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Investigating Factors Affecting Mortality Due to Spinal Cord Trauma in Patients Admitted to the Intensive Care Unit

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ABSTRACT

Objectives: This study was conducted to investigate the factors affecting mortality due to spinal cord trauma in patients admitted to the intensive care unit (ICU).
Methods: This study was conducted in a group of patients who were admitted to the ICU with a Traumatic Spinal Injuries (TSI) diagnosis. The researcher started sampling by assessing the documents of the patients hospitalized in the ICU, and the diagnosis of TSI was confirmed for them. Besides, utilizing a researcher-made checklist, factors affecting the mortality of patients were identified. The data were analyzed using the SPSS software version 16. $P<0.05$ was considered statistically significant.
Results: About 412 (64.2%) patients were men, about 213 (33.2%) of the patients had GCS between 3-8 grade. There were injuries in the pelvis area. Moreover, there was a significant relationship between GCS score status and the number of injury follow-ups in addition to TSI. Therefore, the mortality rate was higher in patients who had lower GCS (Odds ratio=2.32, $p<0.001$). There was also a significant relationship between the number of injuries and the mortality rate, and patients who had multiple traumas had a higher mortality rate. Besides, a significant relationship was observed between the complications caused by trauma, including cerebrovascular accident, cardiac arrest, acute respiratory distress syndrome (ARDS), pneumonia, and the mortality of patients hospitalized in the SICU ($p<0.05$)
Conclusion: The patients' mortality was influenced by factors such as their level of consciousness, the number of traumas caused in the spinal cord, and the occurrence of comorbidities such as cerebrovascular accident, cardiac arrest, ARDS, and pneumonia. Therefore, it is necessary to take the essential measures to reduce these complications.

Keywords: Mortality; Spinal cord trauma; Intensive care unit.

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Introduction

Trauma includes various types, of which Traumatic Spinal Injuries (TSI) is one of the most sensitive types [1-4]. According to the available statistics, it is estimated that there are about 768,473 new traumas annually, and the international incidence of trauma is estimated between 16-64/100,000 [5, 6]. Among the causes of TSI, road accidents and falling from a height can be mentioned as the most important causes. Thus, a significant amount of TSIs often lead to irreversible complications, including chronic disability and death [7-9].

The progress made in the field of trauma care, as well as care related to the intensive care unit (ICU), has significantly reduced the mortality rate of trauma patients [10, 11]. However, depending on the anatomical location of the trauma, the severity of the trauma, and also the age of the individuals, the mortality of the patients could be different. Hence, in the elderly group, due to the presence of co-morbidities, the risk of co-morbidities is several times higher and the decision to follow surgical or conservative methods to treat the disease is often difficult [12, 13].

On the other hand, in the group of children, trauma is considered one of the most important causes of death, and every year about 1,000,000 children die due to trauma. In fact, low- and middle-income countries (LMICs) account for the highest number of traumatic injuries in the group of children, and about 95% of injuries related to children in the world occur in these countries[14, 15]. Various factors, including complications caused by the disease, are effective in TSI mortality [16, 17]. In addition, if the patient is hospitalized in the ICU, these complications might be doubled due to the special conditions of the ICU. Therefore, delirium and pressure ulcers are among the complications caused by the hospitalization of the patient in these departments [18]. TSI causes short-term and long-term damages. Complications include fever, infection, delirium, disability, spinal post-traumatic deformity (SPTD), and others [19, 20].

SPTD is a complication of TSI that might leave many psychological and physical complications for patients. In fact, a physical change has occurred in the body; nevertheless, the extent of the change and the modifications it has caused in the body are diverse and may cause a wide range of traumatic injuries and complications [21]. Surgical site infection (SSI) is another complication caused by trauma or spinal surgery. Infection may occur due to the physical problems of the patient or the performance of the treatment team, the prevalence of which has been reported between 1- 9% in spine surgeries [19, 22]. SSI might necessitate the patient's long-term usage of injectable antibiotics, increase the duration of the patient's hospital stay, and ultimately lead to an increase in the patient's hospitalization costs. For SSI, various factors were identified, including prolonged surgery time, blood loss of at least more than one liter during surgery, and long-term hospitalization of the patient [22-24]. In this way, this study was conducted to investigate the factors affecting mortality due to spinal cord trauma in patients admitted to the ICU.

Materials and Methods

The present study was conducted in a group of patients who were admitted to the ICU, with a TSI diagnosis.

Inclusion Criteria

The inclusion criteria were age between 18 and 65 years, a definitive diagnosis of TSI for the patient based on the attending physician's assessment and records in the patient's file, and the presence of CT scan and MRI results that confirmed TSI.

Exclusion Criteria

The exclusion criteria were hospitalization for late complications of TSI, incomplete information on the type of TSI, unknown patients (failure to provide accurate age and other details), patient referral, and patient death outside of the hospital.

This study was approved by the Ethics Committee of Ilam University of Medical Sciences (IR. MEDILAM.REC.1402.022). After obtaining permission from the corresponding officials of the university, the sampling procedure was conducted.

The researcher began the sampling procedure by reviewing the records of patients hospitalized in the ICU who had a confirmed diagnosis of TSI and satisfied the eligibility requirements. In addition, the researcher's checklist was used to complete factors affecting the patients' death.

The existing checklist includes items: sex, age, ICU outcome, length of ICU stay, Glasgow coma score (GCS), number of injuries on cranial CT, number of injury follow-ups in addition to TSI, injury follow-up -up in addition to TSI, and mechanism of trauma. The evaluated complications included acute kidney injury, drug/alcohol withdrawal, cerebrovascular accident, decubitus ulcer, unplanned intubation, urinary tract infection, pulmonary embolism, myocardial infarction, deep vein thrombosis, sepsis, cardiac arrest, ARDS, and pneumonia.

The researchers collected the data for this study, which was then entered into SPSS software version 16, and analyzed using descriptive and analytical tests such as mean, standard deviation, independent t-test, ANOVA, linear regression, and other related tests.

Results

Table 1 revealed that 412 (64.2%) of the patients were male, and 213 (33.2%) of the patients had the GCS between 3-8 grade. There were injuries in the Pelvis area with 266 (41.4%) caused by road traffic accidents.

Table 1. Demographic characteristics of patients diagnosed with TSI

Variable		**Total N (%)**	**Discharge**	**Death**	***P*-value**
Sex	Male	412 (64.2)	381 (65.2)	31 (53.4)	0.02
	Female	230 (35.8)	203 (34.8)	27 (46.6)	
Age (years)	Mean±SD	39.28 (9.45)	40.2 (9.41)	39.19 (9.45)	0.000
ICU outcome	Discharge	584 (91)	-	-	-
	Death	58 (9)	-	-	
Glasgow coma score (GCS)	3-8	511 (79.6)	459 (78.6)	52 (89.7)	0.000
	9-12	96 (15)	90 (15.4)	6 (10.3)	
	13-15	35 (5.5)	35 (6)	0 (0)	
Number of injury follow-ups in addition to TSI	None	102 (15.9)	98 (16.8)	4 (6.9)	0.04
	One	282 (43.9)	272 (46.6)	10 (17.2)	
	Two	218 (34)	198 (33.9)	20 (34.5)	
	Three	40 (6.2)	16 (2.7)	24 (41.4)	
Injury follow-up in addition to TSI	Thorax	110 (17.1)	100 (17.1)	10 (17.2)	0.35
	TBI	179 (27.9)	159 (27.2)	20 (34.5)	
	Pelvis	213 (33.2)	194 (33.2)	19 (32.8)	
	Orthopedics	100 (15.6)	93 (15.9)	7 (12.1)	
	Abdomen	40 (6.2)	38 (6.5)	2 (3.4)	
The mechanism of trauma	Road traffic crashes	266 (41.4)	242 (41.4)	24 (41.4)	0.59
	Fall	213 (33.2)	192 (32.9)	21 (36.2)	
	Assault/violence-related	144 (22.4)	132 (22.6)	12 (20.7)	
	Other causes	19 (3)	18 (3.1)	1 (1.7)	

Table 2. Univariate model of prognostic factors for mortality among TSI patients admitted to the ICU

Variable	**Odds ratio**	**b**	**OR (95% CI) for mortality**		***P*-value**
			Lower	**Upper**	
Sex	0.61	-0.49	0.35	1.05	0.07
Age	0.98	-0.01	0.96	1.01	0.43
Glasgow coma score (GCS)	2.32	0.8	1.07	4.98	<0.001
Number of injury follow-ups in addition to TSI	0.21	-1.52	0.14	0.32	<0.001
Injury follow-up in addition to TSI	1.15	0.14	0.90	1.47	0.25
The mechanism of trauma	1.06	0.06	0.77	1.46	0.7

Table 3. Predictors of mortality among abdominal trauma patients

Variables	**N (%)**	**Odds ratio**	**b**	**OR (95% CI) for mortality**		***P*-value**
				Lower	**Upper**	
Acute kidney injury	55 (8.6)	0.35	-1.02	0.08	1.5	0.16
Drug/alcohol withdrawal	7 (1.1)	0.000	-18.9	0.000	-	0.999
Cerebrovascular accident	107 (16.7)	2.74	1.01	1.51	4.97	0.001
Decubitus ulcer	75 (11.7)	1.04	0.041	0.45	2.38	0.92
Unplanned intubation	100 (15.6)	0.99	-0.005	0.47	2.09	0.99
Urinary tract infection	52 (8.1)	1.64	0.49	0.70	3.83	0.25
Pulmonary embolism	60 (9.3)	1.37	0.31	0.59	3.18	0.45
Myocardial infarction	7 (1.1)	4.13	1.42	0.74	21.8	0.09
Deep vein thrombosis	9 (1.4)	2.94	1.08	0.59	14.51	0.18
Sepsis	33 (5.1)	1.41	0.34	0.48	4.18	0.52
Cardiac arrest	65 (10.1)	2.29	0.83	1.12	4.68	0.02
ARDS	40 (6.2)	2.76	1.01	1.20	6.31	0.01
Pneumonia	62 (9.7)	2.13	0.75	1.01	4.46	0.04

There was a significant relationship between GCS score status and the number of injury follow-ups in addition to TSI. As a result, patients with lower GCS had a higher mortality rate (Odds ratio=2.32, $p<0.001$). There was also a significant relationship between the number of injuries and the mortality rate, with patients who experienced multiple traumas having a higher mortality rate (Table 2).

The findings indicated a statistically significant correlation ($p<0.05$) between the death of patients admitted to the Intensive Care Unit (ICU) and the complications resulting from trauma, such as cerebrovascular accident, cardiac arrest, ARDS, and pneumonia (Table 3).

Discussion

The purpose of this study was to investigate the variables that affect patients' death from spinal cord injuries who were hospitalized in the ICU. The findings showed a significant relationship between GCS score, number of injuries, and TSI. In other words, those with lower GCS had a higher death rate. The GCS score might be somewhat correlated with both the patient's rate of recovery and mortality. In a study by Morgan, patients with GCS of 14-15 had the lowest mortality rate (2%), and the best recovery rate (22%). Those with GCS of 9-13 had a mortality rate of 3% and recovery of 4%. Those with GCS of 3-8 had the highest mortality rate (5%) and the worst recovery (2%) [25]. The causes of TSI determine the number of injuries that occur in TSI. Epidemiologically, more than one-third of TSI mechanisms, especially in late life, are due to falls. In recent years, movement restrictions in the era of COVID-19, road traffic accidents, violent incidents, and violence have also been mentioned as common mechanisms of TSI [26]. In the present study, the most trauma-causing mechanisms were road traffic accidents, falls, and violence, respectively. The mean age of the research samples (39.28±9.45) indicated that being young in the samples of the present research was a factor in this matter.

Based on the findings of this study, there was a significant relationship between trauma-related complications such as cerebrovascular accident, cardiac arrest, ARDS, and pneumonia with the mortality of patients hospitalized in the SICU. Sex was one of the effective variables in the development of complications and death from TSI. In an epidemiologic study by Mohammad Ismail *et al.,* using a large national trauma database of more than 40,000 surgically managed TSI cases, female sex was found to be associated with a significantly lower risk of in-hospital morbidity and mortality [27]. However, in the present study, there was no correlation between sex and TSI-related mortality. Nevertheless, there was no relationship found in this investigation between sex and death from TSI. The methods used to create TSI, the number of samples, and the place and time of the conducted research can all be factors in the discrepancies between this study and the previously referenced one.

The results showed a greater death rate in individuals with pneumonia, which was statistically significant ($p=0.04$). According to research by Detsky *et al.,* in which sepsis, respiratory failure, and non-emergency surgeries were the most prevalent initial diagnoses for patients admitted to the ICU, half of the patients admitted to the intensive care unit (ICU) died, and a third of the patients returned to their normal lives [28]. In the study by Li *et al.,* in the group of patients with pneumonia, factors such as dialysis, and chronic heart failure were considered as the causes of death of patients in the hospital and ICU departments. Factors such as history of malignancy, immunocompromise, and inotropes/vasopressors did not have a significant effect on the mortality of patients [29]. In the study of Rodriguez *et al.,* it was shown that pneumonia affected the patients' mortality [30]. According to the findings of a study by *Valley et al.,* pneumonia was a risk factor for mortality, and 14.8% of ICU patients, and 20.5% of normal patients died [31]. Indeed, individuals admitted to special departments may die as a result of hospital-acquired pneumonia, which occurs during mechanical ventilation and tracheal intubation [32].

According to the findings, cardiac arrest has also been one of the factors affecting the mortality of patients. In the study of De Jong *et al.,* the 28-day mortality rate in patients admitted to the ICU was 31.2%. Furthermore, the mortality rate in intubated patients who experienced cardiac arrest was higher than in other patients. In fact, if cardiac arrest was accompanied by intubation and hospitalization of the patient in a special ward, it was considered a 28-day mortality and one of the 40 causes of immediate death of patients [33].

This study demonstrated that there was no correlation between acute kidney injury and the mortality of patients. While in the study of Li *et al.,* dialysis was a risk factor in the mortality of patients admitted to the ICU. One explanation for the aforementioned discrepancy was the different study populations. The patients in Li's study were from the internal group, whereas those in the present study belonged to the surgical group [34].

The limitations of the present study were that this study was conducted at a specific time and place and on a limited number of patients with TSI. The strengths of this study were considering the major factors affecting TSI mortality in the researcher's checklist and analyzing them. The results of this study were comparable to those of analytical and epidemiological studies. In addition, the findings of this research could be used in systematic reviews and meta-analyses.

Given that the death rate of patients has been impacted by variables such as the state of consciousness, the number of traumas caused in the spinal cord, and the presence of complications including cerebrovascular accident, cardiac arrest, ARDS, and pneumonia, it is imperative to take the essential measures to reduce these complications.

Declaration

Ethics clearance and consent to participate: The current study was conducted after approval by the Ethics Committee (IR.MEDILAM.REC.1402.022).

Consent for publication: All authors have expressed their consent to the publication of this study.

Conflict of Interest: The authors declared that there was no conflict of interest.

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Authors' Contribution: Study concept and design: HM, AE, SS, KK, MO, AV; acquisition of data: HM, AE, SS, KK, MO, AV; analysis and interpretation of data: HM, AE, SS, KK, MO, AV; drafting of the manuscript: HM, AE, SS, KK, MO, AV; critical revision of the manuscript for important intellectual content: HM, AE, SS, KK, MO, AV; statistical analysis: HM, AE, SS, KK, MO, AV; administrative, technical, and material support: HM, AE, SS, KK, MO, AV; study supervision: HM, AE, SS, KK, MO, AV.

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