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Original Article

Assessment of Readmissions Factors in Military Casualties

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Abstract

Background: Identifying significant contributors to an extended stay in the hospital and readmission rate is of great importance in military settings.

Methods: The present study investigated the factors associated with multiple readmissions and total stay among patients with combat injuries. The data were collected from military personnel (N=775) with combat-related injuries sustained between 2014 and 2019. The data included the pattern and mechanism of injury, Abbreviated Injury Scale (AIS), injury severity score (ISS), primary and subsequent treatments and procedures, source of admission, hospital care unit, and the length of stay in the hospital. The association of the variables of interest with multiple readmissions and total readmission days were assessed by logistic regression.

Results: There was a significant relationship between multiple readmissions and total days and LOS, max AIS, ISS, side effects, and blood transfusion. Among the variables influencing multiple readmissions, ISS>24 had the highest risk.

Conclusion: A longer LOS within the index admission and its associated factors put patients at risk of multiple and more extended readmission events. The outcomes imply that patients with more severe injuries may require higher-quality care for longer durations as part of the initial hospital inpatient stay. This may motivate more effective management of combat-related injuries and the associated medical costs.

Keywords: Readmissions, Military, Casualties.

Introduction

During the past decades, along with the development and use of increasingly more dangerous weapons in wars, some advances in military medical care have led to life-saving treatments and better outcomes for combat-related injuries[1]. Management of traumatic combat injuries is primarily focused on reducing casualties. Over time, it may cause long-term prognosis, morbidity, and survivors' quality of life after the initial discharge from the hospital. There is a need to develop new strategies to improve prognosis and reduce morbidity experienced by wounded military personnel. These new strategies necessitate a careful assessment of the quality of medical care received during the first admission, identifying factors adversely impacting this quality, and designing medical and nursing interventions, which are crucial for developing good-quality services.

Regarding quality assessment, various indices have proved helpful in both civilian and military settings, including the length of the first stay in the hospital (LOS), experienced side effects, and readmission rate [2,3]. The first index, LOS, is widely used to evaluate the degree of efficiency of hospital care[4,5]. Many incentive schemes have been introduced to encourage hospitals to decrease LOS[5]. However, significant reduction plans should be implemented cautiously, as rapid hospital discharge before ensuring the patient's medical stability might increase readmission rates in the long run[4]. This complicates the justification of interventions for considerably shortening LOS. On the other hand, the readmission rate provides a more promising index of the quality of hospital care[5]. By definition, readmission is a hospital admission event within at least one month of the initial admission[6]. Readmissions are common[7] and are more likely to be associated with poor quality of hospital care[8]. The readmission rate is also deemed necessary from an economic standpoint[9]; readmissions highly utilize hospital financial resources and may place an additional cost burden on patients and their families[4,7]. Furthermore, they can affect other members of society by preventing them from receiving their required hospital care. Consequently, a high readmission rate is also a cause for concern in military settings. Many military health providers worldwide set a goal to reduce the overall rate of readmission events [10]. There is a body of research about readmission and its associated factors for trauma patients in civilian practice. However, as civilian and military trauma injuries are entirely different based on injury patterns, the complexity of wounds, and pathophysiologic consequences, such data may not be helpful in the military setting[11]. Readmission events in military practice may correspond to various independent variables, which can be analyzed using statistical methods. Thus, war wounds should be primarily investigated and understood in terms of epidemiology, characterization, and mechanism of injury. A full description of the medical, surgical, and nursing needs of wounded military personnel during index admission and their possible re-hospitalization, as well as the analysis of this information, might provide a solid basis for comparing patient groups. Such assays may help identify the subgroups that are more susceptible to multiple readmissions, discover the main contributors to readmission, and assist modern hospital systems in addressing these issues.

Historically, little published information is available about the epidemiology of injuries sustained in combat [8,12,13], and little is known about the main contributory factors in military re-hospitalization. To our knowledge, such resources are scarcely available for wars in the Middle East. Thus, given the importance of identifying significant contributors to readmission in the military setting, we investigated the factors associated with multiple readmissions and total days of readmission among patients with traumatic combat injuries for the first time in Iran. Identifying these factors will lead to better strategies for meeting particular patient needs and helping patients recover fully. Therefore, in addition to reducing the total number of readmission events by preventing potentially avoidable readmissions, patients' quality of life can be improved. This study presents a description and analysis of the results of investigating readmission events among wounded military personnel at a military hospital in Iran by performing a logistic regression analysis. It was assumed that the number of readmission events and the total days of readmission might be influenced by factors such as the pattern and mechanism of injury, required treatments and procedures, and LOS.

Methods

Study population

This study was conducted in a military hospital in Iran. The data were collected from military personnel with combat-related injuries sustained between 2014 and 2019 who had been transferred to the hospital for receiving initial care. The patients were then followed up for a year in terms of readmission. The data, including the demographic information, the year of admission event, medical history (comorbidities categorized based on the International Classification of Disease, 10th Revision, Clinical Modification [ICD-10-CM] codes)[14], information about trauma injuries and hospital care, discharge disposition, and possible readmissions, were extracted from the patient's medical records and collected through the ongoing observational cohort study. The data about trauma injuries and hospital care included the pattern and mechanism of injury, injury severity score (ISS), Abbreviated Injury Scale (AIS), primary and subsequent treatments and procedures (such as an operation), source of admission (such as the emergency room), experienced side effects, hospital care unit (such as the critical care unit), and the LOS. The collected data on readmissions included the reason for subsequent admission(s), the number of total readmission events, the LOS during readmission, the relationship between the first readmission and the index admission (if any), and the interval between the first readmission and the index admission. The hospital's Institutional Review Board and the associated medical sciences university approved this study.

We determined readmissions if they occurred within one year from the date of discharge from the index admission. Admissions more than a year after an index admission discharge date were not regarded as readmission. Furthermore, the first admission events were included in the study only if there was at least one other admission event during the follow-up period, i.e., a year. The index admissions were excluded if the patient was referred to another hospital or passed away during the follow-up period.

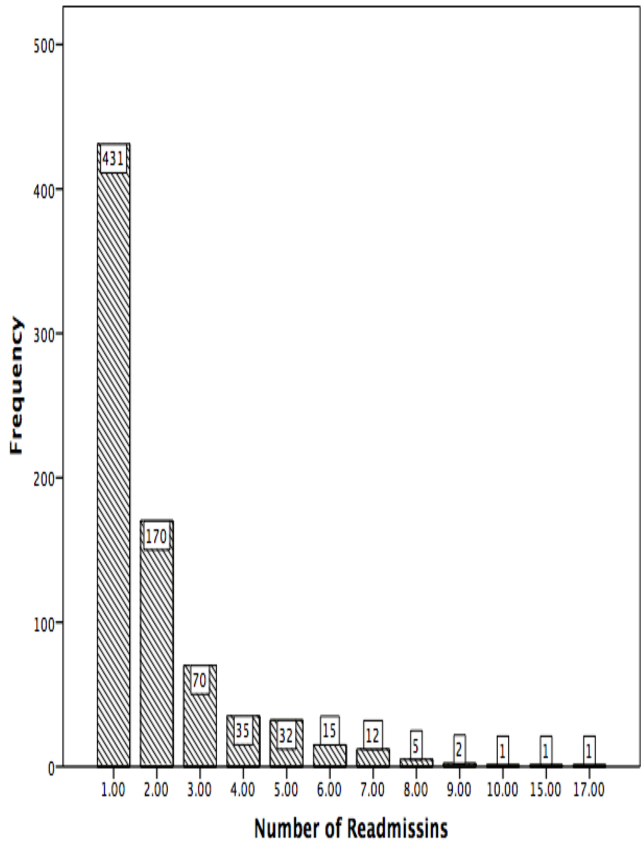
Based on the definition provided by the Association for the Advancement of Automotive Medicine, the AIS is “an anatomically based, consensus derived, global severity scoring system that classifies an individual injury by body region according to its relative severity on a 6-point scale (1=minor and 6=maximal)” (15). The part of the body that received the maximum AIS was considered the injured part of the patient’s body. The ISS is an anatomical scoring system that yields an overall score for patients who have multiple injuries (16). Moreover, the LOS was defined as the number of days from patient admission or readmission until discharge. It was calculated as the time of discharge minus the time of readmission in hours divided by 24. In addition, the total readmission days were calculated by adding the number of days spent in the hospital during each readmission event. The type of trauma was defined as penetrating, blunt, and other types. The mechanism of trauma was also defined as fragments from explosive munitions, bullets fired by a gun, blasts, burns, and others. The definition of other independent variables was obvious.

Statistical analysis

The data of categorical variables are given as numbers and percentages, and continuous variables are presented as mean±SD. The association of variables of interest with multiple readmissions and total readmission days was investigated using logistic regression. Regarding the number of readmissions and total readmission days, the patients were classified into two categories: patients with a single readmission and those with multiple readmissions, and patients with 1-7 days (s) and those with >7 days of re-hospitalization, respectively. In terms of categorical predictors with more than two levels, one of the subgroups was taken as the reference group with which the other groups were compared. A Pearson chi-square contingency table analysis was performed to test the relationships among qualitative variables. All the statistical analyses were performed in SPSS for Windows, version 11.5 (IBM, Armonk, NY), and two-tailed probability values of <0.05 were deemed statistically significant.

Result

After applying the exclusion criteria, 775 male patients were enrolled. Among these, 431 patients had a single readmission, while the rest, i.e., 344, experienced more than one readmission event within a year. The frequency of patients based on the number of readmission events is given in Graph 1.



Graph 1: Frequency of patients based on the number of readmission events

The mean age of the patients was 27.99±7.55 years. Moreover, 166 patients were Iranian (21.42%) whereas 609 had other nationalities (78.58%). Of the 775 patients enrolled, only two had a positive history of addiction, and 10 patients were current smokers. The number of patients admitted in 2014, 2015, 2016, 2017, 2018, and 2019 was 81, 277, 233, 141, 36, and 7, respectively. In the vast majority of the final cohort of patients, no comorbid condition was reported (N=757), and only 2.33% demonstrated 1-3 comorbid condition(s).

The most common reason for readmission event number 1-7 was overall wound infection, while the second most prevalent cause of hospitalization differed among readmission groups. Table 1 presents detailed data about the reason for the readmission event number 1-7. For the eighth readmission event, the patients were frequently admitted because of pain, but the common cause of re-hospitalization 9-15 was bedsores (data not shown in the table as the number of patients was <10 in each group). Furthermore, readmission events mainly occurred without any previous medical planning. Almost all the readmissions happened because patients suffered from either additional or prolonged complications resulting from the primary trauma injury that had been received in combat. Table 2 presents information about the planning status of each readmission event, and Table 3 expresses the relationship between the index admission and the next readmissions.

Three hundred seventy-three patients were readmitted to the hospital within less than a month. Also, 221, 78, 62, and 41 cases were referred to the hospital between 1-3, 3-6, 6-12 months, and one year after the index admission. Table 4 lists the data about the reason for the index admission categorized based on the interval between the first and second admissions explained above.

Regarding the LOS, the average length of hospitalization during the index admission was 9.48±12.07 days, and 442 patients stayed less than a week. t 2 displays the LOS for the index admission among all the participants and compares the frequency of each LOS subcategory between patients with single readmission and those with multiple readmissions. The number of patients in the group of multiple readmissions outweighed those in the single readmission group only in the subgroup of 8-30 days of LOS. For the first readmission event, the number of patients hospitalized 1-6 days before discharge reached 603. Table 7 presents detailed information on the LOS during the first readmission event in the entire sample.

In addition, most investigated combat-related injuries were penetrating (N=639, 82.5%), followed by blunt (N=97, 12.5%). Most of these injuries were caused by fragments from explosive munitions rather than bullets fired by a gun. The most injured part of the body was the extremities (N=360, 46.5%), followed by the head and neck (N=175, 22.6%) and the abdomen and pelvis (N=106, 13.7%), in that order. Overall, patients more frequently had a maximum AIS of 4 (N=332, 42.8%), followed closely by a score of 5-6 (N=298, 38.5%).

Logistic regression was performed to study the relationship between the number of comorbidities, the type and mechanism of trauma, the most active part of the body, LOS, maximum AIS, ISS, the type of operation (if any), patients' need for blood transfusion, side effects (all in terms of the index admission), ICU stay, and the dependent variables of interest. There was no significant relationship between the number of comorbidities, the type and mechanism of trauma, ISS, the most active part of the body, the type of operation, side effects, and ICU stay and multiple readmissions (data not shown). However, at least in one subcategory, the other predictors showed a statistically significant association with multiple readmissions. Table 6 gives the regression analysis results in terms of the odds ratio, P-value, and confidence interval. Moreover, total readmission days were associated with some of the above-mentioned independent variables, including the LOS, the type of trauma, the most active part of the body, maximum AIS, ISS, patients' need for blood transfusion, and side effects. Table 7 summarizes these results.

Table 1: The reason for readmission for readmission numbers 1-7th.

Reason / Number of Readmissions	1	2	3	4	5	6	7	Sum in 1-7 th Readmission	Sum in all Readmission Groups[A]
Wound infections	101(13)	50(15.2)	31(18.8)	18(18.6)	14(21.2)	8(25)	6(28.6)	230	232
Gastrointestinal	25(3.2)	11(3.3)	4(2.4)	3(3.1)	2(3)	0(0.0)	0(0.0)	45	45
Amputation stump complications	14(1.8)	7(2.1)	5(3)	3(3.1)	1(1.5)	1(3.1)	0(0.0)	31	31
Movement restrictions	64(8.3)	27(8.2)	14(8.5)	6(6.2)	2(3)	1(3.1)	1(4.8)	115	115
Deformity in head and neck	63(8.1)	31(9.4)	17(10.3)	12(12.4)	9(13.6)	7(21.9)	4(19)	143	143
After care for surgery	10(1.3)	5(1.5)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	15	15
Respiratory	7(0.9)	2(0.6)	1(0.6)	1(1)	1(1.5)	0(0.0)	0(0.0)	12	12
Ophthalmic	13(1.7)	7(2.1)	3(1.8)	2(2.1)	2(3)	0(0.0)	0(0.0)	28	28
New trauma	18(2.3)	5(1.5)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	23	23
Graft	32(4.1)	13(4)	8(4.8)	5(5.2)	2(3)	0(0.0)	0(0.0)	60	60
Hearing	24(3.1)	8(2.4)	3(1.8)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	35	35
Foreign Body	52(6.7)	20(6.1)	9(5.5)	3(3.1)	2(3)	0(0.0)	0(0.0)	86	86
Osteomyelitis	6(0.8)	2(0.6)	2(1.2)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	10	10
Urinary	8(1)	5(1.5)	3(1.8)	2(2.1)	2(3)	0(0.0)	0(0.0)	20	20
Closure of ostomi	18(2.3)	7(2.1)	4(2.4)	3(3.1)	2(3)	1(3.1)	0(0.0)	35	35
Bedsore	15(1.9)	6(1.8)	4(2.4)	3(3.1)	3(4.5)	2(6.3)	2(9.5)	35	46
Deep vein thrombosis (DVT)	7(0.9)	5(1.5)	3(1.8)	3(3.1)	3(4.5)	1(3.1)	1(4.8)	23	23
Laryngopathy	2(0.3)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	2	2
Neurologic	6(0.8)	4(1.2)	2(1.2)	1(1)	0(0.0)	0(0.0)	0(0.0)	13	13
Cardiologic	2(0.3)	2(0.6)	1(0.6)	1(1)	1(1.5)	1(3.1)	1(4.8)	9	9
Surgical device remove	70(9)	19(5.8)	9(5.5)	5(5.2)	5(7.6)	3(9.4)	2(9.5)	113	114
Pain	75(9.7)	34(10.3)	18(10.9)	14(14.4)	9(13.6)	4(12.5)	3(14.3)	157	161
Non-union of fracture	64(8.3)	19(5.8)	7(4.2)	1(1)	0(0.0)	0(0.0)	0(0.0)	91	91
Vascular	8(1)	2(0.6)	1(0.6)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	11	11
Psychiatric	34(4.4)	23(7)	9(5.5)	7(7.2)	5(7.6)	2(6.3)	0(0.0)	80	80
Wound unhealing	28(3.6)	12(3.6)	7(4.2)	4(4.1)	1(1.5)	1(3.1)	1(4.8)	54	54
Hernia	9(1.2)	3(0.9)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	12	12
Total	775(100)	329(100)	165(100)	97(100)	66(100)	32(100)	21(100)	8(100)	---

Reason: the reason for the first readmission; Interval: the interval between the index admission and the first readmission; All data reported by N (%) except for A reported by N only; Sum in all readmission groups: readmissions 1-15th.

Table 2: Readmission condition for each readmission.

	Readmission Condition		
	Planned N (%)	Unplanned N (%)	Total N (%)
Number of readmission			
1	231(29.8)	544(70.2)	775(100)
2	101(30.7)	228(69.3)	329(100)
3	44(26.7)	121(73.3)	165(100)
4	24(24.7)	73(75.3)	97(100)
5	18(27.3)	48(72.7)	66(100)
6	8(25)	24(75)	32(100)
7	4(19)	17(81)	21(100)
8	1(12.5)	7(87.5)	8(100)
9	0(0.0)	3(100)	3(100)
10	1(50)	1(50)	2(100)
11	0(0.0)	1(100)	1(100)
12	0(0.0)	1(100)	1(100)
13	0(0.0)	1(100)	1(100)
14	0(0.0)	1(100)	1(100)
15	0(0.0)	1(100)	1(100)

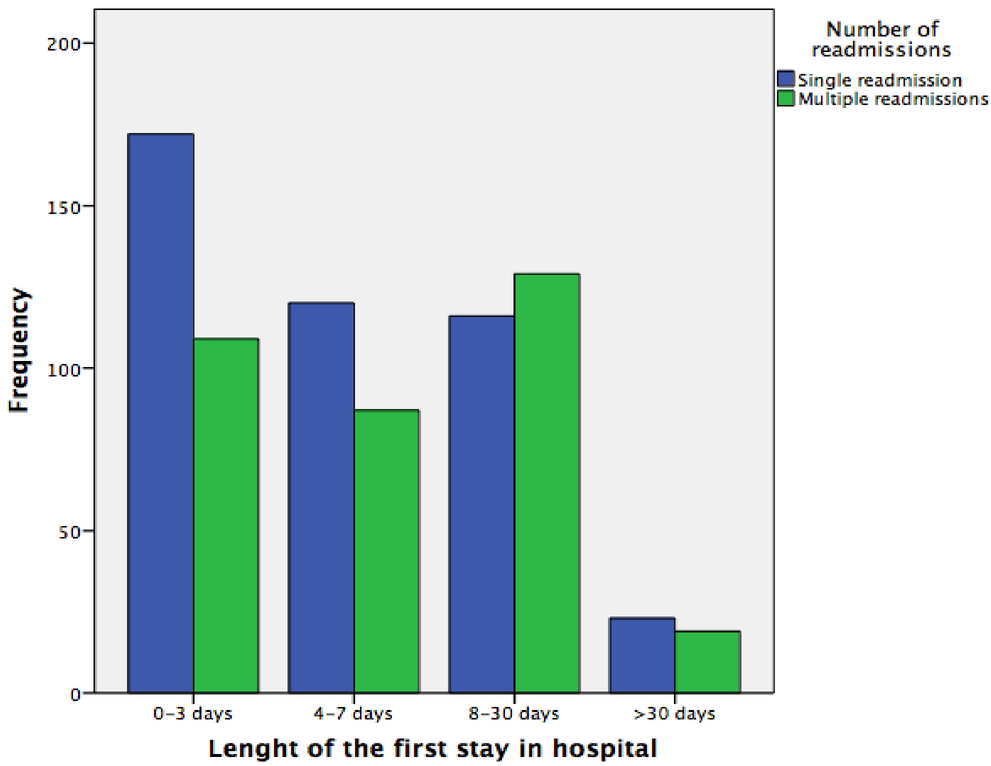
Table 3: Relation of readmission to the index admission among all readmission groups.

	Relationship		
	Primary injury complications N (%)	Unrelated to first admission N (%)	Total N (%)
Number of readmission			
1	739(95.4)	36(4.6)	775(100)
2	313(95.12)	16(4.88)	329(100)
3	161(97.57)	4(2.43)	165(100)
4	92(94.8)	5(5.2)	97(100)
5	63(95.45)	3(4.55)	66(100)
6	29(90.62)	3(9.38)	32(100)
7	19(90.48)	2(9.52)	21(100)
8	7(87.5)	1(12.5)	8(100)
9	3(100)	0(0.0)	3(100)
10	2(100)	0(0.0)	2(100)
11	1(100)	0(0.0)	1(100)
12	1(100)	0(0.0)	1(100)
13	1(100)	0(0.0)	1(100)
14	1(100)	0(0.0)	1(100)
15	1(100)	0(0.0)	1(100)

It seems that a patient who stayed 8-30 days in the hospital for initial care had a 1.75-time higher chance for multiple readmissions than a patient who stayed <3 Days during the index admission. Max AIS exerted another effect on multiple readmissions; those with a maximal degree of AIS, i.e., 5-6, had about twice the chance for more than one readmission event compared to those with the minimum value of AIS, i.e., 1-2. The influence of ISS was also considerable; 1.69 and 2.24 times higher was the possibility of multiple readmissions of patients with ISS 16-24 and >24 compared to those with ISS<9, respectively. Also, the side effect was a statistically significant variable: Patients who developed wound infection as the side effect had a 1.53-time higher chance for multiple readmissions compared to those without any side effect. However, such a significant relationship was not detected in other subgroups of side effects. Similarly, in terms of multiple readmissions, the outcome was about twice worse in patients who required blood transfusion during the index admission.

It was also noted that patients with 8-30 and >30 days of LOS during the index admission had a 2.42- and 4.31-time higher chance for more than a week of readmission, respectively. The most involved part of the body was relevant, too: Patients receiving the most severe injuries to the abdomen and pelvis were nearly twice more likely to stay in the hospital for more than a week during readmissions than those sustaining a head and neck injury. Furthermore, max AIS significantly affected the period of readmission events; patients who had a maximum AIS, i.e., 5-6, had about three-time higher chances for longer readmissions than patients with an AIS of 1-2. As for ISS, we found that patients with an ISS score of 16-24 and >24 had a 1.86- and 3.8-time higher chance of staying >7 days in the hospital within the readmission course, respectively. The odds ratio for side effects showed that patients who developed wound infection were 2.56 times more likely to stay longer in the hospital than those who did not develop any side effects. Furthermore, the odds of a long readmission period for patients who needed blood transfusion were 4.1 times higher than those for the reference group.

The chi-square test results revealed an insignificant relationship between the type of trauma and the mechanism of trauma on the one hand and admission to the intensive care unit (ICU) and side effects on the other hand. Nevertheless, the type and mechanism of trauma were significantly related to the patient's need for transfusion (P=0.001 and P=0.008, respectively). The type and mechanism of trauma also showed significant relationships with the operation, maximum AIS, ISS, and LOS (P<0.001 for all the variables). Moreover, the most active part of the body had significant correlations with all the variables mentioned above (P<0.001).



Graph 2: Frequency of each LOS subcategory between patients with single readmission and those with multiple readmissions.

Table 4: The reason for the first readmission categorized based on the interval between the date of discharge from the index admission and the first readmission.

Interval Reason	≤30 days N (%)	31 days ≤ < 90 days N (%)	90≤ days<180 N (%)	180≤ days<1 year N (%)	1 year N (%)	Total N (%)
Wound infections	72(19.3)	17(7.7)	7(9)	4(6.5)	1(2.4)	101(13)
Gastrointestinal	15(4)	3(1.4)	3(3.8)	3(4.8)	1(2.4)	25(3.2)
Amputation stump complications	9(2.4)	3(1.4)	2(2.6)	0(0.0)	0(0.0)	14(1.8)
Movement restrictions	24(6.4)	24(10.9)	6(7.7)	7(11.3)	3(7.3)	64(8.3)
Deformity in head and neck	28(7.5)	22(10)	4(5.1)	5(8.1)	4(9.8)	63(8.1)
After care for surgery	5(1.3)	4(1.8)	0(0.0)	1(1.6)	0(0.0)	10(1.3)
Respiratory	5(1.3)	1(0.5)	1(1.3)	0(0.0)	0(0.0)	7(0.9)
Ophthalmic	6(1.6)	4(1.8)	1(1.3)	0(0.0)	2(4.9)	13(1.7)
New trauma	4(1.1)	4(1.8)	2(2.6)	4(6.5)	4(9.8)	18(2.3)
Graft	21(5.6)	6(2.7)	2(2.6)	1(1.6)	2(4.9)	32(4.1)
Hearing	5(1.3)	10(4.5)	2(2.6)	3(4.8)	4(9.8)	24(3.1)
Foreign Body	30(8)	11(5)	5(6.4)	2(3.2)	4(9.8)	52(6.7)
Osteomyelitis	3(0.8)	1(0.5)	1(1.3)	1(1.6)	0(0.0)	6(0.8)
Urinary	3(0.8)	0(0.0)	0(0.0)	3(4.8)	2(4.9)	8(1)
Closure of ostomi	4(1.1)	10(4.5)	4(5.1)	0(0.0)	0(0.0)	18(2.3)
Bedsore	7(1.9)	3(1.4)	1(1.3)	3(4.8)	1(2.4)	15(1.9)
Deep vein thrombosis (DVT)	7(1.9)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	7(0.9)
Laryngopathy	0(0.0)	1(0.5)	1(1.3)	0(0.0)	0(0.0)	2(0.3)
Neurologic	4(1.1)	1(0.5)	0(0.0)	1(1.6)	0(0.0)	6(0.8)
Cardiologic	1(0.3)	0 (0.0)	0(0.0)	0(0.0)	1(2.4)	2(0.3)
Surgical device remove	19(5.1)	34(15.4)	9(11.5)	6(9.7)	2(4.9)	70(9)
Pain	42(11.3)	16(7.2)	7(9)	7(11.3)	3(7.3)	75(9.7)
Non-union of fracture	18(4.8)	26(11.8)	14(17.9)	5(8.1)	1(2.4)	64(8.3)
Vascular	8(2.1)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	8(1)
Psychiatric	13(3.5)	13(5.9)	2(2.6)	3(4.8)	3(7.3)	34(4.4)
Wound unhealing	20(5.4)	3(1.4)	3(3.8)	0(0.0)	2(4.9)	28(3.6)
Hernia	0(0.0)	4(1.8)	1(1.3)	3(4.8)	1(2.4)	9(1.2)
Total	373(100)	221(100)	78(100)	62(100)	41(100)	775(100)

Reason: the reason for the first readmission; Interval: the interval between the index admission and the first readmission.

Table 5: Length of stay in hospital during the first readmission in full sample study.

Length of stay (day)	Frequency (N)	Valid percent (%)
1	199	25.7
2	129	16.6
3	109	14.1
4	81	10.5
5	50	6.5
6	35	4.5
7	33	4.3
8	23	3.0
9	17	2.2
10	15	1.9
11	17	2.2
12	13	1.7
13	4	0.5
14	5	0.6
15	7	0.9
16	3	0.4
17	2	0.3
18	1	0.1
19	3	0.4
20	4	0.5
21	4	0.5
22	2	0.3
23	4	0.5
24	2	0.3
25	1	0.1
27	1	0.1
28	3	0.4
29	1	0.1
30	4	0.5
31	1	0.1
33	1	0.1
63	1	0.1
Total	775	100

Table 6: Association of multiple readmissions with LOS, max AIS, ISS, side effect, and patient's need for blood transfusion.

Variable	OR	Lower CI	Upper CI	P-value
LOS (reference: 1-3 days)				
4-7 days	1.14	0.79	1.65	0.47
8-30 days	1.75	1.24	2.48	0.001
>30 days	1.3	0.67	2.5	0.42
Max AIS (reference: 1-2)				
3	0.9	0.45	1.8	0.08
4	1.1	0.68	1.96	0.72
5-6	1.95	1.09	3.46	0.02
ISS (reference: <9)				
9-15	1.15	0.75	1.77	0.52
16-24	1.69	1.02	2.8	0.039
>24	2.24	1.46	3.44	<0.001
Side effect⁺ (reference: no side effect)				
Wound infection	1.53	1.07	2.19	0.019
Patient's need for blood transfusion (no vs. yes)	1.9	1.25	2.85	0.002

LOS: length of stay in hospital, OR: odd ratio, CI: confidence interval, Max AIS: maximum amount of the abbreviated injury scale, ISS: Injury Severity Score. +: Data not shown for other categories of side effect variable, as there was not any significant relationship with other subgroups of the variable.

Table 7: Association of total days of readmissions with LOS, the most involved part of body, max AIS, ISS, side effect, patient's need for blood transfusion.

Variable	OR	Lower CI	Upper CI	P-value
LOS (reference: 1-3 days)				
4-7 days	1.11	0.74	1.65	0.61
8-30 days	2.42	1.68	3.48	<0.001
>30 days	4.31	2.19	8.46	<0.001
The most involved part of body (reference: head and neck)				
Thorax	1.1	0.57	2.2	0.74
Abdomen and pelvic	2.09	1.28	3.42	0.003
Extremities	0.86	0.59	1.26	0.46
External	0.56	0.31	1.001	0.05
Max AIS (reference: 1-2)				
3	0.7	0.32	1.59	0.42
4	1.28	0.68	2.41	0.44
5-6	2.89	1.54	5.42	0.001
ISS (reference: <9)				
9-15	1.54	0.95	2.5	0.079
16-24	1.86	1.07	3.24	0.027
>24	3.8	2.37	6.09	<0.001
Side effect⁺ (reference: no side effect)				
Wound infection	2.56	1.78	3.68	<0.001
Patient's need for blood transfusion (no vs. yes)	4.1	2.68	6.29	<0.001

LOS: length of stay in hospital, OR: odd ratio, CI: confidence interval, Max AIS: maximum amount of the abbreviated injury scale, ISS: Injury Severity Score. +: Data not shown for other categories of side effect variable, as there was not any significant relationship with other subgroups of the variable.

Discussion

In the investigated surviving wounded population, extremity and head and neck injuries accounted for 46.5% and 22.6% of all the wounds, respectively. This pattern is similar to the observations from previous wars, e.g., Afghanistan or Chechnya War[1,11]. The regression analysis revealed no significant correlation between multiple or full days of readmissions and the number of comorbidities, mechanism of trauma, type of operation, and ICU stay. There was a significant relationship between multiple readmissions and total readmission days and some variables such as LOS, max AIS, ISS, side effects, and blood transfusion. The predictor of a significant effect only on the total readmission days was the most involved part of the body.

Here, we focused on multiple readmissions in one year and their total length since we believed that the relevant explanatory factor could be determined only by comparing single and multiple readmissions. This approach also enabled identifying high-risk patients who are the most appropriate target group for reducing the overall number of readmission events. To date, numerous studies have examined 30-day readmission for various severe diseases and suggested that it is associated with the male sex (OR=1.83, P=0.02), ICU stays (OR=2.5, P=0.049), LOS[4], comorbidity score[17], and different socioeconomic factors[18]. However, similar studies are rare in military settings.

Given that the present study examined readmission occurrence resulting from combat-related injuries, we noticed some similarities and differences in the results. First, almost all our participants were young and without any underlying chronic disease or comorbidity, indicating the considerable potential for lowering readmissions after a combat injury in such circumstances. Secondly, there was no difference between different groups of patients in this study in terms of ICU stay. ICU stay during the initial admission is not a significant explanatory factor here. In addition to very different causes for the index admission, another explanation could be that our sample was young, and we examined a much-extended readmission period. Therefore, it is likely that the quality of hospital care and readmissions was affected by various factors in military hospitals compared to regular ones.

Not surprisingly, our findings revealed that the severity of injuries defined by AIS and ISS had essential impacts on multiple readmissions and total readmission days. The most severe injuries led to a considerably higher risk for recurrent and prolonged readmission events. On the other hand, it has been well established that the extreme severity of the disease is associated with high resource use outliers[18,19]. Given these, the findings imply that patients with severe injury or, perhaps, with severe illness might require high-quality care for longer durations, especially as part of the initial hospital inpatient stay. In these patients, premature discharge from the index admission may lead to subsequent readmissions and their associated costs and should thus be avoided. Even though these factors are not alterable, severity indices may help identify high-risk groups of patients.

We also found that longer LOS within the index admission puts patients at risk of multiple and extended readmission events. This result is partially consistent with some other studies on internal medicine patients conducted in civilian settings[4,17,20], which examined a much shorter post-discharge period than the present study. Still, a longer LOS is an essential factor for predicting the risk of repeated future readmissions. Although there are some concerns that an earlier hospital discharge may result in higher readmission rates, a reduction in LOS has not shown any adverse effect on the 30-day hospital readmission rate[4]. A possible explanation can be that improvement in LOS might not necessarily affect the quality of hospital service. Such improvements can be achieved by adopting better hospital discharge procedures[4]. Accordingly, reducing LOS can be an appropriate measure for preventing repeated readmissions.

Contrary to our expectations, the type of operation was not significantly correlated with the frequency and duration of readmission events. Likely, this factor will indirectly exert its effect through other variables such as the need for blood transfusion, AIS, ISS, and LOS. Based on the chi-square test results, the operation type was correlated with these variables.

Moreover, the regression analysis found that side effects might impact the duration and frequency of future re-hospitalizations. Still, this effect was only significant in the subgroup of patients who developed wound infection and was inconsistent among other subgroups. Wound infections can impose significant demands on hospital resources by increasing readmission events and their duration. This outcome is in line with the literature that has determined trauma-related infections significantly contribute to substantial morbidity among wounded military personnel. Given the observation that wound infections were the primary cause of hospitalization, this finding highlights the importance of considering both treatment and preventive measures equally. These measures can include the improvement of patients' immune systems[21], prescription of effective antibiotics[22], and treatment timing[23].

The last significant influence on both dependent variables was the patients' need for blood transfusion. In managing combat-related injuries, blood transfusion is essential because uncontrollable hemorrhage is the primary cause of possibly preventable casualties[24,25]. Our results confirm that the need for blood transfusion is linked to a poor prognosis in trauma combat patients regarding repeated and more extended readmissions. Among all the investigated factors, the most active part of the body was the only factor that correlated with total readmission days but not with multiple readmissions. Injury to the head and neck seems to lead to a higher risk of longer readmission courses.

Briefly, our results provide insight into possible relationships between LOS and readmission and the investigated variables. ISS>24 led to the highest risk among the statistically significant variables influencing multiple readmissions. Regarding total readmission days, LOS>30 days and blood transfusion had the most significant effects, respectively.

Our study had some limitations:

1. The retrospective design of the study, in which almost all the data were collected from patient records.
2. The fact that sample was collected from only one center.
3. We did not evaluate factors such as social determinants and having someone to help at home following discharge.

Our results should be confirmed in studies with larger samples that examine a more comprehensive range of possible risk factors.

Conclusion

Differentiating preventable and non-preventable readmissions might provide a basis for developing effective strategies to reduce the readmission rate in military settings. To this end, high-risk patients for multiple readmissions must be first determined. Referring to the data, we can conclude that the severity of the injury, the LOS in the hospital, developing wound infection, injury to the abdomen and pelvis, and the need for blood transfusion within the index admission appear to be associated with an increased risk of multiple and more extended readmission events. Identifying these risk factors can pave the way for attending to patients who have them, thus, promoting the quality of hospital care. The overall outcome will be more effective management of combat-related injuries and their related medical costs, which may benefit both patients and society.

Authors' contributions

All authors contributed equally to this research.

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Ethical Statement

The proposal was approved in the medical university.

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