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Original Article

Prediction of Mortality Risk in Patients with Traffic Injury: A Case Study in Tabriz Hospitals, Iran

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Abstract

Background: Trauma caused by traffic accidents is one of the main causes of mortality in the world. The trauma is a time-dependent condition. Trauma scoring systems help service providers to determine the severity of the injury and mortality risk and provide appropriate and timely services. This study aimed to predict mortality risk in patients with traffic injuries in Tabriz hospitals. **Materials and Methods:** This descriptive cross-sectional study included 11,238 traffic-injured patients. Databases of the emergency medicine service and forensic medicine were used to collect information. Glasgow Coma Scale, Age, and Systolic Blood Pressure (GAP) scoring system, binary logistic regression model, odds ratio with 95% confidence interval, and sensitivity and specificity were used to predict mortality. **Results:** Overall, 71 cases of death were identified. Pedestrians had the most rates of deaths with 31 cases (43.66%). Head trauma with 31 cases (43.66%) was the main cause of death. Mean (standard deviation) of the GAP score was 21.8 (1.8). The death rates in high-, moderate-, and low-risk groups were 22.4%, 3.18%, and 0.42%, respectively. The likelihood of death in people with saturation of oxygen (SO_2) ≤95 was 1.96 times higher than those with SO_2 >95. The likelihood of death increased by 0.001 times each year. Furthermore, when the GAP score was ≤18, sensitivity was 64%, and for the GAP score of ≤10, sensitivity was 15.5%. **Conclusion:** GAP score seems to be a reliable and easy-to-use scoring method for predicting traffic injury mortality in an Iranian setting and yields reasonable results concerning international standards.

Keywords: Hospital, injury severity, mortality, traffic accident, trauma

Introduction

World Health Organization (WHO) defines trauma as a severe strike of the body with physical factors such as mechanical energy, heat, electricity, chemical substances, and ionization rays.[1] Trauma is the main cause of mortality and morbidity among the young in the first four decades of life.[2,3] More than 5 million die out of injuries annually.[4] Injuries affect 700 million people all over the world.[5] Since multiple injuries are associated with death and disability, major trauma patients undergo serious problems. Indeed, trauma is one of the major reasons for the burden of diseases worldwide.[6] Trauma is a more critical and thoughtful problem in developing countries. The issue might be due to the lack of an organized trauma system and the extent of occasions leading to trauma, for example, traffic accidents.[7]

Trauma caused by traffic accidents is threatening the life of all age groups.[8] It is claimed that annually, traffic accidents result in the death of 21 million people and the disability of

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20–50 million people throughout the world. Unfortunately, 60% of whom are young aged 14–45.[9,10] According to the WHO report, traffic injuries have risen from around 999,000 in 1990 to more than a million deaths in 2002; and it is anticipated to reach 2 million deaths/year in 2020.[11] In comparison with developing countries, traffic injury is the second leading cause of mortality in Iran;[12] 38% of abnormal deaths are due to road accidents in Iran. The statistics released by Iran's forensic medicine showed that in a period of 10 years (2000–2010), 235,587 people were killed because of road accidents, and 2,281,810 people were injured.[13] Traffic accidents also affect costs, and injuries caused by it decrease annual Gross Domestic Product (GDP) by 1%–15% in developing countries.[14]

Trauma is a time-dependent condition, and time is a very vital factor, especially during the 1st h of trauma occurrence. Providing earlier care at trauma centers has been shown to decrease mortality.[15,16] At the beginning of the treatment, trauma scores can help emergency care providers with recognizing the severity of trauma and determining the operation on trauma patients.[17] Many trauma scoring systems (TSSs) have been used so far. The Injury Severity Score (ISS) and the Trauma and ISS (TRISS) are widely accepted TSSs whose calculation requires that all examinations and checkups be performed and that injuries in anatomic locations be noted with detail.[18] The Revised Trauma Score (RTS) is another scoring system, which is widely used. However, it seems that determining an appropriate RTS is very complicated and hard. On the other hand, respiratory rate (RR), a calculation factor of RTS, is less reliable than other factors because it is influenced by patients' condition such as age, mechanism of injury, and mechanical ventilation.[19]

Kondo *et al*. defined the Glasgow Coma Scale (GCS), Age, and Systolic Blood Pressure (SBP) (GAP) score that is a physiological TSS. GAP has fewer parameters. It is similar to TRISS in terms of mortality prediction.[20] The GAP score is easily calculable both in prehospital and hospital admission to the emergency department (ED).[21] The GAP score is based on 27,154 patients from the Japan Trauma Data Bank (2004–2009). Hence, it is a valid scoring system.[20] This study aimed to predict the mortality risk in patients with traffic injury admitted to Tabriz hospitals using the GAP scoring method.

Materials and Methods

Study design, the research community, and data collection

This cross-sectional descriptive study was conducted from September 2016 to February 2018. The study population consisted of all traffic accident victims during the mentioned period, which was transferred to Tabriz hospitals by emergency medicine service (EMS) (including 90% EMS missions). Patients transmitted by other vehicles were not included in the study.

The required information was extracted from the EMS database. The recorded data in this system included name of the patient, age, gender, mission date, key times, saturation of oxygen (SO_2), SBP and diastolic blood pressure (DBP), GCS, the outcome of the mission, and name of the hospital where the patient was transferred, the location and result of the mission, and the mission ID. Furthermore, all the data regarding the dead were extracted from the East Azerbaijan Forensic Medicine Organization database (EAFMOD) and integrated with EMS information. The information extracted from the forensic database included names of the dead, type of the vehicle of the injured and the vehicle involved in the accident, the dead's conditions at the time of the accident, location of the death, part of the body that has been hit, the mechanism of damage, and the final cause of death.

The main outcome of this study was death, which was estimated through the GAP scoring system. Other intervening variables of death were studied through a regression model.

Glasgow Coma Scale, Age, and Systolic Blood Pressure-based scoring

All the individuals under the age of 1–103 were investigated, whose items of GAP measurements were recorded. The GAP scoring system was defined by Kondo *et al*. on 27,154 patients.[20] Based on the GAP scoring system, the predictive variables of hospital mortality were included, which are as follows:

- GCS: 3–15
- Age: if age was <60 years old, score 3 is considered. Furthermore, if age was ≥60 years old, a score of 0 is considered
- SBP: if SBP was ≥120, 60–120, and <60, then scores of 6, 4, and 0 are considered, respectively.

Classification of the patients into different risk groups was based on the score obtained for GAP. The GAP scoring is as follows:

- The GAP score between 3 and 10 is considered as a high-risk group
- The GAP score between 11 and 18 is considered as a moderate-risk group
- The GAP score between 19 and 24 is considered as a low-risk group.

In this study, GAP score was between 3 and 24.

Data analysis

The data were analyzed using the STATA 13 statistical software package (StataCorp, Texas, USA). Descriptive statistics including the number, frequency, minimum and maximum, mean, and standard deviation (SD) were reported for the demographic variables recorded by EMS and EAFMOD. The GAP score was calculated based on age, SBP, and GCS. The mortality rate was calculated in three risk groups, that is, high-risk, moderate-risk, and low-risk group. The binary logistic regression model and odds ratio with 95% confidence intervals for variables were used to investigate the relationship among other variables intervening prediction of patient mortality. The relationship between death and GAP classification group was presented based on the Chi-square test. The sensitivity

and specificity reports were used to determine the predictive power of GAP, and SO_2 scores were also used to predict death. In addition, the radar chart was designed to express the most important causes of mortalities using Microsoft Excel 2017 software. The significance level was considered to be <0.05.

Ethical considerations

This study was part of Ph.D. thesis. The main protocol of this study was reviewed and approved by the Ethics Committee of Tabriz University of Medical Sciences. Its approval code was IR.TBZNED.REC.1396.560.

Results

From a total of 11,238 traffic accident victims in this study, 7816 (69.55%) were male. Regarding age distribution, the mean (SD) of the injured was 34.3 (16.2) years old. Of these, 71 people were identified as dead. The mean (SD) of SBP was 113.1 (24.8) mmHg, and mean (SD) DBP was 72.2 (17) mmHg. Mean (SD) SO_2 was 83.93 mmHg (12.5). Mean (SD) of GCS was calculated to be 14.8 (0.9). In Table 1, the demographic characteristics of the dead and the survived are presented regarding their gender.

Of the 71 died individuals, 29 cases were drivers, 31 were pedestrians, and 11 were pillion passengers. The involved vehicles in accidents and the crash mechanisms are presented in Table 2.

Injured organs of the body are classified into seven groups. The most affected organs among victims were head and face (74.6%) and the least were arms and hands (4.2%). The frequency rates and percentages of other injured organs are presented in Table 3. Furthermore, the most cause of mortalities is presented in Figure 1.

Regarding the Chi-square test, the relationship between death and GAP classification group was statistically significant ($P < 0.000$). A total number of 11,167 individuals (99.37%) survived the accidents while 71 (0.63%) died. The number of individuals in the three categories of GAP classification and their GAP score along with the percentage of death are presented in Table 4.

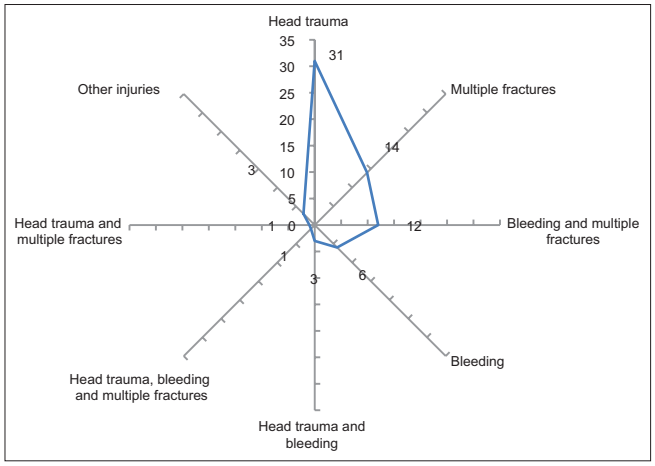

Figure 1: The most causes of mortalities

According to the logistic regression model, the likelihood of death in the high-risk and moderate-risk groups in comparison with the low-risk group was 39.39 and 6.5 times more, respectively. The likelihood of death in the patients with

Table 1: Demographic characteristics of the dead and alive patients based on their gender

Variable	Mean (SD)		*P* (comparing differences between alive and dead)
	Alive	Dead	
Gender (%)			
Female	30.6	7.04	0.0013
Male	69.4	92.96	
Age			
Female	35.63 (31.10)	66.2 (9.50)	0.01
Male	33.64 (18.91)	40.28 (2.45)	
SBP			
Female	111.07 (50.34)	114 (7.48)	0.001
Male	114.04 (28.03)	95 (6.18)	
DBP			
Female	70.52 (33.60)	74 (2.44)	0.001
Male	73 (19.47)	60.31 (3.97)	
SO_2			
Female	91.52 (37.09)	75.01 (4.71)	0.001
Male	91.22 (24.88)	95.2 (1.35)	
GCS			
Female	14.92 (0.1)	11.80 (0.54)	0.001
Male	14.81 (0.1)	11.60 (0.5)	

SD: Standard deviation, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, SO2: Saturation of oxygen, GCS: Glasgow Coma Scale

Table 2: Used vehicles involved in traffic accidents and crash mechanism

	Frequency (%)
The vehicles involved in accidents	
Car	36 (64.29)
Minibus/bus	4 (7.14)
Pickup	4 (7.14)
Truck	4 (7.14)
Trailer	1 (1.79)
Motorcycle	3 (5.36)
Unknown	4 (7.14)
The vehicles used by the dead	
Pedestrian	31 (43.66)
Motorcycle	12 (16.9)
Bicycle	3 (4.22)
Car	20 (28.17)
Pickup	2 (2.82)
Trailer	2 (2.82)
Unknown	1 (1.41)
The crash mechanisms	
The collision of vehicles with each other (V80.4)	25 (35.21)
The collision of vehicles with the dead pedestrian (V09.9)	31 (43.66)
Vehicle collision with a fixed object (V47.9)	6 (8.45)
Overturn of the vehicle carrying the dead (V89.9)	7 (9.86)
Falling over of the vehicle carrying the dead (V89.9)	2 (2.82)

Table 3: The injured parts of the body among the traffic accident victims

Involved organ	Frequency (%)
Head and face	53 (74.6)
Chest and abdomen	35 (49.3)
Pelvis	13 (18.3)
Legs	8 (11.3)
Neck	12 (16.9)
Posterior trunk (the back and spine)	4 (5.6)
Arms and hands	3 (4.2)

Table 4: The number of individuals in different categories of Glasgow Coma Scale, Age, and Systolic Blood Pressure scores and percentage of death

GAP classification category	Frequency (%)		Mean (SD) of GAP score
	Alive	Dead	
High (GAP score 3-10)	38 (77.55)	11 (22.45)	6.2 (2.1)
Moderate (GAP score 11-18)	457 (96.82)	15 (3.18)	17.3 (1.5)
Low (GAP score 19-24)	10672 (99.58)	45 (0.42)	22.1 (1.1)
*P**	0.001		0.001
Total	11,167	71	21.8 (1.8)

*The association both comparing in means and frequency distribution was statistically significant. SD: Standard deviation, GAP: Glasgow Coma Scale, Age, and Systolic Blood Pressure

Table 5: The affective variables on the probability of death based on logistic regression model

Variables	OR	SE	*P*	CI
GAP classification (reference group=low risk)				
High risk	39.4	18.14	<0.0001	15.97-97.16
Moderate risk	6.5	3.21	<0.0001	3.34-12.66
SO_2 (reference group=SO_2 <0.95)				
SO_2 >0.95	1.96	0.63	0.03	1.03-3.70
Age	1.001	0.000	0.003	1.000-1.001

SE: Standard error, GAP: Glasgow Coma Scale, Age, and Systolic Blood Pressure, OR: Odds ratio, CI: Confidence interval, SO_2: Saturation of oxygen

SO_2 below 95 was about 1.96 times higher than those with SO_2 above 95. Moreover, the likelihood of death increases by 0.001 times with 1 year increase in age [Table 5].

Based on the sensitivity and specificity test, when the scores were GAP ≤18 and GAP ≤10, the death likelihoods were 64% and 15.5%, respectively. Furthermore, after adding SO_2 <95 to GAP, the likelihoods of death were predicted 28.2% and 14.8%, respectively. Prediction power of GAP and SO_2 and sensitivity, specificity, and positive and negative predictive values are presented in Table 6.

Discussion

The results of this study showed that most of the patients with traffic injuries were male. Regarding age distribution, the most patients were young. According to crash-related studies, the accident rate is 3–5 times more among men than women. Furthermore, its highest rates are between the ages of 15 and 44 years. This issue imposes a large economic burden on the community.[22]

According to the findings of the study, the number of the dead and the survived men was more than the women. Furthermore, the mean of SBP, DBP, SO_2, and GCS score were worse among the dead. Based on the study of Ahun *et al*. on the prediction of mortality in the ED, the highest number of injured individuals were male, both the dead and survived. Furthermore, SBP was 120 mmHg versus 115 mmHg, DBP was 80 mmHg versus 70 mmHg, SO_2 was 97.5 mmHg versus 92 mmHg, and GCS was 15 versus 13 between the survived and dead.[21] Furthermore, according to Esmaeili *et al*. study on the survival and quality of service provided for patients with traffic injures, GCS and SBP were statistically significant in both groups of the dead and survived ($P < 0.001$).[8] These results are consistent with the findings of the present study.

In this study, the highest number of the dead belonged to pedestrians. In line with the present study and by the cause of trauma and road users in Iran, the classification of the patients injured in road traffic accidents showed that pedestrians with 39.8% were the most injured individuals. Motorcyclists with 33.1%, occupants of the car with 24.3%, bus and minibus occupants with 1.6%, and truck occupants with 1.2% were the other most injured patients.[23] In some other studies, the findings were opposite the findings of this study. In Soltani *et al*.'s study, unlike the present study, the highest rate of death in traffic accidents in Yazd was for motorcyclists with 34 cases, none of whom had helmets.[24]

Head trauma was the most frequent injured part of the body and cause of death. Based on the study by Ghafari Fam *et al*. on pedestrians referred to Shohada Hospital of Tabriz, the most frequent area of injury was lower limbs with 43.5%.[23] Although the findings of this study are different from the findings of the present study, this may be due to the examination of only one hospital and its specialty, which was orthopedic. According to Taghipour *et al*., the anatomy of the individuals injured in driving accidents showed that head injury with a frequency of 220 and face injuries with the frequency of 169 cases were the most damaged areas. Whereas, traumatic brain injury with about 60% of occurrence was the most prevalent cause of death,[25] which is consistent with the findings of the present study.

The findings of GAP scoring in this study were consistent with the findings of Kondo *et al*. study, in which the mortality rate in the low-risk individuals was <5%, and in the moderate- and high-risk groups, it was ≥50%.[20] In Kondo *et al*.'s study, it is indicated that GAP is a better predictor, and it is more commonly used and predicts injury severity better than other injury grading systems.[20] On the other hand, it is easier to use. In fact, in the early predictions of the severity of the injury,

Table 6: Sensitivity, specificity, positive and negative predictive values of Glasgow Coma Scale, Age, and Systolic Blood Pressure, and saturation of oxygen in mortality prediction

Predictors	Survived	Dead	Sensitivity (%)	Specificity (%)	Positive predictive value (%)	Negative predictive value (%)
GAP ≤18						
Yes	495	26	64	99.6	4.9	99.6%
No	10672	45				
Total	11167	71				
GAP ≤10						
Yes	38	11	15.5	95.4	22.4	99.4
No	11129	60				
Total	11167	71				
GAP ≤18 and SO_2 <95						
Yes	216	20	28.2	98.06	8.5	99.5
No	10951	51				
Total	11167	71				
GAP ≤10 and SO_2 <95						
Yes	37	10	14.08	99.6	21.3	99.4
No	11130	61				
Total	11167	71				

GAP: Glasgow Coma Scale, Age, and Systolic Blood Pressure, SO_2: Saturation of oxygen

there is a need for indicators that can be easily calculated. These include indicators such as GCS, blood pressure, heart rate, and RR.[26] Perel *et al*. in their study on patients with hemorrhagic trauma found that variables such as age, blood pressure, and GCS were associated with the early prediction of mortality in patients.[27]

In the present study, based on the binary logistic regression model, the likelihood of death in high-risk and moderate-risk group was much higher than that of the low-risk group. Two variables of SO_2 and age were related to likelihood of death. In the study of Soltani *et al*., a binary logistic regression model was used to investigate the various factors involved in traffic accident injuries. The results showed that gender, the type of vehicle collision, and the time of the accident were effective factors that should be considered.[24] Weather conditions, laws, and culture were among these variables.[28]

Conclusion

It seems that the use of the GAP grading system in predicting mortality risk can be useful due to the items used in GAP and simplicity of calculation and yields reasonable results concerning international standards. In general, in developing countries such as Iran, which design registries of injuries at an early stage, the use of scoring systems such as GAP is useful and constructive for examining the current status.

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Conflicts of interest

There are no conflicts of interest.

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