was not consistently enforced in the beginning of the operation and led to more individuals in the building without actual roles in the rescue or recovery proceedings.

Scene safety issues can also be a consequence of natural disasters or their unintended consequences, such as rising flood waters. When Hurricane Katrina slammed into the Louisiana gulf coast on August 29, 2005, it left 1836 dead and a large number of missing persons, an untold number of which were children. Rescue workers were faced with multiple hazards involving command and scene safety in the days and weeks after the storm. As the city disappeared under water, multiple individuals who did not evacuate were left stranded on rooftops for days, requiring water rescue. These victims were stranded with little food or water, no working toilets, and no power for lights or air-conditioning for several days. Rising tide waters polluted with sewage and decaying bodies disrupted the freshwater supply lines and increased the risk of dehydration and disease. It is estimated that 56 000 pregnant women and 75 000 infants were affected by Hurricane Katrina. Disruption in the supply of safe drinking water, food, crowded shelter conditions, and exposure to environmental toxins put these vulnerable populations at risk.[64] Looting and violence among citizens stranded in their homes and at shelters increased as police were outnumbered and overwhelmed. Until the arrival of the National Guard, the personal safety of prehospital workers was frequently at risk from violence.[65]

Communication

Communication among responding providers is an essential part of the response at all MCEs. Multiagency responses can be especially problematic, with varying channel assignments and available radio frequencies between agencies. Unless a regional interagency communication plan has been developed and tested, there may not be communication compatibility among those involved. At the Columbine scene, not all responding units had access to the Fire Emergency Response Network as had been previously assumed. The lack of frequency coordination between various responders' radio systems created delays in allocation of resources.[62] In addition, numerous 911 cell phone calls from students inside the school began to quickly overwhelm the telephone communication system. Telephone system overload is common in MCEs. Another event that demonstrated the importance of interagency and interoperable communication capability was the Virginia Tech MCE. Medics from the scene reported several “dead zones” in Norris Hall dormitory, which resulted in “a tough time with radio communications traffic.” There was a significant degree of noise and chatter on the EMS radio frequency, which further complicated communication. A separate command frequency was available and was used, but information needed to be transmitted back to first-line responders on the EMS channel. Radios used by other responding agencies consisted of a combination of very high frequency, ultra high frequency, and hospital emergency ambulance radio frequencies.[66]

Another significant communications gap was the lack of credible information available to give to area hospitals concerning the number of patients they might receive. One hospital learned of the incident only when a call requesting a medical examiner at the scene was received. In several instances, on-scene providers called hospitals or other providers directly instead of going through incident command, thus increasing confusion. Upon review, this was determined to have occurred secondary to the lack of an Emergency Operations Center located at the university proper.[55] The lack of standardized on-scene communications can lead to serious safety issues for providers and a hampered response for victims. Preplanning considerations must include interoperability of communication services between incident command, dispatch, providers, and area hospitals.

Triage

Mass casualty triage (MCT) was first described and developed by British Naval surgeon John Wilson. Wilson postulated that in order for medical care to be lifesaving in mass injury, it should be provided to those most in need.[67] Mass casualty triage is intended to distinguish between those requiring immediate lifesaving care and those who can receive delayed care. In an MCE, triage is essential because the need for care can easily overwhelm available resources. Mass casualty triage differs from the triage processes normally performed in an emergency department. Most traditional emergency department triage protocols require several minutes per patient and take a variety of objective and subjective information into account but are appropriate under normal standards when the resources available meet or exceed the needs of the patients presenting for care.

However, during an MCE, the triage objectives change.[68,69] Mass casualty triage systems have been developed to address situations in which the number of casualties is greater than the available resources. In this paradigm shift, the priority becomes maximizing the number of lives saved. The focus changes from the needs of every individual patient to doing the best for the entire group of patients. Resources are allocated, and attention is directed to the most reasonably salvageable patients and not necessarily to the most critically ill or injured. Immediate treatment is directly only to those for whom lifesaving procedures may make the difference. Everyone else has delayed treatment. The aim of MCT is to provide the greatest good to the greatest number.

Altered standards and focus of care in MCT are indeed a grim reality. Many medical ethicists have written about it, and most agree that the utilitarian rule is in play. Using limited resources to obtain the greatest benefit, whether it is given to those most in need or not is the utilitarian concept used in most Western MCT schemes.[69,70]

Mass casualty triage is performed only in the case of a true MCE. There is no set number of victims that qualify a specific incident as an MCE. It is instead a function of the resources available and the severity of injuries of the victims. When the number of patients overwhelms the locally available resources, either in the field or at the treatment center, it is generally considered a mass casualty situation.

Triage is a dynamic process. Primary triage is the rapid patient assessment, assignment, and tagging usually done at the scene of an incident. These assignments can change during the secondary triage process. Secondary triage typically occurs at the health care facility where the patient is transported. There are often more resources available to the patient by the time they reach secondary triage.

Primary MCT is performed by EMS and other first responders at the scene. The goal of any MCT scheme is to assign the patient a triage category based on a rapid assessment of the severity of their injury and their physiologic parameters.[71,72] Primary MCT should be accomplished very quickly, requiring about 30 seconds per patient, and should be based solely on the patient's physiology. The goal of primary disaster triage is to assess how well the patient is able to use their own resources to compensate for their injuries—it should be as objective as possible. It also allows the field provider to determine which patients will benefit the most from the expenditure of their limited resources.

Most MCT systems use 4 color-coded categories: red, yellow, green, and black. Patients categorized as red are believed to have immediate or life-threatening injuries. Persons with these injuries are believed to be salvageable with immediate medical attention. Examples of these conditions include airway obstruction, significant external hemorrhage, shock, sucking chest wounds, or burns to the face and neck. The yellow category represents potentially serious injuries in patients who are stable enough to wait a short period for medical attention. Examples might include patients with an open thoracic wound, penetrating abdominal wound, severe eye injury, long-bone fractures, an avascular limb, or significant burns other than to the face or neck.

The green category represents patients with minor injuries, often termed "the walking wounded." These injuries can wait longer periods for treatment. Examples include minor lacerations, contusions, sprains, superficial burns, partial thickness burns, and ambulatory fractures.[72]

The black category in MCT algorithms represents patients who have either died or are expected to die. This includes patients that are alive but have injuries that are not compatible with survival under the current conditions. Assigning a patient who is still alive to the black category requires a clear understanding of available resources and conditions. Examples include those with no vital signs but also those with signs of impending death, those who do not respond to airway positioning, multisystem trauma with hemodynamic instability, and massive head injury.[73,74]

Two common types of triage models used are the sieve or sort methods. The sieve requires rescuers to initiate little or no treatment and primarily distribute those individuals into groups. This approach can lead to the overtriage of nonwalking casualties (ie, simple foot fracture) and children (infants and toddlers) and the undertriage of individuals with life-threatening injuries such as burns or head injuries.[59]

The sorting style triage tools are more time consuming and complex, for example, using a method based on the revised trauma score.[74] This approach is hypothesized to undertriage casualties who are gravely injured but have stable vital signs due to compensation.[59] These systems are frequently not used for these reasons.

A number of MCT tools or protocols have been developed. The START (simple triage and rapid treatment) protocol was developed in California in 1983 in response to a school bus accident.[75] It relies on rapid assessment of ambulation, airway, circulation, and neurologic function. It is reported that START can be rapidly performed with adult victims and can be readily taught to first responders. The START triage protocol has been criticized for a lack of objective evidence of its effectiveness, a deficiency of most MCT tools.[76] In 1996, Benson et al[77] developed an extension of the START with the "secondary assessment of victim end point" protocol. In this scheme, disaster patients are sorted into 3 categories: those who will survive regardless, those who will die even with maximal effort, and those who would benefit from immediate intervention.[77] The "secondary assessment of victim end point" protocol is particularly intended for situations in which transport to definitive care may be substantially delayed. The triage sieve protocol, used by the British military for primary triage, uses the parameters assessed in the START protocol, with the exception of mental status.[72] The French use a diagnosis-based MCT system, in which the triage officer makes a rapid assessment of field diagnosis and the patient is categorized based on that assessment.[68] The Italian EMS system uses a protocol titled CESIRA (Cosciente, Emorrhagia, Shock, Insufficienza, Rotture, Altre), which triages patients into red, yellow, and green categories. Italian law prevents paramedics from certifying death; thus, the protocol will not allow the use of a black category.[68]

Because many of the MCT protocols that have been developed are based on adults and there are clear anatomic, physiologic, and developmental differences in children, there is a need for a reliable pediatric mass casualty tool. Figure 1 highlights some of the many physiologic differences in children that make it difficult to categorize them using the standard mass casualty tools. The most important of these physiologic differences is the child's amazing ability to compensate for mild-to-moderate injuries. Infants and children can increase their heart rate significantly, thereby maintaining their cardiac output in the early phases of shock. This can serve them well in terms of survivability but makes appropriate triage difficult.

As previously discussed, maintenance of an adequate airway and appropriate oxygenation and ventilation in a child is of paramount importance. Circulation may be maintained for a short time after respirations have ceased in a child. The child is still salvageable in this period. If a pediatric victim of an MCE is encountered by a triage officer during this time when their respirations have ceased but circulation is still intact, then that child's life may be saved with a quick airway intervention.

The 3 objective and physiologic areas measured and assessed in most mass casualty triage algorithms are respirations, perfusion, and mental status. All 3 of these areas can be significantly different at baseline in children vs adults. In a child who is injured, these differences need to be appreciated when assigning a triage category. Heart rate and respiratory rate vary across the pediatric age spectrum. Capillary refill time in children may be effected by ambient temperature, and thus may not be reliable in austere conditions.[78] Any degree of hypothermia can cause a significant delay in capillary refill, which may not necessarily reflect a shock state in a child. Many children are not developmentally capable of following commands at a baseline, so assessing their mental status by their ability to follow commands is not a reliable indicator of central nervous system function. Most children are also developmentally reliant on adults and therefore may not independently self-evacuate to a safe area. Even if they are a child of ambulatory age, they will wait for their parent before moving to the safe zone.

First responders and EMS providers admit they often overtriage a child based solely on their age, even in day-to-day emergency care. Few EMS agencies have specific provisions for children in their MCE response plans.[8] Most EMS agencies do not interact with local schools or daycare centers to practice mass casualty incident drills. In a national survey, fewer than 20% of EMS agencies were found to use a pediatric-specific triage protocol, and less than 15% involved a pediatrician in their medical control.[8] The presence of an objective pediatric triage tool would serve to greatly ease the emotional stress upon the triage officer in this situation.

In answer to these needs, pediatric-specific MCT protocols have been devised. Perhaps the most well known and widely adopted is the JumpSTART algorithm authored by Romig in 2002. JumpSTART uses the existing START algorithm but incorporates pediatric physiologic parameters.[79] It allows for an additional intervention in the apneic child who is found to have a pulse, 5 rescue breaths, given the significance of airway intervention for such children.

The JumpSTART algorithm, combined with START, is depicted in Figure 2. It is designed to be used on any victim who appears to be less than 8 years of age (with START used for older children). The JumpSTART algorithm uses breathing, circulation, and mental status as physiologic parameters, just as in START. The airway is first assessed. If it is not functional, then the airway should be positioned. If this results in spontaneous resumption of respirations, then the patient is tagged red. If the child remains apneic after positioning the airway, then the pulse is assessed. If there is no palpable pulse, then the patient is tagged black. If they still have a palpable pulse but remain apneic, then 5 rescue breaths are administered by the triage officer. If the child remains apneic after this intervention, then they are tagged black and considered deceased. If the 5 rescue breaths results in spontaneous resumption of respirations, then they are tagged red. This delivery of 5 rescue breaths is termed the "JumpSTART."

The JumpSTART algorithm allows for the age-dependant physiologic parameters of a child in terms of respiratory rate, circulation, and mental status assessment.

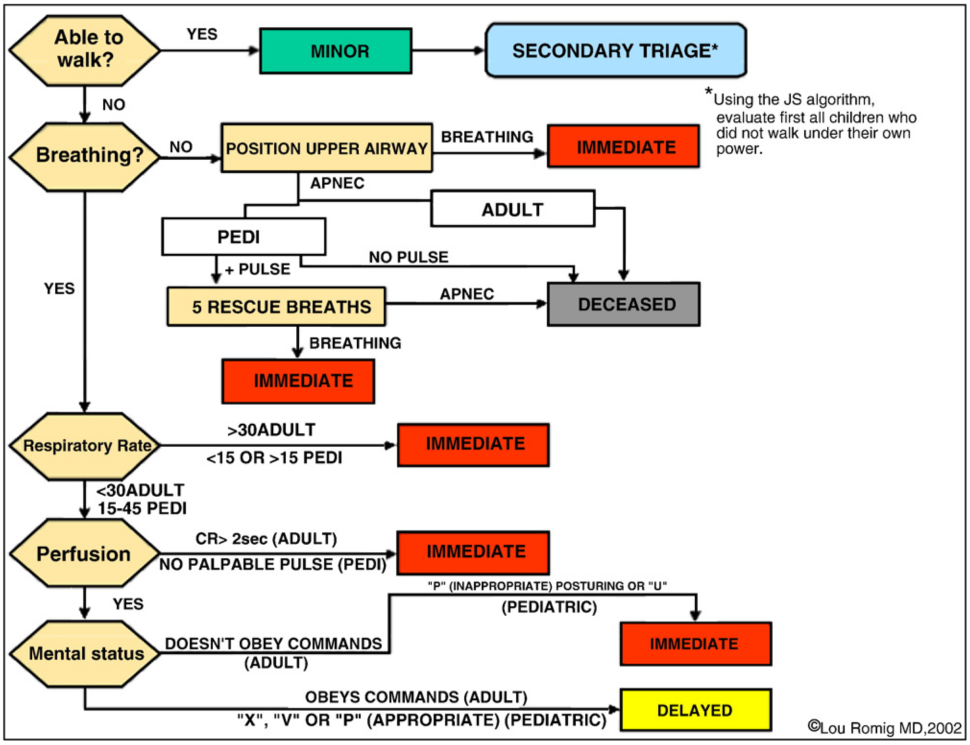

FIGURE 2. Combined START/JumpSTART triage algorithm.

Respirations: In the JumpSTART algorithm, a respiratory rate between 15 and 45 is acceptable. Children with rates less than 15 or greater than 45 are tagged red. Of course, in the interest of time, the exact respiratory rate will have to be quickly estimated.

Circulation: Because capillary refill time can be misleading in a child who is cold, a peripheral pulse is considered a more reliable assessment of perfusion. If the child has no peripheral pulse, they are tagged red. Those patients who do have a palpable peripheral pulse are then assessed for their mental status.

Mental status: In the pediatric patient, ability to follow commands is not necessarily a reliable indicator of mental status. Therefore, the AVPU scale (*A*lert, responsive to *V*erbal stimuli, responsive to *P*ainful stimuli, or *U*nresponsive) is used. If the triage officer determines that the pediatric patient is either *A*lert or responds to *V*erbal stimuli, or appropriately responds to *P*ainful stimuli, they are tagged yellow. If the child is *U*nresponsive or inappropriately responds to *P*ain (posturing) they are tagged red.

Two other protocols for the triage of pediatric patients have been suggested. The Pediatric Triage Tape is a system that uses length-based measurement and assessment of breathing and capillary refill time and is an adaptation of the triage sieve protocol.[80] The Pediatric Assessment Triangle was developed by the American Academy of Pediatrics as a part of the federal Emergency Medical Services for Children project. The Pediatric Assessment Triangle is intended to offer a rapid 30- to 60-second assessment of illness severity in infants and children. It is based on assessments of appearance, work of breathing, and circulation. Although it has been suggested as a disaster triage tool, it was not designed specifically for disaster triage and has not been objectively assessed for that purpose.[25]

There is as of yet no MCT tool specifically developed for children less than the age of 1 year. Infants that present to the safe zone with an adult should be assessed immediately. Certainly, their need for medical care and specialized assessment must be considered in conjunction with their need to remain with their family member because separation from family is a significant risk for children.

Children with special medical needs pose additional challenges for MCE planning and response. These children may be developmentally delayed at a baseline, making their assessment even more difficult. It is recommended to use the JumpSTART algorithm for this population. If any of the assessed physiologic parameters put a child with special needs into the immediate category, then they should be tagged red. If at the completion of the JumpSTART triage algorithm they meet criteria for a yellow tag, then the triage officer must look for significant external injuries. They should be tagged yellow if they have significant external signs of injury such as deep penetrating wounds, severe bleeding, severe burns, or an amputation. If they meet criteria for a yellow tag but have no significant external injury, then they are tagged green.

All MCT tools have limitations. None have been well validated by outcomes data; this makes it very difficult to endorse any single tool.[68,69,72,76] Another significant limitation of all MCT algorithms is that they are not as simple as they appear. They require repetitive practice. Even for providers who are used to doing standard triage under normal standards of care, MCT can be very difficult. It requires a conscious shift in thinking and priorities. Perhaps the most obvious limitation of pediatric-specific algorithms is that they require diligent attention to detail. Most EMS providers do not get enough hands-on experience with pediatric victims to remember a disaster triage algorithm instinctively—it requires a great amount of training and practice to perfect.

Perhaps the most significant issue with current MCT systems is that there is considerable variability in the type of tool used. There is presently no national standard disaster triage protocol. Different jurisdictions use different protocols; yet mass casualty patients frequently cross jurisdictional lines. A common language or universally accepted tool for mass casualties would serve our country well in the face of large-scale disasters that require communication and cooperation between multiple state, local, and federal agencies.

To address some of these limitations, a consensus statement has recently been endorsed by multiple professional organizations. In July of 2008, a panel of experts issued a proposition entitled SALT (Sort, Assess, Life-saving interventions, and Transport/Treatment), which is intended to simplify triage of all victims, ensure that lifesaving interventions are provided before a severity category is assigned, and hopefully provide some uniformity among the tools currently practiced.[69] It attempts to incorporate the most effective parts of all currently available tools and could potentially be taught to those trained in other methods. SALT offers 5 levels of severity. In addition to the red, yellow, green, and black categories seen in most 4-level systems, SALT allows for a gray category. Patients in the gray category have severe injuries or signs of impending death but are not dead at the time of primary triage. It may serve the triage officer well to be able to easily identify those patients who deserve and would benefit from more resources as they become available. SALT is intended to be used for both pediatric and adult victims.

Treatment, Transport, and Disposition

The limits of pediatric surge capacity and capabilities as previously discussed are likely to be an important issue in determining the transport of pediatric victims to definitive care. Adult facilities may need to accept low-acuity pediatric patients; although this may more readily overwhelm the facility than the same number of adult patients due to scarce pediatric supplies or limited pediatric care experience. Tertiary pediatric facilities may be able to provide receiving facilities with needed resources such as anesthesia and pediatric resuscitation teams. Local EMS services need to be aware of the pediatric surge capabilities in the region so that children can be taken to the facilities best capable of caring for them without overwhelming a single hospital. Pediatric patients requiring tertiary care may require transports of long distances to reach specialized facilities with available bed capacity. Plans for the care of children in MCEs should include provisions for long-distance transport.[81] In addition, pediatric planning should include provisions for mental health services because children are particularly vulnerable. Understanding the mental health and social work capabilities in a particular region is an important part of developing a community or regional disaster plan.

Some of the care for pediatric patients in a disaster situation may occur in a DMAT field clinic. DMATs are mobilized by the federal government to assist local entities in a large-scale disaster. Currently, there are no universal requirements for pediatric personnel, training, medication, or equipment within DMATs. There are presently 2 pediatric specialty DMATs.[82] Assessments of pediatric readiness have called for the development of additional pediatric capability in the present DMAT system.[1]

Where Do We Go From Here?

The outcomes for pediatric victims of a disaster can likely best be improved by focusing on the day-to-day readiness of our emergency care system for the management of pediatric victims. Many EMS providers openly admit to being uncomfortable with pediatric patients in their daily practice. Increased focus on education and training of EMS providers in the emergency care of children will pay dividends in better care for day-to-day concerns and better disaster preparedness.

First responders and EMS providers need to have access to the appropriate pediatric equipment as well as the opportunity to practice using that equipment on a frequent basis. There are some tools available to the EMS provider, such as length-based resuscitation tapes that make the dosing of fluids and resuscitation medications a simpler task. This equipment is not always available to EMS providers and does require some familiarity to enable effective use.

Some treatment adjuncts, such as intraosseous needles, can be lifesaving for a pediatric patient. The use of new drills for intraosseous needle placement may make that procedure more successful but, again, requires some training of the EMS professional and availability of the correct equipment.

Another opportunity for improvement is in making decontamination facilities more child and family friendly. These facilities should have warm water available whenever possible and have a plan for children who require some adult supervision in the process.

A nationally standardized disaster triage protocol would provide the advantage of cross jurisdictional compatibility. In addition, research should focus on the validation of disaster triage protocols to ensure that they accomplish their stated purpose.

Perhaps the greatest opportunity for improvement in the prehospital care of pediatric patients is in interagency planning and collaboration, as might be achieved in more frequent and effective community-wide disaster drills. Very few EMS providers participate in drills with local schools or daycare centers. Community-wide disaster drills often do not include pediatric victims in the scenario.[8] Encouraging community-wide drills that would allow first responders and EMS providers to interact with children would increase their comfort level in caring for them and allow the practice of pediatric-specific triage algorithms. Such a drill would also encourage better communication between the different agencies involved in a mass casualty incident and typically generates a productive dialogue. This kind of dialogue is the best forum for communities to find solutions to the many taxing issues of pediatric care in MCEs. ✚

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