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The significance of demographic factors (age, sex, preoperative physiological status) and type of surgery on patients' outcome in ICU

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ABSTRACT

The incidence of postoperative death has changed little in recent years. Most deaths occur in older patients with coexisting medical diseases who undergo major surgery.

The objective of our research was to investigate the significance of demographic factors (age, gender, preoperational physiological status) and type of surgery on the outcome of treatment. This study included 288 patients older than 18 years of age that were treated in the intensive care unit (ICU) for at least 24 hours after a surgical procedure (both elective and emergency) between 1st January 2010 and 31st March 2011. The average age of patients included in the survey was 68 (range 19-88). APACHE II score was between 2.9 and 83.1 points, with an average value of 12.90 points. In this study, male gender (n=186) was much more common than female gender (n=102). Age of patients who died in the ICU was higher than the age of those who were discharged but it was not a statistically significant predictor of patient death. APACHE II score is associated with increased age of patients, neurosurgical operations and incidence of nosocomial infections. Patients' age and female gender had a strong negative correlation with nosocomial infection. Actual mortality rate for patients was 21%. Ratio between actual and predicted mortality was 1.4.

Key words: demographics, ICU, APACHE, type of surgery, nosocomial infections.

Introduction

The incidence of postoperative death has changed little in recent years. Most death occurs in older patients with coexisting medical diseases who undergo major surgery. (1,2)

Acute Physiology and Chronic Health Evaluation (APACHE II) scoring is widely used as an index of illness severity, for outcome prediction, in research protocols and to assess intensive care unit (ICU) performance and quality care. This score has been utilized in logistic regression models to predict mortality. Standardized mortality rate (SMR) or risk adjusted mortality rate allows comparison of actual performance of the institution with predicted performance, based on the average mortality as expressed by national or international data. It also provides individual ICUs with an opportunity to improve processes and techniques of care. (3)

Gender modifies immunologic responses caused by severe trauma or critical illness, but only a few studies have investigated the impact of gender on outcome in postoperative ICU patients. (4)

It is well known that older patients account for an increasing share of patients in the ICU, while data on the impact of age on treatment outcome in critically ill patients remain contradictory and depend on study structure, observed risk factors and statistical analyses. (5)

The complex nature of surgery, which is often performed as an emergency procedure, correlates with the high mortality rate. (6,7)

The aim of our study was to investigate the significance of demographic factors (age, gender, preoperational physiological status) and type of surgery, on hospital mortality, incidence of nosocomial infections and methicillin resistant Staphylococcus aureus (MRSA) infections.

Materials and methods

This retrospective study was performed at the Department of Anesthesiology, Reanimatology and Intensive Care, University Clinical Hospital Mostar.

In the study we included 288 surgical patients, treated in the intensive care unit, who underwent elective or urgent surgical intervention between 1st January 2010 and 31st March 2011.

Since this analysis was based on information that had already been collected, consent from the patients was not needed or requested. The study was approved by the Ethics Committee.

Criteria for enrolling patients in the study were as follows: age >=18 yrs and treatment in the ICU after elective or emergency surgery= > 24 hrs.

The following variables were analyzed for each patient: age presented as a categorical variable - young (18-65 yrs) and old (older than 65), sex, surgery (elective or emergency), type of surgery performed (abdominal, urology, vascular and neurosurgery), APACHE II score. The primary outcomes were: standardized mortality rate, incidence of nosocomial infections and MRSA infections.

Statistical evaluation of data

Nominal and ordinal variables were analyzed using χ^2 test, and if lack of expected frequency occurred the Fisher's exact test was used. Symmetry of distribution was analyzed using the Kolmogorov-Smirnov Test for continuous variables. In the case of symmetry in continuous variable distribution, mean value and measure of dispersion were represented using arithmetic mean and standard deviation and for comparison of those variables parametric tests (Student's t-test, ANOVA test) were applied. Median and interquartile range were used to represent mean value and measure of dispersion in a case of asymmetric distribution of variables, and for comparison of those variables the non-parametric tests (Mann-Whitney U test, Kruskal-Wallis test) were applied.

A software system SPSS for Windows (version 13.0, SPSS Inc., Chicago, Illinois, USA) and Microsoft Excel (versions 11th Microsoft Corporation, Redmond, WA, USA) were used for statistical analysis of the obtained data.

Results

This section presents the statistics and analysis of processed database of patients treated in the Intensive Care Unit of the Mostar University Clinical Hospital during the period 1st January 2010 and 31st March 2011.

The study included 288 surgical patients who underwent an elective or emergency surgical intervention, and were admitted to the ICU after standardized assessment of the severity of their condition, and the need for restoration or monitoring of vital functions.

The average age of patients included in the study was 68 years. The youngest patient included in the study was 19 years old and the oldest 88 years old.

Male gender (n= 186, 64,6%) was significantly more frequent than female (n= 102, 35,4%) (χ^2 test=24,500; df=1; P<0,001) .

Prevalence of elective surgery was significantly higher compared to emergency surgery (χ^2 test=24,500; df=1; P<0,001), while the most common type of surgical procedures included abdominal surgery and urology (χ^2 test=24,500; df=1; P<0,001) (table 1).

APACHE II score in patients included in the study ranged from 2.9 to 83.1, while the mean value of APACHE II score was 12.9 [18.6] points (figure 1).

APACHE II score did not significantly differ between male and female patients (Mann-Whitney U=8261.000; P=0.070).

APACHE II score was 12,90 [18.6] points. According to the predictive model, mortality rate for that score should be 15%.

Actual mortality rate was 21% (n =63), while 79 % of patients (n=225) were discharged from the Intensive Care Unit of Mostar University Clinical Hospital (x^2 test = 91.125; df; p< 0.001). The ratio between actual and predicted mortality was 1.4.

Nosocomial infection occurred in 13.5 % of patients treated in the ICU (χ^2 test=153.125; df=1; P<0.001), and 6.9% of all treated patients had an MRSA infection (χ^2 test=213.556; df=1; P<0.001) (table 2).

The age variable was a significant predictor in this model. Namely, older patients had a higher APACHE II score.

The predictive model for nosocomial infection based on predictors from patients' general characteristics was of statistical significance (Negelkerke R^2=0,101; P<0,001). Older patients had a lower chance of developing a nosocomial infection, while a higher APACHE II score on admission was significantly associated with a higher incidence of nosocomial infection (table 3).

The predictive model of MRSA infection during the course of treatment based on predictors from patients' general characteristics proved to be statistically significant (Negelkerke R^2=0,082; P<0,001). In this model the gender variable is a statistically significant predictor. Chances of MRSA infection are decreased in female patients (table 4).

The age of patients infected with MRSA did not significantly differ from those who were not infected, while analyses of total hospital acquired infections showed that the age of patients with a nosocomial infection was significantly lower compared to patients who did not have any infection (table 5).

Nosocomial infections and MRSA infection were more frequent in male patients (table 6).

APACHE II score did not statistically differ in relation to the presence of nosocomial and MRSA infection, which in this study proved to be an indicator of treatment outcome (table 7).

APACHE II differed significantly depending on the type of surgery performed (Kruskal-Wallis test=19,851; P<0,001). Patients who underwent a neurosurgical procedure had a higher APACHE II score compared to the two other surgical procedures (Mann-Whitney U, P<0,001) (figure 2).

There was no significant difference between incidence of nosocomial infections and MRSA and the surgical procedure performed (table 8).

Patients' age and female gender had a strong negative correlation with noso-

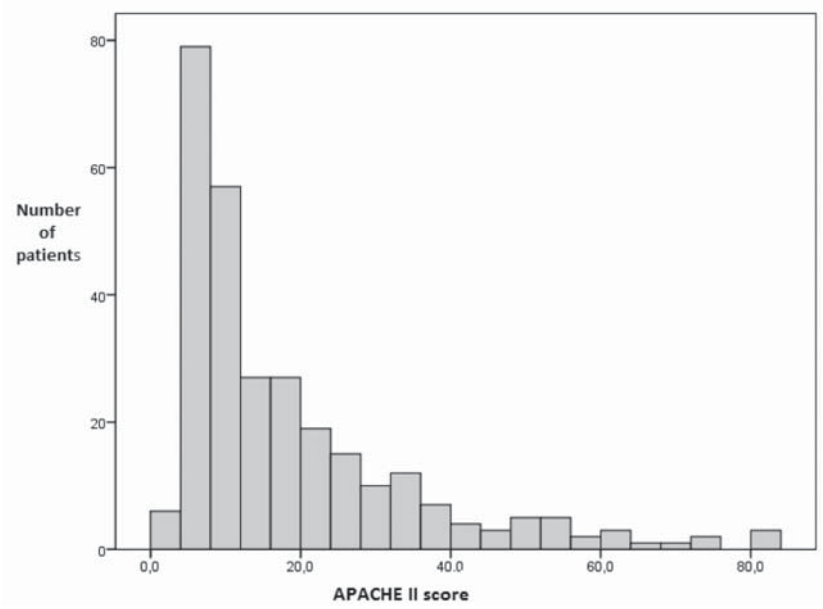
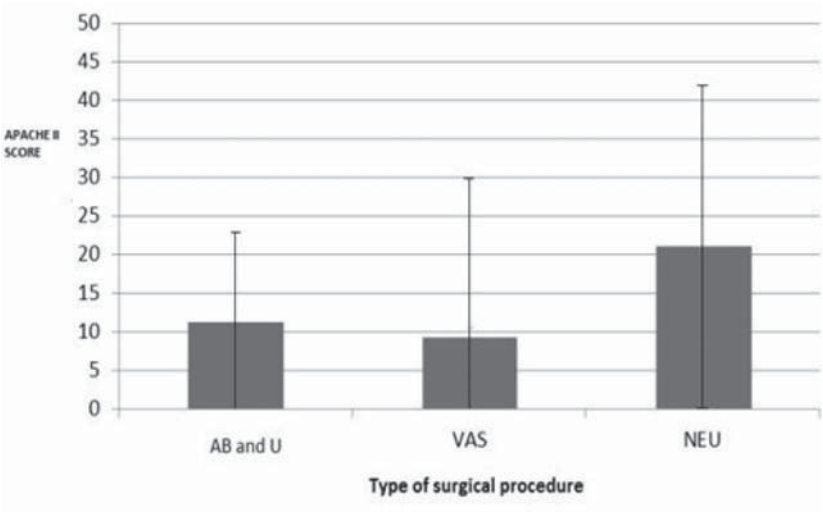


Figure 1. Distribution of APACHE II score in patients treated in the Intensive Care Unit in Mostar University Clinical Hospital during the period 1st January 2010 and 31st March 2011.



AB, abdominal; NEU, neurological; U, urinary; VAS, vascular.

Figure 2. APACHE II score of patients treated in the Intensive Care Unit in relation to the type of surgery performed during the period 1st January 2010 and 31st March 2011.

comial infection. APACHE II score and neurosurgical operations had a positive correlation and were greatly associated with nosocomial infections (table 9).

Discussion

It is well known that older patients account for an increasing share of patients in the ICUata on the impact of age on treatment outcome of critically ill patients remain contradictory and depend on study structure, observed risk factors and statistical analyses. (5)

In our study, the patients who died in the ICU were older than those who were discharged, but their age was not a statistically significant predictor of mortality. It was shown that the age of patients included in the study had a positive correlation with the APACHE II score.

Results obtained by Santini in his doctoral dissertation show that the number of older patients treated in the ICU is increasing and that old age is an independent risk factor that worsens the short-term treatment outcome. Results from the above mentioned dissertation indicate that older age as an independent risk factor, increases the need for mechanical ventilation and prolongs its duration, as well as the duration of patients' treatment in the ICU. In this study, older age was an independent risk factor of patients' mortality outcome. (8)

The study conducted by Angus and colleagues, showed that patients older than 65 account for 60 % of all ICU patient days, and the number of ICU days for patients older than 75 was 7 times greater than for those younger than 65. (9)

Esteban and colleagues, in their multicenter study on the outcome of patients receiving mechanical ventilation, reported that age >70 years is a „critical point" when the mortality outcome greatly increases. (10)

Nevertheless, there are studies that indicate that older age does not account for greater use of ICU resources. The study conducted by Somme and colleagues, reports that ICU length of stay, therapeutic activity, mechanical ventilation and nosocomial infection(s) decrease with age which can only be attributed to limitation of measure application in intensive care treatment of older patients. (11)

The age of patients in our study with some type of hospital-acquired infection was statistically much lower in comparison to patients who did not have any infections, except for those patients infected with MRSA whose age did not statistically differ.

Results obtained from most studies, including the doctorial dissertation by Santini, generally point to a positive correlation between older age and risk of hospital-acquired infections. (8,12-14) However, some recent papers, in line with our study, show that nosocomial infections are less likely to occur

in older patients than in younger patients due to a decreased inflammatory response that can result in diagnostic specimens being infrequently collected and the under diagnosing of nosocomial infections. (15-18)

Regarding the impact of patient's' age on the survival outcome in ICU there are a number of published studies that, in line with our study, indicate that older age is not an independent risk factor of mortality outcome. Boumenedil and colleagues have reported that there is no statistically significant difference in survival outcome for patients aged 80 and over admitted to a medical intensive care unit in relation to younger patients. This study points out that severity of the acute condition and the functional limitation of patients are the two factors that affect survival. (5)

Somme showed in an observational study on mortality, that included 410 patients aged 75 and over, that age is not an independent risk factor. The APACHE II score was the only predictor of mortality in the ICUs. The same study also reported that the APACHE II score was the most important mortality predictor in the ICUs for patients aged 85 and over, which is in line with our study as well. (11)

In our study the APACHE II score had a positive correlation with the incidence of nosocomial infection.

The APACHE II score proved to be a statistically significant predictor of mortality. Patients that underwent a neurosurgical procedure had a significantly higher APACHE II score.

In his doctorial dissertation, Santini mentions the APACHE II score, besides age, as an independent risk factor after 30 days of admission. (8)

In our study, male sex was a statistically significant predictor of MRSA infection. Research results of the impact of gender on different aspects of process and treatment outcome for patients in the ICU are not consistent.

One possible explanation for gender impact on process and treatment outcome is that severe disease modifies immune response in different ways. The aim of the study by Reinikainen and colleagues was to investigate the impact of gender on hospital mortality, length of ICU stay, and intensity of care on patients treated in ICUs. The study included 24 341 patients. Male gender was associated with increased hospital mortality among postoperative ICU patients (P= 0.001) but not among medical patients. Male gender was associated with an increased risk of death particularly among the patients older than 75. Mean length of ICU stay for

Table 1. Distribution of type of surgery and surgical procedures performed on patients treated in the Intensive Care Unit during the period 1st January 2010 and 31st March 2011.

Variables	Number(%) of patients	χ^2 test	P
Surgery			
Elective	222 (77,1)	84,500	<0,001
Emergency	66 (22,9)		
Type of surgical procedure			
Abdominal surgery and urology	193 (67,0)		
Vascular surgery	26 (9,0)	156,646	<0,001
Neurosurgery	69 (24,0)		

Table 2. Incidence of nosocomial infection and MRSA in patients treated in the Intensive Care Unit at the University Clinical Hospital Mostar from 01 January 2010 to 31 March 2011.

Variables	Number (%) of patients	χ^2 test	P
Nosocomial infection			
Yes	39 (13,5)	153,125	<0,001
No	249 (86,5)		
MRSA*			
Yes	20 (6,9)	213,556	<0,001
No	268 (93,1)		

MRSA, Methicillin-resistant Staphylococcus aureus* infection.

Table 3. Predictive model of nosocomial infection during the course of treatment in the Intensive Care Unit during the period 1st January 2010 and 31st March 2011 based on predictors from patients' general characteristics.

Dependent variable	Predictors	Wald	Exp (B)	P	95%CI
Nosocomial infection	Age	9,466	0,961	0,002	0,938-0,986
	Sex	3,520	0,448	0,061	0,194-1,036
	APACHE II	5,780	1,064	0,016	1,011-1,119

Table 4. Predictive model of Methicillin-resistant Staphylococcus aureus (MRSA) infection during the course of treatment in the Intensive Care Unit during the period 1st January 2010 and 31st March 2011 based on predictors from patients' general characteristics.

Dependent variable	Predictors	Wald	Exp (B)	P	95%CI
MRSA-infection	Age	1,163	0,982	0,281	0,949-1,015
	Sex	4,819	0,188	0,028	0,042-0,836
	APACHE II	1,775	1,046	0,183	0,979-1,117

Table 5. Distribution of nosocomial infections and methicillin-resistant staphylococcus aureus in patients in relation to patients' age treated in the Intensive Care Unit in the period from 1st January 2010 and 31st March 2011.

Variables	C [Q] age of patients	Mann-Whitney U	P
Nosocomial infection			
Yes	62 [22]	3548,500	0,007
No	68 [18]		
MRSA			
Yes	62,5 [24]	21870,000	0,170
No	68 [19]		

C [Q], median [interquartile range]; MRSA, Methicillin-resistant Staphylococcus aureus.

Table 6. Distribution of nosocomial infections and methicillin-resistant staphylococcus aureus in relation to patients' gender in patients treated at the Intensive Care Unit during the period 1st January 2010 and 31st March 2011.

Variables	Number (%) of patients		χ^2 test	P
	Men	Women		
Nosocomial infections				
Yes	31 (16,7)	8 (7,8)	4,381	0,036
No	155 (83,3)	94 (92,2)		
MRSA				
Yes	18 (9,7)	2 (2,0)	6,070	0,014
No	168 (90,3)	100 (98,0)		

MRSA, Methicillin-resistant Staphylococcus aureus.

Table 7. Distribution of nosocomial infections and Methicillin-resistant staphylococcus aureus in patients treated in the Intensive Care Unit in relation to APACHE II score during the period 1st January 2010 and 31st March 2011.

Variables	C [Q] APACHE II score at the start of treatment	Mann-Whitney U	P
Nosocomial infections			
Yes	14 [9]	3971,000	0,067
No	10 [9]		
MRSA			
Yes	11 [10]	2273,500	0,257
No	11 [9]		

C [Q], median [interquartile range]; MRSA, Methicillin-resistant Staphylococcus aureus.

male patients was 3.2 and 2.6 days for women. Male patients comprised 61.7% of the study population but consumed 66.0% of days in intensive care. (4)

Nachtigall and colleagues investigated the impact of gender on patients with sepsis, treated in surgical ICUs. They performed an observational, prospective study that included 130 female and 197 male patients treated for sepsis in three ICUs over a period of 180 days. Basic characteristics between patients (in terms of age, comorbidity, and SOFA-score, antibiotic therapy, etc.) did not differ. In this study the ICU mortality for female sepsis patients was 23.1% and for male 13.7% (P = 0.037). These results were confirmed in multivariate regression analysis. (19)

APACHE II score is considered to be the most significant indicator of disease severity and treatment outcome predictor. (20) Standardized mortality rate, or mortality rate based on APACHE II score is one of the indicators of quality treatment assessment in the ICU. Expected mortality rate in our patients was 15 % while the actual mortality rate was 21 %, index 1,4.

We believe that the higher observed mortality rate of patients in comparison to the expected rate was associated with the higher average age of patients (68 yrs.). This conclusion is based on several research results of a number of authors cited and mentioned in this study.

23 % of our patients underwent emergency surgery.

Clarke and colleagues researched the effect of emergency surgery on mortality. Their study included 124 patients. Overall mortality of all patients was 19.4% and in patients more than 80 years of age it was 38 %. (6)

Results of a study conducted by Pears and R.M and the colleagues showed that the number of high-risk surgical patients out of the total surgical population accounted for 13 % and postoperative mortality accounted for 80 % of the total mortality. (2)

Apart from the above mentioned, we believe that several structural factors affected the mortality rate. The ICU of Mostar University Clinical Hospital meets the highest standards of intensive care in terms of equipment and personnel. But apart from this unit, there are no other lower units or palliative care units available and as a consequence, patients in their terminal stage of illness are treated in the ICU until imminent death.

Nosocomial infection in our study occurred in 13.5 % of ICU patients while 6.9 % of patients had an MRSA infection. MRSA infection was greatly associated with male patients. Incidence of nosocomial and MRSA infections did not statistically differ between surgery types.

Nosocomial infections selected and

monitored in our study were: ventilator associated pneumonia (VAP), sepsis and urinary infection, while MRSA was monitored as a separate unit.

Recent bibliographical data lists share of nosocomial infections are as following: VAP = 16.9 % and sepsis= 14.5 %.

In our study APACHE II score is associated with the incidence of nosocomial infections.

In the study on microbiological surveillance of the surgical ICU conducted by Mihaljević and colleagues, APACHE II score = 22 was significantly associated with sepsis occurrence and mortality of patients. (21)

Conclusions

The high average age of our patients (68 years) is associated with an increased actual mortality rate in relation to the expected mortality rate but age was not a statistically significant, independent predictor of patient death.

APACHE II score is associated with an increased age of patients, neurosurgical operations and incidence of nosocomial infections.

Patients' age and female gender had a strong negative correlation with nosocomial infection.

Table 8. Distribution of nosocomial infection and MRSA in patients depending on the surgical procedure during the period 1st January 2010 and 31st March 2011.

Variables	Number (%) of patients			χ^2 test*	P
	AB and U	VAS	NEU		
Nosocomial infections					
Yes	21 (10,9)	3 (11,5)	15 (21,7)	4,894	0,091
No	172 (89,1)	23 (88,5)	54 (78,3)		
MRSA*					
Yes	9 (4,7)	2 (7,7)	9 (13,0)	5,373	0,058
No	184 (95,3)	24 (92,3)	60 (87,0)		

AB, abdominal; MRSA, Methicillin resistant staphylococcus aureus; NEU, neurological; U, urinary; VAS, vascular.

* Fisher's exact test

Table 9. Correlation analyses of monitored variables in patients treated in the Intensive Care Unit over the period 1st January 2010 and 31st March 2011.

Variables		Nosocomial infections	APACHE II
Age			
	Spearman's rho	-0,160**	0,380**
	P	0,007	<0,001
Gender			
	Spearman's rho	-0,123*	0,107
	P	0,036	0,069
Surgery type			
	Spearman's rho	0,123*	0,235**
	P	0,038	<0,001

** Correlation significant at the P<0,01 level

* Correlation significant at the P<0,05 level

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