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Research Article

Factors Predicting Intensive Care Unit Admission in Trauma Patients: A Multicenter Study Based on the National Trauma Registry of Iran

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Abstract

Background: Caring for trauma patients is a paramount international concern. Delays in diagnosing patients in need of intensive care have unredeemable consequences. Identifying predicting factors of intensive care unit (ICU) admission in trauma patients is not without merit regarding this matter. This study aimed to investigate the underlying factors associated with ICU admission in trauma patients.
Methods: A retrospective study was designed based on data from the National Trauma Registry of Iran (NTRI) from 2016 to 2021. ICU admission was considered the primary endpoint. Relationships between demographic variables, injury site, injury mechanism, vital signs, and trauma scores with the outcome were evaluated by univariate analyses. ICU risk factors and their specific odds ratio (OR) were determined by multivariate analysis.
Results: Following univariate and multivariate analyses, age > 55 years, widowhood, injuries due to road accidents, falling from a height, penetrating objects, and gunshot, underlying cardiovascular disease (CVD), injury to head, thorax, abdomen, spine, and lower extremities, hypotension, hypertension (HTN), tachycardia, bradycardia, hyperpnea, low oxygen saturation, high body temperature, Glasgow Coma Scale (GCS) ≤8, and Injury Severity Score (ISS) > 15 were introduced as independent risk factors of ICU admission. Nonetheless, transport to the hospital (personal car) and upper extremity injury reduced the outcome incidence.
Conclusion: Numerous contextual variables were significantly associated with ICU admission, each with its own matter. When entering the emergency room, paying attention to these factors can help diagnose people in need of ICU care sooner.

Keywords: Wounds and Injuries; Intensive Care Units; Emergency Hospital Service; Vital Signs; Risk Factors

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Background

Trauma is among the most critical health system issues worldwide due to its high mortality rate (1, 2). It is the leading cause of death in people below 46 years old, executing more than 16000 people once a day (3, 4). Hemorrhagic shock, sepsis, head injury, and consequent multiple organ failure are the main fatal complications following trauma (5, 6). In developing countries, patients with traumatic injuries occupy a large proportion of hospital beds, which bears a heavy burden on the national care system (2). Trauma is also prevalent in Iran and causes significant morbidity and mortality. In 2016, a nationwide study indicated that road accidents accounted for 35.6 deaths per 100000 all around the country (7). It also remains amongst the most common causes of disability in all age groups of the Iranian population (8-10).

The intensive care unit (ICU) is defined as a hospital ward providing appropriate support to critically ill patients suffering from failure in one or more major organs (including the heart, lungs, and kidneys) (11, 12). More specialized patient care supplied in ICU requires technologies tailored to the patient's condition; hence, it may be costly for the individual or hospital caregivers (13, 14). Nowadays, one of the essential factors considered a primary endpoint regarding different studies is hospitalization in the ICU. People who demand ICU admission following a specific pathological event usually have a worse physical condition than others. This state is also reasonable for trauma. Today, major trauma is among the leading causes of hospital ICU referrals worldwide (15, 16).

The first step in managing trauma is triage performed in the emergency department (ED). Numerous scoring systems have been developed to classify the patients in this stage, including Revised Trauma Score (RTS) and Trauma and Injury Severity Score (TRISS) (17-20). RTS is a validated predictor of mortality in those who go to the emergency room because of trauma. This index consists of three major physiological factors: Glasgow Coma Scale (GCS), systolic blood pressure (SBP), and respiratory rate (RR) (19).

TRISS was applied in triage centers subsequently. In addition to the previous factors mentioned about RTS, it includes the Injury Severity Score (ISS), age, and trauma mechanism (penetrating or blunt) (20).

Following triage, each patient is evaluated through multiple examinations and imaging; therefore, the clinical diagnosis remains finalized. Thus, based on the confirmed diagnosis and the severity of the trauma, the patient is referred to the ICU. From the moment patients are admitted to the emergency room to when they are hospitalized in the ICU, delays caused by additional diagnostic procedures can detrimentally affect individuals in need of resuscitation or careful monitoring (21, 22). The deferral sometimes even reaches several hours. This delay in time-sensitive care can risk a patient's life. For example, if a patient with a stroke reaches to the hospital and he or she remains in the golden time for early intervention, postponing the intensive care service and early revascularization because of doing a diagnosis-confirming magnetic resonance imaging (MRI) results in permanent paraplegia or even death (23). Therefore, we require to know which patient is more of urgency and demands to transfer quickly to the ICU.

However, there is no standardized guideline that contributes to physicians identifying the ICU requirement in trauma patients immediately upon hospital arrival before reaching a final diagnosis. In this regard, if practical scoring systems emerge, it can be hoped that accelerating the transfer of patients will prevent mortality and subsequent morbidity (24). The primary purpose of this study was to evaluate the criteria for traumatized individuals and determine the risk factors for hospitalization in the ICU to predict the demand for this vital outcome.

Methods

Study Design: This was a retrospective analysis of the prospectively gathered data of the trauma patients that have been registered through the National Trauma Registry of Iran (NTRI) from July 2016 to October 2021. This project has been carried out with official approval from Sina Trauma and Surgery Research Center, Tehran University of Medical Sciences, Tehran, Iran, as the NTRI's principal founder. Moreover, the institutional ethics committee has approved the study method and relevant ethical considerations (ethical code: IR.TUMS.SINAHOSPITAL.REC.1400.102).

National Trauma Registry of Iran (NTRI): NTRI started in 2016 at Sina Hospital in Tehran City. In the following years, seven additional hospitals across the country joined the registry (25, 26). The information of trauma patients who entered the emergency room of each center was carefully recorded by two trained nurses. These data included all interventions or diagnostic procedures performed, the patient's demographic characteristics, information about the injury, its type and severity, and nosocomial outcomes (mortality, hospital length of stay, and ICU admission) until they were discharged or died. Incomplete information was completed as much as possible by telephone calls with patients or their relatives as well as reviewing their medical records. After recording each patient's data, quality checkers were hired for each center to check the accuracy and reliability. The data were referred to the relevant registrar for re-evaluation and correction in case of any doubt.

Inclusion and Exclusion Criteria: All trauma patients, 18-year-old or older, whose data were recorded in NTRI from July 2016 to October 2021 were included in the study. Exclusion criteria were dying before reaching the ICU (died either prior to or during admission to ED), leaving the hospital with personal consent or unwillingness to continue treatment, trauma more than two weeks before admission to the emergency room (27), lack of baseline information such as age and sex, and lack of knowledge about ICU admission.

Variables and Endpoints: Age, sex, body mass index (BMI), marital status, occupation, underlying diseases, injury mechanism, injury site, vital signs at arrival, GCS, and ISS were the principal variables of the study. ISS was calculated based on the Abbreviated Injury Scale (AIS) (28, 29). AIS is a score from 1 to 6, rating the damage severity in nine predetermined body areas. However, ISS is computed by summing the AIS squares of the three most severe injuries in six regions (head or neck, face, thorax, abdomen or pelvic content, extremities or pelvic bone, and external parts) ranging from 1 to 75. If the AIS of a single damage is 6, ISS is considered 75. ISS > 15 is considered severe (30). GCS is also employed to assess the patients' mental status. GCS ≤8 represents coma status (30). The primary outcome of this study was hospitalization in the ICU among trauma patients referred to the ED.

Statistical Analysis: Categorical variables were displayed with counts and percentages. Mean and standard deviation (SD) were utilized to present continuous data. Quantitative discrete variables were also represented by the median and interquartile range (IQR). In order to compare the variables between the two groups, the chi-square test (qualitative-qualitative relationships) and Mann-Whitney U test (quantitative-qualitative relationships) were employed. P-value < 0.05 was considered significant. Finally, using multivariate logistic regression, independent factors related to these outcomes were determined. Statistically significant (P-value < 0.05 in univariate analysis) and also clinically important variables were considered eligible to enter the model. The method "Enter" was utilized to adjust the variables with each other. Hosmer and Lemeshow test was applied to assess the model's goodness-of-fit (GOF). The odds ratio (OR) along with the confidence interval (CI) and also P-value were reported as the main output of the model regarding each variable.

Results

From 2016 to 2021, 35173 trauma patients' data were recorded within the NTRI. Considering the inclusion and exclusion criteria, 23905 individuals entered the final analysis (Figure 1).

Of these, 2305 patients (9.6%) required intensive care, and 21600 (90.4%) were not referred to ICU. Demographic information, external cause and site of injury, vital signs, and trauma scores of the study population are summarized in tables 1 and 2.

Demographic Variables: The mean age of the study sample was 43.4 years (SD = 19.0), and 76.3% were men. In the ICU-admitted group, the mean age was 52.7 (SD = 22.9) years, and 71.7% were men (P < 0.001). Widowhood (12.3% vs. 4.7%, P < 0.001), being unemployed (49.0% vs. 33.8%, P < 0.001), and all preexisting comorbidities except infection (P < 0.001; in terms of cancer, P = 0.002) were notably more prevalent in ICU-admitted patients. Infection and BMI, even when categorized, did not show a significant relationship with ICU hospitalization (P = 0.102 and P = 0.083, respectively).

Trauma-Related Baseline Characteristics: About 26.1% of ICU-admitted patients and 46.6% of other participants were transported to the hospital by personal vehicles (P < 0.001). The most common external causes of trauma in both groups were road accidents followed by falls (P < 0.001).

Injuries to the head, face, neck, thorax, spine, abdomen, and lower extremities were more common in ICU-referred trauma patients. On the other hand, injuries to the upper limb or an unspecified site were less prevalent.

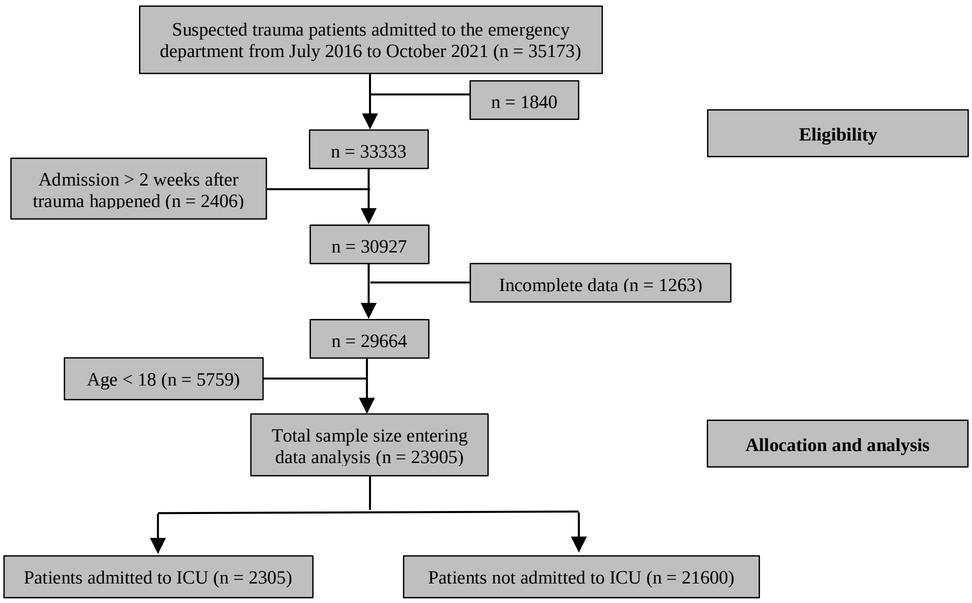

Figure 1. Flow chart of patients' recruitment protocol (ICU: Intensive care unit)

Triage Signs and Trauma Scores: Hypertension (HTN) (19.7% vs. 9.0%, P < 0.001), hypotension (4.2% vs. 1.3%, P < 0.001), tachycardia (7.9% vs. 2.1%, P < 0.001), bradycardia (1.1% vs. 0.3%, P < 0.001), hyperpnea (6.1% vs. 2.8%, P < 0.001), low O2 saturation (7.1% vs. 1.0%, P < 0.001), and high body temperature (7.2% vs. 3.0%, P < 0.001) were more prevalent in the ICU-admitted patients compared to the other group. Additionally, coma state (GCS ≤8) (8.0% vs. 0.2%, P < 0.001) and a severe injury (ISS > 15) (18.0% vs. 2.4%, P < 0.001) were more common among ICU-admitted participants.

Table 1. Patients' demographic characteristics, comorbidities, and cause of injury in either intensive care unit (ICU)-admitted group or non-ICU-admitted group (univariate analysis)

Variable	Total population (n = 23905)	ICU-admitted group (n = 2305, 9.6%)	Non-ICU-admitted group (n = 21600, 90.4%)	P-value*
Age (year) (mean ± SD)	43.4 (19.0)	52.7 (22.9)	42.4 (18.2)	< 0.001
Age > 55 (year) [n (%)]	6083 (25.4)	1047 (45.4)	5036 (23.3)	< 0.001
Gender [n (%)]				
Men	18245 (76.3)	1653 (71.7)	16592 (76.8)	< 0.001
Women	5660 (23.7)	652 (28.3)	5008 (23.2)	
Marital status [n (%)]				
Currently married	16260 (68.0)	1522 (66.0)	14738 (68.2)	< 0.001
Never married	6102 (25.5)	479 (20.8)	11170 (26.0)	
Widowed	1296 (5.4)	283 (12.3)	1046 (4.7)	
Divorced	247 (1.0)	21 (0.9)	240 (1.0)	
Occupation [n (%)]				
Employed	14492 (60.6)	1095 (47.5)	13397 (62.0)	< 0.001
Unemployed	8427 (35.3)	1129 (49.0)	7298 (33.8)	
Student	986 (4.1)	81 (3.5)	905 (4.2)	
BMI (kg/m2) (mean ± SD)	25.4 (3.9)	25.3 (4.1)	25.4 (3.9)	0.083
BMI ≥30 (kg/m2) [n (%)]	2548 (10.9)	222 (10.1)	2326 (11.0)	0.224
Transport to hospital [n (%)]				
Ground ambulance	12990 (54.3)	1678 (72.8)	11312 (52.4)	< 0.001
Personal car	10660 (44.6)	602 (26.1)	10058 (46.6)	
Other	255 (1.1)	25 (1.1)	230 (1.1)	
Cause of injury [n (%)]				
Road accident	10535 (44.1)	1157 (50.2)	9378 (43.4)	< 0.001
Falling	7080 (29.6)	906 (39.3)	6174 (28.6)	< 0.001
Penetrating injuries	3440 (14.4)	106 (4.6)	3334 (15.4)	< 0.001
Crushing injuries	1920 (8.0)	62 (2.7)	1858 (8.6)	< 0.001
Substance poisoning	177 (0.7)	15 (0.7)	162 (0.8)	0.597
Burn injuries	175 (0.7)	3 (0.1)	172 (0.8)	< 0.001
Gunshot	134 (0.6)	26 (1.1)	108 (0.5)	< 0.001
Comorbidities [n (%)]				
Cardiovascular system	2205 (9.2)	441 (19.1)	1764 (8.2)	< 0.001
Endocrine system	1263 (5.3)	229 (9.9)	1034 (4.8)	< 0.001
Psychological disease	561 (2.3)	95 (4.1)	466 (2.2)	< 0.001
CNS	445 (1.9)	89 (3.9)	356 (1.6)	< 0.001
Gastrointestinal system	253 (1.1)	51 (2.2)	202 (0.9)	< 0.001
Respiratory system	243 (1.0)	44 (1.9)	199 (0.9)	< 0.001
Genitourinary system	225 (0.9)	55 (2.4)	170 (0.8)	< 0.001
Cancer	50 (0.2)	12 (0.5)	38 (0.2)	0.002
Infection	12 (0.1)	3 (0.1)	9 (0.0)	0.102

*P-value < 0.05 is considered significant.
ICU: Intensive care unit; CNS: Central nervous system; BMI: Body mass index; SD: Standard deviation

Table 2. Patients' injury site, triage elements, and trauma scores in either intensive care unit (ICU)-admitted group or non-ICU-admitted group (univariate analysis)

Variable	Total population (n = 23905)	ICU-admitted group (n = 2305, 9.6%)	Non-ICU-admitted group (n = 21600, 90.4%)	P-value*
Injury site [n (%)]				
Head	3030 (12.7)	779 (33.8)	2251 (10.4)	< 0.001
Face	1140 (4.8)	190 (8.2)	950 (4.4)	< 0.001
Neck	433 (1.8)	56 (2.4)	377 (1.7)	0.019
Thorax	1057 (4.4)	275 (11.9)	782 (3.6)	< 0.001
Abdomen	736 (3.1)	174 (7.5)	562 (2.6)	< 0.001
Spine	1145 (4.8)	263 (11.4)	882 (4.1)	< 0.001
Upper limb	9518 (39.8)	412 (9106)	9106 (42.2)	< 0.001
Lower limb	10618 (44.4)	1127 (48.9)	9491 (43.9)	< 0.001
Unspecified	238 (1.0)	8 (0.3)	230 (1.1)	0.001
Triage signs [n (%)]				
SBP ≥140 (mmHg)	2372 (10.0)	449 (19.7)	1923 (9.0)	< 0.001
SBP < 90 (mmHg)	370 (1.6)	96 (4.2)	274 (1.3)	< 0.001
PR < 60 (/minute	84 (0.4)	26 (1.1)	58 (0.3)	< 0.001
PR > 100 (/minute)	625 (2.6)	180 (7.9)	445 (2.1)	< 0.001
RR > 20 (/minute)	730 (3.1)	136 (6.1)	594 (2.8)	< 0.001
O2 saturation < 90 (%)	263 (1.7)	121 (7.1)	142 (1.0)	< 0.001
Temperature > 37 (oC)	743 (3.4)	153 (7.2)	590 (3.0)	< 0.001
Trauma scores [n (%)]				
GCS ≤8	220 (0.9)	182 (8.0)	38 (0.2)	< 0.001
ISS > 15	877 (3.9)	396 (18.0)	481 (2.4)	< 0.001

*P-value < 0.05 is considered significant.
ICU: Intensive care unit; SBP: Systolic blood pressure; PR: Pulse rate; RR: Respiratory rate; GCS: Glasgow Coma Scale; ISS: Injury Severity Score

ICU Admission's Associative Factors: Variables augmenting ICU hospitalization risk included: age > 55 years (OR: 2.163, CI: 1.855-2.523), injuries due to falling from a height (OR: 2.163, CI: 1.037-1.398) and gunshot (OR: 2.806, CI: 1.451-5.425), underlying cardiovascular (OR: 1.318, CI: 1.099-1.580) or central nervous system (CNS) (OR: 1.403, CI: 1.029-1.914) disorders, injury to head (OR: 2.978, CI: 2.516-3.525), thorax (OR: 2.260, CI: 1.807-2.826), abdomen (OR: 3.995, CI: 2.990-5.338), spine (OR: 2.091, CI: 1.681-2.602), and lower extremities (OR: 1.225, CI: 1.046-1.434), hypotension (OR: 1.915, CI: 1.306-2.810), HTN (OR: 1.685, CI: 1.432-1.981), tachycardia (OR: 1.607, CI: 1.208-2.139), bradycardia (OR: 2.199, CI: 1.201-4.932), hyperpnea (OR: 1.809, CI: 1.340-2.444), low oxygen saturation (OR: 2.877, CI: 2.013-4.112), high body temperature (OR: 1.756, CI: 1.337-2.307), GCS ≤8 (OR: 18.019, CI: 10.718-30.293), and ISS > 15 (OR: 4.241, CI: 3.446-5.220). On the contrary, the upper extremity injury (OR: 0.496, CI: 0.419-0.587) was associated with less likelihood of ICU admission (Table 3).

Discussion

Due to the high prevalence of trauma, it is crucial to investigate potential risk factors leading to specifically associated outcomes such as mortality or ICU admission. Excessive ED crowds and extended delays in ICU access to patients can be dangerous for various reasons (22, 31, 32). Part of these hesitations might be due to the insufficient studies regarding predictive factors that can help in a trauma patient's rapid and accurate management. Despite the great matter of this issue, there are still a few comprehensive studies on patients with different types and mechanisms of trauma.

Table 3. Identifying risk factors for intensive care unit (ICU) admission in trauma referrals (unadjusted binary logistic regression)

Variable	OR	95th CI	P-value*
Age > 55 (year)	2.141	1.827-2.510	< 0.001
Gender (women)	0.935	0.793-1.102	0.422
Marital status (widowed)	1.238	1.157-1.325	< 0.001
Occupation (unemployed)	0.969	0.851-1.103	0.631
Transport to hospital (personal car)	0.718	0.620-0.830	< 0.001
Cause of injury (road accident)	2.795	1.721-4.540	< 0.001
Cause of injury (falling)	3.725	2.285-6.075	< 0.001
Cause of injury (penetrating injuries)	2.191	1.289-3.725	0.004
Cause of injury (crushing injuries)	1.722	0.974-3.044	0.062
Cause of injury (gunshot)	8.306	3.728-18.508	< 0.001
Cause of injury (burn)	1.316	0.231-7.508	0.757
Comorbidities (cardiovascular system)	1.298	1.081-1.560	0.005
Comorbidities (endocrine system)	0.958	0.767-1.196	0.707
Comorbidities (psychological disease)	1.131	0.842-1.519	0.413
Comorbidities (CNS)	1.325	0.971-1.809	0.076
Comorbidities (gastrointestinal system)	1.095	0.723-1.659	0.668
Comorbidities (respiratory system)	1.286	0.836-1.977	0.252
Comorbidities (genitourinary system)	1.305	0.870-1.958	0.199
Comorbidities (cancer)	1.028	0.406-2.605	0.953
Injury site (head)	2.956	2.498-3.498	< 0.001
Injury site (face)	0.989	0.782-1.251	0.926
Injury site (neck)	0.785	0.506-1.218	0.280
Injury site (thorax)	2.326	1.867-2.898	< 0.001
Injury site (abdomen)	3.315	2.494-4.407	< 0.001
Injury site (spine)	2.088	1.678-2.598	< 0.001
Injury site (upper limb)	0.521	0.441-0.615	< 0.001
Injury site (lower limb)	1.205	1.030-1.409	0.020
Injury site (unspecified)	0.423	0.124-1.438	0.168
SBP ≥140 (mmHg)	1.637	1.392-1.927	< 0.001
SBP < 90 (mmHg)	1.782	1.219-2.607	0.003
PR < 60 (/minute)	2.199	1.087-4.449	0.028
PR > 100 (/minute)	1.499	1.129-1.989	0.005
RR > 20 (/minute)	1.799	1.336-2.422	< 0.001
O2 saturation < 90 (%)	2.704	1.907-3.832	< 0.001
Temperature > 37o (C)	1.687	1.287-2.212	< 0.001
GCS ≤8	17.436	10.479-29.010	< 0.001
ISS > 15	4.203	3.420-5.164	< 0.001

*P-value < 0.05 is considered significant.
OR: Odds ratio; CI: Confidence interval; CNS: Central nervous system; SBP: Systolic blood pressure; PR: Pulse rate; RR: Respiratory rate; GCS: Glasgow Coma Scale; ISS: Injury Severity Score

This study aimed to determine the ICU admission risk factors comprehensively in trauma patients. However, reviewing the results of similar articles and comparing them with this essay is not without merit.

One of the most critical factors influencing the strength of a study is sample size. In this study, 23905 people were recruited, which is considered favorable compared to related investigations. Among the articles examining the relationship between trauma and ICU admission, only two studies had a larger sample size (23909 and 281522 patients, respectively). Haider et al. reviewed the United States (US) National Data System designed for more comprehensive purposes than trauma, unlike the NTRI (33). The sample size difference with the study of Lavoie et al. (34) is also minimal (4 patients). The rest generally contain fewer than 3000 individuals, which is much more subordinate than the study presented (35-39).

ICU admission rate in this study was computed 9.6%. Through other similar analyses of patients with different types of trauma, Kong et al. (38) reported a lower percentage (1.8%), and Haider et al. (33) and Lavoie et al. (34) declared a higher percentage (28.0% and 32.0%, respectively). Diverse factors can affect this noted discrepancy. The criteria for hospitalization of patients in the ICU may be distinct in different countries, and some are more cautious in this regard. Another factor is the age distribution of the participants. Perhaps in studies with a high ratio of ICU admissions, a higher percentage of older people entered, significantly altering the statistics. These can be confusing in comparative analysis between the two groups.

The main demographic variables commonly used in similar articles are age and gender. Another essential difference between this study and the others is that important baseline factors such as marital status, occupation, BMI, and underlying diseases were also examined. Following the complete analysis, age > 55 and widowed marital status were recognized as independent predictors of ICU hospitalization in trauma. Previous studies have already revealed the impact of age, but widowhood is the first to be raised (33). Of course, this could be stemmed from older people who are more likely to be widows, and the analysis may have been influenced by more senior age. However, the fact that even multivariate analysis did not eliminate the effect indicates that more attention should be paid to it. Regarding comorbidities, cardiovascular diseases (CVDs) were strongly associated with higher ICU admission rates. These interconnections cannot be easily justified. Further investigations still remain necessary.

The cause of trauma (or the mechanism of injury) is another important variable associated with trauma. The classifications mentioned in various studies are very numerous. The effect of injury mechanism on ICU hospitalization in trauma patients has been previously investigated, but no significant relationship has been observed (34, 36). On the other hand, an influential independent association was found in this study between road accidents, falling, penetrating injuries, and gunshots and the likelihood of ICU hospitalization. The gunshot had the most significant impact. According to these results, referring patients' injury mechanisms should be considered carefully when entering the emergency room.

One of the most critical elements affecting the major outcomes in trauma patients, including hospitalization in the ICU, is the injury site. Studies have demonstrated that head and spine damage can render higher mortality (35). Moreover, abdominal and thoracic harms increase ICU admission (36, 37, 39). The present study has also confirmed previous findings, especially regarding head injuries. However, there exists little evidence of lower and upper limb harm and their possible relation to trauma ICU admission. Interestingly, the current analysis revealed that patients with upper extremity injuries were less admitted to the ICU. There are high numbers of upper limb injuries which occur following low-energy traumas. In addition, according to the literature, there are less upper limb injuries which accompany abdominal and head or spinal traumas compared to lower extremity injuries (40-43). On the other hand, lower limb injuries are more likely to face the consequences (44). Damage to vital areas such as the pelvis and femur, which are at high risk of severe bleeding or death, could be the underlying cause of this finding.

Vital signs upon arrival at a trauma center can be an essential indicator in predicting subsequent care concerning the patients. Arterial blood pressure, pulse rate (PR) and RR, body temperature, and blood oxygen saturation are influential variables used in various ICU indices such as Acute Physiology and Chronic Health Evaluation II (APACHE) II or the Simplified Acute Physiology Score III (SAPS III) (45). This investigation found that high ICU admission rate was associated with hypotension, HTN, tachycardia, bradycardia, hyperpnea, and increased body temperature. Previous studies have declared the same results (17, 27, 30). However, they have focused more on trauma mortality rather than ICU admission, which has been assessed in a small number of articles (36, 37).

Several indices are utilized to assess the severity of injury in trauma patients. ISS and GCS are the two top trauma severity scores employed in the NTRI. The study results indicated that higher ISS and lower GCS were strongly associated with ICU admission. Numerous investigations have scrutinized the impact of these indices (36, 39). Lavoie et al. also concluded that the ISS was a strong predictor of ICU admission following receiver operating characteristic (ROC) analysis [area under the curve (AUC) = 0.843] (34). Moreover, low GCS (especially below 8) is also significantly associated with ICU hospitalization, proved in similar articles (33, 36, 38, 39).

As with other retrospective investigations, there was an unavoidable possibility of bias in this study. Selective bias might have occurred due to the incompleteness of the information regarding several registry participants, which inevitably rendered them useless. Some variables (especially comorbidities and, less commonly, the mechanism of injury) were subjective, which could increase the likelihood of recall bias. Obviously, accurate data collection in the NTRI and its standard protocol significantly reduced the occurrence of different biases but did not decrease it to zero.

Conclusion

ICU admission is an essential outcome in the evaluation of trauma patients. In this study, it was uncovered that older age, widowhood, injuries due to road accidents, falling, penetrating objects, and gunshots, underlying CVD, damage to the head, thorax, abdomen, spine, and lower extremities, hypotension, HTN, tachycardia, bradycardia, hyperpnea, low O_2 saturation, high body temperature, coma state, and very severe injury (ISS > 15) were directly related to this endpoint. In contrast, transport to the hospital (personal car) and upper extremity injury showed the opposite relationship. As a result, patients with one or more of these factors should be evaluated more carefully, and it must not be postponed if ICU admission is required.

Conflict of Interest

The authors declare no conflict of interest in this study.

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The institutional ethics committee has approved the study method and relevant ethical considerations (ethical code: IR.TUMS.SINAHOSPITAL.REC.1400.102). All methods were performed in accordance with the relevant guidelines and regulations. Informed consent was obtained from all participants or their legal guardian. Consent for publication is not applicable for the present study.

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