Epidemiology of Terror-Related Versus Non-Terror-Related Traumatic Injury in Children

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Epidemiology of Terror-Related Versus Non–Terror-Related Traumatic Injury in Children

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ABSTRACT. *Objective.* **In the past 2 years hundreds of children in Israel have been injured in terrorist attacks. There is a paucity of data on the epidemiology of terror-related trauma in the pediatric population and its effect on the health care system. The objective of this study was to review the accumulated Israeli experience with medical care to young victims of terrorism and to use the knowledge obtained to contribute to the preparedness of medical personnel for future events.**

Methods. **Data on all patients who were younger than 18 years and were hospitalized from October 1, 2000, to December 31, 2001, for injuries sustained in a terrorist attack were obtained from the Israel National Trauma Registry. The parameters evaluated were patient age and sex, diagnosis, type, mechanism and severity of injury, interhospital transfer, stay in intensive care unit, duration of hospitalization, and need for rehabilitation. Findings were compared with the general pediatric population hospitalized for non–terror-related trauma within the same time period.**

Results. **During the study period, 138 children were hospitalized for a terror-related injury and 8363 for a non–terror-related injury. The study group was significantly older (mean age: 12.3 years [standard deviation: 5.1] v 6.9 years [standard deviation: 5.3]) and sustained proportionately more penetrating injuries (54% [*n* = 74] vs 9% [*n* = 725]). Differences were also noted in the proportion of internal injuries to the torso (11% in the patients with terror-related trauma vs 4% in those with non–terror-related injuries), open wounds to the head (13% vs 6%), and critical injuries (Injury Severity Score of 25+; 25% vs 3%). The study group showed greater use of intensive care unit facilities (33% vs 8% in the comparison group), longer median hospitalization time (5 days vs 2 days), and greater need for rehabilitative care (17% vs 1%).**

Conclusions. **Terror-related injuries are more severe than non–terror-related injuries and increase the demand for acute care in children.** *Pediatrics* **2003;112:e280–e284.**

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URL: http://www.pediatrics.org/cgi/content/full/112/4/e280; ***trauma, terror, injury, pediatric.***

ABBREVIATIONS. *ICD-9-CM, International Classification of Diseases, Ninth Revision-Clinical Modification*; ISS, Injury Severity Score; ICU, intensive care unit.

Hundreds of children have been injured and dozens killed by terrorist acts in Israel since October 2000. During 2001 alone, 254 children aged 0 to 17 had visited public hospitals in Israel after a terror-related injury (Ministry of Health, Department of Health Information, personal communication, May 14, 2003). Terror incidents include shootings into crowds and at passing vehicles or people, suicide bombers, car bombs, stabbings, stone throwing, and more. Terror attacks took place in the street, in malls, on buses, at schools, in discothèques, and in other social gathering places. The frequency of these attacks was not steady during the period and was affected by political circumstances, tightness of military curfew, religious dates, opportunity, and more—weeks could pass with no attack, followed by a week in which 3 attacks would take place.

Terror affecting children on such a large scale is uncommon, and a literature search failed to yield specific reports of pediatric injuries as a result of terrorism apart from 1 on the Oklahoma City bombing.[1] Most of the studies to date on children and terrorism have dealt with the potential effect of chemical or biological agents[2,3] or the psychological impact.[4]

Literature on children and civilian war injuries is more common.[5,6] However, there is a major difference in injury mechanisms between terror and war victims. Although war casualties are caused more by explosive wounds as a result of fragmenting antipersonnel weapons such as rockets, artillery shells, mortar bombs, and mines,[5] terror injuries are caused by a variety of injury mechanisms, including gunshot wounds; stab wounds; explosion injuries; burns; and nontypical injuries caused by the penetration of nails, bolts, metal balls, or other sharp objects driven by the explosives.[7]

The aim of the present study was to review the accumulated Israeli experience with medical care for young victims of terrorism. Some of the Israeli children exposed to terrorist acts had gunshot wounds, stab wounds, burns, and injuries caused by rocks and other objects. These types of injuries are well

known, and their management has been well described.[8] However, the majority of sustained wounds were caused by penetration of foreign objects—shell fragments, nails, bolts, nuts, metal balls, and so forth—driven by bomb explosions usually in enclosed areas, which posed a great challenge to both medical and paramedical personnel in many disciplines. Furthermore, the explosions were usually mass casualty events, flooding trauma centers with a large volume of patients who were in critical condition and required urgent care. The present study characterizes the population of pediatric patients who are hospitalized in trauma centers for treatment of terror-related injuries as compared with patients with non–terror-related trauma and evaluates the shift in the pattern of need for trauma care in children.

METHODS

The study population consisted of all patients who were younger than 18 years and were injured in terrorist acts. Cases of injury from terrorist acts were identified though the use of the *International Classification of Diseases, Ninth Revision-Clinical Modification* (*ICD-9-CM*)[9] codes for external cause of injury (e-codes) from E990 to E998.

The study period extends from October 1, 2000, to December 31, 2001. Data on patient characteristics, nature of the injury, and outcome were obtained from the Israel National Trauma Registry, which records all hospitalizations for physical trauma at 9 trauma centers (6 level 1) in the country. In-hospital deaths and transfers to acute care hospitals are noted as well. All 9 centers are part of designated tertiary-care and referral hospitals that receive the majority of severe or complicated cases of physical injury.

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[10,11] was used to analyze the diagnostic data: type of injury (fracture, dislocation, etc) was distributed along the matrix columns and cross-matched with bodily region affected (brain, head, torso, upper extremity, lower extremity, other), distributed in the matrix rows. The severity of injury was measured with the Injury Severity Score (ISS),[12] an anatomic scoring system that grades overall injury on a scale of mild (score of 1–8), moderate (score of 9–14), and severe (16+). Findings were compared with the general pediatric population hospitalized for non–terror-related trauma within the same time period.

SAS statistical software was used for the statistical analysis. Pearson χ^2 test was used for categorical data, *t* test for continuous variables, and Wilcoxon nonparametric test for continuous variables with a nonnormal distribution. $P < .05$ was considered statistically significant.

RESULTS

Patient Characteristics

During the study period, 138 children were hospitalized for a traumatic injury caused by a terrorist act, and 8363 children were hospitalized for injuries caused by other types of trauma. The distribution of the groups by sex and age is shown in Table 1. The male to female ratio by percentage was 55% to 45% in the terror-related trauma group and 69% to 31% in the non–terror-related trauma group ($P = .0007$, χ^2 test). The terror-related study group was also older, with a mean age of 12.3 years (standard deviation: 5.1) versus 6.9 years (standard deviation: 5.3) in the comparison group ($P < .0001$, *t* test). The 15- to 17-year age group accounted for 50% of the terror-related trauma group but only 12% of the patients with non–terror-related traumatic injuries ($P < .0001$, χ^2).

TABLE 1. Comparison of Demographic Characteristics Between Patients With Terror-Related Injuries and Those With Non–Terror-Related Trauma

	Terror*		Non-Terror*	
	n	%	*n*	%
Total	138	100	8363	100
Sex*				
Male	76	55.1	5730	68.6
Female	62	44.9	2628	31.4
Age group*				
0–2	10	7.9	2345	28.7
3–6	14	11.1	1989	24.3
7–10	11	8.7	1509	18.5
11–14	28	22.2	1324	16.2
15–17	63	50.0	1009	12.3
Mean (± SD; y)	12.3	(5.1)	6.9	(5.3)

* Differences between groups are statistically significant at the $P < .05$ level.

Types of Injuries

Most of the terror-related injuries occurred on the road (54%), followed by public or commercial buildings (36%), whereas most of the non–terror-related injuries occurred at home (40%), followed by the road (29%) and school (7%). The mechanism of injury in the terrorism victims included explosions in 92 patients (67%), gunshots in 35 (25%), and other in 11 (8%), and in the patients with non–terror-related trauma, the mechanisms were falls (53%), traffic accidents (21%), burns and scalds (8%), and other (18%).

The majority (65%) of the terrorism victims had multiple injuries, whereas 65% of the patients in the comparison group had only a single injury. The patients in the study group also had proportionately more penetrating injuries (54% [$n = 74$] vs 9% [$n = 725$]) and fewer blunt injuries (45% [$n = 61$] vs 85% [$n = 7050$]; $P < .0001$). Burns were noted in 8% of both groups, although they tended to be accompanied in the terror-related group by penetrating injuries caused by explosions. In addition, in this group, the burns were usually more severe and affected a higher percentage of body surface.

Seventy-five patients who were injured by terror-related trauma (54%) sustained open wounds, a much higher proportion than in the non–terror-related trauma group (14%, $n = 1208$). Bone fractures occurred in 66 patients (48%) in the terror-related trauma group compared with 38% in the non–terror-related trauma group ($n = 3166$; $P < .001$). Injuries to blood vessels were also more common in the study population (12% vs 1%).

Figure 1 displays the distribution of injuries by body area affected (a person may appear in >1 column if injuries to multiple body areas are sustained). The terror-related trauma group had more injuries overall as the majority of injuries were to multiple body regions. As a result, an excess of injuries in this population is noted in all but the traumatic brain injuries group. The high proportion of traumatic brain injuries in the patients with non–terror-related trauma was attributed to the high incidence of con-

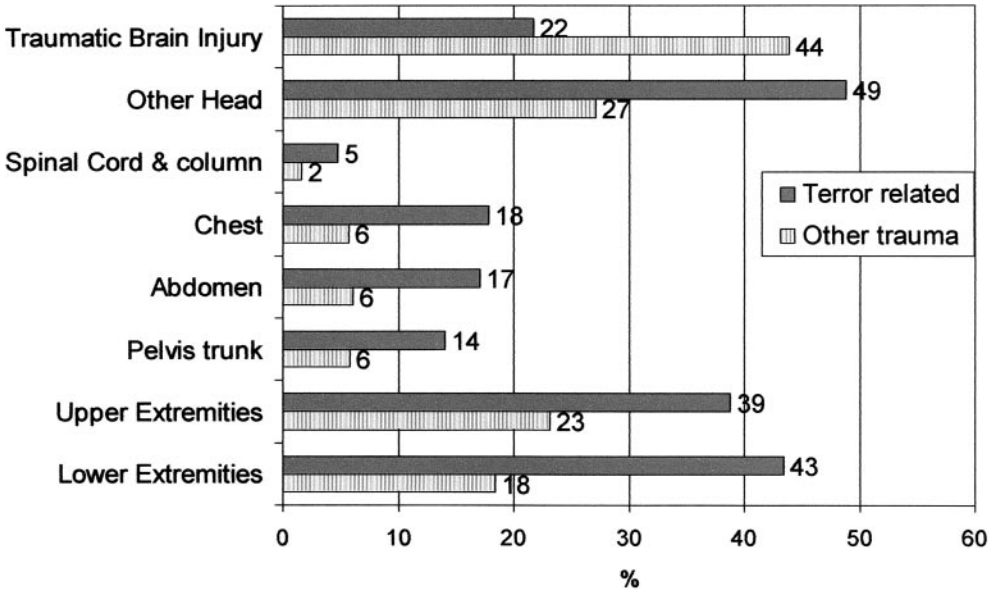

Fig 1. A comparison of the distribution of injuries by body-region for terror-related versus non–terror-related casualties. Note: a patient may be injured in >1 body region and thus may appear in >1 column.

cussions or suspected concussions caused by falls. When the nature of injury was added to the analysis, striking between-group differences were found in the proportion of internal torso injuries (11% in the study group vs 4% in the comparison group) and in open head wounds (13% vs 6%).

Figure 2 shows the severity of injury in the 2 populations, as based on the ISS.[12] The proportion of critical to fatal injuries (ISS score of 25 or more) was significantly higher in the terror-related than in the non–terror-related trauma group (25% vs 3%; $P < .0001$). Penetrating injuries were noted in 54% of the terror-related trauma group—compared with only 9% in the other group—of whom 49% had an ISS of 16+. In addition, 45% of those with gunshot wounds had an ISS of 16+, compared with 33% of the patients with other types of injury. Five percent of the patients in the terror-related trauma group died compared with 1% of the children who were hospitalized for non–terror-related traumatic injuries.

Resource Utilization

The proportion of children who required surgery or an operating room procedure was >2-fold higher in the terror-related than in the non–terror-related trauma group (56% vs 23%; $P < .0001$). The terrorism victims also had a significantly higher rate of utilization of intensive care unit (ICU) facilities (33% vs 8%), longer total hospitalization stay (median: 5 days vs 2 days), and greater need for rehabilitation, defined as a discharge to a rehabilitation facility (17% vs 1%; $P < .0001$ for all parameters). These data are presented in detail in Table 2. The rate of transfer from other hospitals was not significantly different between the groups (12% in victims of terror and 11% in the patients with non–terror-related trauma).

DISCUSSION

The present study shows that the epidemiology of terror-related injuries is fundamentally different

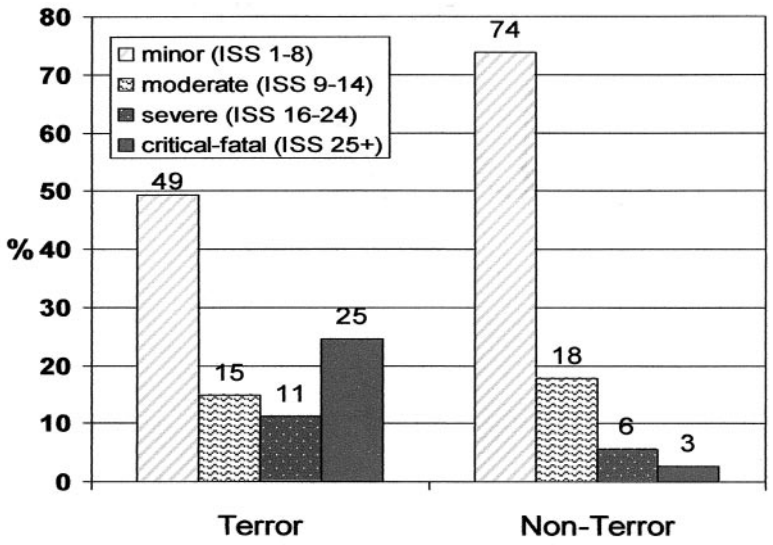

Fig 2. A comparison of injury severity for terror-related and non–terror-related injuries.

TABLE 2. Comparison of Resource Utilization Between Children Injured in Terror-Related and Children Injured in Non–Terror-Related Trauma

	Terror*		Non-Terror*	
	n	%	*n*	%
Total	138	100	8363	100
Operations/procedures				
Yes	77	55.8	1908	22.8
No	61	44.2	6455	77.2
ICU stay				
Yes	45	32.6	633	7.6
No	93	67.4	7726	92.4
Total length of hospital stay				
<7 d	83	61.5	7466	89.7
≥8 d	52	38.5	861	10.3
Median (IQR; d)	5	(1-11)	2	(1-4)
Destination at discharge				
Home	89	65.0	8036	96.1
Rehabilitation	23	16.7	80	1.0
Death	7	5.1	57	0.7
Transfer	9	6.5	112	1.3
Other	10	6.7	78	0.9

IQR indicates interquartile range.
* A significant ($P < .0001$) difference between the 2 groups was found for all variables in this table.

from the epidemiology of non–terror-related trauma injuries in children. Differences were found in patient age, number of diagnoses, body region affected, type (penetrating vs blunt) and mechanism of injury, severity of injury, ICU utilization, duration of inpatient stay, and inpatient mortality rate. Furthermore, compared with patients with non–terror-related trauma, victims of terror often arrive in bulk, as part of a mass casualty event. This poses a sudden load on hospital resources and requires special organization and preparedness. The effect of a mass casualty event on the treatment of individual patients needs to be examined further.

Our results indicate that terror-related injuries in children follow the pattern previously reported in adult populations.[13] Specifically, ISS scores are higher and hospitalization is longer than for injuries that are incurred in non–terror-related traumatic circumstances.

Terrorist acts in Israel seem to affect children who are older than the normal pediatric trauma patients. This may be partly explained 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.

Twelve percent of the children were transferred to other hospitals. Transfer is usually recommended if treatment for a specific injury may be better provided at another institute or to unite family members who were injured at the same event but evacuated to different hospitals. Previous studies of mass casualty events in Israel reported a 7.3% rate of interhospital transfer after initial evacuation[14] in a mixed adult and child population. The higher rate of interhospital transfer in the pediatric age group compared with the general population may reflect increased caution exercised by trauma care providers when dealing with children.

The greater need for health care resources by victims of terror compared with patients with non–terror-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, frequently clustered.[15] This group required more than twice the hospital stay than the comparison group and had more than twice the rate of surgical procedures. They also had a higher rate of stay in the ICU. This increased use of hospital facilities—and the increased costs incurred thereby—should be taken into consideration in preparatory guidelines for mass casualty events.

The spectrum of pediatric injuries caused by terrorism has been poorly documented. In the only relevant study conducted so far, Quintana et al[1] found that the pathophysiology of the blast injuries sustained by children who were 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.[1] Unfortunately, this study cannot be compared directly with ours, which focuses only on the treatable population and the demands that it places on trauma centers. The Israel Trauma Registry data cover only hospitalized patients and do not account for nonhospitalized injured patients, patients with acute (immediate) traumatic stress reaction (who are usually treated in the emergency department), and patients who die on the scene or are declared dead on arrival. Nevertheless, the hospitalized population contains a substantive proportion of terror victims; it is estimated that 30% of patients who attend the emergency department as a result of a terror-related injury are hospitalized (Ministry of Health, Department of Health Information, personal communication, May 14, 2003).

Besides the physical damage, devastating terrorist incidents shake the sense of safety, security, and well-being of surviving children and thus may increase their risk of substance abuse and mental illness.[16] In Israel, millions of children use public transportation to commute to and from school, and many of the terrorist explosions occurred on buses or at bus stations. Gidron et al[17] examined coping strategies and their relationship to anxiety about terrorism among Israeli bus commuters. 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 may have to cope with lost or injured siblings or parents and a lack of the full support that they need.

CONCLUSIONS

The relatively high number of children affected by terrorist acts in Israel in the past 2 years has increased substantially the cumulative workload in trauma centers and shifted the pattern of care in accordance with the extent and severity of specific terror-related injuries. The experience gained in Israeli trauma centers can contribute to the preparedness of medical personnel to cope with future events

in Israel and elsewhere. Additional studies of the patterns and anatomic distribution of terror-related injuries in children are needed to enhance secondary and tertiary management. 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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