

RESEARCH

Terrorism-Related Injuries Versus Road Traffic Accident-Related Trauma: 5 Years of Experience in Israel

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ABSTRACT

Background: Terrorism victims comprise the minority among trauma injured people, but this small population imposes a burden on the health care system. Thirty percent of the population injured in terrorist activities experienced severe trauma (injury severity score ≥ 16), more than half of them need a surgical procedure, and 25% of the population affected by terrorism had been admitted to intensive care. Furthermore, compared with patients with non-terrorism-related trauma, victims of terrorism 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 present study compared terrorism-related and road accident-related injuries and examined clinical characteristics of both groups of patients.

Methods: This study is a retrospective study of all patients injured through terrorist acts and road traffic accidents from September 29, 2000 to December 31, 2005, and recorded in the Israel Trauma Registry. Data on the nature of injuries, treatment, and outcome were obtained from the registry. Medical diagnoses were extracted from the registry and classified based on *International Classification of Diseases* coding. Diagnoses were grouped to body regions, based on the Barell Injury Diagnosis Matrix.

Results: The study includes 2197 patients with terrorism-related injuries and 30,176 patients injured in road traffic accidents. All in all, 27% of terrorism-related casualties suffered severe to critical injuries, comparing to 17% among road traffic accident-related victims. Glasgow Coma Scale scores ≤ 8 , measured in the emergency department, were among 12.3% of terrorism victims, in contrast with 7.4% among people injured on the roads. The terrorism victims had a significantly higher rate of use of intensive care facilities (24.2% vs 12.4%). The overall inpatient death rate was 6.0% among terrorism victims and 2.4% among those injured in road traffic accidents.

Conclusions: Casualties from terrorist events are more severely injured and require more resources relative to casualties from road traffic accidents. (*Disaster Med Public Health Preparedness*. 2009;3:196–200)

Key Words: trauma injuries, terrorism, road traffic accident, mortality, intensive care unit, mass casualty event

World Health Organization (WHO) data show that in 2002, nearly 1.2 million people worldwide died as a result of road traffic injuries. In addition to these deaths, between 20 million and 50 million people globally are estimated to be injured or disabled each year. If current trends continue, the number of people killed and injured on the world's roads will rise by more than 60% between 2000 and 2020, and road crash injury is likely to be the third leading cause of disability-adjusted life-years lost. In 2000, road traffic accidents (RTAs) were the ninth leading cause of the global burden of disease.¹ Similar to the trend in RTAs, international terrorism has become a threat to the civilized world. Most terrorism-related adverse events, casualties, and deaths involved bombs and guns (conventional weapons).² Terrorists will con-

tinue to favor conventional explosives for several reasons. They are easy to buy or steal, do not require sophisticated equipment or operator training to use, can be transported and concealed easily, and are capable of causing widespread damage with a single attack.³ Despite its public profile, terrorism is not on the WHO top 10 list of causes of death. Even in Israel, a country constantly threatened by war and terrorism, more people have been killed or injured as a result of RTAs than war and terrorism.⁴ Since the beginning of El Aqsa Intifada, between September 29, 2000 and May 1, 2006, Magen David Adom (the Israeli emergency medical service) treated a total of 7844 civilian casualties as follows: 999 killed, 642 severely injured, 940 moderately injured, and 5263 lightly injured.⁵ Terrorist attacks took place mostly in crowded places (bus stations, buses, shopping malls,

restaurants, markets, pubs, and dance clubs) and often resulted in mass casualty events (MCEs). The most frequent terrorist attack mechanism was suicide bomb explosion, but several events included shootings into crowds, vehicular assault, stabbings, rock throwing, and the like.⁶

The annual mortality from RTAs has been 3 times higher than civilian mortality from terrorism. In the most intensive years of Intifada (2001, 2002, and 2003), 872 people were killed in terrorist events⁵ and 1612 in RTAs.⁷

Terrorism victims comprise the minority among trauma-injured people, but this small population imposes a burden on the health care system. Thirty percent of the population injured in terrorist activities and admitted to the hospital experienced severe trauma (injury severity score [ISS] ≥ 16). More than half of them need a surgical procedure in the operating room and one fourth of the terrorism-affected population had been admitted to the intensive care unit (ICU).⁸ Furthermore, compared with patients with non-terrorism-related trauma, victims of terrorism often arrive in bulk, as part of an MCE. This causes a sudden overload on hospital resources and requires special organization and preparedness.⁹

The present study compared terrorism-related and RTA-related injuries and examines clinical characteristics of both groups of patients. The objective was to describe the injury characteristics of terrorism-related and RTA hospitalizations and their influence on the types of injuries in Israel during the study period. We believe that this effort will enrich the knowledge of physicians who are caring for trauma victims.

METHODS

This study is a retrospective study of all patients injured through terrorist acts and RTAs from September 29, 2000 (the day the riots began) to December 31, 2005, and recorded in the Israel Trauma Registry (ITR). Until 2000, the database was fed by 8 hospitals (6 level 1 trauma centers in Israel and 2 regional centers). One regional trauma center was added in 2001 and another in 2003, totaling 10 hospitals. Since the year 2003, the ITR includes all 6 level 1 trauma centers in Israel and 4 of the largest regional trauma centers in the country. The study deals with proportions and rates, so the inclusion of 2 hospitals during the study period does not present a problem.

Data on the nature of injuries, treatment, and outcomes were obtained from the registry. Medical diagnoses were extracted from the registry and classified based on *International Classification of Diseases, 9th Revision, Clinical Modification*, coding. Diagnoses were grouped to body regions, based on the Barell Injury Diagnosis Matrix.¹⁰ SAS statistical software (SAS, Cary, NC) was used for the statistical analysis and comparison between groups. Statistical analysis included conventional tests such as Pearson chi-square for categorical data, *t* tests for continuous variables, and Wilcoxon nonparametric tests when continuous variables did not distribute normally. A value of $p < .05$ was considered statistically significant.

RESULTS

Study Population

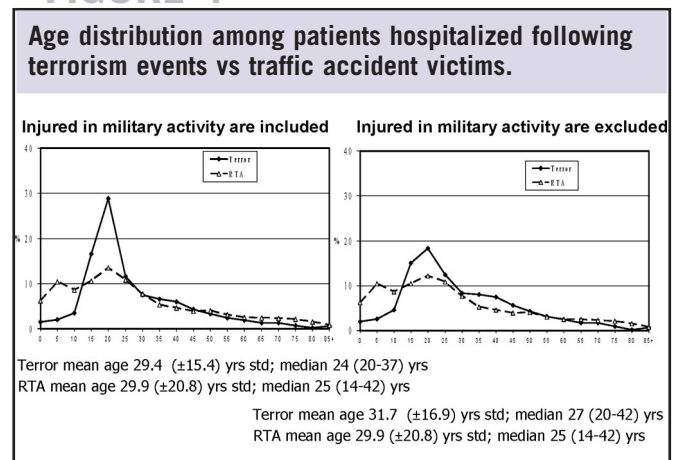
During the study period, 120,457 patients were hospitalized in ITR hospitals. Our study is focused on 2197 patients, hospitalized for a traumatic injury caused by a terrorist act and comprising 2% of those hospitalized in ITR hospitals, and 30,176 victims injured in RTAs and comprising 25% of those hospitalized in ITR hospitals.

Patient Characteristics

Males comprised 75% of the population affected by terrorism and 67% of patients hospitalized after RTAs ($p < .0001$). The age of the patients from the terrorism-related study group was similar to that of the RTA group (mean 29.4 years, standard deviation [SD] 15.4; mean 29.9 years, SD 20.8, respectively). When patients injured due to military activity were excluded, the mean age of those hospitalized for a traumatic injury caused by a terrorist act was 31.7 (SD 16.9). The age distribution (Fig. 1) demonstrates that many children younger than 15 years (25%) are becoming the victims of RTAs (compared with 7% among victims of terrorist acts), whereas among those injured in terrorist acts teenagers and young people (ages 15–30 years) represent the population at risk (57% compared with 35% among those injured in RTAs).

Among 2197 people injured due to terrorist acts, 973 (44%) were injured in 89 MCEs (an event that causes ≥ 10 casualties on the scene). Most MCEs were suicide bombings ($n = 75$, 84%). Shooting into the crowd was the mechanism in 11 events (12%), 3 events (3%) included bombing and shooting, and 1 event included running over the crowd with a vehicle. MCE victims arrived at the hospital immediately after the events; the average number of admitted patients per event was 10.9 ± 10.2 (median 8 patients; 25th percentile 4 patients; 75th percentile 14 patients). From 1 to 5 hospitals took part in the treatment of MCE victims from the same event. The mean number of hospitals participating in the same event was 1.6. The mean number of people hospitalized following an MCE per hospital that took part in the treatment of MCE

FIGURE 1



casualties was 7.1 patients (± 5.5 ; median 6.0 patients; 25th percentile 3.5 patients; 75th percentile 9 patients).

Among MCE-related casualties, 31% sustained severe to critical injuries (ISS ≥ 16). Non-MCE casualties comprised 56% ($n = 1224$) of terrorism-related hospitalizations; 23% of them suffered severe to critical injuries. Among non-MCE casualties, 496 (40.9%) were injured during military activity and the others were civilians. A total of 27% of terrorism-related casualties sustained severe to critical injuries, compared to 17% among RTA-related victims ($p < .0001$). Glasgow Coma Scale (GCS) scores measured in the emergency department (ED) were ≤ 8 (indication of severe coma) for 12.3% of terrorism victims, in contrast to 7.4% of RTA victims ($p < .0001$).

Injury Profiles

Most terrorism victims were injured by explosion ($n = 1229$, 56%), 36% ($n = 799$) by gunshot, and 8% ($n = 169$) by other mechanism. Frequency of penetrating blunt injuries and burns is depicted in Table 1. The patients injured due to terrorism had proportionately more penetrating injuries (61.1%) than patients injured in RTAs (1.7%; $p < .0001$). Terrorism victims also had 12% of combined blunt and penetrating injuries and 4% of penetrating injuries, combined with burns. Most of the patients injured in RTAs had blunt injuries (97.5%). Almost 8% of terrorism victims suffered from burns, which were rare among those injured in RTAs.

More than half of all terrorism victims had multiple injuries (57%), compared to 47% in the group of RTA victims ($p < .0001$). Among terrorism-related victims injured in 1 to 3 regions of the body, frequency of severe injury (ISS 16+) was higher than among those injured in RTAs. Frequency of ISS > 16 was similar in both groups when the number of body regions injured was ≥ 4 (Table 2). Traumatic brain injury and injury to the spine were almost twice as frequent among those injured in RTAs, whereas injury to the extremities was more frequent among victims of terrorist acts (Fig. 2).

Resources Utilization

The most frequent evacuation facility was ambulance: 73% of those injured in RTAs and 81% of those injured in terrorist acts arrived by ambulance. In contrast with those injured in RTAs, 13% of those injured in terrorist acts arrived at the hospital by helicopter (vs 1%). One fourth of people injured in RTAs arrived by private vehicle or by themselves, 96.2% of them were injured with ISSs 1 to 14, versus 5% injured in terrorist acts, 93.3% of them with ISSs 1 to 14.

Computed tomography in the ED was carried out on 35.9% of those injured in terrorist acts compared with 39.7% of those injured in RTAs ($p = .0004$) and radiographic examination was required among 56.4% of the injured in terrorist acts and 54.8% in RTAs ($p = .15$).

More than half of those injured in terrorist acts required surgery or an operating room procedure (55.6%, $n = 1221$) compared with 31.4% of those injured in RTAs ($n = 9475$; $p < .0001$). Among patients who had undergone surgery, 27% of terrorism victims needed more than 1 procedure, compared with 14% among those injured in RTAs who had undergone surgery. One third of the victims of terrorist acts were transferred to the operating room directly from the ED compared with 8.5% of those injured in RTAs. Among patients who were transferred to the operating room directly from the ED, 46.7% of terrorism victims and 45.4% of those injured in RTAs required intensive care.

The terrorism victims had a significantly higher rate of use of intensive care unit (ICU) facilities (24.2% vs 12.4%; $p < .0001$). ICUs were the first admitting department for 23.2% ($n = 510$) of the patients admitted; 9% of ICU admissions ($n = 196$) were transferred there directly from the ED. Among RTA victims, ICUs were the first admitting department for 11% and 7.5% were transferred to the ICU directly from the ED. Among MCE-related casualties, the average number of patients admitted to the ICU was 3.0 per event (median 2.0 patients; 75th percentile 4 patients; 95th percentile 1 patient).

TABLE 1

Trauma Type and Inpatient Death Rate Among Terrorism Victims and Road Casualties

Trauma Type	Terror-Related Trauma				Road-Related Trauma			
	Injured		Inpatient Death		Injured		Inpatient Death	
	n	%	n	%	n	%	n	%
Penetrating	1342	61.1	94	7.0	497	1.7	15	3.0
Penetrating and blunt	264	12.0	17	6.4	200	0.6	17	8.5
Penetrating and burn	89	4.1	2	2.3	3	0.0	0	0
Blunt	407	18.5	18	4.4	29,385	97.4	679	2.3
Blunt and burn	44	2.0	1	2.3	34	0.1	1	2.9
Burn	34	1.6	0	0	25	0.1	0	0
Unknown	17	0.7	0	0	40	0.1	0	0
Total	2197	100	132	6.0	30,184	100	712	2.4

TABLE 2

Severity of Injury and Number of Body Regions Injured Among Terrorism Victims and Road Traffic Accident Casualties

No. Body Regions Injured	Terror-Related Trauma				RTA-Related Trauma			
	Injured		ISS 16+		Injured		ISS 16+	
	n	%	n	%	n	%	n	%
1	947	43.0	89	9.4	15,974	52.9	937	5.9
2	571	26.0	138	24.2	7,839	26.0	1,184	15.1
3	329	15.0	161	48.9	3,769	12.5	1,343	35.6
4	188	8.6	108	57.5	1,597	5.3	973	60.9
5+	102	4.6	88	86.3	856	2.8	725	84.7
Unknown	60	2.8	—	—	149	0.5	—	—
Total	2,197	100	584	26.6	30,184	100	5162	17.1

Compared with those who were injured in RTAs, terrorism victims had longer hospital lengths of stay (median 5 days vs 3 days; $p < .0001$). They also more frequently finished their hospitalization in the rehabilitation department (12.3% vs 8.7%; $p < .0001$). Among those who stayed in the ICU, median length of ICU stay was longer for those injured in terrorist acts (4 days vs 3 days; $p = .56$).

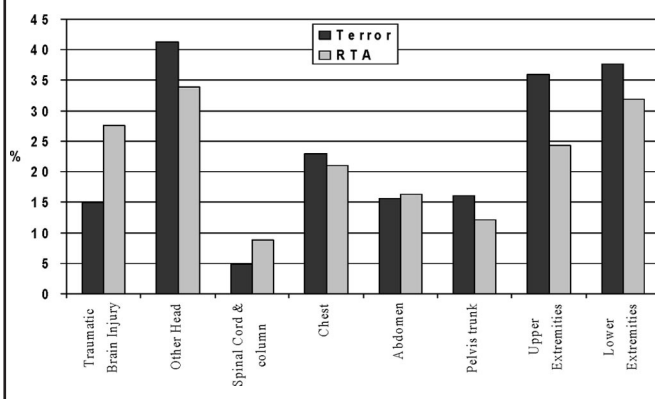
Patient Outcomes

The overall inpatient death rate was 6.0% ($n = 132$) among terrorism victims and 2.4% ($n = 713$) among those injured in RTAs. Most of those injured in RTAs had blunt injury, and the inpatient mortality rate among them was 2.3%. Among terrorism victims with blunt injury, the inpatient mortality rate was 4.4%, and among those with penetrating injury, it was 7.0% (Table 1).

Most terrorism victims who died during hospitalization died within the first 24 hours (72.7% vs 52.9% among RTA-related fatalities; $p = .001$; Fig. 3). One third of terrorism victims who died in the hospital died in the operating room.

FIGURE 2

Body region injured distribution among patients hospitalized following terrorism events vs road traffic accidents. Note: A patient with injuries in more than 1 body region may appear in more than 1 column.

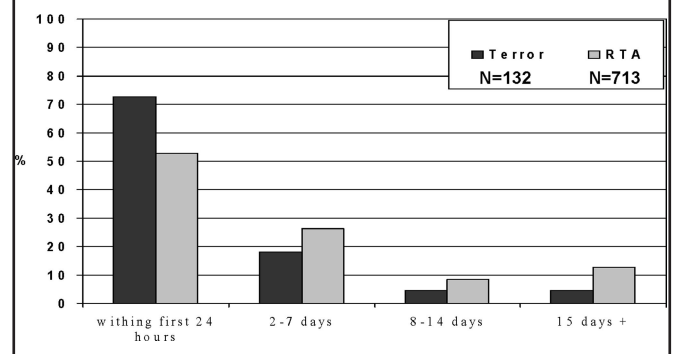


DISCUSSION

Terrorism-related injuries are in the minority among total numbers of patients hospitalized for traumatic injury. Many more people have been killed or injured as a result of RTAs in Israel than as a result of war and terrorism.⁴ Despite this, a small group of terrorism victims has unique characteristics that pose a challenge for hospital services. These patients are often injured in MCEs, resulting in large numbers of injured people needing care on scene, as well as triage and transportation to the ED. In existing practice, the most severely injured victims are the first to be evacuated to a hospital. If they are stable enough, they are transported to the nearest trauma center. When the nearest trauma center is too distant and the patient is unstable, he or she is transferred to the nearest hospital for initial stabilization and later transferred to a regional trauma center. Patients with minor injuries are usually spread out among more distant hospitals. In reality, in 20% to 30% of cases the victims are transported by civilians regardless of their severity.¹¹ Our database does not include patients who were discharged from the ED. Still, 46% of terrorism-related hospitalization arrived at the hospital as a result of MCEs (at an average of 6.9 hospitalized patients per

FIGURE 3

Time to death during hospitalization among patients hospitalized following terrorist events vs road traffic accidents.



hospital in every event), with one third of the patients sustaining severe to critical injuries. Such massive numbers of injured people result in an overload of EDs and require special organization and preparedness of hospitals.

Most terrorism victims sustained penetrating injuries induced by gunshot or contents of suicide bombs, which often include nails, screws, and bolts. This shrapnel causes multiple wounds.⁹ The treatment of patients with severe injuries who arrive as a result of isolated events can be handled within the resources of the trauma center, based on reports from physicians from general surgery and other surgical subspecialties, as well as nursing staff.¹² Because one third of terrorism-related victims were transferred to the operating room directly from the ED, hospitals should be prepared to activate reserve surgical teams in a terrorist event. After surgery, almost half of all terrorism victims needed intensive care. Among almost one quarter of terrorism victims, the first hospitalization department was the ICU. Availability of beds in the ICU is one of the important issues in dealing with terrorist events. According to the conclusions of Einav et al,¹³ after a terrorism event anesthesiologists and general, thoracic, and vascular surgeons are in immediate demand for lifesaving surgery in both the ED and the operating room. Orthopedic surgery, plastic surgery, and anesthesiology services should be prepared to handle an excessive and continuous operating room load for >24 hours.

Penetrating injury, which is frequent among terrorism casualties, caused high inpatient mortality rates (7%). In addition, the blunt trauma of terrorism victims resulted in higher mortality rates than that of those injured in RTAs. Falling objects or impact from a blast displacing the victim's body against a stationary object usually caused blunt injuries.¹² We suggest that the mechanism of blunt injury in an RTA applies less energy to the human body and results in less severe blunt injuries. The high frequency of traumatic brain injury and lower extremity injuries among pedestrians (compared with other users of roads) is explained by the mechanism of their injury. A pedestrian struck by a passenger car commonly sustains fractures of the tibia and fibula at the time of impact. Following the impact, the pedestrian is thrown onto the hood of the car or through the windshield, where he or she may sustain truncal injury, such as fractures of ribs or a rupture of the spleen. Finally, the pedestrian slides off the car as the brakes are applied and may land on the upper extremities or head. Frequency of cervical spine injury and chest and abdomen trauma among drivers of cars and passengers is a known adverse effect of safety belt usage.¹⁴

In general, the group of terrorism victims was more severely injured than victims of RTAs, which resulted in longer hospital stays, a higher rate of surgical procedures, a higher rate and longer lengths of stay in the ICU, and higher lengths of stay in the rehabilitation department. Possible recommendations for the specific treatment of terrorism victims may include faster recruitment of non-ED medical staff, trained to work in the ED at the beginning of MCEs; assignment of emergency physicians to direct the victims, according to severity of their injury, to the most appropriate treatment inside the ED; freeing operating

rooms for terrorism victims; recruitment of orthopedic services due to their higher frequency of injuries of extremities; and better coordination between multidisciplinary teams to treat patients with multiple injuries.

In conclusion, although casualties from terrorist events are less frequent than RTA casualties, they are more severely injured and therefore require more medical resources.

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Authors' Disclosures

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