

Prehospital Response and Field Triage in Pediatric Mass Casualty Incidents: The Israeli Experience

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Israel has been subject to hundreds of violent acts against the civilian population in the last several years, many of them mass casualty incidents involving children. The pediatric age group is characterized by unique anatomical, physiological, and developmental traits that make the treatment of traumatic injury particularly difficult. The aim of this article is to review and analyze the cumulative experience gained in Israel with the management of children injured in mass casualty incidents, with a focus on the structure and modified triage algorithm of the national emergency medical system and the recommendations of the National Committee on the Management of Pediatric Mass Casualty Incidents.
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In recent years, Israel (area, 21,946 km²; population, 6.7 million) has been subject to waves of violent terrorist acts against civilian populations (AACPs) that have killed and injured hundreds of individuals. The reported inhospital mortality for trauma induced by AACPs in Israel is 4.4% [1,2] or 3 times higher than the rate for motor vehicle crashes (1.4%) and almost 15 times higher than the rate for other mechanisms of injury (0.3%) [1,2]. Overall, AACPs were responsible for 10.9% of all inhospital deaths from trauma from 2000 to 2002 [1].

Acts that involve more than 20 individuals are defined by the national emergency medical services (EMS) system as mass casualty incidents (MCIs). MCIs, aside from the physical and mental injury they inflict, strain emergency services and pose a particular challenge to professionals involved in each phase of the continuum of care. This is especially true when the victims are children because of the great variability in the ages of affected children and their unique anatomical, physiological, and developmental characteristics. Moreover, pediatric victims of AACPs suffer injuries not typically seen in that age group. Finally, medical and paramedical personnel worldwide

are also less experienced with the emergency management of critically ill or injured children than they are with adults.

The aim of this paper is to review and analyze the cumulative experience gained in Israel with the management of children injured in MCIs. We focused on the

Abbreviations: ED, emergency department, EMS, emergency medical services, EMT, emergency medical technician, ICA, intensive care ambulance, ITR, Israel Trauma Registry, MCI, mass casualty incident, MDA, Magen David Adom, MICU, mobile intensive care unit.

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modified prehospital response and field triage practiced by the national EMS system and the recommendations for improving outcomes by the National Committee on the Management of Pediatric MCIs appointed by the Israel Ministry of Health.

Characteristics of Injuries in Pediatric Victims of MCIs

Between January 2001 and December 2004, 52 MCIs occurred in Israel, including explosions, shootings, stabbings, and stone throwing. Most occurred in public venues such as malls, markets, buses, and restaurants. In 22 MCIs caused by explosions, a total of 1392 victims were evacuated by Magen David Adom (MDA—the national EMS system) from the scene. Of these victims, 166 were children who were subsequently hospitalized. Of the 166 children, 66 (40%) were aged 0-12 years, and 100 (60%), 13-18 years; the male to female ratio was 1:1 (Israel Trauma Registry data, personal communication). According to the Israel Trauma Registry, these children accounted for 70% of the total number of children hospitalized for injuries during this period.

The injury severity scores by age group are shown in Table 1. Most patients sustained injury in multiple body regions. The most common site of injury was the extremities (62.8%), followed by the head (47.3%) and torso (37.2%); 18.2% of the children suffered traumatic brain injury [1]. Most of the wounds were caused by penetration of foreign objects (shell fragments, nails, bolts, nuts, metal balls, etc) driven by bomb explosions, usually in enclosed areas. Compared with children who sustained non-terror-related injuries [2], the victims of MCIs suffered a relatively high proportion of penetrating injuries (54%) and a lower proportion of blunt injuries (45%).

Prehospital EMS in Israel

All prehospital EMS in Israel are provided by Magen David Adam (MDA), a non-governmental organization. Many of its practices are based on the guidelines of the Prehospital Trauma Life Support course, which emphasizes life-saving procedures on the scene and further stabilization en route to the hospital.

The MDA operates as a 2-tier system, with 350 (126/shift) regular, basic life support ambulances and

120 (64/shift) advanced life support, mobile intensive care units (MICUs). The regular ambulances are staffed by one emergency medical technician (EMT)/driver and another EMT or volunteer. The MICUs are staffed by an EMT/driver and either physicians or paramedics (20 units) or paramedics only (44 units). Calls are processed by 11 regional dispatching centers around the country.

The medical response to MCIs may be divided into 3 phases [3]:

- (a) The “chaos” phase starts immediately after the occurrence of the event (explosion of a suicide bomber, for example) lasting for 10 to 20 minutes. It is characterized by disorganization among the first teams responding to the scene, owing to a lack of medical command and pressure from victims and bystanders.
- (b) The medical organization (command) phase begins with the arrival of the EMS commander at the scene, lasting for 10 to 30 minutes. The functions of the EMS commander are 4-fold: (1) identify the victims who need immediate care, (2) organize the evacuation of victims from the scene, (3) verify open routes to and from the scene, and (4) allocate victims to the appropriate medical facility.
- (c) In the restoration phase, victims with minor injuries are evacuated, and routine is restored. This phase takes place from 50 to 70 minutes from the onset of the event. Some of the victims, particularly those with acute stress reactions, may arrive at emergency departments hours or days after the event.

To improve the efficiency and intelligence of the EMS system, in 2001, the MDA upgraded its communications system, specially trained and equipped approximately 1500 volunteer “first responders” nationwide, and recruited EMTs who could respond at all hours [4]. It even began holding its national educational and social events in large urban locations, to which participants were required to arrive in ambulances. Importantly, to help the staff cope with young victims, the MDA initiated mandatory pediatric advanced life support courses for all relevant personnel and equipped ambulances with appropriately sized apparatus for pediatric care.

Table 1 Distribution of children involved in MCIs by age group and by injury severity scores.

Age (y)	Injury severity scores					Total
	Not known	1-8	9-14	16-24	25-75	
0-12	1 (0.6)	35 (21)	9 (5.4)	13 (8)	8 (5)	66 (40)
13-17	1 (0.6)	46 (28)	14 (8.4)	17 (10)	22 (13)	100 (60)
Total	2 (1.2)	81 (49)	23 (13.8)	30 (18)	30 (18)	166 (100)

Values are presented as number (percentage).

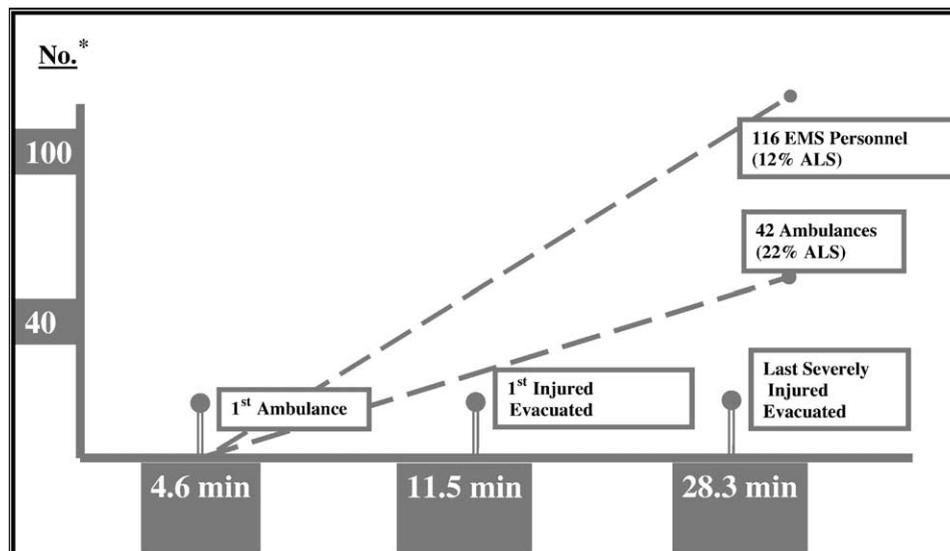


Figure 1 MDA amassed timetable (average values) in MCIs. *Refers to absolute number of EMS personnel or ambulances at the scene.

Field Triage in MCIs

Triage is the medical screening of patients according to their need for treatment and the resources available in MCIs when conventional standards of medical care cannot be delivered to all victims [5,6]. Critically injured victims (who are salvageable) who need immediate care should be rapidly identified, given lifesaving measures, and transported to the appropriate facility. The allocation of victims to facilities should occur with consideration of their available capabilities to avoid overcrowding. The goal of triage is to optimize care for the maximum number of salvageable patients.

The approach used in Israel is based on the experience gained by the MDA and trauma centers during the recent waves of terrorism and by Israeli medical relief teams serving abroad in Armenia, Argentina, Mexico, Kenya, Honduras, Turkey, Sri Lanka and El Salvador [7]. Victims of MCIs are initially categorized into 1 of 3 treatment groups [8-10]: immediate care, delayed care, or unsalvageable. Numbers, colors, or symbols may be used to denote the different categories. In Israel, a blue tag is added to identify children and a gray one to identify patients with a combined injury induced, for example, by chemical and conventional weapons. Some teams prefer a site-based categorization. No matter what the method is, the signs must be appropriate and clear.

The extensive experience with traumatic injuries in Israel prompted the MDA to switch from its original “scoop-and-run” policy to the “save-and-run” method for both adults and children. This approach stipulates an optimal on-scene treatment time, that is, “10 golden minutes,” and an optimal arrival time for definitive care, that is, a “golden hour.” Analysis of the MDA registry found that with this protocol, the median time from call to arrival at the scene was 6 minutes (within 10 minutes

in 81% of cases), the median on-scene treatment time was 11 minutes (within 10 minutes of arrival in 49% of cases), and the median transportation time was 8 minutes (within 10 minutes in 46% of cases).

The save-and-run protocol was applied in all 22 MCIs from 2000 to 2004. The first ambulance arrived at the scene within an average time of 4.6 minutes; the first casualty was evacuated at 11.5 minutes; and the last emergency patient was evacuated at 28.3 minutes (Figure 1). Sixty-eight life-saving procedures were performed at the scene for 73 of the 281 victims (26%) with injuries categorized as urgent (total N = 1392). Patients were evacuated to 1 or more of 3 hospitals. Multiple facilities, including designated trauma centers, were used when there was a danger of overwhelming a single one.

Special Considerations for Children

Whether children should receive priority over adults within the same triage category remains controversial. The Save the Children Fund in 1923 and the United Nations Children’s Fund in 1990 declared that children must receive relief first, but these recommendations are not universally accepted [11].

Be that as it may, triage poses a greater challenge in children, and mastering the art of triage in this population requires extensive education and training [12]. Measurements of vital signs, particularly blood pressure—which forms the basis of rapid assessment in adults [13,14]—are difficult to obtain and time-consuming, and patient cooperation may be limited. Furthermore, the unique physiological and anatomical characteristics of children lead to different mechanisms of injury than adults. For example, approximately 60% of all MCI and

disaster injuries involve the head in pediatric victims. In states of altered consciousness, pediatric upper airways tend to become obstructed because of the relatively large, flaccid tongue, or kinked because of flexion of the relatively large head and short occiput. Children also have more pliant and flexible bones than adults and are therefore subject to fewer bone fractures. However, internal organ injuries in the absence of fractures of the overlying bony skeleton, in the chest or upper abdomen for example, are not uncommon [15].

Other important differences are the less mature thermoregulatory mechanisms and the higher surface area-to-mass ratio in children compared with adults. This makes children more susceptible to heat loss and hypothermia, particularly during exposure to extreme conditions, such as cold weather, decontamination with cold water during biochemical events, or undressing during field triage. Furthermore, owing to their smaller body size and smaller total blood volume, what may seem to be relatively minor bleeding may in fact represent a significant volume loss in a child.

In addition to physical injuries, emotional trauma caused by the child's exposure to a terrorist AACP or by separation from the parents is an important factor in pediatric care. Because children tolerate multiple organ injuries better than adults [15], prognosis is usually dependent upon the severity of the associated head injury, if present [16]. Children have a better prognosis for most, if not all, disaster-related conditions.

Recommendations of the National Committee for the Management of Pediatric Mass Casualty Incidents

The National Committee for the Management of Pediatric MCIs was formed to improve the management of children involved in MCIs. The 11-member committee was appointed by the Emergency Division of the Ministry of Health and was composed of pediatric and trauma medical and paramedical experts from the MDA national EMS system, various hospitals, and the Israel Defense Forces. Both the prehospital and hospital phases of care were covered. Special attention was directed to work force, equipment, and training. The recommendations for the prehospital phase of care follow.

Definitions

- (a) *Pediatric age in MCI*: The definition of pediatric age varies greatly among hospitals in Israel, as well as worldwide. Where to draw the line to distinguish between children and adults is difficult because of the many medical and logistic

factors involved. In trauma victims, the main concern is the relative lack of staff knowledge and skill level in the management of infants and preschoolers. However, variability in body size and emotional attitudes is typical of older children as well. Therefore, the committee defined the age cutoff at 12 years.

- (b) *Pediatric MCI*: The committee defined a pediatric MCI as an MCI involving 10 or more children aged 0-12 years, with or without adult victims. In pediatric MCIs, staff must address special attention to the needs of children at all levels of care: prehospital, primary (field) triage, hospital triage, and secondary triage (interhospital transfer).
- (c) *Pediatric staff*: The committee recommended using specially trained interdisciplinary medical and paramedical staff in the management of pediatric MCIs.

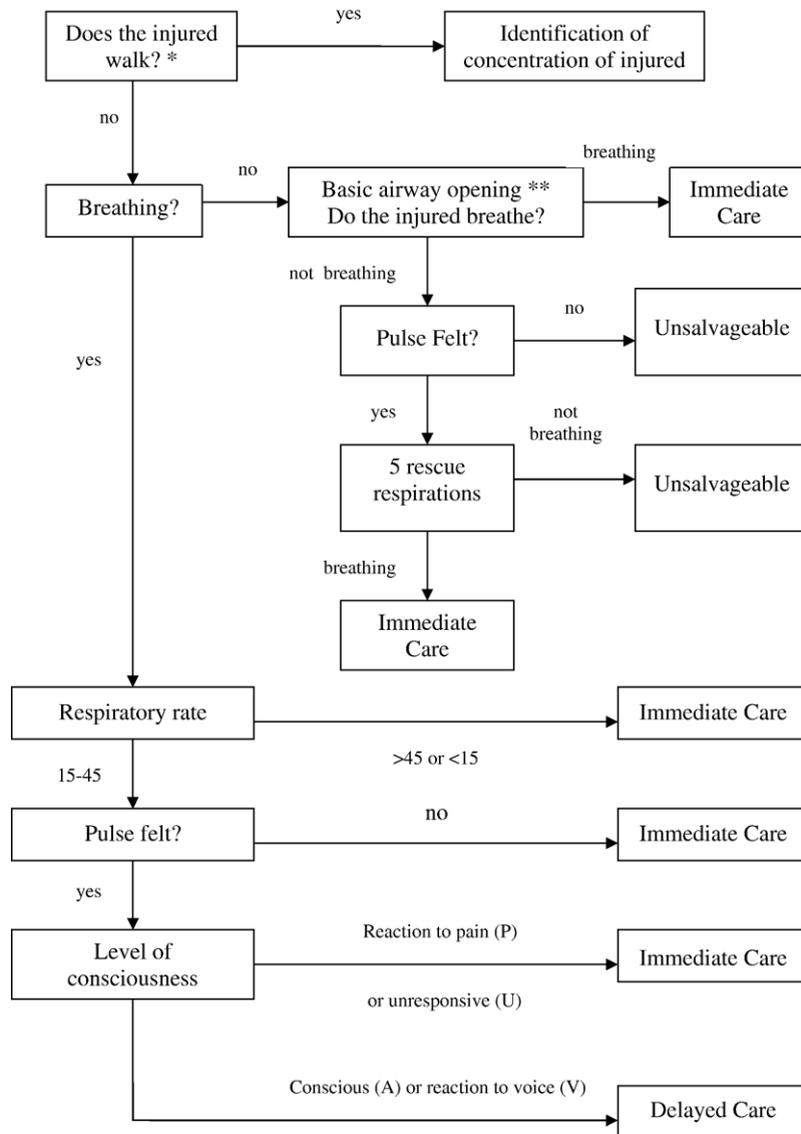
Prehospital Phase

The MDA is responsible for the management of all MCIs, general and pediatric. Because of the particular structure of the institution [17], paramedics constitute the main professional group managing children, assisted by EMTs, drivers, medics, and physicians when available.

The committee found that MDA paramedic teams were deficient in their knowledge and skill levels for pediatric management because of the relative rarity of pediatric MCIs; some providers even avoided the delivery of care to this age group. Therefore, they recommended that the MDA offer an ongoing (once every 6 to 12 months) training course in professional skills, decision making, and team management in pediatric MCIs, including case presentations based upon real events, at all levels (scene managers, providers) and phases (prehospital and field, inhospital and secondary triage) of care. The purpose of this course was to emphasize the unique anatomical, physiological, and psychological characteristics of children. The committee also suggested that paramedics be encouraged to practice advanced airway management in hospital operating rooms. Furthermore, the committee recommended that the MDA promote awareness of pediatric issues during its routine activities.

Field Treatment and Triage

The patient care guidelines of the Prehospital Trauma Life Support and Advanced Trauma Life Support courses [18,19] are the same for adults and children. However, the unique characteristics of children, combined with the relative infrequency of pediatric MCIs, may lead to difficulties in performing certain clinical procedures, such as intubation of the trachea or achieving vascular access. The committee therefore recommended that only life-saving procedures that could not be achieved by other means, such as opening the airway or maintaining



* Triage of infants who do not walk according to the whole algorithm

** Basic airway opening – mouth opening and secretion extraction

Figure 2 The JumpSTART triage algorithm.

oxygenation/ventilation, should be performed for children at the scene. Other procedures that are routinely performed at the scene for adult victims, such as establishing an intravenous line, should be postponed until the child's arrival to the emergency department.

Because injuries are such stressful events for children, and the younger the child, the more difficult the communication, the committee recommended that the EMS staff find an adult familiar to the child, if possible, to accompany him/her to the hospital. However, if such a person is not available, patient evacuation should not be delayed.

The committee recommended that field triage be continuously performed by the senior staff of the MDA using the JumpSTART [20] method of simple triage and

rapid treatment (Figure 2), modified for children aged 1-8 years, which takes into account differences in ability to walk, respiratory rate, obedience to commands, and other special considerations for infants. In this modified version, 2 steps were added to determine death. Maintaining a consistent primary triage method for adults and children is important in MCIs involving a mixed population of adults and children and in cases when a victim's age cannot be determined.

Evacuation

The committee recommended that children be preferentially evacuated to a hospital with pediatric capabilities.

Children with severe injuries who cannot be stabilized should be evacuated to the nearest hospital, with secondary transfer to a pediatric facility as necessary. This process should be coordinated by the Civil Defense Unit of the Israeli Defense Forces. Because the emergency department must make special arrangements for the admittance of children, the committee recommended that the MDA notify the hospitals of the type of event and estimated number of victims to expect.

Apparatus

The committee recommended that every MICU/ICA MDA ambulance be equipped with age-appropriate advanced life support apparatus (eg, endotracheal tubes, laryngoscopes) for 2 children and to add 4 such bags to the extra equipment in every mobile "storage" unit. If space limitations preclude the use of separate bags, the equipment for each age group could be included in the portable bags. In addition, 300 specially equipped pediatric advanced life support bags were to be distributed to paramedics for use in MCIs. In this manner, there would be enough equipment to take care of at least 10 severely injured children in the early stages of MCI events (about 10 minutes after the call) in urban areas. These instructions did not cover non-age-dependent equipment for which a shortage was not expected.

The committee also recommended that each ambulance contain a resource indicating the appropriate size of the equipment and doses of medications for different age groups as determined by a Broselow tape. Adjustable cervical collars should be provided for use in children younger than 3 years old; cervical collars for older children are routinely carried in ambulances in Israel.

Summary

The relatively high number of children affected by terrorist acts in Israel in the recent wave of violence has substantially increased the cumulative workload of healthcare professionals at the scene and in hospitals and trauma centers and has shifted the pattern of care in accordance with the needs imposed by terror-related injuries. A well-organized, well-equipped, and well-trained multidisciplinary medical system at the prehospital and hospital phase can decrease the enormous toll these events have upon lives as well as in physical and psychological morbidity. The experience gained in Israel can contribute to the preparedness of medical personnel to cope with future events in this country and elsewhere. Further studies of other aspects of traumatic injury, such as its short- and long-term psychological consequences, are still needed to provide a more comprehensive understanding of the impact of acts of terrorism on children.

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