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Original Article

Assessment of Mortality Predictors in Geriatric Pelvic Traumas Patients in ICU

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SUMMARY

Background: The frequent exposure of older individuals to trauma has increased the importance of trauma management and the parameters affecting survival in the elderly. This study aimed to contribute to the literature on the parameters that should guide geriatric fluid management and to evaluate the predictive power of these parameters for mortality.
Methods: Demographic data, comorbidities, drug use history, type of pelvic trauma, shock follow-up parameters, operating conditions, complications, Acute Physiology and Chronic Health Evaluation II score and mortality status were retrospectively recorded in patients with pelvic trauma admitted to the emergency department from 2019–2022 and required intensive care follow-up.
Results: The study population was divided into two groups; the survival (n = 210) and the mortality group (n = 36). The mean age of the patients was 75.6 ± 7.1 years and 60.2% of the patients were male. Age and proportion of male patients were significantly higher in the mortality group than in the survival group (median age 74 vs. 81 years and male sex 57.1% vs. 77.8%). The serum lactate level ($p < 0.001$), shock index ($p < 0.001$), age-related shock index ($p < 0.00$), trauma-specific frailty index ($p < 0.001$), and mean length of stay in intensive care unit ($p < 0.001$) were significantly higher in the mortality group than that for survival group. Multivariate logistic regression analyses revealed that cardiovascular diseases, beta blocker use, lactate levels, shock index, age shock index, trauma specific frailty index were associated with mortality.
Conclusion: Successful trauma resuscitation in geriatric patients should be managed by monitoring more reliable parameters such as shock index, age-related shock index, and serum lactate value, instead of relative values such as blood pressure and pulse.

1. Introduction

An ageing population is one of the most important social problems of the 21st century. According to previous studies, older individuals will constitute 22% of the population of the USA by 2050.[1] Owing to their mobility and active lifestyle, the exposure of this population to trauma is increasing. Older patients constitute approximately 20% of all trauma patients.[2] Trauma has increased from 7th to 5th in the ranking for causes of death in older persons. The increase in older population and frequent exposure to trauma have increased the importance of trauma management in intensive care units for older persons.[1]

Geriatric patient management is challenging for emergency trauma teams and intensive care workers. During evaluation, both age-related changes and accompanying comorbidities of the patient should be known and managed appropriately.[3] Older patients should be considered as a whole, with anatomical and physiological aging of the organ systems, comorbidities, and frailty indices. Recently, multidisciplinary approaches have increased the success rate of trauma management.[4]

As there is a slowdown in the response to trauma in geriatric patients, they are more affected than the younger population by injuries that occur with the same severity and manner.[5] The complication rate, number of days in the intensive care unit, and mortality rate is high for reasons such as high comorbidities and routine use of multiple drugs in elderly trauma patients.[2] Fluid resuscitation failure in older patients is not the only factor affecting mortality; it is the only factor that can be corrected. Delayed unsuccessful management increases mortality.[1] When evaluating fluid resuscitation in geriatric patients, the use of specially developed age-related follow-up parameters instead of classic follow-up parameters increases the chance of success.[6,7]

Our study aimed to contribute to the literature on the parameters that should be used as a guide in geriatric fluid management and to evaluate the predictive power of these parameters for mortality in the intensive care unit.

2. Materials and methods

This study was approved by the Eskişehir Education and Training Hospital of Medicine Non-Interventional Clinical Research Ethics Committee (Date: 27.01.2023 Decision No: 12). All procedures were performed according to the ethical rules and principles of the De-

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claration of Helsinki.

2.1. Study population

In our study, 1074 patients with pelvic trauma (including 246 with isolated pelvic trauma), aged > 65 years, who were admitted to the Eskişehir City Hospital Emergency Department between 2019 and 2022, and required intensive care follow-up were examined. Patients with pelvic trauma and aged < 65 years, who did not require intensive care follow-up were excluded. Patients with multiple traumas were excluded from the study. The study population was divided into two groups; the survival and the mortality group.

2.2. Data collection

Demographic data, comorbidities, drug use history, type of pelvic trauma, shock follow-up parameters, operating conditions, complications, Acute Physiology and Chronic Health Evaluation (APACHE) II scores, expected death rates, and mortality status were retrospectively recorded for patients with pelvic trauma who were admitted to the emergency department between 2019– 2022 and required intensive care follow-up.

2.3. Statistical analyses

The data was summarized in the form of "median (interquartile range)" for continuous variables and proportions for categorical variables. The distribution of the data for normality was tested using the Shapiro–Wilk test, and the homogeneity of group variances was tested using the Levene test. Categorical variables were examined using the chi-squared test. Not all continuous variables were normally distributed; therefore, the Mann-Whitney U test was used to compare continuous variables between the two groups. A multivariate logistic regression analysis forward conditional method was used to detect the predictors of mortality among the patients' demographic characteristics, laboratory parameters, and several specific emergency and intensive care scoring systems. Statistical significance was set at $p < 0.05$. All statistical analyses were performed using SPSS 22.0 (IBM SPSS Ver. 22.0, IBM Corp, Armonk NY, USA).

3. Results

3.1. Patient characteristic

The mean age of patients was 75.6 ± 7.1 years and 60.2% of the patients were male. The study population was divided into two groups: survival (n = 210) and mortality (n = 36). Age and male sex were significantly higher in the mortality group (median age 74 vs. 81 years and male sex 57.1% vs. 77.8%). The most common comorbidities were hypertension (55%, n = 136), diabetes mellitus (44.7%, n = 110), and cardiovascular diseases (23.5%, n = 58) (Table 1). There were no significant differences between the mortality and survival groups in terms of cardiovascular disease or hypertension. Diabetes was observed to be significantly higher in the survival group (100 vs. 10, p = 0.027). Pelvic trauma causes included falls (66.6%), traffic accidents (31.8%), and pathological fractures (1.6%). Lateral compression-type pelvic fractures were observed in 47.5% of patients (n = 117). Surgery was required in 56% of the patients and total hip replacement was performed in 68.1% of the patients. Cardiovascular events (n = 27) were observed in 10.9% of patients, thromboembolic events in 4.9% (n = 12), and infection in 6.5% (n = 16) of patients (Table 2).

3.2. Shock results

With respect to parameters followed during shock after trauma, systolic blood pressure ($p < 0.001$), diastolic blood pressure ($p < 0.001$), and mean arterial pressure ($p < 0.001$) were significantly higher in the survival group. Whereas, heart rate ($p < 0.001$) was significantly lower in the survival group. In the mortality group, the serum lactate level ($p < 0.001$), shock index ($p < 0.001$), age-related shock index ($p < 0.001$), trauma-specific fragility index ($p < 0.001$), and mean length of intensive care unit stay ($p < 0.001$) were significantly higher.

Table 1
Patient characteristics of the study.

	Survival group (n = 210)	Mortality group (n = 36)	p value
Age	74 [69–79.2]	81 [76.5–84.7]	< 0.001
Gender (male)	120 (57.1%)	28 (77.8%)	0.019
Comorbidity			
Cardiovascular disease	46 (21.9%)	12 (33.3%)	0.136
Diabetes mellitus	100 (47.6%)	10 (27.8%)	0.027
Hypertension	114 (54.3%)	22 (61.1%)	0.447
Shock parameters			
Haemoglobin	11.8 [9.3–13.7]	10.8 [8.5-13.7]	0.491
Lactate	1.9 [1.2–2.4]	2.7 [1.7-4.4]	< 0.001
Base excess	8.5 [-34.0–39.7]	14.5 [-10.7-42.7]	0.678
Systolic blood pressure (mmHg)	124 [110–130]	90 [85-100]	< 0.001
Diastole blood pressure (mmHg)	75 [70–76]	55 [50-60]	< 0.001
Mean blood pressure (mmHg)	91 [82.9–95.2]	68.3 [60.0-73.3]	< 0.001
Heart rate (bpm)	85 [78–95]	105 [88-115]	< 0.001
Shock index	0.70 [0.61–0.83]	1.02 [0.93-1.41]	< 0.001
Age-related shock index	51.9 [45.6–63.4]	85.5 [69.5-105.2]	< 0.001
Trauma specific frailty index	15 [2–175]	30 [9.5-57.5]	< 0.001
Intensive care admission			
APACHE II	9 [5–17]	20.5 [14-28]	< 0.001
Predictive mortality rate	9.95 [3.82–20.97]	26.6 [16.53-49.68]	< 0.001
Operation need, n (%)	132 (62.8%)	16 (44.4%)	0.037
Duration of intensive care stay, days	5 [2–11]	11.5 [3-14]	0.031

APACHE II: Acute Physiology and Chronic Health Evaluation II.

The pulse response during shock was significantly lower in patients using beta-blockers (67 vs. 87.5, p < 0.001) (Table 3). In patients using anticoagulant drugs, the mortality rate was significantly higher (18 vs. 18, p = 0.007) (Table 4). Using multivariate logistic regression presence of cardiovascular disease (p = 0.003), serum lactate level (p < 0.001), beta blocker use (p = 0.039), shock index (p = 0.009), age shock index (p < 0.001), trauma specific frailty index (p < 0.001), APACHE II score (p < 0.001), expected death rate (p = 0.002) was found to be statistically significant associated with mortality (Table 5).

4. Discussion

In our study, we demonstrated that serum lactate level, shock index, and age-related shock index used in trauma resuscitation can predict mortality in older patients. We showed that systolic, diastolic, and mean arterial pressure could not predict mortality and pulse response could not occur, especially in older patients using beta-blockers. The shock index, age-related shock index, trauma-specific fragility index, and serum lactate levels were significantly higher in the mortality group.

Examination of the causes of pelvic trauma in older patients revealed that falls were the most common cause. Advanced age; neurological, visual, and cognitive disorders; previous history of falling; and drug use are risk factors for falls. In a previous study, it was observed that the rate of protecting the hip and head with the help of the arms decreased in the older patients (33–50% vs. 90%).[8,9]

Henry et al. reported that lateral compression pelvic fracture, which is a simpler and milder trauma, is more common in older individuals, whereas more severe and serious anteroposterior pelvic fractures are more common in younger people. However, they observed that pelvic trauma requiring blood transfusion occurred at a higher rate in older patients, and the need for angiographic treatment developed more frequently. This study determined that the severity of injury depends on variables other than the mechanism of occurrence, emphasizing that the main determinant of mortality is age rather than the mechanism of occurrence.[10] In our study, we encountered lateral compression fractures most commonly in older patients, which is consistent with the literature. However, we found that age was the most important predictor of mortality.

Concomitant diseases in patients and their degrees are as important as age. The reason for poor prognosis in older patients is not limited to the physiological decrease in adaptive and homeostatic responses after trauma. Many studies have examines diseases that worsen trauma prognosis in older individuals, and cirrhosis, coagulopathies, COPD, ischemic heart disease, and diabetes mellitus have been identified as the five diseases that have been proven to worsen prognosis.[1–3] In a study conducted by Min et al. with more than 3000 patients, it was determined that at least one of these diseases was present in 25% of the patients > 65 years. The post-traumatic mortality rate of older patients with comorbid diseases was almost two times higher. In the same study, a relationship was found between injury and patient factors including age, sex and comorbidities.[4] We examined the comorbidities in our study and observed that cardiovascular disease was an important predictor of mortality (p = 0.003).

The trauma-specific frailty index is a risk marker that aims to predict trauma prognosis due to age-related physiological changes and an increased incidence of comorbidities. It is a scoring system in which approximately 50 different variables are quantitatively evalu-

Table 2
Pelvic trauma characteristics of patients.

	n (%)
Mechanism of injury	
Motor vehicle accident	78 (31.8%)
Fall	164 (66.6%)
Pathological fracture	4 (1.6%)
Complications	
No complication	191 (77.7%)
Cardiac event	27 (10.9%)
Thromboembolic event	12 (4.9%)
Infections	16 (6.5%)
Type of pelvic trauma	
Anterior posterior compression	83 (33.7%)
Lateral compression	117 (47.5%)
Vertical shear	2 (0.9%)
Combination	44 (17.9%)
Operation necessity	138 (56.0%)
Type of operation	
Hip replacement	94 (68.1%)
The others (plate, nail, screw)	44 (31.9%)

Table 3
Characteristics of patients using beta blocker.

	Beta blocker (n = 24)	Non-beta blocker (n = 222)	p value
Heart rate (bpm)	67 [65–95.2]	87.5 [80–100]	< 0.001
Mortality	6 (25%)	30 (13.5%)	0.130

Table 5
Multivariate logistic regression analysis on the risk factors associated with mortality for pelvic fractures.

Variable	Odds ratio	95% confidence interval	p value
Age	1.077	0.734–1.581	0.704
Gender (male)	0.328	0.070–1.534	0.157
Cardiovascular diseases	0.022	0.002–0.277	0.003
Using beta blocker	19.402	1.157–325.210	0.039
Using anticoagulant	0.811	0.111–5.911	0.836
Lactate levels	1.128	1.065–1.194	< 0.001
Shock index	0.937	0.893–0.984	0.009
Age shock index	1.015	1.008–1.021	< 0.001
Trauma specific frailty index	1.008	1.004–1.012	< 0.001
APACHE II	1.629	1.273–2.084	< 0.001
Expected death rate	0.999	0.998–1.000	0.002

APACHE II: Acute Physiology and Chronic Health Evaluation II.

Table 4
Characteristics of patients using anticoagulants.

	Anticoagulant group (n = 76)	Non-anticoagulant group (n = 170)	p value
Transfusion necessity			
Erythrocyte suspension	38 (50%)	72 (42.3%)	0.265
Fresh frozen plasma	18 (23.7%)	34 (20%)	0.513
Platelet suspension	2 (2.6%)	10 (5.9%)	0.274
Operation necessity	48 (63.1%)	100 (58.8%)	0.521
Duration of intensive care stay, days	7 (3–15)	5 (2–11.2)	0.087
Mortality	18 (23.7%)	18 (10.6%)	0.007

ated, and its predictive power for prognosis has been proven in prospective studies.[11] Dunham et al. showed that frailty is an independent marker of post-traumatic postoperative complications, mortality, and length of hospital stay. They suggested that the degree of frailty should be considered as a basis, rather than the age of the patient alone. It has been emphasized that age is a simple predictor of prognosis in geriatric patients, and the frailty score is stronger.[12] Hruska et al. recommended that centers accepting geriatric trauma patients should definitely evaluate their frailty. They emphasized that geriatric trauma patients should be managed by a multidisciplinary team experienced in geriatrics.[13] Our study evaluated the trauma-specific frailty index of our patients and found it to be an independent predictor of mortality ($p < 0.001$).

Vital signs are generally used to determine the need for fluid resuscitation and transfusion in patients with trauma in intensive care units. Systolic blood pressure, mean arterial pressure, and pulse normalization are the major targets for resuscitation. However, older patients may sometimes have normal vital signs, even if they have a pathological condition. Since there is no vital sign limit for age, unsafe resuscitation and important pathologies, such as hypovolemia, may be missed in patients. Using a sensitive scale during resuscitation may cause unnecessary fluid overload and increase the risk of mortality.[6,7] In some studies on the parameters that should be used to determine fluid and transfusion needs in older patients, it has been shown that systolic and diastolic blood pressure, and shock index are strong markers, but pulse value alone is misleading.[14,15] On the other hand, Ohmori et al. emphasized that systolic blood pressure, pulse rate, and the Glasgow Coma Scale were not useful; only the shock index was a reliable indicator for predicting mortality.[16] Normally, in traumatic hemorrhage, systolic blood pressure drops and the pulse increases; thus, the shock index increases. Rady et al. found that a shock index above 0.9 was sensitive in predicting patients requiring rapid treatment, mortality, and intensive care admission.[17] To make the shock index more reliable, an age-related shock index has been developed, and many studies have proven its reliability.[6,7,18] In our study, the shock index and age-related shock index were significantly higher in the mortality group, and both indices were significant predictors of mortality ($p = 0.009$, $p < 0.001$). We believe that this must be followed during resuscitation.

A study by Heffernan et al., which compared the pulse response during trauma in young and older individuals, compared 5000 older and younger trauma patients and showed that mortality increased at a heart rate > 90 in the older and > 130 in the younger patients. They showed that systolic blood pressure < 110 mmHg in the older and < 95 mmHg in the younger patients increased mortality. Vitals were found at different limits during hemorrhagic shock in older and younger patients.[19] The fact that most older patients are hypertensive overshadows their hypotensive response during hypovolemia. This situation brings us to the concept of elderly vitals, whose importance is increasing daily. Studies now emphasize the necessity of determining age-adjusted vital sign limits for trauma success.[20]

Studies have emphasized that the detection of tissue hypoperfusion in shock recognition and resuscitation should be based on blood gas parameters rather than vital signs, particularly in geriatric patients. It has been emphasized that the serum lactate level is a more reliable parameter than vital signs.[1,3,5] Our results showed that serum lactate level was significantly higher in the mortality group ($p < 0.001$), and that serum lactate level was a predictor of mortality ($p < 0.001$).

The tachycardia response, which is an indicator of hypovolemia, may not occur in trauma for reasons such as the use of beta-blockers; which are very common in older patients; and decreased sensitivity of the myocardium to catecholamines due to the nature of old age.[1–3] In our study, we showed that the pulse response did not occur effectively in the group that used beta-blockers. The heart rate was significantly lower in the drug use group ($p < 0.001$). Although we found that heart rate was significantly higher in the mortality group ($p < 0.001$), we believe that for this reason, isolated heart rate is not a reliable follow-up parameter for shock and resuscitation.

Evaluating the amount of bleeding in trauma patients is both difficult and important. Therefore, excessive and unnecessary transfusions should be avoided. The use of anticoagulant drugs for comorbidities is very common in older individuals, yet the management of trauma caused by anticoagulants is more difficult.[21] In our study, although there was no significant difference in the amount of transfusion between the groups using and not using anticoagulants, mortality was significantly higher in the group using anticoagulants ($p = 0.007$).

Many studies have investigated the mortality determinants in geriatric trauma, and hemorrhage has been emphasized as an important predictor of mortality in pelvic traumas.[22–24] While the mortality rate of all pelvic traumas is between 5–30%, it increases to 40–50% in patients with hemorrhagic traumas. If geriatric pelvic trauma occurs in the form of open pelvic fractures, the mortality rate can reach 81%.[22] In our study, the mortality rate was 14.6% and no significant change was observed in the mortality group in terms of transfusion requirements. The 2016 "post-traumatic major bleeding and coagulopathy" guideline recommended avoidance of aggressive fluid therapy in blunt pelvic traumas until bleeding control is achieved.[25] In a study conducted by Husmann et al. in 266 trauma centers, the mortality rate was 22% in the low-volume group receiving less than 1500 cc of fluid in 1896 unstable trauma patients, while the rate was 27% in the group receiving more than 1500 ml of fluid ($p = 0.001$). They emphasized the importance of appropriate fluid resuscitation.[26] In our study, no significant changes were observed in the amount of fluid or blood resuscitation in the mortality group.

In a study by Ojodu et al. investigating the predictors of mortality in geriatric pelvic trauma, it was found that hemoglobin level at admission, detection of vascular injury, and amount of transfused erythrocyte suspension were independent risk factors affecting mortality in the older patients.[24] Arroyo et al. emphasized that increasing age, shock, and time until the procedure, predict mortality and complications.[27] Again, Choi et al. found that older age, male sex, lower income level, and seasons were associated with mortality in elderly Korean patients with skeletal fracture.[28] In our study, we found that apart from the APACHE II score and expected death rate in the intensive care unit, serum lactate level, shock index, age-related shock index, and trauma-specific frailty index also predicted mortality.

As this was a retrospective study, the biggest limitation was that the vital signs of patients could not be recorded at frequent intervals.

Therefore, we believe that successful trauma resuscitation in geriatric patients should be managed by monitoring more reliable parameters such as shock index, age-related shock index, and serum lactate value, instead of relative values such as blood pressure and pulse.

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Data sharing and availability

Authors can confirm that all relevant data are included in the article and/or its supplementary information files.

Conflict of interest

The authors declare no conflict of interest.

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