Impact of Trauma System Preparedness on the Outcomes of Severe Child and Adolescent Injuries

Raouf Afifi

Received: 28 April 2011 / Accepted: 2 December 2012 / Published online: 20 December 2012
© Association of Surgeons of India 2012

Abstract Severe child trauma poses a heavy burden upon the public's health and the nations' economies, in terms of mortality, morbidity, and disability. The burden varies by the maturity level of the adopted trauma system. This work aimed to identify the impact of trauma system maturity upon the outcomes of care of severely injured children. Discharge data for hospitalized trauma children in Florida (mature trauma system) and Indiana (immature trauma system) were retrospectively analyzed. All severely injured children, 1–15 years of age with an injury severity score ≥ 25 during 1999–2000 were included. Assessment involved the differences in specified treatment procedures, survival rates, hospital length of stay, and the need for post-hospital institutional care. Analysis revealed that Indiana children significantly stay longer in hospital, and that no differences in the rates of patient mortality, discharge home, and selected procedures were found. Trauma system maturity impacts the volume and complexity of interventions, as well as the mortality, morbidity, and disability associated with the severe child and adolescent trauma. The cost of such burden could be directed to improving quality of the state's injury management services.

Keywords Immature trauma system · Injury severity score ≥ 25 · Mature trauma system · Pediatric trauma · Trauma outcomes

Introduction

Death, the gravest outcome of injury, represents a considerable fraction of severe childhood injury burden [1]. On the other hand, nonfatal injury was the leading cause of both temporary

and permanent disability for patients aged ≤ 19 years [2] and accounted for a major proportion of health service utilization in children. The patterns of fatal childhood injury suggest that one third of deaths are due to homicides in an urban setting, e.g., house fires (34 %), firearms (19 %), and motor vehicle crashes (7 %) [3]. In the U.S.A., the American College of Surgeons-Committee on Trauma (ACS-COT) has defined the resources for optimal care of trauma patients [4]. Pediatric trauma outcomes particularly involve the mechanism of injury, the pattern of tissue damage, pre-hospital triage, transport, and time lapse until professional treatment. Whether the trauma system is mandated, non-mandated, or voluntarily evolving is the mainstay of trauma outcome. With a well-defined trauma triage policy, as in a mandated trauma system, high-risk patients are transported directly to a level I/II trauma center (TC) for specialized care, compared to transporting them to the nearest emergency department, as in the non-mandated system. The U.S. Congress had reestablished the Trauma Care Systems Planning and Development Act [5] program within the Services-Health Resources and Services Administration (HRSA) to aid in the assessment of current trauma systems. In one HRSA report, it was noted that there were inadequate data systems needed for evaluation in 30 of the 38 states reporting some effort at trauma system development. Whereas 37 of 50 states had some central reporting of trauma registry data from TCs, 22 of the 37 states with TC data do not collect non-trauma center (NTC) injury data [6]. Of 1,154 general TCs, including 353 level I/II TCs in the U.S.A. [7], Florida has a mature trauma system that consists of 216 hospitals, 20 of which are level I/II TCs, as designated by the ACS. Indiana lacked such mandated triage policy, a key criterion for a mature trauma system. The state, instead, only encompassed out of 117 hospitals seven level I/II TCs, three of which were taking serious steps toward eligibility for the ACS-TC consultation-verification program. The aim of this study, therefore, was to assess the differences in the outcomes of high-risk pediatric

R. Afifi (✉)
Preventive Medicine Department, Armed Forces Hospitals,
PO Box 1347, 21944 Taif, Kingdom of Saudi Arabia
e-mail: raoufafifi@hotmail.com

trauma, in terms of survival rates, hospital length of stay (HLOS), and proportion discharged home in a mandated trauma system (as Florida's) vs. non-mandated system (as Indiana's). Particularly, discharge data from all hospitals in the two states would be analyzed.

Materials and Methods

The study used the same trauma discharge database described in a previous study by this investigator [8]. Subjects included all trauma children aged 1–15 years admitted in Florida and Indiana hospitals and TCs. The total number of subjects was 14,537 (11,059 Florida and 3,478 Indiana during 1999–2000). “Trauma cases” defined by the International Classification of Diseases, ninth revision, Clinical Modification (ICD-9) diagnosis code 800.00 to 959.9 (“injury” or “poisoning”) [9] were admitted to the study. A maximum of 10-diagnosis and 10-procedure ICD-9 codes were available in the database. Relevant hospital discharge data included demographic, diagnostic, surgical procedures, mechanism of injury, and pattern of injury. Risk variables were the following: (1) age 1–15 (frequently categorized as 1–5, 6–10, and 11–15), (2) sex, (3) pattern of injury (spleen, liver, pelvis, femur, and spinal cord injury), (4) injury mechanism [motor vehicle accidents (MVA), falls, or gunshot wounds (GSW)], “other causes,” and “missing E-code” categories [10], (5) injury severity score (ISS), 1 to 75, split into four categories (1–8, 9–15, 16–24, and ≥ 25 to describe mild, moderate, mild severity, and severe injuries, respectively), (6) selected interventions (splenectomy,

ventilation ≥ 4 days, or tracheostomy), (7) hospital designation, according to trauma management capacity, either level I/II TC or NTC. Unavailable data included vital signs, the Glasgow Coma Scale (GCS), time elapsed between diagnosis and treatment, and the Glasgow Outcome Scale (GOS). Whereas the principal outcome variable of interest was survival, equally important were other outcomes including the HLOS and post-discharge institutional care. The modified ISS measure [11] to categorize trauma severity was used in the study. Severely injured patients would frequently be tested as stratified by TC/NTC. Chi-square tests of independence with odds ratios (OR) and their 95 % confidence intervals (CIs) were performed for comparisons involving nominal or ordinal variables. Also, *t* tests (or Mann Whitney *U* tests when normality distribution could be a concern) were used to compare the differences in the means of internal ratio scale variables. Our statistical analyses were conducted at level of significance $\alpha = 0.05$; *p* value < 0.05 results were considered statistically significant.

Results

As in Table 1, the risk of admitting severe injuries in children aged 1–5 years to all types of healthcare facilities was significantly lower in Florida (21.3 %) than in Indiana (30.6 %), (OR 0.62, CI 0.41, 0.92). The mean age, age group proportions, and sex distribution could not be discriminated significantly in the two states. Florida significantly experienced higher rate of all-severity trauma admissions during the study

Table 1 Pediatric trauma admissions: Florida vs. Indiana by age, ISS, and injury mechanism

State Population	Florida 16 million		Indiana 6.0 million		OR	CI
	<i>n</i>	Rate per 100,000/year ^a	<i>n</i>	Rate per 100,000/year ^b		
All trauma admissions	11,059	34.5 ^a	3,478	29.0 ^b	1.18	0.60, 2.4
Patients with ISS ≥ 25	445		160			
Male (ISS ≥ 25)	298	67.0 %	101	63.0 %	1.30	0.65, 8.3
Mean age ($\pm$ SD) year	9.7 $\pm$ 4.45		8.9 $\pm$ 4.99			
1–5 years (ISS ≥ 25)	95/445	21.3 %	49/160	30.6 %	0.62	0.41, 0.92
6–10 years (ISS ≥ 25)	123/445	27.6 %	39/160	24.4 %	1.19	0.87, 1.80
11–15 years (ISS ≥ 25)	227/445	51.1 %	72/160	45.0 %	1.27	0.89, 1.90
MVA (ISS ≥ 25)	220	49.4 %	49	30.6 %	2.20	1.50, 3.30
Fall (ISS ≥ 25)	32	7.2 %	04	2.5 %	3.00	1.10, 8.70
GSW (ISS ≥ 25)	10	2.2 %	03	1.9 %	1.20	0.33, 4.40
All other (ISS ≥ 25)	54	12.2 %	34	21.2 %	0.51	0.32, 0.82
Total E-code (ISS ≥ 25)	316	71.0 %	90	56.2 %	1.90	1.80, 2.00
No E-code (ISS ≥ 25)	129	29.0 %	70	44.0 %	0.53	0.36, 0.76

^a Rate/year: Florida = $(11,059/16,000,000) \times 100,000/2 = 34.5$

^b Rate/year: Indiana = $(3,478/6,000,000) \times 100,000/2 = 29.0$

period (34.5/100,000 vs. 29.0/100,000, OR 1.18, CI 0.60, 2.4). Notably, MVA among ISS ≥ 25 patients was the most predominant injury mechanism in either state (49.4 % Florida and 30.6 % Indiana, being significantly higher in Florida; OR 2.20, CI 1.5, 3.3). Likewise, the frequencies of all injury mechanisms among ISS ≥ 25 children, other than GSW, significantly differed. Florida had almost as triple severe fall injury proportion as in Indiana (7.2 vs. 2.5 %, OR 3.0, 1.1, 8.7). Otherwise, Florida “all other” mechanisms, including those with no E-code, were less frequent compared to Indiana’s (12 vs. 21 %, OR 0.51, CI 0.32, 0.82, and 29 vs. 44 %, OR 0.53, CI 0.36, 0.76, respectively, Table 1). As in Table 2, no significant difference in the distribution of the selected ten procedures in the two states’ high risk trauma patients has been found. Stratified by TC/NTC, only splenectomy was being performed more frequently among Florida TC patients (OR 4.35, CI 1.1, 18.7, Table 2). Outcome-wise, no mortality rate differences across the two states have record, whether or not stratified by TC/NTC (Table 3). Similar findings have been obtained regarding discharge home as an outcome (Table 3). On the other hand, Indiana risky patients, unstratified, stay longer in hospital compared with Florida peers (mean HLOS 15.3 $\pm$ 23.6 days vs. 10.8 $\pm$ 13.09 days, $p=0.021$, respectively; Table 4). Stratified

by TC/NTC, Indiana risky patients stay at TC as long as 18.07 $\pm$ 26.1 days, compared with Florida counterparts who stay 11.06 $\pm$ 12.7 days, on average ($p=0.005$; Table 4). Moreover, Indiana TC risky patients stay 6–10 days that is almost double the duration of Florida counterparts (20.7 $\pm$ 23.6 days vs. 10.7 $\pm$ 12.7 days, $p=0.005$; Table 4).

From the data completion standpoint (Table 5), Florida misses an E-code for ISS ≥ 25 children, unstratified by age, less frequently than Indiana, either unclassified by TC/NTC (29 vs. 43.8 %, OR 0.53, CI 0.36, 0.76) or classified by TC/NTC (28 vs. 40 %, OR 0.6, CI 0.39, 0.92; 31 vs. 55 %, OR 0.37, CI 0.17, 0.79, respectively). The same trend applies for age groups 6–10 years and 11–15 years, as well as those who had no E-code but have the 10 diagnoses documented [(25.2 vs. 46.2 %, OR 0.39, CI 0.19, 0.83); (31 vs. 74 %, OR 0.5, CI 0.29, 0.83); and (15.5 vs. 8.1 %, OR 2.07, CI 1.1, 3.9), respectively].

Also, 6- to 10-year-old TC children with ISS ≥ 25 show a similar trend, as well as the 11- to 15-year-old NTC children (24.7 % Florida vs. 46.7 %, Indiana, OR 0.38, CI 0.16, 0.88), (13 vs. 29 %, OR 0.26, CI 0.09, 0.72; Table 5). Likewise, the prevalence of missing an E-code among trauma children with an ISS < 25 was consistently lower in Florida than in Indiana (1,567/10,614=15 vs. 1,048/3,318=32 %, OR 0.38, CI 0.15, 0.41; Table 5, footnote).

Table 2 Distribution of ISS ≥ 25 patients by the 10 procedures (altogether and stratified by TC/NTC)

	Florida <i>n</i> =445 (349 TC, 96 NTC)		Indiana <i>n</i> =160 (120 TC, 40 NTC)			OR	CI	
Craniotomy	64 (14.4 %)		25 (15.7 %)			0.91	0.55, 1.50	
ICP	136 (30.6 %)		46 (28.8 %)			1.10	0.73, 1.60	
Abdominal surgery	59 (13.3 %)		22 (13.8 %)			0.96	0.57, 1.60	
Splenectomy	41 (9.2 %)		9 (5.6 %)			1.70	0.81, 3.60	
Splenic salvage	4 (0.1 %)		3 (2.0 %)			0.48	0.11, 2.10	
Ventilator ≥4 days	120 (27.0 %)		44 (27.5 %)			1.03	0.69, 1.54	
Tracheostomy	30 (6.7 %)		5 (3.1 %)			2.24	0.85, 5.90	
Bronchoscopy	15 (3.4 %)		5 (3.1 %)			1.08	0.39, 3.03	
Swan–Ganz catheter	7 (1.6 %)		7 (4.4 %)			0.35	0.12, 1.00	
Caval interruption	3 (0.7 %)		3 (3.0 %)			1.10	0.03, 53.0	
	Trauma center (TC)				Non-trauma center (NTC)			
	FL (<i>n</i> =349)	IN (<i>n</i> =120)	OR	CI	FL (<i>n</i> =96)	IN (<i>n</i> =40)	OR	CI
Craniotomy	16.0 %	16.7 %	0.96	0.55, 1.70	8.3 %	12.5 %	0.64	0.20, 2.08
ICP	33.5 %	32.5 %	0.96	0.61, 1.50	19.8 %	17.5 %	0.16	0.45, 3.03
Abdominal surgery	11.2 %	10.0 %	1.13	0.57, 2.20	20.8 %	25 %	0.79	0.33, 1.88
Splenectomy	7.0 %	1.7 %	4.35	1.10, 18.7	17.7 %	17.5 %	1.02	0.40, 2.58
Splenic salvage	0.90 %	0.8 %	1.03	0.11, 10.1	1.0 %	5.0 %	0.20	0.02, 2.20
Ventilator ≥4 days	29.0 %	31.0 %	0.94	0.58, 1.44	19.8 %	17.5 %	1.16	0.45, 3.03
Tracheostomy	7.0 %	2.5 %	2.88	0.85, 9.70	6.3 %	5.0 %	1.27	0.25, 6.56
Bronchoscopy	4.0 %	3.3 %	1.21	0.39, 3.76	1.0 %	2.5 %	0.41	0.03, 6.73
Swan-Ganz catheter	2.0 %	3.3 %	0.59	0.17, 2.60	1.0 %	3.0 %	0.10	0.001, 54
Caval interruption	3.0 %	0.5 %	0.40	0.001, 1.1	0.1 %	52.%	0.64	0.195, 2.1

NB. The number of performed procedures per patient may exceed the number of patients; some often needed more than one procedure

Table 3 ISS ≥ 25 patients by mortality rates and discharge home (altogether and stratified by TC/NTC)

Outcome measures ^a	Florida <i>n</i> =445 (349 TC, 96 NTC)		Indiana <i>n</i> =160 (120 TC, 40 NTC)		OR	CI
		%		%		
Mortality rate (MR)						
MR 1–5 years	(121/445) (37/095)	27.2	(49/160) (20/049)	30.6	0.846	0.57, 1.26
MR 6–10 years	(33/123)	39.0	(10/039)	41.0	0.925	0.46, 1.87
MR 11–15 years	(51/227)	27.0	(19/072)	26.0	1.060	0.47, 2.41
Discharge home	(196/445)	22.5	(75/160)	26.4	0.808	0.44, 1.44
Discharge home 1–5 years	(43/095)	44.0	(20/049)	47.0	0.892	0.62, 1.28
Discharge home 6–10 years	(57/123)	45.0	(21/039)	41.0	1.199	0.60, 2.41
Discharge home 11–15 years	(96/227)	46.0	(34/072)	54.0	0.567	0.20, 1.22
ISS ≥ 25 Cases ^b		42.3		47.0	0.819	0.48, 1.40
	Trauma Center (TC)		Non-trauma Center (NTC)			
	Florida	Indiana	Florida	Indiana		
	<i>n</i> =349	<i>n</i> =120	<i>n</i> =96	<i>n</i> =40		
Crude MR	103/349 (29.5 %)	40/120 (33.3 %)	18.8 % 18/96	9/40 (22.5 %)	0.95	0.32, 1.66
MR 1–5 years	29/71 (41.0 %)	18/434 (2.0 %)	33.3 % 08/24	2/6 (33.3 %)	1.00	0.15, 6.70
MR 6–10 years	27/97 (28.0 %)	9/30 (30.0 %)	23.0 % 06/26	1/9 (11.1 %)	2.4	0.25, 23.2
MR 11–15 years	47/181 (26.0 %)	13/472 (7.7 %)	8.7 % 4/46	6/25 (24.0 %)	0.30	0.08, 1.92
Discharge home (total)	138/349 (39.5 %)	55/120 (46.0 %)	58/96 (60.45)	20/40 (50.0 %)	1.53	0.73, 3.21
Discharge home 1–5 years	32/71 (45.0 %)	20/043 (37.7 %)	11/24 (46.0 %)	0/0/6 (0.0 %)	1.40	0.00
Discharge home 6–10 years	42/97 (43.3 %)	15/030 (50.0 %)	15/26 (58.0 %)	6/9 (67.0 %)	0.68	0.14, 3.34
Discharge home 11–15 years	(35.4 %) 64/181	20/047 (42.6 %)	32/46 (70.0 %)	14/25 (56.0 %)	1.80	0.66, 4.93

^a Reference category: All ISS ≥ 25 (dead+alive) per cause of injury per state (Table 1); Patients with ISS ≥ 25 , all care levels^b Computation for MR: based on the following totalsFlorida and Indiana patients (all ages with ISS ≥ 25) at TC setting=349 and 120, respectivelyFlorida and Indiana patients (all ages with ISS ≥ 25) at NTC setting=96 and 40, respectively

Table 4 Distribution ISS ≥ 25 patients by hospital length of stay (combined and stratified by TC/NTC)

Outcome measures	Florida <i>n</i> =445 (349 TC, 96 NTC)	Indiana <i>n</i> =445 (349 TC, 96 NTC)	<i>p</i> value			
Mean HLOS (±SD)	10.8 ±13.09	15.34±23.6	0.021			
Mean HLOS (1–5 years)	7.76±8.32	13.37±21.7	0.085			
Mean HLOS (6–10 years)	0.33±12.90	17.08±21.8	0.073			
Mean HLOS (11–15 years)	2.30±14.50	15.74±25.8	0.284			
	Trauma Center (TC)			Non-Trauma Center (TC)		
	Florida <i>n</i> =349	Indiana <i>n</i> =120	<i>p</i> value	Florida <i>n</i> =96	Indiana <i>n</i> =40	<i>p</i> value
Mean HLOS (± SD) d	11.06±12.7	18.07±26.1	0.005	9.8±14.6	7.2±9.4	0.098
Mean HLOS (± SD) d (1–5 years)	7.50±7.30	14.3±22.7	0.435	8.6±11.0	7.0±10.4	0.462
Mean HLOS (± SD) d (6–10 years)	10.70±12.3	20.7±23.6	0.050	8.8±15.4	5.0±3.8	0.664
Mean HLOS (± SD) d (11–15 years)	12.7±19.9	20.0±30.4	0.518	1.9±16.0	8.0±10.7	0.124

Discussion

The utilized administrative trauma data helped describe the outcomes of high-risk injury among this population stratum in the different settings of care and trauma system maturity. However, several important pieces of clinical information are not generally available in an administrative database that normally would be obtainable in a more refined trauma registry, e.g., vital signs, the GCS score, the pre-hospital time lapse, and the GOS. There could be limitations in using HLOS outcome variable, too. In some states, hospitals may be providing inpatient rehabilitation, part of the overall inpatient stay; others transfer them to skilled nursing facilities. The

administrative database we used does not code hospital transfers. Another limitation comparing multi-state trauma systems was the absence of E-codes, which may partly be due to the limited number of computer fields available to list the diagnoses. In the Indiana's administrative database, 15 fields are available for diagnoses, compared to 10 fields in the Florida's. Indiana recording system has been significantly missing E-codes more frequently than Florida. This trend has also been observed between the oldest two age groups (6–10 and 11–15 years). Analysis also indicates that E-code underreporting in less risky traumatized children (ISS <25) in Indiana accounts to 32 vs. only 15 % in Florida (Table 5). Indiana's E-code missing

Table 5 Distribution ISS ≥ 25 Patients by Coding Omission (Combined Stratified by TC/NTC)

Outcome measures ^a	Florida <i>n</i> =445 (349 TC, 96 NTC)		Indiana <i>n</i> =160 (120 TC, 40 NTC)					
			%	%	R	CI		
Missing E-code (all patients)	129/445		29.0	70/160	43.8	0.53	0.36, 0.76	
Missing E-code 1–5 years	29/95		30.5	18/49	36.7	0.72	0.35, 1.50	
Missing E-code 6–10 years	31/123		25.2	18/39	46.2	0.39	0.19, 0.83	
Missing E-code 11–15 years	70/227		31.0	34/72	74.0	0.50	0.29, 0.83	
Missing E-code (with 10 diagnoses)	69/445		15.5	13/160	8.1	2.07	1.10, 3.86	
ISS ≥ 25 cases	Trauma Center (TC)		Non-trauma Center (NTC)					
	Florida	Indiana	OR	CI	Florida <i>n</i> =96	Indiana <i>n</i> =40	OR	CI
Missing E-code (total)	99/349 (28.4 %)	40.0 % (48/120)	0.60	0.39, 0.92	30/96 (31.3 %)	22/40 (55.0 %)	0.37	0.17, 0.79
Missing E-code 1–5 years	17/71 (23.0 %)	15/43 (34.9 %)	0.59	0.26, 1.35	11/24 (4.8 %)	3/6 (50.0 %)	0.85	0.14, 5.07
Missing E-code 6–10 years	24/97 (24.7 %)	14/30 (46.7 %)	0.38	0.16, 0.88	12/46 (6.1 %)	15/26 (57.7 %)	0.44	0.09, 2.11
Missing E-code 11–15 years	58/181 (32.0 %)	19/47 (40.0 %)	0.69	0.36, 1.35	12/96 (12.5 %)	2/40 (29.4 %)	0.26	0.09, 0.72
Ten diagnoses/no E-code	16.3 %	9.2 %	1.93	0.98, 3.83	(12.5 %)	29.4 %	0.37	0.08, 1.73

Florida: 1,567/10,614=14.8 % vs. Indiana: 1,048/3,318=32.0 %. OR=0.375, 95 % CI 0.343, 411 ($p < 0.001$)

^a Patients with an ISS <25 and missing an E-code

leads to bias and impacts the epidemiologic value of trauma data, e.g., comparing the mechanisms of injury between states. It also impacts monitoring the efficiency of injury prevention programs and has a negative influence upon the precision in predictability of measuring the outcome.

Outcome analysis using the same dataset did not distinct the risk of mortality between the states' severely injured children. The likely "under-representativeness" of trauma-related mortality events due to missing "late mortalities," e.g., when trauma patients transferred elsewhere have passed away, may contribute to equivocal mortality data. In either situation, injured patients hospitalized at level I TCs are at lower risk of death after the trauma system had been established [12]. The mean HLOS for high-risk children in Indiana hospitals, either acute care hospital or TC, was longer, a finding that warrants further investigation to see whether quality trauma care availability statewide was involved. Although splenectomy rate among TC risky patients, combined, in Indiana was higher than that in Florida, there was not a corresponding significant variation in the rate of splenectomy among the same patient populations either in TC or NTC. This finding reflects the positive impact of the evolving trend of advocating a conservative management rather than splenectomy in cases of blunt splenic trauma. As of 2005, there were no universally accepted norms that can be used to assess state trauma systems by listing the optimal and achievable distribution of high-risk patients who should be treated in level I/II TCs. Existing triage protocols alone do not guarantee compliance with triage instructions [13]. Florida TCs receive up to 54 % of trauma children, but what is unknown is whether this proportion is the goal for all trauma patients. Interstate comparisons of evolving systems may help establish these norms. However, other means of assessment need to be conducted to support the establishment of mandated systems, e.g., cost-effectiveness-analysis studies. Thereby, on the short run, retrospective trauma studies should provide valid reference for resource-limited states not only on the degree to which trauma systems save lives, but on the component of trauma system improvement that can most assist in achieving optimal cost-effective trauma care.

Conclusions and Recommendations

Embracing a mandated trauma system provides appropriate environment to maintain quality under an umbrella of a mature trauma system. As of the time of this study, Indiana was among the states that did not have such system, the absence of which may probably have impacted the

outcomes of childhood trauma in its severest forms. This study provides that high-risk children under Indiana's non-mandated trauma system had an equal opportunity of surviving severe injuries, although they stay longer in hospital. Despite the database limitations, e.g., lacking some evaluative information, such as GCS score, the goal and objectives of this research have been accomplished. Using existing pediatric trauma administrative data, the analysis could describe the differences in the severe trauma outcome variables in the studied states. The current Indiana child trauma database may well be a basis for more integrated data system when resources have been directed to help Indiana's trauma system reach maturity.

References

1. Aitken MF, Tilford JM, Barrett KW (2002) Health status of children after admissions for injury. *Pediatrics* 110:337–342
2. Dowd M, Kenan HD, Bratton SL (2002) Epidemiology and prevention of childhood injuries. *Crit Care Med* 30(11):S358–S392
3. Weesner CL, Hargarten SE, Aptakamian C (1994) Fata childhood injury patterns in an urban setting. *Ann Emerg Med* 23:231
4. American College of Surgeons-Committee on Trauma (ACS-COT) (1993) Resources for optimal care of the injured patient. American College of Surgeons, Chicago
5. Bass RR, Gainer PS, Carlini AR (1999) Update on trauma system development in the United States. *J Trauma Inj Infect Crit Care* 47(3):S15–S21
6. Health Resources and Services Administration (HRSA) A 2002 national assessment of state trauma system development, emergency medical services resources, and disaster readiness for mass casualty events: executive summary. Web. <http://doh.state.fl.usidemo/trauma/PDFs/NationalassessmentofTraumaSystems/pdf>. Accessed 18 Jan 2005.
7. Danseco ER, Miller TR, Spicer RS (2000) Incidence and costs of 1987–1994 childhood injuries: demographic breakdowns. *Pediatrics* 105:E27
8. Afifi R (2010) High risk trauma children in a mandated vs. a non-mandated trauma system (I): a comparative distribution. *Egypt Pediatr Assoc. Gazette* 58(4):18–29
9. Department of Health and Human Services (US) (DHHS), National Center for Health Statistics (1980) International classification of disease, 9th revision, clinical modification. Hyattsville (MD). DHHS Pub No PHS 80–1260.
10. Centers for Disease Control and Prevention (CDC) (1997) U.S. Recommended framework for presenting injury mortality data. *MMWR* 46(RR 14):1–30
11. Osler T, Baker SP, Long W (1997) A modification of the injury severity score (ISS) that both improves accuracy and simplifies scoring. *J Trauma* 43(6):922–925
12. Mullins RJ, Veum-Stone J, Helfand M (1994) Outcome of hospitalized injured patients after institution of a trauma system in an urban area. *JAMA* 27(24):1919–1924
13. Huei-Ming M, Mackenzie EJ, Alcorta R (1999) Compliance with pre-hospital triage protocols for major trauma patients. *J Trauma* 46:168–175