



## Risk factors of mortality in nosocomial infected traumatic patients in a trauma referral center in south of Iran

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### ABSTRACT

**Purpose:** Trauma-related injuries are the leading cause of death worldwide. Some risk factors make traumatic patients susceptible to infection. Furthermore, some mortality risk factors, including length of hospitalization and increasing age, were detected in non-traumatic infected patients. This study aimed to assess mortality risk factors among nosocomial infected traumatic patients in Rajaei trauma center, Shiraz, Iran.

**Methods:** This prospective cohort study was conducted during a period of 2 years since April 2015 to March 2017 in Rajaei hospital, which is the center of emergency medical services for traumatic injuries in Shiraz, Iran. Centers for Disease Control and Prevention/National Healthcare Safety Network surveillance system criteria were applied to define 5 types of nosocomial infections. The variables analyzed as the risk factors of infection and mortality included sex, age, mechanism of injury, site of injury, injury severity score (ISS), surgical intervention, length of hospitalization, intensive care unit (ICU) admission, and type of pathogen. Then, the incidence of nosocomial infection and also risk factors of mortality in traumatic patients were evaluated. All data analyses were performed using the statistical package for social sciences, version 15 (SPSS Inc., Chicago) and  $p \leq 0.05$  is considered to be statistically significant.

**Results:** The incidence of nosocomial infection was 7.2% ( $p < 0.001$ ). Pneumonia was the most common type of infection detected in our study. Infection led to a 7.8-fold increase in mortality of the traumatic patients ( $p < 0.001$ ). Admission in intensive care units and old age were the main risk factors of mortality in infected traumatic patients. Old age, gunshot and motor vehicle accidents, trauma to extremities and abdomen, higher injury severity score, and prolonged hospitalization, made the traumatic patients more susceptible to infection.

**Conclusion:** The really high incidence of nosocomial infection in traumatic patients in Iran depends on some risk factors that should be considered. Also infection increases the mortality rate in the traumatic patients, which could be reduced by eliminating its risk factors.

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## Introduction

### Background

According to the center for disease control (CDC), trauma-related injuries remain a leading cause of death in the United States each year.<sup>1</sup> In the United States, there were at least 1.7 million nosocomial infections yearly with the annual cost of \$9.8 billions.<sup>2</sup> Iran, as a developing country with a population of 73 million, is also

faced with a high incidence of injury-related mortality and morbidity. Nosocomial infection caused a 12.7-fold increase in the odds of late death and was the most important risk factor for late death in traumatic patients. On the other hand, traumatic patients were most susceptible to infection, which could in turn threaten their lives.<sup>3</sup> According to the studies conducted in Iran, the incidence of nosocomial infection varied from 2.4% to 9.4%.<sup>4–6</sup>

Getting infected depended on some risk factors, such as age (particularly infancy and senescence), underlying diseases, prolonged hospitalization, immune compromised state, and intensive care units (ICUs) admission.<sup>4,6,7</sup>

Also, mortality in patients with nosocomial infection depended on some risk factors such as young age, ICU admission, hospital

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with more than 1000 beds, length of hospitalization, requirement for prolonged specialized central venous access and infection with methicillin-resistant *Staphylococcus aureus* or multidrug-resistant *Pseudomonas aeruginosa*.<sup>8–12</sup>

Bacteria are the main causes of developing infection. According to CDC, almost half of the bacteria are gram-negative, with *Escherichia coli*, *P. aeruginosa*, *Enterobacter*, and *Klebsiella pneumoniae* being the most prevalent ones. In addition, *Staphylococcus aureus*, *coagulase-negative staphylococci*, and *enterococci* are the most prevalent micro-organisms among the gram-positive bacteria.<sup>13</sup>

The most common types of infection are urinary tract infection (UTI), pneumonia (PNEU), blood stream infection (BSI) or septicemia, and surgical site infection (SSI).<sup>4,6,14</sup>

Studying nosocomial infection is of utmost importance because of increase in the possibility of patients' mortality and morbidity due to infection, prolonged hospitalization, and consequently increase in the costs.<sup>4</sup>

### Objective

To the best of our knowledge, this is the first study investigating mortality in nosocomial infected traumatic patients in Iran. Therefore, the present study aims to investigate the incidence, epidemiological risk factors, and mortality risk factors of nosocomial infection in traumatic patients referred to Rajaei hospital, Shiraz, Iran.

### Methods

#### Setting

This prospective cohort study was conducted in Rajaei hospital, which is the greatest referral center of emergency medical services for traumatic injuries in Shiraz, Fars province, southwestern Iran. This center has 7 general wards each providing 32 beds, 2 emergency wards each providing 20 beds, and 6 ICUs each containing 9 beds.

#### Data collection

The study data were gathered during 2 years (April 2015 to March 2017). During this period, a daily surveillance for nosocomial infection was conducted for all the patients presenting with no signs and symptoms of infection within the first 48 h of admission. When a patient had multiple infections after the admission date, only the first occurrence was included. The patients who were already infected prior to the study and were below 15 years old were excluded because this center only admits the patients above 15 years old. It should be noted that only traumatic patients were included and no post discharge surveillance was performed. Surveillance was conducted by direct patient examination for signs and symptoms of infection, review of microbiology, hematology, and cerebrospinal fluid (CSF) laboratory results, and analysis of radiological reports, particularly chest radiographs. For every patient meeting the inclusion criteria, swab cultures were taken twice per week, urine cultures were obtained once per week, sputum cultures were taken once per week and 2 consecutive blood cultures were drawn during fever or clinical features of sepsis. If meningitis (MEN) was suspected, the samples of blood or CSF were collected and sent to laboratory for testing. The specimens were then processed according to standard histological methods and all the data were entered into a specific data collecting form.

The variables analyzed as the risk factors of infection and mortality included sex, age, mechanism of injury, site of injury, injury severity score (ISS),<sup>15</sup> surgical intervention, length of hospitalization, ICU admission, and type of pathogen.

### Definition

Centers for Disease Control and Prevention/National Healthcare Safety Network (CDC/NHSN) surveillance definitions criteria<sup>16</sup> were used to define 5 nosocomial infections in the study, namely SSI, UTI, PNEU, BSI, and MEN.

### Data management and statistical analysis

The incidence of nosocomial infection in the traumatic patients was computed by the frequency of the new traumatic patients with nosocomial infection divided by all the traumatic patients in the study period who were admitted more than 48 h in hospital. Categorical variables were compared using chi-square test. Besides, Odds Ratios (ORs) and the corresponding 95% Confidence Intervals (CIs) were calculated for the independent variables by means of logistic regression models. In the multivariate analysis, backward elimination ( $\alpha$ -to remove = 0.1) was used as the inclusion criteria. All data analyses were performed using the statistical package for social sciences, version 15 (SPSS Inc., Chicago) and  $p \leq 0.05$  was considered to be statistically significant.

### Results

In this study, the incidence of nosocomial infection was 7.2% (761 out of the 10553 traumatic patients,  $p < 0.001$ ). Among the participants, 130 were female (17.1%) and 631 were male (82.9%). Additionally, the infected patients' ages ranged from 15 to 92 years, with the median age of 33 years (interquartile range = 24–50).

According to Table 1, the incidence of nosocomial infection increased by increase in age ( $p = 0.04$ ). Besides, the incidence of nosocomial infection was significantly correlated to mechanism of injury. Accordingly, the infection created by gunshot was more prevalent compared to other injury mechanisms ( $p < 0.001$ ). Generally, most of gunshot injuries were in thorax. Nosocomial infection was also significantly correlated to ISS, trauma to extremities and abdomen, and prolonged hospitalization. Moreover, infection increased the mortality rate in the traumatic patients, so that mortality in traumatic patients with nosocomial infection was 15.6% (119/761) compared with 2% (194/9792) of death in traumatic patients without nosocomial infection ( $p < 0.001$ ).

Among the infected patients, 63.9% and 36.1% were admitted in ICUs and general wards, respectively.

Although *Staphylococcus* was the most common micro-organism in SSI, BSI, MEN, and UTI, *Acinetobacter* was the most common one in PNEU. In addition, gram-negative (50.9%, 315/619) and gram-positive bacteria (49.1%, 304/619) had an almost equal frequency distribution among the traumatic patients ( $p < 0.001$ , Table 2). Also 12% of infected traumatic patients were infected by *Yeast*, which is a fungal infection.

According to Table 3, the most common type of infection was PNEU (39.4%) among all the survived and non-survived infected patients. Additionally, MEN followed by BSI caused most of the mortalities (24.4% and 22.4%) in comparison to other infection types. On the other hand, SSI caused the lowest mortality (7.4%) among all infection types. Moreover, mortality in the infected patients increased with increase in age and ICU admission ( $p < 0.001$ ).

For multivariate analysis, all the covariates were considered and backward elimination ( $\alpha$ -to remove = 0.1) was performed. The final model has been presented in Table 4. Based on the results, the only factors related to high mortality rate were old age and admission in ICUs.

The results revealed that ICU admission led to a 7.73-fold increase in the odds of mortality and was the most important risk factor for mortality in the infected patients. Age  $\geq 65$  years also

**Table 1**  
Comparison of the infected and non-infected groups regarding different risk factors.

Risk factors		Infected n (row %)	Non- infected n (row %)	Total n (column %)	p-value <sup>a</sup>
Age (years)	15–45	514 (6.8)	7018 (93.2)	7532 (71.3)	0.039
	46–64	159 (7.9)	1848 (92.1)	2007 (19.0)	
	≥65	88 (8.7)	926 (91.3)	1014 (9.7)	
Sex	Female	130 (6.8)	1777 (93.2)	1907 (18.1)	0.462
	Male	631 (7.3)	8015 (92.7)	8646 (81.9)	
Mechanism of injury	Car accident	348 (8.3)	3840 (91.7)	4188 (39.7)	<0.001
	Motor accident	192 (7.9)	2241 (92.1)	2433 (23.0)	
	Pedestrian accident	75 (9.4)	721 (90.6)	796 (7.5)	
	Assault injury	7 (1.4)	488 (98.6)	495 (4.7)	
	Falling down	90 (5.5)	1540 (94.5)	1630 (15.4)	
	Struck by objects	29 (3.4)	813 (96.6)	842 (8.1)	
	Gunshot	20 (11.8)	149 (88.2)	169 (1.6)	
Surgical intervention	No	650 (7.3)	8224 (92.7)	8874 (84.1)	0.300
	Yes	111 (6.6)	1568 (93.4)	1679 (15.9)	
Injury severity score (ISS)	0–8	209 (4.9)	4095 (95.1)	4304 (40.8)	<0.001
	9–15	249 (5.7)	4154 (94.3)	4403 (41.7)	
	≥16	303 (16.4)	1543 (83.6)	1846 (17.5)	
Site of injury	Extremities	64 (19.5)	264 (80.5)	328 (3.1)	<0.001
	Face	80 (3.2)	2411 (96.8)	2491 (23.6)	
	Thorax	249 (6.0)	3934 (94.0)	4183 (39.6)	
	Abdomen	195 (17.9)	895 (82.1)	1090 (10.4)	
	Head and neck	68 (4.4)	1470 (95.6)	1538 (14.6)	
	Multiple organs	105 (11.4)	818 (88.6)	923 (8.7)	
Length of hospitalization (days)	3–7	33 (0.7)	4965 (99.3)	4998 (47.4)	<0.001
	8–29	342 (6.9)	4644 (93.1)	4986 (47.2)	
	≥30	386 (67.8)	183 (32.2)	569 (5.4)	
Survival	Alive	642 (6.3)	9598 (93.7)	10240 (97.0)	<0.001
	Dead	119 (38.0)	194 (62.0)	313 (3.0)	

<sup>a</sup> Comparison between infected and non-infected traumatic patients.

**Table 2**  
Distribution of pathogens based on infection types.

Infection type		MEN n (%)	UTI n (%)	PNEU n (%)	SSI n (%)	BSI n (%)	Total n (%)
Culture result	No growth	26 (21.8)	2 (3.3)	16 (5.3)	6 (2.8)	1 (1.5)	51 (6.7)
	Acinetobacter	35 (29.4)	8 (13.3)	94 (31.3)	61 (28.4)	11 (16.4)	209 (27.5)
	Staphylococcus	48 (40.3)	22 (36.7)	83 (27.7)	89 (41.4)	44 (65.7)	286 (37.5)
	Enterobacter	2 (1.7)	4 (6.7)	23 (7.7)	18 (8.4)	1 (1.4)	48 (6.3)
	<i>P. aeruginosa</i>	1 (0.9)	2 (3.3)	34 (11.3)	12 (5.5)	6 (9.0)	55 (7.2)
	Yeast	7 (5.9)	21 (35)	36 (12.0)	25 (11.6)	2 (3.0)	91 (12.0)
	Gram-negative bacillus	0 (0.0)	1 (1.7)	1 (0.4)	1 (0.5)	0 (0.0)	3 (0.4)
	Streptococcus	0 (0.0)	0 (0.0)	13 (4.3)	3 (1.4)	2 (3.0)	18 (2.4)
Total n (%)		119 (100.0)	60 (100.0)	300 (100.0)	215 (100.0)	67 (100.0)	761 (100.0)

Abbreviations: MEN, meningitis; UTI, urinary tract infection; PNEU, pneumonia; SSI, surgical site infection; BSI, blood stream infection (p < 0.001).

resulted in a 5.18-fold increase in the odds of mortality in these patients.

## Discussion

This study was conducted on the data collected from a level I trauma center during 2 years. High incidence of nosocomial infection in traumatic patients was detected in our study. In a survey which was conducted in Korea, the incidence of SSI following gastrectomy was 3.12%.<sup>17</sup> Another research demonstrated that the monthly incidence rates varied between 4.14 and 6.61 per 1000 bed-days for UTI and between 0.09 and 1.25 per 1000 bed-days for BSI.<sup>18</sup> This indicated the higher incidence of nosocomial infection in our survey compared to other studies. This difference is may be because of this fact that the participants in our survey were trauma patients who are more prone to infection due to fractures or open wounds than non-traumatic ones.

Our results showed that nosocomial infection increased the mortality rate among the traumatic patients. Nosocomial infection caused a 7.8-fold increase in the mortality of traumatic patients in

our study. Also in a study which was conducted in Shiraz, Iran nosocomial infection caused a 12.7-fold increase in the odds of late death and was the most important risk factor for late death in traumatic patients.<sup>3</sup>

Additionally, mortality in the infected traumatic patients depended on two risk factors that were ICU admission and age ≥65. ICU admission in infected traumatic patients is itself a risk factor for mortality regardless of severe states of patients in ICU because in multivariate analysis all of the factors such as injury severity score were considered and the only factor that was analyzed was infection. Several studies indicated that admission in ICUs was more responsible for death in non-traumatic patients in comparison to admission in general wards. Also, Bueno-Cavanillas et al showed that mortality was higher in younger non-traumatic patients who suffered from nosocomial infections.<sup>8,9,19</sup> In addition, length of hospitalization and culture results were the other risk factors of mortality in non-traumatic patients in previous studies that were not confirmed in traumatic patients in our survey.<sup>10,12</sup>

The results of the current study showed that infection in traumatic patients depended on some risk factors, such as age,

**Table 3**  
Comparison of survived and non-survived infected groups regarding different variables.

Variables		Survived n (row %)	Non-survived n (row %)	Total n (column %)	p-value <sup>a</sup>
Gender	Female	108 (83.1)	22 (16.9)	130 (17.1)	0.658
	Male	534 (84.6)	97 (15.4)	631 (82.9)	
Age (years)	15–45	461 (89.7)	53 (10.3)	514 (67.5)	<0.001
	46–64	128 (80.5)	31 (19.5)	159 (20.9)	
	≥65	53 (60.2)	35 (39.8)	88 (11.6)	
Length of hospitalization (days)	3–7	27 (81.8)	6 (18.2)	33 (4.4)	0.769
	7–30	286 (83.6)	56 (16.4)	342 (44.9)	
	>30	329 (85.2)	57 (14.8)	386 (50.7)	
Type of infection	BSI	52 (77.6)	15 (22.4)	67 (8.8)	<0.001
	SSI	199 (92.6)	16 (7.4)	215 (28.3)	
	PNEU	252 (84)	48 (16)	300 (39.4)	
	UTI	49 (81.7)	11 (18.3)	60 (7.9)	
	MEN	90 (75.6)	29 (24.4)	119 (15.6)	
Admission in	ICU	376 (77.4)	110 (22.6)	486 (63.9)	<0.001
	Other wards	266 (96.7)	9 (3.3)	275 (36.1)	
Culture result	No bacterial growth	43 (84.3)	8 (15.7)	51 (6.7)	0.588
	Acintobacter	169 (80.9)	40 (19.1)	209 (27.5)	
	Staphylococcus	245 (86)	40 (14)	285 (37.5)	
	Enterobacter	44 (91.7)	4 (8.3)	48 (6.2)	
	<i>P. aeruginosa</i>	45 (81.8)	10 (18.2)	55 (7.2)	
	Yeast	79 (85.9)	13 (14.1)	92 (12.1)	
	Gram-negative bacil	2 (66.7)	1 (33.3)	3 (4)	
	Streptococcus	15 (83.3)	3 (16.7)	18 (2.4)	
	Head and neck	60 (88.2)	8 (11.8)	68 (8.9)	
Body region	Face	71 (88.8)	9 (11.2)	80 (10.5)	0.507
	Thorax	211 (84.7)	38 (15.3)	249 (32.7)	
	Abdomen	157 (80.5)	38 (19.5)	195 (25.6)	
	Extremities	55 (85.9)	9 (14.1)	64 (8.5)	
	Multiple organs	88 (83.8)	17 (16.2)	105 (13.8)	
Surgical intervention	Yes	91 (82)	20 (18)	111 (14.6)	0.455
	No	551 (84.8)	99 (15.2)	650 (85.4)	
ISS classification	1–8	182 (87.1)	27 (12.9)	209 (27.5)	0.138
	9–15	214 (85.9)	35 (14.1)	249 (32.7)	
	≥16	246 (81.2)	57 (18.8)	303 (39.8)	

Abbreviations: MEN, meningitis; UTI, urinary tract infection; PNEU, pneumonia; SSI, surgical site infection; BSI, blood stream infection; ICU, intensive care unit; ISS, injury severity score.

<sup>a</sup> Comparison between survived and non-survived infected traumatic patients.

**Table 4**  
The results of logistic regression analysis on the effects of different variables on survival.

Variables		B	SE	Wald	p-value	OR (95% CI)
ICU admission		2.04	0.38	29.18	<0.001	7.73 (3.68–16.25)
Type of infection	BSI	–	–	6.13	–	1
	SSI	0.58	0.43	1.87	0.17	0.55 (0.23–1.29)
	PNEU	0.64	0.36	3.18	0.07	0.52 (0.25–1.06)
	UTI	0.40	0.49	0.67	0.41	0.66 (0.25–1.74)
	MEN	0.09	0.39	0.05	0.81	0.91 (0.42–1.98)
Age (years)	15–45	–	–	35.47	–	1
	45–64	0.72	0.25	7.78	0.005	2.05 (1.23–3.41)
	≥65	1.46	0.28	34.58	<0.001	5.18 (2.99–8.97)

Abbreviations: OR, odds ratio; CI, confidence interval; ICU, intensive care unit; MEN, meningitis; UTI, urinary tract infection; PNEU, pneumonia; SSI, surgical site infection; BSI, blood stream infection.

mechanism of injury, site of injury, ISS, and length of hospitalization. The findings of a previous study demonstrated that aging was associated with an increased risk of acquiring infection.<sup>20</sup> Our results showed that gunshot injuries following by pedestrian accidents, car accidents, and motor accidents were the main injury mechanisms that caused infection. In an almost similar research, Laurent et al reported that patients with motor vehicle accidents, gunshot wounds, stab wounds, and pedestrian trauma were more likely to develop nosocomial infections compared to blunt trauma patients.<sup>21</sup> Moreover, we confirmed that patients with trauma to the extremities and abdomen were more likely to develop infection. When we analyzed, we understood that patients with trauma to extremities were more prone to infection because majority of them had multiple fractures in extremities

(including arm, forearm, hand, femur, leg and foot) and this makes a wider area than other sites like face, thorax, etc. This fact makes them more susceptible to infection. However, another study indicated that patients with injuries to the head or chest had a higher risk of nosocomial infection, while injuries to the extremities were associated with a lower risk of nosocomial infection compared to abdominal injuries.<sup>21</sup> Furthermore, recent studies showed that length of hospitalization was much higher in patients with nosocomial infection compared to those without nosocomial infection, which is consistent with our study results.<sup>21,22</sup> In addition, Niven et al stated that ISS was an independent predictor of development of nosocomial infection.<sup>22</sup> Our results also showed that nosocomial infection was significantly correlated to ISS. In addition, possibility of getting infected was



much higher in ICUs compared to general wards in our report. This result is similar to the recent studies.<sup>7</sup>

Therefore, development of infection resulted from the interaction among the patients, medical team, infected instruments, and pathogenic organisms.<sup>23</sup>

As mentioned above, nosocomial infections are categorized into several types. The most prevalent type detected in our study was PNEU, which is similar to the results of the study performed in Tunes, Egypt in 2005.<sup>24</sup> However, another study conducted in Shiraz, Iran in 2013 revealed that UTI was the most prevalent infection.<sup>5</sup> High prevalence of PNEU must be because of this fact that the most common site of trauma in our survey was thorax or chest. Additionally, one of the most important points of this study was that the rate of MEN (15.6%) was quite high in comparison to the recent studies.<sup>25</sup> The previous studies presented neurosurgical interventions, prolonged duration of lumbar or ventricular drainage, head trauma, and CSF leakage as the important risk factors for MEN.<sup>26–29</sup>

Generally, different pathogens cause nosocomial infection. In our study, the most frequently single isolated micro-organism was *Staphylococcus* (37.5%), which is similar to the results of the study carried out in Slovenia.<sup>30</sup> In another study done in Greece, *P. aeruginosa* was the most infection-producing micro-organism.<sup>31</sup> Furthermore, gram-negative and gram-positive bacteria had an almost equal frequency distribution among the traumatic patients in our study. However, gram-negative bacteria were more frequently isolated from cancer patients compared to gram-positive ones in another study.<sup>32</sup>

The present research had some advantages. One of these strong points was inclusion of all the patients referred to Rajaee hospital in the study period. Also to the best of our knowledge, this is the first study investigating mortality in nosocomial infected traumatic patients in Iran. In addition, this study was performed on a large sample size in 2 years, thus making the results more accurate and reliable.

On the other hand, this study had some limitations. The first limitation was that some risk factors, such as presence of catheters were not assessed in this study. Besides, administration of and resistance against antibiotics were not investigated in this study.

Overall, the findings of this study showed that the incidence of nosocomial infection was high in the traumatic patients in Fars province and, subsequently, in Iran. Considering the risk factors of mortality, admission in intensive care units and old age, we recommend some precautionary measures be taken in order to decrease the incidence of such infections. Additionally, with regard to the high rate of MEN in this study compared to other studies, further studies are suggested to be conducted on this infection. Future investigations on the effects of antibiotics on nosocomial infection are also warranted. Finally, this was the first study on risk factors of mortality in nosocomial infected traumatic patients. Hence, more investigations on the causes and risk factors of such infections and their mortality in traumatic patients seem to be necessary.

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## Appendix A. Supplementary data

Supplementary data related to this article can be found at <https://doi.org/10.1016/j.cjtee.2018.03.002>.

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