

Mortality pattern according to autopsy findings among traffic accident victims in Yazd, Iran

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Objective: To describe mortality pattern and to determine undiagnosed fatal injuries according to autopsy findings among road traffic accident victims in Yazd, Iran.

Methods: In this retrospective study, 251 victims of road traffic accidents who were admitted to a tertiary trauma hospital over a two-year period (2006 and 2007) and received medical cares were included. Hospital records were reviewed to gather demographic characteristics, road user type, and medical data. Autopsy records were also reviewed to determine actual causes of death and possible undiagnosed injuries occurred in the initial assessment of the emergency unit or during hospitalization.

Results: There were 202 males (80.5%) and 49 females (19.5%). The mean (\pm SD) age of fatalities was 34.1 (\pm 21.5) years. Pedestrian-vehicle accidents were the most common cause of trauma (100 cases, 39.8%). The most common cause of death was central nervous system injury (146 cases, 58.1%). The other causes were skull base fractures (10%), internal

bleeding (8%), lower limb hemorrhage (8%), skull vault fractures (4%), cervical spinal cord injury (3.6%), airway compromise (3.2%), and multifactor cases (5.1%), respectively. Thirty-six fatal injuries in 30 victims (12%) mainly contributed to death according to autopsy, but were not diagnosed in initial assessments. The head (72.2%) and cervical spine (13.8%) regions were the two most common sites for undiagnosed injuries.

Conclusion: Training courses for emergency unit medical staff with regard to interpreting radiological findings of head and neck and high clinical suspicion for cervical spine injuries are essential to improve the quality of early hospital care and reduce the mortality and morbidity of traffic accident patients.

Key words: *Accidents, traffic; Autopsy; Wounds and injuries; Iran*

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Road traffic accident trauma is considered as a major cause of morbidity and mortality among young population worldwide.¹ A considerable number of injured patients die after arrival at hospital, where assessments and treatments delivered are supposed to be complete and effective enough to decrease the rate of deaths.² Initial assessments (vital signs and consciousness level), cardiopulmonary resuscitation (CPR), surgical procedures, and diagnostic devices such as radiological imaging that are usually simultaneously provided at emergency units guide the medical staff to an emergency response and an appropriate

management of severely injured trauma patients. Factors such as wearing seat belt, changes in vehicle design and composition of the vehicle fleet during the past two decades have resulted in changes of trauma pattern among traffic accident victims.³ In Iran, heavier passenger car models, which resisted deformation in crashes, have been replaced partially by smaller, more light-weight and four wheel drive vehicles.⁴ Therefore, the authors think that there is still a profound need to determine injury patterns and early medical cares in road traffic accident victims, especially those who lose their lives following arrival to hospital. In addition, finding out undiagnosed fatal injuries according to autopsy findings, as an accurate tool, can improve the quality and accuracy of early hospital medical cares for traumatic patients. This is especially considered important in developing countries such as Iran due to the high rate of deaths from road traffic accidents per 100,000 population (25.8) compared to that of the world population (19.9).⁵

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The purposes of the current study were to describe early hospital cares for fatal traffic crashes' patients in a tertiary referral hospital and find out mortality pattern according to postmortem reports, as an accurate tool, in Yazd, Iran.

METHODS

The city of Yazd, located in the center of Iran, is the capital of Yazd province with an estimated population of 432 194 people including its suburbs in 2006. The Shahid Rahnemoon general hospital is the main tertiary referral center for admission of traumatic patients. It is an affiliation of Shahid Sadoughi University of Medical Sciences and Health Services. In the emergency unit of this hospital, a general physician with the aid of surgery interns and nurses performs primary evaluations of traumatic patients including Glasgow coma scale (GCS), intravenous access, limb stabilization, hemorrhage control, etc. If there is a need for CPR, this team is accompanied by an extra CPR team consisting of an anesthesiologist and operation room staff for resuscitation of patients. There is also an on-call attending general surgeon ready for any emergent surgical operation. Further consultations are requested with other specialties like orthopedic surgeons, neurosurgeons and urologists, if applicable. Diagnostic imaging services such as plain X-ray, computed tomography (CT) scan and ultrasound are accessible through out the day (24 hours), and are provided by a diagnostic radiology resident.

This retrospective study was performed in Forensic Medical Center of Yazd, which serves for all over the province and besides to medico-legal activities and judgements, dead patients who were needed to be autopsied are referred to this center. Based on Iranian laws, all traumatic deaths are needed to be referred to medico-legal centers to determine the accurate mechanism of death. According to unpublished data obtained from the Yazd Forensic Medical Center, about 11 678 referrals have been registered due to road traffic accidents in 2006 and 2007. Of these cases, 910 were dead cases and autopsy was performed for all of them. Inclusion criteria consisting of victims that were transported to the Shahid Rahnemoon Hospital, had vital signs on arrival and underwent initial assessments, resuscitation, and medical cares. Those victims that had lost their lives before arrival to hospital, or were

transferred to other medical centers were not included in this study. As a result, a total of 251 eligible victims were assessed and their hospital records and reports of autopsies were retrospectively evaluated by a trained general physician to obtain the following variables: demographic characteristics, road user type (pedestrian, motorcyclist, car occupant, autobus or minibus occupant and truck occupant), GCS on admission to the emergency unit for revealing the conscious state of the patient that was classified into severe (< 8), moderate (9 to 12) and mild (13 to 15), intensive care unit (ICU) admission, operative procedure, and hospital stay duration (time from arrival to death).

To determine the severity of the injuries, Abbreviated Injury Scale (AIS) and Injury Severity Score (ISS) were calculated using autopsy findings. AIS is a simple numerical method for ranking and comparing injuries by severity, developed in the 1960s from an aid to investigate road traffic accidents in the United States.⁶ Baker et al.⁷ described the ISS, which gave a much better correlation between overall severity of injury and probability of survival. In ISS, the body is divided into six separate regions (head and neck, face, chest, abdominal and pelvic contents, extremities and pelvic girdle, and external regions). It assigns each a severity value from one (minor) to six (nearly fatal). The score was calculated by squaring and summing the three highest squares on the AIS from different body regions. The ISS was considered as mild (1-8), moderate (9-15), and severe (16-75).⁸

The actual causes of death according to autopsy reports were classified as central nervous system (CNS) injury, skull vault fractures, skull base fractures, cervical spinal cord injury, airway/ventilation compromise, and hemorrhage from extremities or internal bleeding (hypovolemic shock).

A fatal injury that contributed to death according to autopsy report and was not diagnosed upon initial assessments or during hospitalization, either in clinical examinations or in diagnostic imaging workups was documented.

For statistical analysis, descriptive indices such as frequency, percentage, mean and standard deviation (\pm SD) were used to express data. Comparison of categorical variables was done with the Chi-square test. *P*

values less than 0.05 were described statistically significant. All analysis were done by SPSS software for Windows (Version. 13) (SPSS Inc, Chicago, IL).

RESULTS

A total of 251 autopsy records were reviewed in this study. There were 202 males (80.5%) and 49 females (19.5%). The mean (\pm SD) age of fatalities was 34.1 (\pm 21.5) years (range: 1 to 89 years). The second (11 to 20 years) and third (21 to 30 years) decades of life were the two most common age ranges of victims (21.9% and 30.7%, respectively). The categorization of victims according to the cause of trauma and the road user type was as follows: pedestrian-vehicle (100 cases, 39.8%), motorcyclist (83 cases, 33.1%), car occupant (61 cases, 24.3%), autobus/minibus occupant (4 cases, 1.6%) and truck occupant (3 cases, 1.2%). Forty-eight patients (19.1%) underwent a total of 57 operative procedures before death. The hospital-related variables, GCS on arrival and surgical operations were listed (Table 1).

The head (220 cases, 87.6%) and face (169 cases, 67.3%) were the two most common body regions to sustain injury. The frequency of injured body regions and distribution of victims based on maximum AIS in each anatomic region are presented in Table 2. The mean (\pm SD) ISS of victims was 23.2 (\pm 10.4). No statistically significant difference was observed regarding ISS numbers between males and females (23.3 ± 10.8 vs. 22.8 ± 8.9 ; $P=0.7$) nor between children and adults (20 ± 8 vs. 23.6 ± 10.7 ; $P=0.1$).

The majority of deaths were due to a central nervous system (CNS) cause (146 cases, 58.1%) such as epidural hematoma, subdural hematoma, intraventricular hemorrhage, etc.

Table 1. Hospital-related variables, GCS on arrival to emergency unit, and surgical operations in 251 traffic accident victims in Yazd, Iran

Items	Cases (percentage)
ICU admission	84 (33.5%)
CPR	247 (98.4%)
GCS	
< 8	195 (77.7%)
9-12	17 (6.8%)
13-15	39 (15.5%)
Surgical operation	48 (19.1%)
Type of operative procedure	
Craniectomy	20 (8%)
Tube thoracostomy	13 (5.2%)
Exploratory laparotomy	15 (6%)
Thoracotomy	3 (1.2%)
Open heart massage	2 (0.8%)
Cervical traction	1 (0.4%)
Limb amputation	1 (0.4%)
Femoral pin	1 (0.4%)
Femoral artery repair	1 (0.4%)

Table 2. Frequency of injured body regions among 251 traffic accident victims of Yazd, Iran and distribution of victims based on maximum AIS in each anatomic region.

Body regions	No. of victims (%)*	AIS 1-3	AIS 4-6
Head	220 (87.6%)	80 (36.4%)	140 (63.6%)
Neck	25 (10%)	25 (100%)	0
Face	169 (67.3%)	166 (98.2%)	3 (1.8%)
Thorax	70 (27.9%)	46 (65.7%)	24 (34.3%)
Abdominal and pelvic contents	46 (18.3%)	37 (80.4%)	9 (19.6%)
Spine	19 (7.6%)	14 (73.7%)	5 (26.3%)
Upper extremities	136 (54.2%)	135 (99.2%)	1 (0.8%)
Pelvis and lower extremities	144 (57.4%)	140 (97.2%)	4 (2.8%)

*Percentages were calculated in each region separately from total number of victims (251 cases, 100%)

In 13 victims (5.1%), more than a single cause was recorded in autopsy as the cause of death: CNS and lower limb hemorrhage in one patient, CNS and cervical spinal cord injury in one patient, CNS and internal bleeding in one patient, skull vault and base fractures in 8 patients, lower limb hemorrhage and skull base fracture in one patient and airway compromise with internal bleeding in one patient (Table 3).

Thirty-six fatal injuries which mainly contributed to death according to autopsy reports and were not diagnosed in initial assessments were documented among 30 victims of 251 cases (12%). The head (72.2%) and cervical spine (13.8%) regions were the two most common sites for undiagnosed injuries. Table 4 presents the frequency of undiagnosed fatal injuries according to autopsy reports.

Table 3. Causes of death among 251 traffic accident victims in Yazd, Iran according to road user types.

Death causes	Car occupant	Motorcycle	Auto/minibus occupant	Pedestrian	Truck occupant	Total
CNS	33 (22.6%)	50 (34.2%)	2 (1.4%)	59 (40.4%)	2 (1.4%)	146 (58.1%)
Skull base fracture	7 (28%)	8 (32%)	1 (4%)	9 (36%)	0	25 (10%)
Internal bleeding*	7 (35%)	5 (25%)	0	8 (40%)	0	20 (8%)
Lower limb hemorrhage	3 (15%)	7 (35%)	1 (5%)	9 (45%)	0	20 (8%)
Skull vault fracture	2 (20%)	5 (50%)	0	3 (30%)	0	10 (4%)
Cervical spine cord injury	3 (33.3%)	3 (33.3%)	0	3 (33.3%)	0	9 (3.6%)
Airway Compromise	3 (37.5%)	2 (25%)	0	3 (37.5%)	0	8 (3.2%)
Multifactor	3 (23%)	3 (23%)	0	6 (46%)	1 (8%)	13 (5.1%)

* Hemorrhage from abdominal or pelvic contents.

Table 4. Distribution of clinically significant undiagnosed fatal injuries according to postmortem reports in 30 victims of road traffic accidents in Yazd, Iran.

Anatomic region, diagnosis	Cases (percentage)
Head	
Skull base fracture	14 (38.9%)
Skull vault fracture	9 (25%)
Subarachnoid hemorrhage	2 (5.5%)
Subdural hemorrhage	1 (2.8%)
Thorax	
Lung contusion	1 (2.8%)
Abdominal and pelvic contents	
Liver laceration	1 (2.8%)
Aortic rupture	1 (2.8%)
Kidney hemorrhage	1 (2.8%)
Retroperitoneal hemorrhage	1 (2.8%)
Spine	
Cervical spinal cord injury	5 (13.8%)
Total	36 (100%)

DISCUSSION

The gender and age distribution of victims were similar to former reports from Iran.^{4,9} Men were more affected by car crash-related death than women, especially in the second and third decades of life. Not only in car traffic accidents, but also in all types of injuries, men are more susceptible than women as a result of cultural norms and higher level of outdoor activities of men in our society.¹⁰ Pedestrian-vehicle accidents were the most common mechanism of sustained injuries. This finding can be explained by high load of pedestrians in developing countries in comparison to developed countries.¹¹ Some hazardous behaviors such as not using the sidewalks, crossing the roadway barriers and under-using overhead pedestrian bridges are common malpractices of young male pedestrians in developing societies.^{9,12} Following pedestrians, motorcyclists and car occupants formed the second and third most common groups of fatalities, respectively. There was no information regarding helmet use in motorcyclists or seat belt in car occupants. Use of seat belts and safety helmets is mandatory in Iran. However, according to the high frequency of head and face injuries in this study and a former report from Iran indicating using of seat belt in less than 3% of car passengers,¹³ and helmet use in 8.6% of motorcyclists,¹⁴ we believe that limited

number of motorcyclists or car occupants used such protective devices. It has been shown that the use of seat belts is the most effective means of reducing fatal and nonfatal injuries in road traffic accidents.¹⁵

Injuries to the head region accounted for the majority of injuries (87.6%). Subsequently, craniectomy was the most commonly performed emergency surgery and severe injuries due to a CNS cause (e. g. subarachnoid hemorrhage, subdural hematoma, etc.) were recognized as the major mechanisms of death based on postmortem findings, consistent with a former report from Iran.¹⁶

There have been several studies, designed based on autopsy findings, used for clinical audit of trauma systems, as well as accurate, standard, and valuable tools for data gathering and determination the actual cause of death.^{17,18} The results of such studies can potentially help medical system authorities improve the trauma care through adjustment of diagnosis and treatment protocols.¹⁹ According to the current study, 12% of patients had undiagnosed injuries that were significantly contributed to death, mainly in the head and spine regions. This is of paramount importance to all physicians, surgeons and other medical staff who deal with multiple trauma patients. It is essential for surgical team as the basis of trauma care to be trained regarding neurosurgical problems and radiological findings of the head, neck and cervical spine regions. They should be familiar with brain CT scans and signs of skull base and vault fractures. This enables them to save time and request for consultation with neurosurgeons earlier, possibly resulting in better early trauma care.

Cervical spine injuries in multiple trauma patients is assessed by radiological tools such as cross-table lateral view or a three-view cervical spine series, oblique views, CT scan, and MRI. According to Platzer et al.²⁰ experience from 118 polytrauma patients at Vienna General Hospital, cervical CT scan was the most efficient dynamic imaging tool showing a sensitivity of 100% in detecting skeletal injuries. They noted that poor technical quality of radiographs or incomplete visualization of the cervical spine in 6.5% of patients was the cause of delays in diagnosis.

The selection and review of autopsy reports is considered as the strength of this study. Accurate reports

of autopsy enabled us to determine the exact mechanisms of death. However, we only included the dead cases from road traffic accidents in our study. Therefore, the results might not be extendable to the whole trauma system and all other causes of trauma.

We encountered some limitations during this study. First, the retrospective method of reviewing the medical records can potentially underestimate the true incidence of undiagnosed injuries.²¹ Second, we only recruited patients who died after road traffic accidents, therefore, the results may not be expanded to all types of trauma in patients with different severity of injuries and prognosis. Third, due to the lack of an emergency medical system during the study period, exact data regarding prehospital events, time of transportation, received first medical cares such as fluid resuscitation, cervical collar was not documented to analyze.

In addition to policies taken by authorities to increase public education against high-risk behavior driving, particularly for young men, periodic training courses for emergency unit medical staff, particularly for surgical residents and interns based on the Advanced Trauma Life Support (ATLS) principles,²² training the skills of interpreting radiological images and CT scans of the head and neck, equipping emergency units with modern and adequate imaging settings, and performing educational mortality reports according to medico-legal autopsy examinations, are all necessary to improve the quality of early hospital care of traumatized patients, and to minimize the mortality and morbidity of traffic crashes.

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