Evaluating Risk Factors of Geriatric Trauma Mortality by Logistic Regression; A Cross-Sectional Study in 2011 - 2016

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Abstract

Background: Trauma is the main cause of death in all age groups, as well as the 7th leading cause of fatality among the elderly. Compared to the youth, the risk of mortality and length of hospital stay are higher in elderly patients experiencing similar trauma and injury severity.

Objectives: The present study aimed to identify the risk factors for mortality in the elderly.

Methods: This was a cross-sectional study conducted on 65304 trauma patients who were referred to Shahid Rajaee (Emtiaz) Hospital trauma referral center, Shiraz, Iran 2011 - 2016. Information such as age, gender, injured body region, length of hospital stay, injury severity score (ISS), injury mechanism, nosocomial infection, and mortality was recorded. Injury severity scores and injured body regions were determined based on a conversion of international classification of diseases, the 10th revision (ICD-10) injury codes to Abbreviated Injury Scale (AIS-98) severity codes using a domestically developed electronic algorithm. The binary logistic regression was used to determine the partial effects of independent risk factors.

Results: Patients over 60 had a mean age of 70.79 ± 8.83. Mortality rates were 4.7% (330) and 1.05% (614) among patients over and under 60, respectively. The most important risk factors for geriatric mortality included age over 75 [OR = 1.91, 95% CI (1.28 - 2.85)], nosocomial infection [OR = 10.56, 95% CI (6.52 - 17.10)], ISS (16 - 24) [OR = 12.51, 95% CI (7.28 - 21.490)], head injury [OR = 13.17, 95% CI (5.83 - 29.77)], and pedestrian accidents [OR = 1.47, 95% CI (1.47 - 1.95)]. Aging led to increased mortality due to nosocomial infection. Among the elderly patients, males had a higher mean injury severity score compared to females.

Conclusions: According to our results, mortality rates increased by age in geriatric trauma patients. With similar severity of injuries, there was a greater risk of mortality for trauma patients with very old age compared to old patients. Aging, gender (males), nosocomial infection, ISS, and head injury were the most significant predictors of mortality in the elderly.

Keywords: Geriatric, Injury Severity Score, Mortality, Risk Factor, Trauma

1. Background

According to the World Health Organization (WHO), the age of 60 years and over are considered as elderly (1). European countries expect a 30% increase in the elderly population by the year 2050 (2). A comparison of Iran's population pyramid in the past two decades reveals the inversion of this pyramid that can predict a significant increase in the elderly population in the years to come (3). Considering the increasing population of the elderly, increased trauma cases are predictable for the future. In recent years, trauma had an increasing rate among the elderly and had become a huge public health problem around the world (2). Trauma is a main cause of death in all age groups and the 7th leading cause of death amongst the elderly (4). Researches have shown that age can be one

of the most critical risk factors for mortality resulting from trauma (5, 6). Geriatric trauma patients are different from younger patients not only in physiology, but also in terms of indices related to injury and physiological response to injury (7). Compared to young individuals, the risk of mortality and length of hospital stay are higher in the elderly with similar trauma and injury (8, 9). There are numerous mechanisms of injury leading to geriatric trauma. Falling down is the most common mechanism of trauma-related injury and death in the elderly, which mostly occurs in the age group of 65 and over (10). According to our literature review, no study in Iran has assessed the risk factors of geriatric trauma-related mortalities. Identifying the risk factors in this vulnerable age-group can pave the way for implementation of policies toward reduction of injury sever-

ity, length of hospital stay and mortality, as well as improving quality of life. Shahid Rajaee Trauma Center (Emtiaz) is the primary referral center for adult trauma in Fars and patients referred to this center with level 1 of trauma. By determining the factors that affect geriatric trauma mortality, the preventive strategies to reduce the risk of mortality and morbidity in elderly patients can be established.

2. Objectives

This study aims to evaluate mortality in elderly trauma and determinating the independent risk factors affecting mortality in geriatric trauma patients.

3. Methods

Data were collected from all hospitalized patients in the emergency department and other wards of Shahid Rajaee Referral Hospital from 2011 to 2016. Information was collected from all hospitalized patients. Cases with incomplete information were excluded from the study. Eventually, a total of 65304 deceased individuals were selected as subjects.

3.1. Measurements and Data Collection

After a patient is screened and admitted, a unique eight-digit code is generated under the title "SERIAL CODE" by the hospital admission unit. Upon admission, information regarding baseline demographic characteristics such as age, gender, time of admission, and injury mechanism are routinely recorded by the admissions staff. Our trained staff extracted the information regarding the length of stay, injured body region, and injury severity score (ISS) (1 - 3, 4 - 8, 9 - 15, 16 - 24, > 25) from these records; information on nosocomial infectious complications were recorded in a separate data bank during hospitalization.

3.2. Injury Severity Score and Injured Body Regions

Abbreviated injury scale (AIS) is an anatomical scoring system producing an overall score for patients with multiple injuries. All patients received an ICD-10 code based on their primary and secondary diagnoses. In the ICD-10 lexicon, each injury was described by a code ranging from S.00 to T79.7; code descriptions were provided. An algorithm was designed in order to convert each code to its respective AIS-2005 score. Each ICD-10 injury code was assigned to one of the 6 ISS body regions. According to the AIS severity scale, each patient's injured body regions corresponded to the injured body region with the highest ISS. In this regard, all injuries received an AIS code ranging from 1 (minor injury) to 6 (an injury considered 'incompatible with life'), which was allocated to one of the six body regions (head, face, chest, abdomen, extremities [including pelvis], and external). Patients with multiple injuries were scored by adding the squares of the three highest AIS scores in three predetermined body regions. This process provided the ISS, which could range from 1 to 75.

3.3. Statistical Analysis

Data were properly imported to the IBM SPSS Statistics for Windows, version 21.0 (IBM Corp., Armonk, N.Y., USA), where all analyses were performed and figures were prepared using R software for windows. A multiple logistic regression was performed via the "Enter" method to reflect the partial effects of each covariate on geriatric trauma mortality. Covariates included age, gender, nosocomial infection, ISS, an injured body region, and injury mechanism. A two-sided P value of < 0.05 was considered statistically significant.

4. Results

There were a total of 65304 records, with a mean age of 35.22 ± 16.71, collected during 2011 - 2016. Out of which, 64360 patients (98.6%) had survived and 944 (1.4%) patients had passed away. There were 7053 patients over the age of 60 that was 10.8% of the total dataset; the mean age equaled to 70.79 ± 8.83 for elderly patients (60 and over). Men accounted for 74.8% of injuries and male to female ratio equaled to 2.97:1. The head and neck (41.7%) were the most commonly injured regions among all patients followed by the extremities (33%). These findings were slightly different for individuals over 60; in this regard, extremities (34.7%) were the most injured body region, then the head and neck (33.7%) came after. The majority of patients had ISSs between 4 - 8 and no nosocomial infections were detected. The two most common injury mechanisms included car accidents (38.9%) and motorcycle accidents (19.8), while in patients over 60, falls (41.5%) and car accidents (29.1%) were the most frequent mechanisms (Table 1).

Mean injury severity scores stratified by age and gender are shown in Figure 1. This reveals that aging has increased mean ISSs, a trend which is probably higher in men compared to women. This trend is a little distinct in the 18 - 30 years' age group.

The mean length of hospitalization was higher in the elderly patients with an ISSs between 16 - 24 compared to younger patients with the same ISS; meanwhile, in adults (18 - 30), those with highly severe injuries (ISS > 25) spent more time in the hospital (Figure 2).
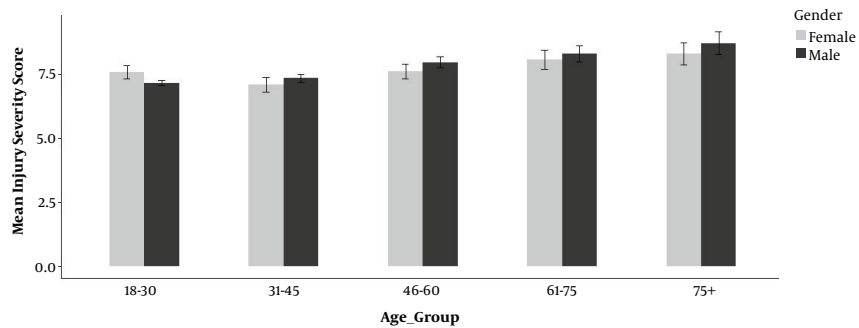
Figure 1. Mean injury severity scores stratified by age and gender
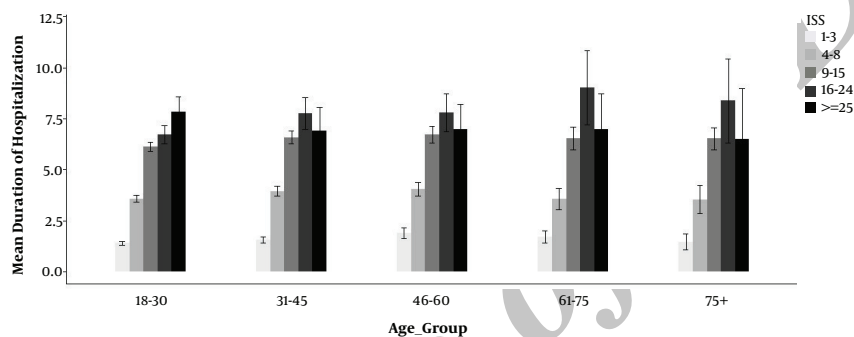

Figure 2. Mean hospitalization length stratified by age and the injury severity score (ISS)

4.1. Regression Analysis

A logistic regression was performed on patients over 60 in order to determine the risk factors for mortality in this age group. Age, gender, injured body region, injury mechanism, nosocomial infection, and ISS were the predictor variables and mortality was the independent variable. Comparing to patients who were in car accidents, patients who were hurt by other mechanisms of injury had a smaller sample size; therefore, this category was not significant. After adjustment of covariates, the most important risk factors for geriatric death were age over 75 [OR = 1.91, 95% CI (1.28 - 2.85)], nosocomial infection [OR = 10.56, 95% CI (6.52 - 17.10)], ISS of 16 - 24 [OR = 12.51, 95% CI (7.28 - 21.490], head injury [OR = 13.17, 95% CI (5.83 - 29.77)], and pedestrian accidents [OR = 1.47, 95% CI (1.47 - 1.95)].

Figure 3 shows that nosocomial infections had increased by age. In addition, as shown in Table 2, the mortality odds ratio increased by aging. It can be concluded that nosocomial infection is a significant risk factor for death in elderly patients; furthermore, Figure 4 shows that mortality decreased by year. The highest percentage of the male was in 2012, after which the percentage of death declined.

5. Discussion

5.1. Aging and Mortality in the Elderly

Our study results revealed a significant mortality rate due to geriatric trauma (4.7%). In this regard, we made a comparison between mortality risk factors for geriatric trauma in the two age groups of 60 - 75 (old age) and > 75 (very old age). Results showed a higher risk of death in very old age comparing to old age (OR = 1.91). Old age is a well-known risk factor associated with increased mortality due to trauma (5). Numerous trauma studies have investigated the relationship between demographic variables, especially the variable of age and mortality in trauma patients independent of other risk factors and determined aging as a significant risk factor for mortality among elderly patients. However, these studies reported a higher mortality rate in very old age compared to old age (11-13). In the present study, very old patients had a higher mortality rate than old individuals (65 - 74).

5.2. Gender and Mortality in the Elderly

According to our findings, men, had the highest rate of trauma and the highest risk of mortality pertained to the

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Table 1. Population Characteristics (Stratified by Totals and Age of Over 60)

Variable	Total	> 60
Age, y (mean ± SD)	35.22 ± 16.71	70.79 ± 8.83
Gender		
Male	48866 (74.8)	4176 (59.2)
Female	16438 (25.2)	2877 (40.8)
Injured body region		
Head and neck	27234 (41.7)	2379 (33.7)
Thorax	5994 (9.2)	828 (11.7)
Spine	3584 (5.5)	583 (8.3)
Extremities	21535 (33)	2449 (34.7)
Abdomen	6957 (10.7)	814 (11.5)
Nosocomial infection		
Non-nosocomial	64731 (99.1)	6973 (98.9)
Nosocomial	573 (0.9)	80 (1.1)
Injury severity score		
1 - 3	10871 (16.6)	849 (12)
4 - 8	20759 (31.8)	2882 (40.9)
9 - 15	946 (1.4)	127 (1.8)
16 - 24	4332 (6.6)	511 (7.2)
> 25	2219 (3.4)	269 (3.8)
Injury mechanism		
Car accident	25433 (38.9)	2051 (29.1)
Motorcycle accident	12908 (19.8)	590 (8.4)
Fall	11041 (16.9)	2929 (41.5)
Assault	6595 (10.1)	231 (3.3)
Pedestrian accident	4852 (7.4)	1030 (14.6)
Struck by objects	3650 (5.6)	200 (2.8)
Others	825 (1.3)	22 (0.3)
Outcome		
Survivor	64360 (98.6)	6723 (95.3)
Non-survivor	944 (1.4)	330 (4.7)
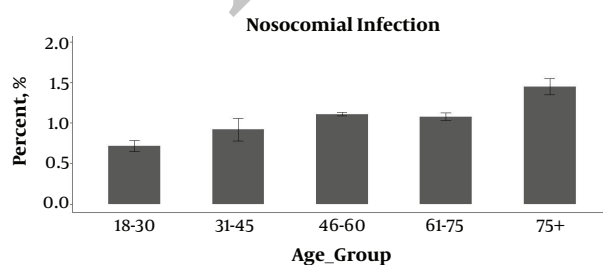
Figure 3. Percent of nosocomial infection by age stratify
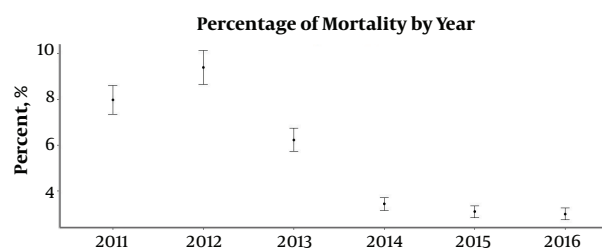
Figure 4. Percent of mortality by year

elderly (OR = 1.95). These results were consistent with the results of Bouamra's study, which showed an association between increased mortality due to trauma and the process of aging (> 65); elderly men had a higher mortality in that study (14).

5.3. Mechanism of Injury

In the present study, falling was the most common mechanism of injury in the elderly patients, while the leading risk factor for mortality in the elderly was road-traffic accidents, especially pedestrian accidents (OR = 1.47). Considering the increasing population of the elderly, there will be an increased risk of motor-vehicle accidents among elderly pedestrians and drivers. Yadollahi et al. showed the highest risk of late death belonging to pedestrian trauma (15). Numerous studies showed road-traffic accidents as a significant mechanism of injury among the youth, as well as the elderly. Meanwhile, they showed that risk of falls (same-level falls in particular) increased by aging (16, 17). Results from a systematic review and meta-analysis of mortality-related factors in the elderly revealed that high mortality had a stronger association with low-level falls comparing to road-traffic accidents (OR = 2.88) (18).

5.4. Injured Body Regions

Head injury is one of the leading causes of fatality in geriatric trauma patients (19). Based on our results, a significant increase was seen in the mortality rate of elderly patients with a head injury compared to old individuals with injuries to other regions (OR = 13.17). These results were consistent with the results of Patel's study (12) on mortality due to severe head injury in the elderly. This study showed that severe injuries with similar scores could increase mortality as age increased. That study reported a mortality rate of 71% in the age group of 65 - 75, 75% in the age group of 70 - 75, and 87% in individuals over 80; very old patients had higher mortality due to head injury compared to old patients (11).

Table 2. Logistic Regression for Predictors of Mortality Among Patients Over 60

Variable	P Value	Exp (B)	95% CI for Exp (B)	
			Lower	Upper
Age, y				
60	-	-	-	-
61 - 75	0.257	1.25	0.84	1.85
+ 75	0.001	1.91	1.28	2.85
Gender				
Female	-	-	-	-
Male	< 0.001	1.95	1.52	2.50
Nosocomial infection				
Non-nosocomial	-	-	-	-
Nosocomial	< 0.001	10.56	6.52	17.10
Injury severity score				
1 - 3	-	-	-	-
4 - 8	0.001	2.38	1.41	4.03
9 - 15	0.052	2.58	0.99	6.73
16 - 24	< 0.001	12.51	7.28	21.49
> 25	< 0.001	5.81	3.08	10.96
Injured body region				
Abdomen	-	-	-	-
Head	< 0.001	13.17	5.83	29.77
Thorax	< 0.001	5.06	2.11	12.23
Spine	< 0.001	7.30	3.02	17.66
Extremities	0.013	2.92	1.25	6.82
Injury mechanism				
Car	-	-	-	-
Motorcycle	0.30	0.80	0.53	1.21
Fall	< 0.001	0.43	0.32	0.58
Assault	0.012	0.27	0.10	0.74
Pedestrian	0.008	1.47	1.47	1.95
Struck by objects	0.025	0.31	0.31	0.86
Others	0.998	0.00	0.00	

5.5. Injury Severity Score and Mortality in the Elderly

The variable of "age" is an important risk factor for increased number and severity of injuries (20). In the present study, mean ISS increased by aging. Injured elderly with 16 < ISS < 24 had a significantly higher mortality compared to elderly patients with 1 < ISS < 3 (OR = 12.51). Furthermore, the elderly with 16 < ISS < 24 had a higher length of hospital stay. ISS is the most appropriate trauma score predicting in-hospital mortality (21); it is also more accurate score in terms of geriatric trauma outcome (13). In the Chang

et al. study, the highest mortality in ISS > 20 belonged to very old patients (over 75) (13). The Gowing et al. study also introduced aging and injury severity as important predictors of in-hospital mortality. In this study, very old patients with mean age of 77 and mean ISS of 23 had the highest rate of in-hospital mortality (22).

5.6. Hospital-Acquired Infections (HAIs) and Mortality

In this study, an increased rate of nosocomial infections had an association with increased age. There was a

1.1% rate of nosocomial infections among individuals over 60. In comparison, elderly patients with nosocomial infection had significantly higher mortality than patients without infection (OR = 10.56). Aging increases the risk of nosocomial infection (23). Compared to young individuals, the elderly had a higher rate of mortality due to infection (17). In a study by Yadollahi et al. nosocomial infection was considered an independent predictor of late death in elderly patients over 65, with consideration to confounding factors; in this regard, the risk of death was increased by 12.7 times (15).

Numerous studies have been conducted on the risk factors of mortality in the elderly. In a study by Janice et al. co-morbidity, age, ISS, and GCS were independent indices predicting mortality in elderly trauma patients. Moreover, results from a study by Chang et al. indicated ISS > 30, post-injury GCS status and hemodynamic function as the predicting factors for mortality due to geriatric trauma (13). In our study, the risk factors for mortality were compared in the two age groups of "old" and "very old" and the effects of aging were evaluated on mortality by equalization of the risk factors; this comparison is one of the most significant strengths of this study. To the best of our knowledge, there hasn't been a study in Iran on trauma and the risk factors of mortality in different elderly age groups, yet. Short post-trauma follow-up periods were a limitation of our study. For future research, we suggest considering co-morbidity as a risk factor for mortality in geriatric trauma. Due to incomplete data including past medical history, we could not compare the rank of trauma mortality in front of other illness, and since the present study was retrospective, data might not be as accurate as a prospective study.

5.7. Conclusion

According to our results, mortality is affected by aging in geriatric trauma cases. With the similar severity of the injury, very old trauma patients have a higher chance of death comparing to old patients. Increased age, gender (males), nosocomial infection, ISS, and head injury were the most significant factors predicting mortality in the elderly. Considering the adverse outcomes of trauma in elderly patients and the risk factors of mortality in this vulnerable age group, we can reduce the risk of mortality and morbidity by creating safer environments to avoid accidents by constant monitoring and special treatments following trauma.

Acknowledgments

Footnote

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