SPECIAL REPORT

The Impact of Terrorism on Children: A Two-Year Experience

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Abbreviations:
ED = Emergency Department
EMS = Emergency Medical Services
EMT = Emergency Medical Technician
ISS = injury severity score
ITR = Israel Trauma Registry
MCE = Mass-Casualty Event
MDA = Magen David Adom
MICU = mobile intensive care unit

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Abstract

Objectives: To review and analyze the cumulative two-year, Israeli experience with medical care for children victims of terrorism during the prehospital and hospital phases.

Methods: Data were collected from the: (1) Magen David Adom National Emergency Medical System Registry (prehospital phase); (2) medical records from the authors' institutions (pediatric triage); and (3) Israel Trauma Registry (injury characteristics and utilization of in-hospital resources). Statistical analyses were performed as appropriate.

Introduction: During the recent wave of violence in Israel and the surrounding region, hundreds of children have been exposed to and injured by terrorist attacks. There is a paucity of data on the epidemiology and management of terror-related trauma in the pediatric population and its effects on the healthcare system. This study focuses on four aspects of terrorism-related injuries: (1) tending to victims in the prehospital phase; (2) triage, with a description of a modified, pediatric triage algorithm; (3) characteristics of trauma-related injuries in children; and (4) utilization of in-hospital resources.

Results: During the study period, 41 mass-casualty events (MCEs) were managed by Magen David Adom. Each event involved on average, 32 regular and nine mobile intensive care unit ambulances with 93 medics, 19 paramedics, and four physicians. Evacuation time was 5–10 minutes in urban areas and 15–20 minutes in rural areas. In most cases, victims were evacuated to multiple facilities. To improve efficiency and speed, the Magen David Adom introduced the use of well-trained "first-responders" and volunteer, off-duty professionals, in addition to "scoop and run" on-the-scene management. Because of differences in physiology and response between children and adults, a pediatric triage algorithm was developed using four categories instead of the usual three. Analysis of the injuries sustained by the 160 children hospitalized after these events indicates that most were caused by blasts and penetration by foreign objects. Sixty-five percent of the children had multiple injuries, and the proportion of critical to fatal injuries was high (18%). Compared to children with non-terrorism-related injuries, the terrorism-related group had a higher rate of surgical interventions, longer hospital stays, and greater needs for rehabilitation services.

Conclusion: Terrorism-related injuries in children are severe and increase the demand for acute care. The modifications in the management of pediatric casualties from terrorism in Israel may contribute to the level of preparedness of medical and paramedical personnel to cope with future events. Further studies of other aspects of traumatic injuries, such as its short- and long-term psychological consequences, will provide a more comprehensive picture of the damage inflicted on children by acts of terrorism.

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Introduction

During the recent wave of violence in Israel and the surrounding region, hundreds of children have been injured and dozens have been killed. Terrorism affecting children on such a large scale is uncommon, and a literature search yielded only one specific report about pediatric injuries due to terrorism,[1] and very little information regarding the epidemiology and management of terrorism-related trauma on the pediatric population. To date, most of the studies of children and terrorism have dealt with its psychological impact[2–4] or the potential effects of chemical or biological agents.[5,6]

Terrorist acts against the civilian population, and against children in particular, have a devastating impact on the body and mind. They present a great challenge to professionals in all fields and to the disciplines of medical care, as well as to the societal structure and infrastructure. Owing to the paucity of data relative to the epidemiology and management of terrorism-related trauma in the pediatric population and its effect on the healthcare system, the cumulative Israeli experience gained and lessons learned are shared. This paper focuses on four main aspects: (1) tending to victims of terror in the prehospital phase; (2) triage, with a description of a modified pediatric, triage algorithm; (3) characteristics of terror-related injury in children; and (4) utilization of in-hospital resources.

Background

Prehospital Phase

Israel covers an area of 21,946 km^2 (13,387 mi^2) and is populated by about 6.7 million inhabitants. All of the prehospital emergency medical services (EMS) throughout the country are provided by the government-owned Magen David Adom (MDA). Currently, there are 350 (115 per shift) regular ambulances and 52 (25 per shift) mobile intensive care units (MICUs) in service. About half of the MICUs are staffed by physicians and paramedics and only about half by paramedics. Calls are processed by six dispatching zones spread around the country. The MDA is the first responder in mass-casualty events (MCEs) and operates in wartime as well as during relative peacetime. The data presented in this section were abstracted from the MDA Registry.

Mass-casualty events are defined as events involving >20 casualties. Between September 2000 and December 2002, MDA crews responded to >1,000 calls for acts of terrorism, including shootings, car bombings, and suicide bombers, of which 41 were MCEs. The number of casualties ranged from 21 to 101, with an average of 25 per event; 160 of the hospitalized victims were <18 years old. Thirty-five MCEs (85%) took place in large urban areas or roads, and six (15%) in small towns/rural areas or roads. On average, 32 regular and nine MICU ambulances, staffed by a total of 93 medics, 19 paramedics and four physicians, participated in victim evacuation at each event. The scene-to-hospital evacuation time was 5–10 minutes in urban areas and 15–20 minutes in rural areas. In six (15%) MCEs, casualties were evacuated to a single medical facility, in 12 (29%) to two facilities, and in 23 (56%) to ≥3 facilities. Multiple facilities, including designated trauma centers, were used when there was a danger of overwhelming a single facility.

With the increase in the number of MCEs over time and the experience gained with each new event, the MDA introduced several measures to cope with the need for a large number of ambulances and staff within the shortest possible response time. First, approximately 1,500 "first-responder" volunteers from around the country, were specially educated and trained to arrive at the scene quickly and to initiate medical care even before the arrival of the MDA crews. The volunteers were equipped with appropriate medical supplies and on-call capabilities at home and work. Second, to expand the number and radius of distribution of ambulances and personnel around large cities and to significantly shorten response time of professionals, the MDA sought volunteer emergency medical technicians (EMTs), paramedics, and ambulance drivers who could respond to calls from home with fully equipped ambulances even when off-duty. Concomitantly, radio and beeper communication systems for all personnel were expanded and upgraded, and a policy of "scoop-and-run" management at the scene was instituted. Finally, to increase staff availability and readiness, the MDA began holding all of its national educational and social events in large urban locations rather than in small, remote places, and participants in these events were required to arrive in ambulances. Together, these measures created a rapid, efficient, and intelligent response system.

Triage of Children

Triage is the medical screening of patients according to their need for treatment and the resources available in mass-casualty situations, when conventional standards of medical care cannot be delivered to all victims.[7,8] 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 current wave of terrorism and by Israeli medical relief teams serving abroad (in Armenia, Argentina, Mexico, Kenya, Honduras, Turkey, and El Salvador).[9]

General Triage Techniques

Victims of a multi-casualty event initially are categorized into one of three treatment groups: (1) immediate care; (2) delayed care; or (3) unsalvageable.[10–12] 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 tag is used to identify patients with combined injuries (induced, for example, by chemical and conventional weapons). Some teams prefer a site-based categorization. No matter which method is used, the signs must be appropriate and clear.

Special Considerations for Children

Whether children should get priority over adults within the same categories remains controversial. The Save the Children Fund in 1923 and the United Nations Children's Fund (UNICEF) in 1990 declared that children must receive relief first, but this recommendation is not universally

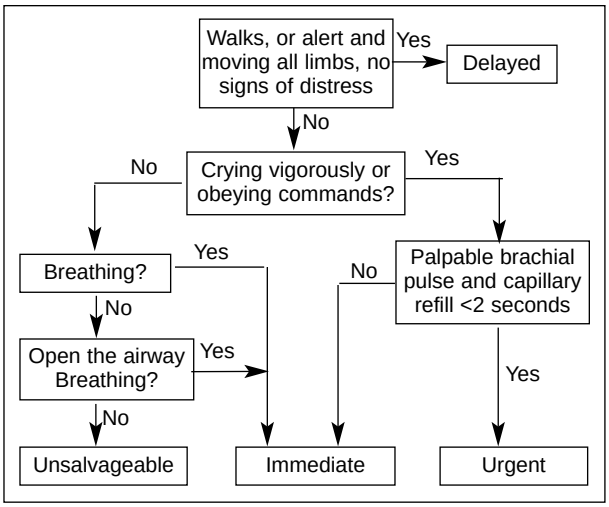

Figure 1—Algorithm for mass casualty pediatric triage

Parameter	Conventional Triage	Modified Triage
Triage site	Inside emergency department	Outside emergency department
Triage professional	Nurses	Senior physician
Assessment technique	Clinical + physiological measurements	Clinical
Measurement of vital signs	Required	Not performed
Extent of resuscitation	Maximal care for every patient	Unsalvageable category implemented
Decision to transfer	Performed after initial care	From triage, according to patient condition and availability of local resources

Table 1—Comparison of conventional triage system and mass casualty triage algorithm formulated by authors

accepted.[13] Nevertheless, triage poses a greater challenge in children, as measurements of vital signs, particularly blood pressure—which forms the basis of rapid assessment in adults[14,15]—are difficult to obtain, are time-consuming, and cooperation is limited. Furthermore, their physiological and anatomical characteristics of children lead to different mechanisms of injury from those for adults. For example, in children, approximately 60% of all MCEs and disaster injuries affect the head. In states of unconsciousness, upper airways of children tend to become obstructed by their 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 do adults, and therefore, are subject to fewer bone fractures. However, internal organ injuries in the absence of fractures of the overlying bones, for example in the chest or upper abdomen, are not uncommon.[16] Other important differences are the less mature thermoregulatory mechanism and higher surface area-to-mass ratio in children compared to adults, which make them 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 at triage. Furthermore, owing to their smaller body size and smaller total blood volume, what may seem to be minor bleeding may represent a significant volume loss.

In addition to physical injuries, emotional trauma, for example caused by separation from the parents, is an important factor in pediatric care. Because children tolerate multiple organ injuries better than do adults,[16] prognosis usually depends on the severity of the head injury, if present,[17] Children have a better prognosis for most, if not all, disaster-related conditions.

Modified Algorithm for Pediatric Triage

The current suggested guidelines for triaging children in MCEs[17,18] fail to take most of these special considerations into account. They all use methods that require blood pressure measurement, and all automatically categorize young infants who cannot walk, for immediate care. None include an air-opening maneuver for children who are not responding on presentation or accounts for differences in physiological parameters with age. In consequence, on the basis of extensive experience, a new algorithm was formulated for pediatric triage in MCEs (Figure 1) that uses four priority categories instead of three: I—Immediate care/shock room; II—Urgent care/emergency department; III—Delayed care; and IV—Unsalvageable. In view of the lack of objective parameters for triaging children, this algorithm emphasizes the need for clinician experience in pediatrics and trauma care for the quick and accurate assessment of respiratory, circulatory, and central nervous system function. The most important aim of triage is the rapid identification of patients in Category I. As noted in the work of Hirshberg *et al*[19] and supported by our experiences with the patients in the immediate-care group, it particularly is important to identify critically injured children who require treatment in shock rooms, and of those in the Delayed care group, it is important to identify children with anxiety and acute emotional stress who need to see a social worker or mental-health professional.

In general hospitals, a separate area in the emergency department should be designated and equipped for the assessment and care of children. Carts with appropriate equipment for the level of care (Immediate or Delayed) should be prepared in advance, and, should be brought to the site at the time of the event, with consideration of the possibility with under-triage of some Immediate care patients.

The triage site ideally should be staffed by two experienced physicians, one with expertise in emergency medicine and the other with expertise in pediatrics, pediatric emergency medicine, or critical care. The physicians should be assisted by one nurse each for tagging patients and delivering medical care. In addition, auxiliary personnel are needed to carry stretchers and security guards also should be positioned. At least one physician and one nurse should be available for each patient admitted to the Immediate-care site. All medical staff assigned to triage must be specially trained in the necessary resuscitation techniques.

	n	(%)
Gender		
Male	84	(52.5)
Female	76	(47.5)
Age group (years)		
0–2	13	(8.1)
3–6	17	(10.6)
7–10	18	(11.2)
11–14	38	(23.8)
15–17	74	(46.3)
Total	160	(100)
Mean ±SD (years)	11.9 ±5.1	

Table 2—Demographic characteristics of children with terrorism-related injuries (n = number)

Differences between conventional triage systems and our mass casualty triage algorithm are summarized in Table 1. An example of our experience using the algorithm is described elsewhere.[7]

Methods

Characteristics of Terrorism-Related Injuries in Children Database

The study population was comprised of all of the 160 children (age <18 years) who were injured in the 41 MCEs from 2000 to 2002. Data on patient characteristics, nature of the injuries, and outcome were obtained from the Israel Trauma Registry (ITR), which records all of the hospitalizations for physical trauma at nine trauma centers (six Level-1) in the country. All of the nine centers are part of designated tertiary-care and referral hospitals that receive the majority of severely injured or complicated trauma cases. In-hospital deaths and transfers to acute care hospitals were noted. The ITR does not account for non-hospitalized injured patients, patients with acute traumatic stress reactions (who usually are treated and discharged from the emergency department), and patients who die on the scene or are declared dead on arrival.

Medical diagnoses derived from the registry were coded according to the ICD-9-CM, and included up to 10 diagnoses per patient. The Barell Injury Diagnosis Matrix was used to analyze the diagnostic data.[20-22] The severity of injuries was measured with the Injury Severity Score (ISS),[23] an anatomical scoring system that grades overall injury on a scale of mild (score of 1–8), moderate (score of 9–14), and severe (16+). SAS (SAS, Inc, Chicago, IL USA) statistical software was used for the statistical analysis.

Results

The distribution of the group by gender and age is in Table 2. The male to female ratio was 52.5:47.5, and mean value for the ages was 11.9 ±5.1 years. The 15–17 year age group accounted for 46% of the children with terrorism-related trauma.

The characteristics of the terrorism-related injuries are listed in Table 3. The mechanisms of injury included explosions for 92 patients (67%), gunshots in 35 (25%), and other in 11 (8%). Most of the injuries occurred on the road (54%), followed by public or commercial buildings (36%). The majority of children sustained wounds caused by blasts and by penetration of foreign objects—shell fragments, nails, bolts, nuts, metal balls, etc.—driven by bomb explosions, usually in enclosed areas, including buses. Sixty-five percent of the victims had multiple injuries: 54% penetrating and 45% blunt. The proportion of critical to fatal injuries (ISS of ≥25) was significantly high (18%); 30% of the children had an ISS of ≥16. Five percent of the patients died.

	n	(%)
Injury Severity Score		
1–8	82	(52.9)
9–14	27	(17.4)
16–24	18	(11.6)
25+	28	(18.1)
missing	5	
Type of Injury*		
Fracture	67	(44.7)
Internal injury	41	(27.3)
Open wound	84	(56.0)
Burns	13	(8.7)
Site of Injury*		
Brain (including concussion)	32	(21.3)
Other head	74	(49.3)
Spinal cord or column	4	(2.7)
Chest	25	(16.7)
Abdomen	25	(16.7)
Pelvis trunk back and buttock	25	(16.7)
Upper extremity	58	(38.7)
Lower extremity	70	(46.7)

Table 3—Characteristics of terrorism-related injuries for 160 children (n = number; *More than one in some cases)

Burns were present in 8.7% of the children, and they tended to be accompanied by penetrating injuries due to explosions. The burn injuries usually were severe and involved a large proportion of body surface area. Open wounds were present in 56%, bone fractures in 44.7%, and injuries to blood vessels in 12%. More than 70% of the victims had head injuries A relatively high proportion sustained injury to the torso (chest and abdomen) (33%) and the extremities (85.4%).

In-hospital Resource Utilization

Data for the utilization of in-hospital resources by the 160 children injured in a MCE are provided in Table 4. Fifty-six percent of the children required surgery or an operating room procedure, more than twice the rate for a non-terrorism-related trauma group.[22] Compared to the non-terrorism-related trauma group, the terrorism victims had a significantly higher rate of utilization of intensive care unit (ICU) facilities (30%), longer total hospital stay

Resource	n	(%)
Surgical procedure (n = 160)	90	(56.3)
ICU admission (n = 159)	48	(30.2)
LOS 8 days or longer (n = 155)	59	(38.1)
	Median (days)	**Range (days)**
In-hospital LOS (n = 155)	5	(1–12)
ICU LOS (n = 159)	4	(1–8.5)

Table 4—Utilization of in-hospital resources by 160 pediatric victims of terrorism-related trauma (n = number; ICU = intensive care unit; LOS = length of stay)

(median value = 5 days), and greater need for rehabilitation (defined as a discharge to a rehabilitation facility) (17%).[22] The rate of inter-hospital transfer was 12%.

Discussion

Acts of terrorism inflict a great deal of physical and mental injury to affected children, strain emergency services and medical resources, and pose a great challenge to professionals involved at each phase of the continuum of care.

Various aspects of the preparedness and performance of emergency medical services (EMS) systems in MCEs and disaster situations have been discussed widely in the medical and paramedical literature.[24–27] In Israel, three phases of EMS functioning at the MCE scene have been identified: (1) The "chaos" phase starts immediately after the occurrence of the event (explosion of a suicide bomber, for example) and lasts 10 to 20 minutes.[28] It often is characterized by disorganization among the first teams responding, owing to a lack of medical command and pressure from victims and bystanders; (2) The medical organization (command) phase begins with the arrival of the MDA-EMS commander on the scene and lasts from 10 to 30 minutes. The functions of the commander are fourfold: (a) identify victims who need immediate care; (b) organize the evacuation of victims from the scene; (c) verify open routes to and from the scene; and (d) triage victims to the appropriate medical facility; (3) In the last phase, victims with minor injuries are evacuated and routine is restored. This phase takes place 60–70 minutes following the onset of the event. Some of the victims, particularly those with acute stress reactions, may arrive in emergency departments hours or days following the event.

To improve efficiency and speed of all of the phases, the Magen David Adom has introduced the use of well-trained "first responders" and volunteer off-duty professionals, in addition to the "scoop-and-run" on-the-scene management and triage to multiple facilities. All of these apply to both adults and children. To better cope with young victims, the MDA initiated mandatory pediatric advanced life support courses for all relevant personnel, and equipped ambulances with appropriately sized apparatus. Every EMS system must find its own optimal solution depending on the local demand for care on the one hand and availability of local resources on the other.

In MCEs caused by terrorist bombings, triage is the key to successful management.[29] It is performed in the field and emergency departments. The aim of field triage is to identify the critically injured victims who need immediate care, provide them with life-saving procedures, and transport them to the appropriate facilities, with consideration of available capabilities in order to avoid overcrowding. Mastering the art of field triage, particularly of children, requires extensive education and training.[29] However, Risavi *et al*[30] found that participation in a two-hour intervention can improve prehospital triage of mass casualties. In the hospital, the triage officer is responsible for sorting victims by the severity of injuries. In Israel, a four-category triage algorithm for children has been introduced in order to account for the unique physiological features and differences in response that from adults. So far, results have been promising,[7] and further studies of this method currently are being conducted.

Terrorism-related injuries in children follow the pattern previously reported for adult populations.[29,31] Specifically, injury severity scores (ISS) are higher and hospitalization is longer than that for injuries incurred in non-terrorism-related traumatic circumstances. The spectrum of pediatric injuries caused by terrorism has been poorly documented. In the only relevant study conducted so far, Quintana *et al* found that the pathophysiology of the blast injuries sustained by children exposed to the Oklahoma City bombing differed significantly from other forms of pediatric trauma, and was characterized by a high incidence of cranial injuries, fractures, and traumatic amputations. Intra-abdominal and thoracic injuries occurred frequently in fatal cases, but infrequently in survivors. However, this study cannot be compared directly with the current study population including children surviving to hospital admission only.

The age of the patients coincides with those in a previous study that terrorist acts in Israel seem to affect children older than those who are part of the usual pediatric-trauma-patient population.[22] This may be explained partly by the location of the events, that is restaurants, discothèques, or other social meeting places that are accessed more by older children and young adults.

Some of the Israeli children exposed to terrorist acts suffered gunshot wounds, stab wounds, burns, and/or injuries caused by rocks and other objects. The nature and management of these types of injuries have been well-described.[32] However, the majority sustained wounds caused by penetration of foreign objects—shell fragments, nails, bolts, nuts, metal balls, etc.—driven by bomb explosions usually in enclosed areas, which posed a new challenge in management to medical and paramedical personnel from many disciplines. Children in the study group suffered a relatively high proportion of penetrating injuries (54%) and a lower proportion of blunt injuries (45%), compared to children who sustained non-terrorism-related injuries.[22]

The greater need for healthcare resources by victims of terrorism compared to patients with non-terrorism-related trauma reflects the greater complexity and extent of injuries in the study group. Most of the study group had penetrating injuries induced by various mechanisms, which led to multiple wounds that frequently were clustered.[33] This group required more than twice the length of hospital stay than did the comparison group, and required more than

twice the rate of performance of surgical procedures.[22] They also had a higher length of stay in the intensive care unit.[22] This increased use of hospital facilities—and the increased costs incurred thereby—should be taken into consideration in preparatory guidelines for mass-casualty events.

Twelve percent of the children were transferred to other hospitals. Transfer usually is recommended when the treatment for a specific injury may be provided better at another institution or to unite family members injured at the same event, but evacuated to different hospitals. Previous studies of MCEs in Israel reported a 7.3% rate of inter-hospital transfer following initial evacuation in a mixed adult and child population.[34] The higher rate of inter-hospital transfer of the pediatric age group compared to the general population may reflect increased caution exercised by trauma-care providers when dealing with children.

Besides the physical damage, studies have shown that devastating terrorist incidents also shake the sense of safety, security, and well-being of surviving children, and thus, may increase their risk of substance abuse and mental illness.[35] In Israel, millions of children use public transportation to commute to and from school, and many of the terrorist-induced explosions occurred on buses or at bus stations. Gidron *et al* examined coping strategies and their relationship to anxiety about terrorism among Israeli bus commuters.[36] Moreover, bomb blasts in public places often injure whole families; so, in addition to the need to overcome their own injury—with subsequent healing, rehabilitation or residual disability—many young victims also may need to cope with lost or injured siblings or parents and a lack of the full support they require. Involvement of therapists from hospital admission to the emergency department appears to help diminish long-term manifestations of acute stress reactions.

Conclusion

The relatively high number of children affected by terrorist acts in Israel in the recent wave of violence has increased substantially the cumulative workload of healthcare professions on the scene and in hospitals and trauma centers, and has shifted the pattern of care in accordance with the extent and severity of specific terrorism-related injuries. A well-organized, multi-disciplinary medical system at the prehospital and hospital phase can decrease the enormous toll in lives as well as in physical and psychological morbidity. The application of the experience gained in Israel can contribute to the preparedness of medical personnel to cope with future events in this country and elsewhere. The inclusion of other aspects of traumatic injury, such as its short- and long-term psychological consequences, will provide a more comprehensive picture of the damage inflicted by acts of terrorism.

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