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Differences in risk-adjusted outcome of road traffic injuries in urban tertiary care centers of Pakistan

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ORIGINAL ARTICLE

Differences in risk-adjusted outcome of road traffic injuries in urban tertiary care centers of Pakistan

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Abstract

Objective: To assess the differences in road injury survival in three tertiary care hospitals in an urban setting.

Methods: The study was conducted in and comprised all road traffic injury victims presenting to the three state-run tertiary care centres in Karachi from September 2006 to October 2009. Patients' age, gender, mode, and delay in arrival, severity of injury were noted. Data was stratified by hospital of presentation. A logistic regression model was developed and probability of survival was assessed after adjusting for various risk factors, including patient characteristics and injury severity.

Results: There were 93,657victims in the study, but complete information was missing in 6,458(6.89%) study subjects, including survival information. Overall, 83,837(89.5%) were males; 64,269(74%) were aged between 16 and 45 years; 84,016(95%) had injury severity score of ?15; and overall survival was 84,141(96.5%).

Conclusion: Significant differences existed in risk-adjusted survival of road injury victims presenting to public hospitals of Karachi. These differences pointed to variations in the process of care, and highlighted opportunities for improvement.

Keywords: Road traffic Injuries, Survival, trauma system, Surveillance, Outcome. (JPMA 65: 984; 2015)

Introduction

Low- and middle-income countries (LMICs) are experiencing escalating road traffic crash and fatality rates and the consequent human and material costs threaten their economic and social development.[1,2] In addition, their fragile health systems are challenged by the growing burden of trauma and by the absence of a health system's approach to addressing death and disability from road injury.[3] High-income countries (HICs) have improved their outcomes of road injury by developing integrated trauma systems that address the spectrum of care from roadside rescue to social rehabilitation.[4-6] Of these health interventions, improvements in facility-based trauma care have been the most notable and it has been demonstrated that the survival rates of trauma patients are better at designated trauma centres compared with those at non-designated hospitals.[4,5] Even between similarly designated trauma centres, variations in outcomes occur and may represent a substantial differential of quality in the delivery of trauma care.[7,8] Appreciation of the existence of a quality chasm would be an essential first step towards closing such a gap by a process of measuring and monitoring differences in the risk-adjusted outcomes of injuries between trauma centres and using these differentials as targets for highlighting and rectifying system deficiencies.[9,10] Documentation of such evaluations are lacking in the literature from low-income countries.[10]

The current study was planned to assess the differences in survival outcome of victims of road injuries who reported to three government-run, urban tertiary care hospitals of Karachi.

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Subjects and Methods

The study was conducted in Karachi and comprised data on all road traffic injury (RTI) victims regardless of age and gender presenting to the three state-run participating centres from September 2006 to October 2009. Those who were Dead on Arrival (DOA) were excluded. The study used the surveillance data of the Road Traffic Injury Research & Prevention Centre (RTIR&PC). This represents the largest urban RTI surveillance network of the country, covering five major trauma centres 24 hours a day. All five of these institutions are tertiary care teaching hospitals with 24-hour emergency and multi-disciplinary trauma coverage. Three of the five institutions are funded and managed by the government and do not levy fee for services (Centres1, 2, 3) and the other two are managed by private trusts. The centres have loosely delineated catchment areas in the city with considerable overlap and variations resulting from patient/attendant/ambulance service or based on pattern of predominant injury so that larger numbers of head injured are evacuated to Centre 1 with the best-known neurosurgical unit in the public sector. Prior ethical approval of RTIR&PC was obtained for the study.

For data acquisition, the major sources of information included patients or their attendants, eyewitnesses, police, ambulance and hospital records. The data collectors recorded information round the clock in the emergency departments (EDs) of all the five hospitals, whereas those who were admitted were followed up through their hospital course to determine their 30-day outcome. Information was collected on patients' demographics, details of crash in terms of victims, vehicle types, and causes and location of the incident and mode of arrival. Both anatomical and physiological details of injuries were obtained using Abbreviated injury scores (AIS),[11] Glasgow coma score (GCS), respiratory rate (RR) and systolic blood pressure (SBP). For assessment of injury severity, information was gathered from treating physicians, and hospital records and Injury severity scores (ISS) and Revised Trauma Scores (RTS) were calculated for each victim. Information on mode of transport and time interval between incident and hospital arrival was also recorded. In-hospital information included details of investigations, operative interventions, admitting service, length of stay and discharge disposition.

For the purpose of the study, outcome was defined as death within 30 days or discharge from the facility. Age of the individuals was categorised into three groups for initial descriptive analysis, but >45 years age group was further subdivided to highlight the differences in survival outcome in the regression model. The hospitals were identified through codes to ensure confidentiality. The mode of arrival to the hospital was categorised as ambulances, police or private vehicle or other forms of public transport such as taxis or 3-wheeler rickshaws. The duration between the incident and the time of arrival at the hospital was also subdivided into two categories as those presenting within one hour of the incident and those presenting one hour after the injury. ISS was used to assess the severity of patients' injuries and classification of injuries according to body regions. Injury severity scores were arbitrarily divided into three categories: 1-15, 16-25 and above 25. These groups were compared with each other for categorical variables.

The comparison of risk-adjusted outcome in terms of survival was done between the public-sector hospitals, which not only cater to most of the trauma burden of the city but also have similarly constrained resources for trauma care compared to the two other participating private hospitals. Logistic regression was used to assess the association between the study variables and the outcome, which was survival after an injury incurred due to RTI. To probe the differences of outcome of the three centres, two scenarios were created with the help of the logistic regression model; one with high probability of survival and the other with low probability of survival. The first scenario described a victim between 15-25 years, ISS <15 and RTS >7, brought into the hospital within 1 hour of injury through a private car. The second case scenario was that of a victim >65 years of age, ISS>25 and RTS<4, brought into the hospital by police after 1 hour of injury. Both scenarios were adjusted for type of injuries according to body regions.

Data were analysed using SPSS 16.

Results

Over the study period of 38 months, the surveillance system recorded information on 93,657 victims of road injury in the three state-run tertiary centres and this was used for primary analysis. Complete information was missing in 6,458(6.89%) study subjects, including survival information. The largest volume of patients was seen at Centre 1, which catered to 40,903(43.6%) patients. Overall, there were 83,837(89%) males in the study and 64,0269(74%) patients were between 16 and 45 years of age. Injuries categorised as group 1 (ISS score ≤15) accounted for 84,016(96.3) of the total. Private vehicles were used to evacuate the victims to hospital in 65,148(74.7) cases; and 70,046(74.8) RTI victims arrived in the hospital within 1 hour of incident regardless of the mode of transport. Total number of injuries recorded were 156,024, out of which 78,236 (50.14%) were treated at Centre 1, while Centre 2 and Centre 3 catered to 40.746(26.1%) and 37,042(23.8%) respectively. Overall, extremity 56,102(35.9%) and external 46,174(29.6%) injuries were the most common, followed by head 25,605(16.4%) and facial 23,920(15.3%) injuries. A large proportion of injuries presenting to Centre 1, 28788(36.8%) and 3, 16008 (43.2%) were extremity and pelvic injuries, while Centre 2 catered to 16098(39.5%) external injuries. Leaving aside the missing data, the survival was the outcome in 84141(96.5%) cases (Table-1).

Using regression analysis to assess the survival difference in elderly population, the >45 years age group was sub-divided into 45-64 and >65 years. The chances of survival were much higher in Centre 2 and Centre 3 (Odds Ratio [OR]: 1.7; Confidence Interval [CI] 1.5-1.8) compared to Centre1. This difference amplified after adjustment for age, gender, anatomical regions, injury severity, mode of arrival and delays in reaching the EDs and chances of survival were 4.4 times better (CI:3.4-5.7) for Centre 2, and

Table-1: Basic characteristics of road traffic victims presenting to the three tertiary care centres of Karachi, Pakistan.

	1 n(%)	2 n(%)	3 n(%)	Total n(%)
Centre				
Total registered	40,903 (43.6)	28,302 (30.2)	24,452 (26.1)	93,657
Gender				
Males	36,740 (89.8)	24,784 (87.6)	22,313 (91.3)	83,837(89.5)
Females	4,163 (10.2)	3,518 (12.4)	2,139 (8.7)	9,820(10.5)
Age (Years) n=86,468				
0-15	4,448 (11.9)	3,280 (12.5)	2,639 (11.5)	10,367 (11.98)
16-45	27,493 (73.8)	19,135 (72.9)	17,398 (75.7)	64,0269 (74.0)
>45	5,308 (14.25)	3,830 (14.6)	2,937 (12.8)	12,075(13.9)
Injury Severity Score n=87,199				
1-15	35,732 (95.3)	25,835 (97.2)	22,449 (97.2)	84,016 (96.3)
16-25	803 (2.1)	248 (0.9)	169 (0.7)	1,220 (1.4)
> 25	974 (2.6)	500 (1.9)	489 (2.1)	1,963 (2.25)
Mode of arrival n=87,199				
Ambulance	8,107 (21.6)	3,564 (13.4)	5,862 (25.4)	17,533 (20.1)
Police	797 (2.1)	388 (1.5)	345 (1.5)	1,530 (1.75)
Private	27,349 (72.9)	21,517 (80.9)	16,282 (70.5)	65,148 (74.7)
Public & Others	1,256 (3.3)	1,114 (4.2)	618 (2.7)	2,988 (3.42)
Time of presentation n=87,199				
< 1hr	28,648 (76.4)	22,672 (85.3)	18,726 (81)	70,046 (74.8)
> 1hr	8,861 (23.6)	3,911 (14.7)	4,381 (19)	17,153 (18.31)
Distribution of injuries	78,236 (50.14)	40,746 (26.16)	37,042 (23.78)	156,024
Head Injury (n=25,605)	13759 (17.5)	6287 (15.4)	5649 (15.3)	25,605 (16.4)
Facial Injury (n=23,920)	11967 (15.3)	6287 (15.4)	5657 (15.3)	23,920 (15.3)
Chest Injury (n=2,068)	882 (1.1)	479 (1.2)	707 (1.9)	2,068 (1.32)
Abdominal Injury (n=2,164)	1164 (1.4)	379 (0.9)	621 (1.7)	2,164 (1.38)
External Injury (n= 46,174)	21676 (27.7)	16098 (39.5)	8400 (22.7)	46,174 (29.6)
Extremity/ pelvic Injury (n=56,102)	28788 (36.8)	11306 (27.7)	16008 (43.2)	56,102 (35.9)
Survival n=87,199				
Expired	1,693 (4.5)	730 (2.7)	635 (2.7)	3,058 (3.5)
Survived	35,816 (95.5)	25,853 (97.3)	22,472 (97.3)	84141 (96.5)

Table-2: Regression model - Survival Probability in Public-sector hospitals.

	Unadjusted OR (95% CI)	p-value	Adjusted OR† (95% CI)	p-value
Centre				
1	(ref)		(ref)	
2	1.7 (1.5-1.8)	<0.001	4.4 (3.4-5.7)	<0.001
3	1.7 (1.5-1.8)	<0.001	4.2 (3.3-5.4)	<0.001
Age (years)				
0-14	(ref)		(ref)	
15-25	1.3 (1.2-1.5)	<0.001	0.98 (0.71-1.4)	0.92
26-45	0.75 (0.66-0.85)	<0.001	0.62 (0.45-0.85)	0.003
46-65	0.43 (0.37-0.49)	<0.001	0.36 (0.25-0.51)	<0.001
>65	0.27 (0.22-0.34)	<0.001	0.16 (0.09-0.26)	<0.001
Mode of arrival				
Ambulance	(ref)		(ref)	
Police Vehicle	0.8 (0.68-0.93)	<0.001	1.1 (0.74-1.7)	0.585
Private Vehicle	10.9 (10.1-11.9)	<0.001	1.5 (1.2-1.8)	<0.001
Public & Others	1.4 (1.2-1.6)	<0.001	0.95 (0.66-1.4)	0.797
Time of presentation				
< 1hr	(ref)		(ref)	
> 1hr	0.64 (0.59-0.69)	<0.001	0.91 (0.74-1.11)	0.359

†Also adjusted for Injury Severity Score, Revised Trauma Score, and Type of Injury. OR: Odds Ratio. CI: Confidence interval.

Table-3: Characteristics of patients who died in public sector hospitals with probability of survival (Trauma Injury Severity score) > 50%.

		Centre 1		Centre 2		Centre 3	
	N	N	%	N	%	n	%
Distribution among public sector hospitals	457	352	77%	53	11.60%	52	11.30%
Age (in Years)							
1-15	42	35	9.9%	1	1.9%	6	11.5%
16-45	289	218	61.9%	32	60.3%	39	75.0%
>45	126	99	28.1%	20	37.7%	7	13.4%
Head Injury							
No	54	31	8.8%	11	20.8%	12	23.1%
Yes	403	321	91.2%	42	79.2%	40	76.9%
Facial Injury							
No	201	142	40.3%	30	56.6%	29	55.8%
Yes	256	210	59.7%	23	43.4%	23	44.2%
Chest Injury							
No	421	328	93.2%	46	86.8%	47	90.4%
Yes	36	24	6.8%	7	13.2%	5	9.6%
Abdominal Injury							
No	427	331	94.0%	51	96.2%	45	86.5%
Yes	30	21	6.0%	2	3.8%	7	13.5%
Extremity/ Pelvic Injury							
No	255	200	56.8%	21	39.6%	34	65.4%
Yes	202	152	43.2%	32	60.4%	18	34.6%
External Injury							
No	174	114	32.4%	32	60.4%	28	53.8%
Yes	283	238	67.6%	21	39.6%	24	46.2%

Table-4: Differences of survival in public-sector hospitals. Survival prediction model.

Centre	Probability of survival in favourable case scenario*	Probability of survival in non-favourable case scenario†
Centre1	0.9936	0.058
Centre2	0.9986	0.219
Centre3	0.9985	0.21

*Based on regression model an ED patient aged 15-25 years, head, pelvic, extremity injuries, ISS <15, RTS >7 brought in by private vehicle in <1 hour of injury.
†Based on regression model an ED patient > 65 years of age, head, pelvic, extremity injuries, ISS >25, RTS < 4, brought in by police after 1 hour of injury.

4.2 times higher for Centre 3 (CI: 3.3-5.4) compared to Centre 1. Other factors which affected the chances of survival included age and mode of arrival. Age group 16-25 years showed 1.3 times better chances of survival compared to the reference group (age 1-15 years), but this effect faded when other variables were taken into account. All other age groups showed lesser chances of survival compared to reference age group. Likewise patients coming through private transport had a higher chance of survival (OR 10.9; CI: 10.1-11.9) compared to those transported through ambulance; and this difference persisted after adjustment with other variables. Time taken to arrive in the ED did not show a significant association with survival after adjustment with other variables (p=0.359) (Table-2).There were 3,058(3.5%) deaths recorded during the study period and their distribution pattern across variables were calculated (Table-3).

Using the survival prediction model, it was seen that a young patient aged between 15-25 years, with ISS<15 and RTS>7, brought in by private vehicle within 1 hour of injury (Case 1) was more likely to survive compared to someone >65 years of age, with ISS>25 and RTS <4, brought in by police after 1 hour of injury (Case 2) (Table-4). This held true even if the scenario was matched for head injury. When this model was compared against the three public-sector hospitals, the results showed that the survival of young patients with minor injuries was similar in all of them, with survival probability of >99%. However, for Case 2, the survival was significantly low in the busiest public-sector hospital. The predicted survival was 5%, 22% and 21% for Centres1, 2 and 3 respectively.

Discussion

Besides regionalisation of trauma care and strengthening of triage, high-quality in-hospital care has been shown to provide improved outcomes of trauma in HICs.[5,12,13] Lack of in-depth information limits the ability to evaluate and compare the quality of trauma care in those countries where injury burden is the highest.[10,14,15] Our study over a

3-year period presents the first risk-adjusted RTI outcome of urban tertiary care hospitals in a low-income country.

Since healthcare in Pakistan is free for service and there is considerable amount of out-of-pocket expenditure, a large number of RTI victims (>93,000) sought care in public-sector hospitals, of which, 43% were seen at a single public-sector tertiary care hospital (Centre 1). The results show that the burden of RT is presenting to tertiary care hospitals is not only high but also poorly distributed and triaged.

One of the most important determinants of survival as cited by many researchers is facility-based trauma care.[5,6,16] Our study also demonstrated that, after adjusting for age, type of injury, injury severity, and time since injury and mode of transport, the hospital was the single most significant determinant of survival. Comparison of the probability of survival indicates that the outcome is significantly worse for the highest volume centre (Table-2). This difference is accentuated in patients with overall lesser probability of survival (Table-4).

Although the details of trauma care processes were not available for in-depth analysis in this surveillance data, studies from HICs suggest that there are variations in treatment and outcome of common injuries between hospitals and these are often a result of deviation from the standard of care and preventable errors.[8,17,18] Several factors seem to have contributed to the difference in outcomes of our study subjects presenting to the different participating centres.

For instance, the highest mortality for severe injuries was observed in the highest-volume centre. Trauma centre volumes not only play an important role in trauma centre designation and accreditation, but have also shown to improve survival in trauma patients, especially those with severe injuries. However, it appears from our study that high-volume centres in LMICs may be chronically overloaded to a point of diminishing effectiveness. This effect has been described before by studies in which the best outcomes were demonstrated for middle-volume centres, and mortality was relatively high for low- or high-volume trauma centres.[18,19]

Besides, for patients who died despite having a high TRIS score, the lowest survival was observed in patients with head injuries (Table-3). This pattern has been documented elsewhere as the predominant cause of preventable trauma deaths.[20] In the current study, it is also noteworthy that the highest number of head and facial injuries were seen at Centre 1, which is the major referral centre for neuro-spinal trauma in the public sector. This centre operates a "no refusal" admission policy and with a lack of triage of head-injured patients from incident sites or other centres, is often overburdened with admissions and inter-facility transfers.[21] This could have caused a selection bias with patient crowding and associated poor outcomes. Recently, it has been documented that better outcomes of neuro-trauma have been reported with moderate patient volume, even in specialised centres.[22]

Our survival prediction model created two distinct scenarios, which precisely demonstrated the difference of survival in public-sector hospitals, especially for patients who had potentially unfavourable risk parameters. Potential reasons for poor in-hospital survival could be manifold, but pre-hospital delays, inadequate initial resuscitation, lack of trauma guidelines, as well as prolonged emergency stay and non-availability of experienced and senior staff to advise management are cited as potential factors for poor outcome of trauma patients.[20,23] Some studies from HICs favour in-house attending surgeons and activation of multidisciplinary trauma teams to improve the initial patient treatment, optimise decision-making of the house staff, and minimise delays to critical interventions. However, evidence-based data is limited, and inconsistent, and has not been studied in resource-poor settings.[24]

The striking difference of outcomes between Centre 1 and the others has to be seen in the context of higher volumes, high ISS scores, and predominant head injuries. This implies that outcomes between centres also depend upon pre-hospital triage, distribution of injuries and volumes versus resources in individual medical centres. Distribution of the injured needs to match the availability of clinical resources; hence trauma outcomes cannot be assessed accurately in care facilities without taking into account triage and pre-hospital care.

With this background, there are number of policy implications of our study. Designation of trauma centres with commensurate trauma-care facilities and trained personnel in place is the key to improving trauma care at hospital level, but needs to be accompanied by development of triage and pre-hospital care systems. Installing integrated trauma systems is far more effective than enhancing the capabilities of individual components and facilities.[25]

A continuous cycle of evaluation with regular assessment of quality of trauma-care implemented along efficient trauma-care pathways is essential. Further studies for in-depth assessment of quality indicators are needed, for which implementation of hospital-based trauma registries would provide better assessment of quality of trauma-care.

In terms of limitations of the study, surveillance data was used, which does not include hospital-based quality indicators. The analysis did not account for those patients who got discharged from the ED or left against medical advice.

Conclusion

That significant differences exist in the risk-adjusted survival of road trauma patients presenting to the 3 major public-sector hospitals of Karachi has been demonstrated by the study. These differences may point to variations in processes of care, but, in addition, the high-volume trauma centre may be burdened to a point of diminishing effectiveness, resulting in less than predicted survival outcomes. Improvement of outcome in road traffic injuries may be contingent not just on monitoring the indicators of quality of care, but also having effective pre-hospital triage with a view to improving efficient distribution of RTI burden among major trauma centres. Integrating the components of a trauma system rather than a focus on facility-based care is more likely to provide the roadmap to improved trauma outcomes in fragile health systems.

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