Mortality Profile of Geriatric Trauma at a Level 1 Trauma Center

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Abstract

Background: The management of geriatric trauma patients is challenging because of the altered physiology and co-existent medical conditions. To study the in-hospital mortality profile of geriatric trauma victims and the parameters associated with the mortality, we conducted this retrospective analysis. Methods: In a retrospective review of geriatric trauma admissions (above 60 years) over a 3-year period, we studied the association of age, gender, comorbidities, mechanism of injury (MOI), Glasgow coma score (GCS), injury severity score (ISS), systolic blood pressure, and hemoglobin (Hb) level on admission with hospital mortality. Univariate and Multivariable logistic regression was used to estimate odds and find independent associated parameters. P < 0.05 was considered as statistically significant. Results: Out of 881 patients, 208 (23.6%) patients died in hospital. The most common MOI was fall (53.3%) followed by motor vehicle collision (31.1%) and other mechanisms (14.5%). The in-hospital mortality was significantly higher and adjusted odds ratio (OR) for mortality were higher for male gender (2.11 [1.04–4.26]), higher ISS (6.75 [2.07–21.95] for ISS >30), low GCS (<8) (4.6 [2.35–8.97]), low Hb (<9) (1.68 [0.79–3.55]), hypotension on admission (32.42 [10.89–96.52]) as compared to other groups. Adjusted OR was 3.19 (1.55–6.56); 7.67 (1.10–53.49); 1.13 (0.08–17.12) for co-existent cardiovascular, renal, and hepatic comorbidities, respectively. Conclusion: Male gender, higher ISS, low GCS, low Hb, hypotension on admission, co-existent cardiovascular, renal and hepatic comorbidities are associated with increased mortality in geriatric trauma patients.

Keywords: Geriatric trauma, Mortality predictors, Trauma mortality

Introduction

Trauma is the fifth-most common cause of mortality in the elderly.¹⁻² Management and care of geriatric trauma patients are challenging due to high morbidity and mortality in this age group. The Eastern Association for the Surgery of Trauma (EAST) guidelines have highlighted the need for a robust predictive model for geriatric trauma to improve the outcome.³ Geriatric patients are a substantial subset of patients presenting in trauma emergency. The factors predicting the outcome after trauma are still not well-established.¹⁻⁴ In an attempt to study the effect of certain patient and injury-related parameters on the outcome of geriatric trauma victims, we conducted this retrospective multivariable analysis. We studied the profile of geriatric trauma patients, analyzed the occurrence and odds of in-hospital mortality with age, gender, comorbidities, mechanism of injury (MOI) and admission parameters – Glasgow coma score (GCS), injury severity score (ISS), systolic blood pressure (SBP), and hemoglobin (Hb) level.

Methods

A retrospective cohort analysis of geriatric trauma admissions (above 60 years) over a 3-year period (2013–2015) at the tertiary care trauma center in India was conducted. Data regarding patient characteristics (age and gender), MOI, SBP, ISS, Glasgow Coma Scale (GCS), Hb level on admission, and comorbidities were obtained from the computerized patient recording system. The patients who were dead on arrival to the hospital were excluded.

Patients were divided into different groups based on the study parameters. According to age, they were divided into three
groups, i.e., 60–69 years, 70–79 years, and 80 years and above. Similarly, based on MOI, they were categorized into those sustaining injury due to fall (including high- or low-level falls), motor vehicle collision (MVC) (including road or railway accident), and 'others' (including assault, fall of heavy object, being hit by animal, and bullet injury). Patients were grouped into hypotensive (<90 mmHg) or normotensive according to SBP on admission. Similarly, based on Hb on admission, patients were divided into two groups: those with level <9 g/dL and above 9 g/dL. Injuries were characterized into mild (ISS 1–15), moderate (ISS 15–30), and severe (ISS above 30) based on ISS. GCS was used to classify injuries into mild (GCS above 8) and severe (GCS < 8). The primary outcome measure was overall in-hospital mortality and mortality in various groups.

The secondary measures were the odds of mortality for age, gender, comorbidities, MOI, GCS, ISS, SBP, and Hb level on admission.

**Statistical analysis**

Quantitative data were expressed as frequency and percentage. The Chi-square test was used to test the association between the qualitative variables. $P < 0.05$ was considered as statistically significant. Univariate and multivariable logistic regression analysis was used to estimate the odds and adjusted odds ratios (OR) for mortality. Adjusted OR with 95% confidence interval (CI) accounted for the confounding among the variables. Data were analyzed using the statistical software Stata 14.0 (StataCorp. 2015. Stata Statistical Software: Release 14. College Station, TX: StataCorp LP). The patients with particular missing data were not included for that parameter analysis.

**RESULTS**

We studied 881 trauma patients above 60 years of age. Out of 881 patients, 208 (23.6%) patients died in hospital and 673 (76.4%) were discharged.

There were 421 patients between 60 and 69 years of age, of whom 110 (26.1%) expired. Between 70 and 79 years of age, 67 (20%) patients expired out of 335 admitted patients. Above 80 years of age, 31 (24.8%) out of 125 admitted patients expired ($P = 0.135$).

There were 575 (65.3%) male patients in the study. The mortality was higher in male patients when compared with female patients (28% vs. 15.36%, $P = 0.00$). (Adjusted OR: 2.11; 95% CI: 1.04–4.26) [Table 1].

The most common MOI was fall (53.3%) followed by MVC (31.1%) and other mechanisms (14.5%) [Figure 1]. The MOI was not specified for nine patients (1.2%). The mortality was maximum (35.4%) due to MVC followed by falls (18.5%) followed by other mechanisms (17.2%) ($P = 0.00$).

SBP on admission could be retrieved for 808 patients out of which 85 (10.5%) patients presented with hypotension. 91.76% (78 out of 85) patients with hypotension expired in the hospital as compared to 16.1% patients with normal SBP on admission ($P = 0.00$) (adjusted OR: 32.42; 95% CI: 10.89–96.52).

The records for GCS on admission could be obtained for 741 patients, of whom 641 (86.5%) patients had GCS more than 8. Mortality was higher in patients with GCS < 8 when compared with patients having GCS more than 8 (70% vs. 13.9%) ($P = 0.00$) (adjusted OR: 4.6; 95% CI: 2.35–8.97). ISS could be retrieved for 829 patients. 63.8% patients had ISS of 15 or less. Mortality was 10.8% in this group. Two hundred and sixty (31.4%) patients had ISS between 15 and 30 and ISS was more than 30 in 40 (4.8%) patients. Mortality in patients with ISS of 15–30 was 43.1% (112/260) and ISS more than 30 was associated with 57.5% (23/40) mortality ($P = 0.00$).

The data for Hb concentration on admission could be retrieved for 625 patients. Hb was <9 g/dL in 92 (14.7%) patients. Mortality was higher in patients with Hb <9 g/dL (41.3% vs. 25.9%, $P = 0.002$) (adjusted OR: 1.68; 95% CI: 0.79–3.55).

Two hundred and seventy-one (30.7%) patients out of 881 had preexisting comorbidities [Figure 2 and Table 2]. Mortality was higher in patients with comorbidities when compared with patients without comorbidities (33.2% vs. 19.3%). Cardiovascular comorbidities observed in 139 (51.3% of comorbid) patients were the most common comorbidities followed by endocrine comorbidities in 71 (26.2%) patients [Table 1]. However, comorbidities associated with the highest odds for mortality after geriatric trauma were renal disease (adj OR 7.67; 95% CI: 1.1–53.5), followed by cardiovascular (adjusted OR: 3.19; 95% CI: 1.55–6.56).

**DISCUSSION**

Geriatric trauma victims are at high risk for mortality due to frail anatomy, low physiological reserve, and multiple comorbidities. We observed 23.6% in-hospital mortality among population above 60 years admitted in our trauma center. The mortality in geriatric trauma patients has been reported to vary from 10% to 57%.[78] European association for surgery of trauma suggests that the increased risk of trauma mortality begins at...
The American College of Surgeons recommends 55 years of age as a special consideration for triage. Goodmanson et al. found that an increased risk of mortality above 57 years of age. The “National policy on older persons” adopted by the Government of India in 2009 defined senior citizen as a person who is 60 years old or above. Thus, we included patients who are 60 years of age or above in our study.

We did not find age to be a significant predictor of mortality ($P = 0.135$). Contrary to our results, most of the studies have concluded that age has a definite impact on mortality after geriatric trauma irrespective of ISS or comorbidities. Wilson et al. found a 2-fold increase in mortality after 74 years of age when compared with mortality between 65 and 74 years of age. Hashmi et al. suggested that although age is an important risk factor for mortality after geriatric trauma, the odds of mortality do not change significantly after 74 years. Campbell-Furtick et al. suggested that the age group of 60–64 years which is often excluded from elderly population analyses should be included to understand the optimal management and effects of frailty and decreased physiological reserve.

The in-hospital mortality rate was significantly higher in males (28%) when compared to females (15.36%) ($P = 0.00$), in our study. This is consistent with the findings of Hranjec et al. who found an increased risk of mortality above 70 years of age in males when compared to females.

### Table 1: Results

| Variable | Group | Number of patients, $n$ (%) | $P$ | Odds Ratio (95% CI) | Adjusted Odds Ratio (95% CI) |
|----------|-------|-----------------------------|-----|---------------------|------------------------------|
|          | Alive | Dead                        |     |                     |                              |
| Age (years) |       |                             |     |                     |                              |
| 60-69    | 311 (73.87) | 110 (26.13) | 0.135 | 0.70 (0.50-0.99) | 1.15 (0.61-2.16) |
| 70-79    | 268 (80.00) | 67 (20.00) | | 0.93 (0.58-1.47) | 1.31 (0.58-2.98) |
| 80 and above | 94 (75.2) | 31 (24.8) | |                     |                              |
| Gender   |       |                             |     |                     |                              |
| Female   | 259 (84.64) | 47 (15.36) | 0.00 |                     |                              |
| Male     | 414 (72.0) | 161 (28.0) | | 2.14 (1.49-3.07) | 2.11 (1.04-4.26) |
| MOI      |       |                             |     |                     |                              |
| Fall     | 383 (81.49) | 87 (18.51) | 0.00 |                     |                              |
| MVC      | 177 (64.6) | 97 (35.4) | | 2.41 (1.71-3.38) | 1.01 (0.54-1.86) |
| Others   | 106 (82.81) | 22 (17.19) | | 0.91 (0.54-1.52) | 0.78 (0.30-2.76) |
| GCS      |       |                             |     |                     |                              |
| 8 or more | 552 (86.12) | 89 (13.88) | 0.00 |                     |                              |
| <8       | 30 (30.00) | 70 (70.00) | | 14.47 (8.93-23.45) | 4.6 (2.35-8.97) |
| ISS      |       |                             |     |                     |                              |
| <15      | 472 (89.2) | 57 (10.8) | |                     |                              |
| 15-30    | 148 (56.92) | 112 (43.08) | | 6.24 (4.33-9.05) | 4.94 (2.69-9.07) |
| >30      | 17 (42.50) | 23 (57.50) | | 11.20 (5.65-22.2) | 6.75 (2.07-21.95) |
| Hb (g/dl) |       |                             |     |                     |                              |
| >9       | 395 (74.11) | 138 (25.9) | 0.002 |                     |                              |
| 9 or less | 54 (58.70) | 38 (41.30) | | 2.01 (1.27-3.18) | 1.68 (0.79-3.55) |
| Hypotension |       |                             |     |                     |                              |
| No       | 606 (83.82) | 117 (16.18) | 0.00 |                     |                              |
| Yes      | 7 (8.24) | 78 (91.76) | | 57.71 (25.97-128.22) | 32.42 (10.89-96.52) |
| Comorbidities  |       |                             |     |                     |                              |
| Cardiovascular | No | 579 (78.14) | 162 (21.86) | 0.004 |                     |                              |
| Yes      | 93 (66.91) | 46 (33.09) | | 1.76 (1.19-2.62) | 3.19 (1.55-6.56) |
| Respiratory | No | 660 (76.83) | 199 (23.17) | 0.036 |                     |                              |
| Yes      | 12 (57.14) | 9 (42.86) | | 2.48 (1.03-5.98) | 0.85 (0.14-5.38) |
| Neurological | No | 654 (76.58) | 200 (23.42) | 0.454 |                     |                              |
| Yes      | 19 (70.37) | 8 (29.63) | | 1.37 (0.59-3.19) | 0.51 (0.12-2.12) |
| Endocrine | No | 618 (76.30) | 192 (23.70) | 0.824 |                     |                              |
| Yes      | 55 (77.46) | 16 (22.54) | | 0.93 (0.52-1.67) | 0.66 (0.25-1.74) |
| Renal    | No | 669 (76.90) | 201 (23.10) | 0.002 |                     |                              |
| Yes      | 4 (36.46) | 7 (63.64) | | 5.82 (1.68-20.09) | 7.67 (1.10-53.49) |
| Hepatic  | No | 671 (76.09) | 204 (23.31) | 0.013 |                     |                              |
| Yes      | 2 (32.22) | 4 (66.69) | | 6.57 (1.19-36.17) | 1.13 (0.08-17.12) |

OR: Odds ratio, CI: Confidence interval, MOI: Mechanism of injury, GCS: Glasgow Coma Score, ISS: Injury severity score, MVC: Motor vehicle collision, Hb: Hemoglobin *The first group(level) for each variable was taken as reference in regression analysis

**Figure 2: Comorbidities**
Table 2: Comorbid conditions

| Comorbid conditions observed in our patients |
|---------------------------------------------|
| Cardiovascular conditions                   |
| Hypertension                                |
| Arrhythmias (atrial fibrillation)           |
| Coronary artery disease                     |
| Congestive heart failure                    |
| Rheumatic heart disease                     |
| Respiratory conditions                      |
| Asthma                                      |
| COPD                                        |
| Tuberculosis                                |
| Neurological and psychiatric illnesses      |
| History of cerebrovascular accident         |
| Parkinson’s disease                         |
| Dementia                                    |
| Seizure disorder                            |
| Depression                                  |
| Endocrine conditions                        |
| Diabetes mellitus                           |
| Thyroid disorders                           |
| Renal                                        |
| Chronic renal failure                       |
| Acute on chronic renal failure              |
| Hepatic                                     |
| Chronic liver disease                       |

**COPD:** Chronic obstructive pulmonary disease

*et al.*, [13] while Sampalis *et al.* have reported increased mortality in female patients. [14]

In our study, fall was the most common MOI however, mortality was highest in persons sustaining injury due to MVCs. While the difficult mobility and frailty predisposes elderly population to frequent falls, the high-energy impact in MVC likely accounts for greater injury severity and hence ensuing mortality. Review of literature reveals the variable effects of MOI on mortality in geriatric trauma. Sampalis *et al.* found falls to be a strong predictor of mortality when compared with RTA (OR: 1.51). [14] Grossman *et al.* found that patients with a history of fall had better survival when compared with RTA. [11] Konda *et al.* concluded that patients with comorbidities sustained more falls so MOI could be a surrogate for patient’s underlying condition and the outcome could be the result of combined effect. [15]

Low GCS signifies head trauma or compromised CNS perfusion due to excessive blood loss and has been associated with increased mortality. [13, 16, 17] We found that low GCS (<8) on presentation was associated with significantly higher mortality (70%) when compared with patients with high GCS (13.88%). It was a strong predictor of mortality when adjusted for the confounding variables (adjusted OR: 4.60).

ISS is a uniform measure to compare injury severity. Most of our patients had ISS <15 (67.3%) with a mortality of 10.78%. It was observed that mortality was maximum in patients with ISS above 30 (57.5%). Although the ISS cutoff for the evaluation of mortality has been variously taken, most of the previous studies have associated higher ISS with increased mortality. [13, 14, 17] Knudson *et al.* and Hranjec *et al.* found ISS to be the single variable that correlated most significantly with the mortality. We also noted that ISS had a significant effect on mortality.

SBP on admission is one of the markers of tissue perfusion and adequacy of compensatory mechanisms to ongoing physiological insult. Other more precise markers for organ perfusion are base deficit and venous lactate level. These are the objective parameters in identifying occult shock and mortality in normotensive geriatric trauma patient. We defined hypotension as SBP <90 mm Hg, although some authors consider 110 mmHg as hypotension in the geriatric age group. In our study, significantly higher mortality was observed in patients with hypotension (91.76% vs. 16.18%, P = 0.00). There was a strong association between SBP on admission and mortality (adjusted OR: 32.42 [10.89–96.52]) after adjusting for confounders. The wide CI is attributable to a relatively less number of patients with low blood pressure (n = 85). Hranjec *et al.* have found a 40% increase in mortality in patients with SBP <90 mmHg as compared to patients with higher BP. [13] However, Pandit *et al.* did not find it to be predictive of mortality and proposed shock index to be a better marker for prediction of mortality.

In our study, the mortality was more in geriatric patients with Hb <9 g/dl as compared to those with higher Hb (41.3% vs. 25.8%; P = 0.002) and patients with lower Hb had higher odds of dying (OR: 2.01 [95% CI 1.27-3.18]; adjusted OR: 1.68 [95% CI 0.79–3.55]). A relationship between Hb level and risk of death has been demonstrated by Lichtveld *et al.*, with 22% reduction in risk with each mmol/L increase in Hb, [10] irrespective of patients age, wherein no cutoff for Hb value was assigned and mortality assessment continued after hospital discharge. Our results are specific to the elderly age group within the period of hospital stay. Horst *et al.* also found that elderly trauma survivors had higher Hb levels than nonsurvivors. [19] In Indian scenario, it is difficult to comment whether anemia is due to acute blood loss or chronic which may be due to factors such as poor nutritional status. While we expect acute traumatic hemorrhage to alter Hb level, chronic anemia due to preinjury status cannot be ignored. The Hb level would be expected to affect the outcome as it will reflect the degree of decompensation to similar blood loss, subsequent compromise in oxygen carrying capacity and adequacy of tissue oxygenation. It will also determine the requirement of blood and its components, with higher blood transfusion predisposing the patients to side effects such as possible lung injury, hypothermia, and coagulopathy. The adjusted odds ratio for mortality in low Hb group did not seem to be statistically significant. But, the effect on mortality was found to be clinically significant due to above reasons.

Labib *et al.* suggested that it is not the patient age per se, but a high incidence of comorbidities that is responsible for the difference in mortality between the young and the elderly patient. [20] Clements *et al.* found that the patients with higher ISS died early during their admission (within 48 h), whereas late deaths were
usually due to medical complications. In our study, patients with cardiovascular and renal comorbidities had significantly higher mortality than the patients without comorbidities. The presence of endocrine or neuropsychiatric illnesses did not affect the mortality. Grossman et al. found that hepatic diseases had the maximum impact on mortality, followed by renal diseases and cancer.[11] Morris et al. studied the effect of preexisting conditions on mortality in all adult trauma patients, irrespective of age. They found maximum odds of dying in patients with cirrhosis followed by congenital coagulopathy, ischemic heart disease, chronic pulmonary disease, and diabetes mellitus.[21]

Our study being a retrospective analysis was restrained by the paucity of data. The inclusion of assessment of objective markers of tissue perfusion such as base deficit and serum lactate levels on admission would have been more useful. The evaluation of time-related mortality since admission and the length of hospital stay would have been more precise and would have accounted for the effect of complications during hospital stay. However, our study broadly encompasses the mortality as the outcome and has attempted to outline the mortality profile of a large study group of geriatric trauma patients. Besides, to the best of our knowledge, there has been no such study examining the mortality profile of geriatric trauma patients in the Indian population.

**CONCLUSION**

Male gender, higher ISS, low GCS, low Hb, hypotension on admission, coexistent cardiovascular and renal comorbidities are associated with increased mortality in geriatric trauma patients. While age, MOI and respiratory, neurological, hepatic and endocrine abnormalities are not associated with increased mortality after geriatric trauma.

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**Research quality and ethics statement**

The authors of this manuscript declare that this scientific work complies with reporting quality, formatting, and reproducibility guidelines set forth by the EQUATOR Network. The authors also attest that this clinical investigation was determined to require institutional ethics committee review, and the corresponding approval number is IEC-439/07.06.2019, RP-07/2019. We also certify that we have not plagiarized the contents in this submission and have done a Plagiarism Check.

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**Conflicts of interest**

There are no conflicts of interest.

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