International Trauma Care: A Comparison between Jerusalem, Israel, and Fairfax County, Virginia, USA

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Abstract

Background: Trauma is viewed by many as a global problem. The phenomenon of similar outcomes within differing healthcare delivery systems can illuminate the strengths and weaknesses of various trauma systems as well as the effects of these characteristics on patient outcome.

Objectives: To compare and contrast demographic and injury characteristics as well as patient outcomes of two urban/suburban trauma centers, one in Israel and the other in the United States.

Methods: Study data were obtained from the trauma registries of two trauma centers. Demographic variables, injury characteristics and outcomes were compared statistically between registries.

Results: Significant differences between the registries were found in demographic variables (age), injury characteristics (Injury Severity Score and mechanism of injury), and outcome (mortality and length of stay). Age and Injury Severity Score were found to be significant predictors of outcome in both registries. The Glasgow Coma Score was found to contribute to patient outcomes more than the ISS. Differences were found in the relative impact of injury and demographic factors on outcomes between the registries. After including the influence of these factors on patient outcomes, significant differences still remained between the outcomes of the trauma centers.

Conclusions: Despite possible explanations for these differences, true comparisons between centers are problematic.

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Conventional wisdom holds that the world is turning into one big global village. In terms of modern trauma care, this village looks very western in character. Many medical institutions throughout the world have incorporated the western model of trauma healthcare delivery even though the popular culture is not necessarily western in nature. For example, the first designated trauma center in Israel, inaugurated in Jerusalem in 1990, is very similar to those in the United States. In 1992, Israel officially adopted the American College of Surgeons Guidelines for Trauma Systems [1]. Gradually, another five centers were opened throughout the country. However, due to national differences in the delivery of trauma services such as evacuation and patient care protocols, local Israeli trauma care was adapted to fit the local conditions and was probably improved. Unfortunately, no evaluation was done to determine whether these gradual changes altered the quality of the country's trauma care.

Several studies have compared the delivery of trauma services between countries. Comparison among countries is thought to be one method of generating etiologic hypotheses regarding controversial risk factors for injury [2]. For example, a comparison between a regional Canadian and American trauma center [3] revealed that while overall mortality rates and discharge dispositions were similar between institutions, there were differences in the cost and utilization of healthcare services. When a rural African hospital was compared to a level I trauma center [4], overall trauma mortality rates were similar in both institutions (about 6%) but many other aspects of trauma care – such as severity of injury and pre-hospital care – were significantly different. On the other hand, a comparison of trauma mortality among three nations at different economic levels found that mortality decreased with increased economic level primarily due to pre-hospital care [5].

In his presidential address to the American Association for the Surgery of Trauma, Meyer [6] states that trauma should be viewed from a global perspective. He hypothesizes that the dramatic increase in global trauma can be attributed partially to the misconception that trauma is a local as opposed to an international problem.

Many similarities and differences exist between trauma centers and systems in Israel and those in the U.S. The present study investigates one trauma center and system in the U.S. and

ISS = Injury Severity Score

one in Israel; both are situated in or near their nation's capital. The Israeli trauma center is located in Jerusalem, a city of approximately 500,000 people; the American trauma center is located in a suburb close to Washington D.C. with a potential catchment population of approximately one million. In both systems there is a centralized command post that advises ambulances where the injured are located and triages which type of ambulance arrives at the scene. In both cases the hospital is informed of the incoming injured with a brief accounting of the case. A fully equipped emergency/trauma room and medical personnel are available 24 hours a day with specialty physicians on call. Both centers maintain a trauma registry that includes all patients admitted to either of the hospitals due to any type of trauma.

Differences, though, do exist. In Israel, there are three types of ambulances: the regular ambulance containing at least one trained emergency medical technician; a mobile intensive care unit with a paramedic, physician and driver/emergency medical technician; and an intermediate-level mobile intensive care unit that contains the same personnel and equipment as the mobile intensive care unit except for the physician. The ambulance personnel report and consult with the hospital trauma team about the incoming injury. An unknown but probably small proportion of patients arrive at the hospital via private cars. In the American system, all injuries in the county in which the center is located are coordinated through a central location within a state-wide trauma system. Through this location, the decision is made whether to send one of two types of ambulances (basic life support with two emergency medical technicians or advanced life support with two paramedics), or a helicopter (with a trained paramedic and a flight nurse or two paramedics). The hospital is notified in advance by the coordination center of an incoming trauma. The central command post also determines where the injured patient will be sent. All hospitals in the area are classified according to their ability to treat multiple trauma. Those with the most advanced treatment capabilities are classified as level I centers, while hospitals with fewer resources are classified as level II or Level III. The data from this study come from the level I center, which was the most comparable to the trauma center in Israel. It should be noted that while the Israeli hospital accepted all trauma patients, some of the more severely injured patients might have also been sent to other Israeli centers whose data are not used in this study.

It was determined that the most appropriate way to evaluate these similarities and differences would be to compare information in the trauma registries maintained by the two centers. Studies based on registry data are considered useful because they contain injury descriptions, physiologic information and outcome data, often in a similar format [7]. The phenomenon of similar outcomes within differing healthcare delivery systems and differing demographics can illuminate the strengths and weaknesses of various trauma systems as well as the effects of these characteristics on patient outcome. With this objective in mind, the current study was conducted to compare and contrast demographic and injury characteristics as well as patient outcomes of two urban/suburban trauma centers, one in Israel and one in the USA.

Methods

Population

Study data were obtained from the trauma registries of the above described two trauma centers for the years 1995–96. A system was set up at each center whereby data collectors for the registries received notification of all patients admitted due to injury. The records of these patients were then reviewed by either a trained medical records specialist or a registered nurse whose main role was trauma data registrar. The extracted data were then entered into the respective registries by the registrar. Inclusion criteria for this study were diagnoses of an injury requiring hospitalization during the 2 years of data collection. All patients in the registries were included in the analyses.

Variables

Three types of variables were extracted from the registries: demographic data, injury characteristics, and measures of patient outcome.

Demographic data consisted of the age and gender of the subject. Age was placed into three categories: 0–14 years, 15–54 years, and 55 years old and older. These categories were consistent with the literature and the distribution of patients in both registries.

Injury characteristics were the mechanism of injury, bodily site of injury, Glasgow Coma Score and Injury Severity Score. Due to the large variety of mechanisms of injury, the authors chose to condense this variable into four categories: motor vehicle crashes, falls, intentional injuries, and other. The data were condensed from the E-code designation listed for each patient in both directories. MVCs include all patients who were injured in contact with any type of motor vehicle irrespective of whether the patient was the driver, passenger or pedestrian. All falls irrespective of the height of the fall or location were placed in the fall category. Injuries resulting from purposeful intent to harm regardless of whether the patient was the perpetrator and/or the victim were considered intentional injuries. All other categories of E-codes were placed into the "other" category.

ISS was coded in both registries as designated by the Abbreviated Injury Scale. ISS was reclassified into three categories: minor injuries with ISS ranging from 1 to 15, moderate injury where ISS ranged from 16 to 24, and severe injury with ISS of 25 and above.

Outcome measures were hospital length of stay and in-hospital mortality. Length of stay of survivors was evaluated from two aspects: short length of stay (2 days or less) and long length of stay (more than 2 weeks).

MVCs = motor vehicle crashes

Results

The Israeli registry comprised 3,536 cases versus 2,333 in the U.S. registry. Only 19 subjects had missing data related to age, and 2 related to ISS. All other data were complete. Demographic characteristics are described in Table I. The majority of patients in both registries were males, although the distribution of ages differed between registries. While the Israeli register contained a more even distribution of patients, the U.S. registry contained an overwhelming majority of patients aged 10–54 years.

As can be seen in Table 1, differences were found in the mechanism of injury as well as the ISS. In Israel, a similar percentage of patients were injured due to MVCs or falls, while in the U.S. there was an almost sevenfold difference between the number of patients injured due to an MVC as compared to a fall. It should also be noted that the percentage of patients with intentional injuries was also higher in the USA. The American registry contained a higher percentage of patients with higher ISS.

Outcome characteristics also differed between the registries. Lengths of stay were longer in Israel, while the mortality rate was higher in the U.S. registry [Table 1]. Several variables were shown to be associated with increased mortality. These included increased age (over 55 years old), higher ISS (25–75) and mechanism of injury (intentional injuries followed by MVC over falls and other injuries). Among survivors, there was a larger percentage of Americans with a short length of stay than Israelis, while in Israel there was a higher percentage of patients who stayed longer than 14 days. This was true for all ages and ISS scores. The U.S. hospital also showed higher percentages of patients who were discharged early with low ISS scores. The higher mortality rate in the American hospital was also consistent across all age and ISS levels.

When reviewing the descriptive results of the study, we noted differences between the registries in the relative amount of patients discharged during different time periods. These periods seemed to be concentrated around short length of stay (discharge within 2 days after admission), regular discharge (within 2 weeks of admission) and late discharge (after 2 weeks post admission). Therefore, two separate logistic regressions were carried out – the first determined what factors influenced a short length of stay and the second addressed factors related to late discharge (after 2 weeks).

Logistic regressions were carried out for each hospital alone and both hospitals combined in order to determine what demographic and injury characteristics significantly affected outcome. Predictor variables were age, gender, ISS, mechanism of injury, and Glasgow Coma Score. As expected, both age ($P<0.001$) and ISS ($P<0.001$) significantly affected survival in both institutions. Above the influence of ISS, GCS also contributed to a lack of survival in both institutions ($P<0.001$). Differences between institutions were found in the relative contribution of age, ISS and GCS on survival [Table 2]. Mechanism of injury did not contribute to survival in the Israeli registry sample, but it slightly affected survival in the American registry sample. While trauma is thought to be a male dominated "disease," gender did not contribute to survival.

Several factors in both hospitals affected which patients were discharged within 2 days [Table 3]. Younger patients and those with lower ISS scores were more likely to be discharged within 2 days from both hospitals. However, the level of the effect of these variables differed between hospitals. There was a significant interaction between hospital and age on early discharge ($P<0.001$). Similarly, mechanism of injury was a significant contributor to shorter lengths of stay [Table 3]. The strength of the effect also differed between hospitals. Those who fell and those who were victims of an intentional or sustained another miscellaneous type of injury were more likely to be discharged within 2 days than those involved in a road accident in Israel. This effect was reversed in the U.S. registry population for all but intentional injuries. In both cases, severe GCS was associated with lengths of stay longer than 2 days. Similar results were found when investigating the contribution of age and ISS on long lengths of stay [Table 4]. In both hospitals, higher age and ISS significantly contributed to long lengths of stay. Age effects were stronger in the Israeli hospital. Overall, mechanism of injury was less likely to contribute to long lengths of stay, whereas a severe GCS was a great contributor.

Table 1. Demographic characteristics, injury characteristics and patient outcomes

	Israel		United States		Total	
	No.	%	No.	%	No.	%
Gender						
Male	2,254	64	1,616	69	3,870	66
Female	1,282	36	717	31	1,999	34
Age (yr)						
0–14	1,105	31	239	10	1,334	23
15–54	1,631	46	1,857	80	3,488	60
> 55	794	23	234	10	1,028	17
ISS						
1–15	2,919	83	1,731	74	4,650	79
16–24	291	8	259	13	550	10
25–75	326	9	341	14	667	11
Mechanism of injury						
MVC	1,155	33	1,410	60	2,565	44
Falls	1,384	39	220	9	1,604	27
Intentional	284	8	297	13	581	10
Other	713	20	406	17	1,119	19
Length of stay: all patients						
< 2 days	965	27	1,099	47	2,064	35
3–14 days	2,024	57	1,037	44	3,061	52
> 15 days	547	16	197	8	744	13
Mortality						
Alive	3,411	96	2,160	93	5,571	95
Died	125	4	1,73	7	298	5

GCS = Glascow Coma Score

Table 2. Odds ratio and 95% confidence interval for survival* based on age, ISS, Glasgow Coma Score and mechanism of injury, by hospital

	Israel			U.S.			Both		
	OR	CI		OR	CI		OR	CI	
		Low	High		Low	High		Low	High
Predictor variables									
Hospital: Israel/ U.S.							0.75	0.53	1.0
Age									
0–14/55+	13.5**	5.9	30.7	4.7*	1.8	11.8	8.8**	4.9	15.9
15«–54/55+	6.8**	3.6	12.6	5.5**	2.9	10.8	6.3**	4.0	9.9
ISS									
1«–15/25+	64.2**	29.9	137.0	29.3**	14.2	60.2	41.2**	24.3	69.6
16«–24/25+	11.5**	5.3	25.0	9.5**	4.8	18.7	10.2**	6.2	17.0
Glasgow Coma Score									
3«–8/9«–15	9.2**	5.2	16.0	21.6**	12.1	38.5	13.1**	8.9	19.4
Mechanism of injury									
Falls/MVC	0.86	0.45	1.6	0.81	0.36	1.9	0.86	0.53	1.4
Intentional/MVC	0.76	0.39	1.5	0.28**	0.15	0.56	0.48***	0.30	0.77
Other/MVC	0.48	0.22	1.1	0.79	0.43	1.5	0.65	0.40	1.1

* Survival: lives as opposed to dies. ** P<0 .01. *** P<0 .05. OR = odds ratio, CI = confidence interval.

Table 3. Odds ratio and 95% confidence interval for short length of stay* of survivors based on age, ISS, Glasgow Coma Score and mechanism of injury, by hospital

	Israel			U.S.			Both		
	OR	CI		OR	CI		OR	CI	
		Low	High		Low	High		Low	High
Predictor variables									
Hospital: Israel/ U.S.							3.77**	3.25	4.37
Age									
0–14/55+	5.10**	3.98	6.55	2.58**	1.61	4.13	4.63**	3.73	5.73
15–54/55+	2.27**	1.74	2.9	2.10**	1.46	3.02	2.23**	1.82	2.74
ISS									
1–15/25+	25.10**	6.26	100.56	43.33**	10.72	175.14	33.64**	12.59	89.93
16–24/25+	5.84***	1.36	25.07	2.65	0.59	11.90	4.02***	1.41	11.45
Glasgow Coma Score									
9–15/3–8	2.74***	1.13	6.67	8.46**	4.74	15.08	6.05**	3.74	9.79
Mechanism of injury									
Falls/MVC	1.58**	1.28	1.96	0.69****	0.49	0.99	1.08	0.91	1.28
Intentional/MVC	1.53****	1.07	2.18	2.20**	1.52	3.20	1.60**	1.26	2.02
Other/MVC	1.23	0.97	1.55	0.33**	0.25	0.43	0.67**	0.56	0.80

* Short length of stay: <2 days vs. >2 days. ** P<0.001. *** P <0 .01. **** P<0.05.

Discussion

The primary results of this study were the differences in patient lengths of stay and mortality. No overt differences in the two systems were discovered to readily explain these differences. It is possible that the reasons for the differences are beyond the ability of any investigation that relies on data included in the average trauma registry. In order to answer such questions, vastly more data would need to be coded into the registry. Such data would include pre-hospital and post-hospital information, as well as details such as time from injury to definitive treatment and in-hospital treatments and complications. Jurkovitch and Mock [7] agree that a method, albeit not yet available, is needed to control for extraneous factors that might account for observed differences.

Another potential reason for differences in outcomes could be the use of drugs and/or alcohol by patients in the registries. This information is not available in the Israeli registry. However, it should be noted that according to national surveys the level of drug and alcohol use is much higher in the U.S. than in Israel. For example, the National Household Survey on Drug Abuse found that in 1995, 52.2% of American adults reported alcohol use and 6.1% reported use of an illicit drug within the previous month [8]. This contrasts with a survey conducted in Israel, also in 1995, which showed the incidence of alcohol and illegal drug use among adults to be 5.06% and 0.38%, respectively [9].

Table 4. Odds ratio and 95% confidence interval for long length of stay* of survivors based on age, ISS, Glasgow Coma Score and mechanism of injury, by hospital

	Israel			U.S.			Both		
	OR	CI		OR	CI		OR	CI	
		Low	High		Low	High		Low	High
Predictor variables									
Hospital: Israel/ U.S.							0.25**	0.19	0.31
Age									
0–14/55+	0.21**	0.15	0.30	0.27***	0.11	0.63	0.22**	0.16	0.30
15–54/55+	0.38**	0.28	0.50	0.47***	0.28	0.79	0.39**	0.31	0.50
ISS									
1–15/25*	0.04**	0.02	0.05	0.05**	0.03	0.07	0.04**	0.03	0.06
16–24/25*	0.15**	0.0	0.23	0.34**	0.22	0.55	0.22**	0.16	0.30
Glasgow Coma Score									
9–15/3–8	0.38**	0.23	0.60	0.25**	0.16	0.38	0.30**	0.22	0.41
Mechanism of injury									
Falls/MVC	0.50**	0.38	0.66	0.63	0.31	1.25	0.52**	0.40	0.67
Intentional/MVC	0.65***	0.42	0.99	0.86	0.48	1.54	0.72	0.51	1.01
Other/MVC	1.16	0.85	1.56	0.57****	0 .34	0.96	1.00	0.78	1.29

* Long length of stay: length of stay >14 days vs. <14 days. ** $P<0.001$. *** $P<0.01$. **** $P<0.05$.

Another study that evaluated the data from another Israeli registry from a similar period found similar results in terms of the percentage of patients with low ISS, the ratio of males to females, and the percentage of MVCs [10]. These similar results lend some validity to the Israeli data evaluated in this study.

A very large difference between the systems was noted in the percentage of patients whose hospital stay was less than 2 days. In general, patients in Israel were not discharged as quickly as in the U.S. Healthcare providers in both countries are acutely aware of the issue of containment of healthcare costs. However, universal healthcare coverage and socialized medicine exist in Israel but not in the USA. Perhaps the pressure to discharge patients earlier is stronger in the U.S. than it is in Israel where the diagnosis-related group system is just beginning to take hold. It should also be noted that those injured in MVCs in Israel are covered by a more liberal type of health insurance, thus there was a significant contribution of mechanism of injury to longer lengths of stay in Israel for those injured in an MVC.

Another different approach is reflected in patient observation following trauma. In Israel, patients are often left in the emergency room under observation for several days, often without being admitted to the hospital. This practice is much less common in the U.S. Such patients would not appear on the Israeli registry. Therefore, calculations involving length of stay might be biased to some extent.

Quality of pre-hospital care could also affect hospital outcomes. If the quality of care pre-hospital is less optimal, then more patients would die in the field. These patients would not be included in the trauma registry. However, if the pre-hospital care is good, then it is possible that more severely injured patients would survive to arrive at the hospital, and would therefore be included in the registry and possibly increase the in-hospital mortality rate. This may well be the case in this study, as the percentage of patients with ISS scores above 25 was 9.6% in the Israeli center as opposed to 14.2% in the American center.

Jerusalem is perceived as a city with a high rate of violence-related injuries caused by acts of terrorism in recent years. The results of this study show that such perceptions are not necessarily accurate during periods of relative calm in the region. For example, in 1995, there were 69 homicides in Israel (1.2 per 100,000) [9], while the crude homicide rate in the USA for that year was 8.6 per 100,000 population. The percentage of intentional injuries resulting in hospitalization was higher in the U.S. registry, but the proportion of suicides as opposed to injuries perpetrated against another was equivalent in both registries. Similar results were found in a study comparing mortality rates in Los Angeles and Mexico City, with relatively high rates of homicide and suicide found for Los Angeles County [11].

In the Israeli registry there was a higher percentage of falls but a lower percentage of MVCs (Falls: U.S. 9.4% vs. Israel 39.1%, MVC: U.S. 60.4% vs. Israel 32.7%). Comparisons with other registries also found higher injury rates due to MVCs as compared to falls [11,12]. The results of this study could be attributed to two factors. The first is that the central command post at the U.S. center may have sent those who fell and did not have serious injuries to other hospitals in the catchment area. However, those with more serious injuries possibly due to MVCs would have been triaged to the level I center of this study. It should be noted that the Israeli registry contained a higher percentage of the elderly since the elderly had a higher percentage of falls (39.2% of those who fell were elderly in Israel as compared to 14.1% in the U.S.). The second factor could be standard-of-living differences between the two locations. In Fairfax Country in 1997 there were 704,718

registered vehicles and 721,645 registered drivers as compared to 130,632 registered vehicles and 197,078 registered drivers in the greater Jerusalem area.

We found in the logistic regression that GCS had a greater influence than that of the ISS on outcome. This could indicate that head injuries might not receive the proper weighting within the ISS scale.

It should be noted that the current investigation was retrospective in nature. The data in the registries were collected independently with no standardization of data entry. It is possible that the same information might have been coded differently in the two sites.

This study found that age, ISS and GCS affect patient outcomes in both countries. The relative influence of each of these factors on outcome is different between the countries. The impact of mechanism of injury is even more variable. However, even after these factors are taken into account, differences in patient outcomes still exist. Are these differences due to different approaches to pre-hospital care and/or in-hospital treatment? Or are these differences due to methods of data recording in the registries? The answers to these questions are not provided by this study nor can they be answered by any study using a standard trauma registry. In order to evaluate differences in pre-hospital or in-hospital treatment a much larger data set would be needed, one that would require a much larger dedication of resources than most healthcare institutions would be willing to provide. The question then remains as to the value of standard registries when comparisons between them are of limited benefit. Perhaps as far as trauma registries are concerned, we have a long way to go before we become one global village.

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