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**Original Article**

# Intensive Care Unit-Acquired Infections: Incidence, Risk Factors and Associated Mortality in a Turkish University Hospital

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**SUMMARY**: In this prospective study, 93 intensive care unit (ICU)-acquired infections seen in 131 ICU patients were evaluated. Infection rates were found to be 70.9 in 100 patients and 56.2 in 1,000 patient-days. Pneumonia (35.4%) and bloodstream infections (18.2%) were the most common infections; *Staphylococcus aureus* (30.9%) and *Acinetobacter* spp. (26.8%) were the most frequently isolated microorganisms. The results of multivariate logistic regression analyses estimating the risk factors for ICU-acquired infections were as follows: length of stay in ICU (>7 days) (odds ratio [OR]: 7.02; 95% confidence interval [CI]: 2.80 - 17.56), respiratory failure as a primary cause of admission (OR: 3.7; 95% CI: 1.41 - 9.70), sedative medication (OR: 3.34; 95% CI: 1.27 - 8.79) and operation (before or after admission to ICU) (OR: 2.56; 95% CI: 1.06 - 6.18). In logistic regression analyses, age (>60 years) (OR: 3.65; 95% CI: 1.48 - 9.0), APACHE II score >15 (OR: 4.67; 95% CI: 1.92 - 11.31), intubation (OR: 3.60; 95% CI: 1.05 - 12.39) and central venous catheterization (OR: 7.85; 95% CI: 1.61 - 38.32) were found to be significant risk factors for mortality. The difference in mortality rates between patients with ICU-acquired infection and uninfected patients was not statistically significant (mortality rates: 42.3 and 45.6%, respectively). A high incidence of nosocomial infections was found, and the risk factors for ICU-acquired infections and mortality were determined.

## INTRODUCTION

Nosocomial infections (NIs) constitute an important worldwide health problem with high morbidity and mortality rates as well as economic consequences. NIs have become especially prominent in intensive care units (ICUs), where the incidence is two to five times greater than in the general inpatient population (1). The causes of the increased risk for NIs in ICUs have been reported to include the growing complexity of ICUs, the impaired host defenses of patients, invasive monitoring and procedures, exposure to multiple antibiotics and colonization by resistant microorganisms (2).

In hospitals with effective programs for NI surveillance, infection rates can be reduced by approximately one-third (3).

The objective of this study was to determine the incidence and risk factors for ICU-acquired infections, to clarify the distributions of the predominant organisms, and to evaluate the relation of ICU-acquired infections and other risk factors to mortality in ICU patients at Kocaeli University Hospital, Turkey.

## PATIENTS AND METHODS

Kocaeli University Hospital is a 390-bed teaching hospital with about 12,000 admissions annually. The population of Kocaeli is 1,150,000 and there is only one university hospital. The hospital has two adult ICUs run by the Anaesthesiology Department, a two-bed medical ICU for medical patients and a nine-bed surgical ICU for surgical patients. When necessary, however, medical patients can be followed in the surgical ICU, and vice versa. Both ICUs run two shifts per day, with 2 physicians, 3 nurses and 2 nursing assistants working on each shift. There is no isolation room for infected patients in these ICUs. Education on infection control procedures is provided every year for staff in the ICUs. The infection control measures and guidelines on the prevention of NI follow the criteria of the Centers for Disease Control and Prevention (CDC), Atalanta, Ga., USA (4).

Approval from the local Ethics Committee for the study was not required as data used for the study were collected routinely for clinical purposes. Patient names were not disclosed and all the information about the patients was kept confidential.

A total of 280 patients were admitted to the ICUs from October 2002 to August 2003, and the 131 staying more than 48 h were included in the study. Patients were monitored daily for the development of infection during the ICU stay and for 72 h after discharge. The risk factors for mortality during only the ICU stay were evaluated. Patients who were readmitted 72 h after discharge from the ICU were regarded as new admissions. Patients with infection at the time of admission were included in the non-infected patients' group. However, such patients were included in the group of patients with ICU-acquired infection when they developed a new infection with a different microorganism or in another anatomical site during the ICU stay (Figure 1). In these circumstances, infection on admission was evaluated as a risk factor for the development of ICU-acquired infection.

An infectious disease physician followed all the patients and collected data. Information on each patient was recorded on standardized forms. This included age, gender, admission and discharge dates, origin of patient (home or other hospital unit), hospital length of stay prior to ICU admission, primary reason for ICU admission, underlying diseases, antibiotic usage for at least 1 month prior to admission, surgical

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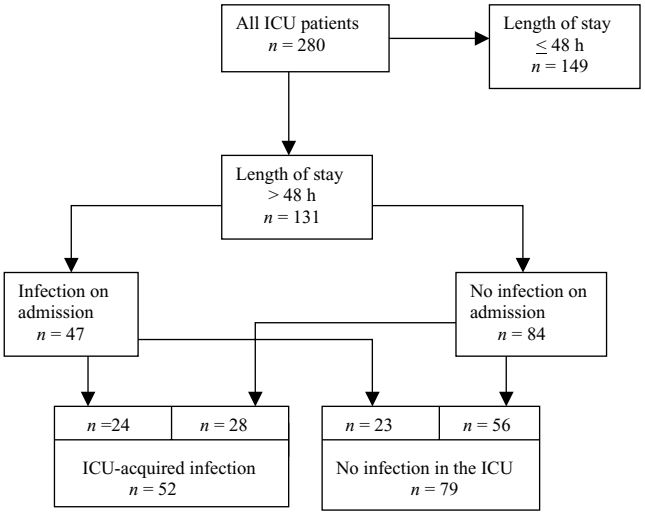


Fig. 1. Schematic presentation of study population according to presence/absence of infection.

operation (1 week before and during the ICU stay), invasive procedures and their period of application (endotracheal intubation, mechanical ventilation, tracheotomy, nasogastric tube, urinary catheterization, peripheral and central intravenous catheterization (CVC), surgical drainage, hemodialysis, bronchial endoscopy, blood transfusion), drug usage and period of application ($H_2$ receptor blocker, steroid, sedative medication), period during which the head of the ICU bed was in a horizontal position (30°), drug addiction (with intravenous drugs as opiates and derivatives for at least 6 months prior to admission), infection on admission and ICU-acquired infection, culture results and administered antibiotics. Prophylactic antibiotic treatment was evaluated but not empiric treatment. To assess the severity of illness on the first day in the ICU, the Acute Physiology and Chronic Health Evaluation (APACHE) II score was used (5).

Decisions on infection or colonization were based on laboratory and clinical evidence. NI was diagnosed according to the standard definitions of the CDC (4,6). Appropriate empiric antimicrobial therapy was given to patients when necessary. Patients were always sampled by bacteriological culture before beginning a new antibiotic therapy. Chest radiography was performed two times a week. Cultures were taken when infection was suspected.

Risk factors for ICU-acquired infection were classified as intrinsic or extrinsic. Intrinsic risk factors were age, gender, cause of admission to ICU, and APACHE II score at admission to the ICU. Some intrinsic risk factors were dichotomized as present or absent such as two or more: underlying diseases, comorbidity, infection on admission and ICU-acquired infection. Extrinsic factors were origin of patients (home or other hospital unit), hospital length of stay prior to ICU admission and length of stay in ICU. The following extrinsic risk factors were recorded as present (at any time during the ICU stay) or absent in a particular patient before the development of ICU-acquired infection: endotracheal intubation, mechanical ventilation, tracheotomy, nasogastric tube, urinary catheterization, peripheral catheterization, CVC, surgical drainage, hemodialysis, bronchial endoscopy, blood transfusion, horizontal position of the head of the bed (<30°), sedative medication, $H_2$ receptor blocker, immunosuppressive therapy, prophylactic antibiotic usage before admission and operation (before or after admission).

The same risk factors mentioned above plus ICU-acquired infections were included in the analysis for mortality.

Patients were classified into 12 categories according to the reason for their admission. However, for the data analysis, the diagnostic groups were classified as pulmonary, neurologic, cardiac, infectious diseases and others.

For statistical analysis, the length of stay in the ICU was grouped into two classes (I: ≤7 days; II: >7 days) because the median length of stay of the patients without ICU-acquired infection was 7 days. APACHE II scores were also grouped into two classes (I: ≤15; II: >15) because the median value for APACHE II scores was 16.

Use of $H_2$ receptor blockers and peripheral venous catheterization were excluded from the statistical analysis because all patients had received them.

Data from both ICUs were combined for analysis, because the number of patients in each ICU was too small for analysis.

Infection rates per 100 patients and per 1,000 patient-days were calculated (7).

**Statistical analyses**: The statistical analyses were done with SPSS software, version 11.5, and values of $P < 0.05$ were considered to indicate statistical significance. Mann-Whitney U-test was used for comparison of age and length of stay in ICU between patients with and without ICU-acquired infection, because they were not normally distributed. Gender, cause of admission, presence of underlying disease and some extrinsic risk factors such as endotracheal intubation, mechanical ventilation, tracheotomy, nasogastric tube, urinary catheterization, peripheral catheterization, CVC and surgical drainage, etc. were compared using chi-square test between patients with and without ICU-acquired infection. After categorical variables were assessed with chi-square tests, all of the risk factors and invasive procedures that were found to be significant with univariate analyses were included in a model, and logistic regression analysis was done. We used the forward stepwise (likelihood ratio) method for the logistic regression analysis. The same statistical tests were used to compare the patients who died and who survived in the ICUs.

## RESULTS

The data collected in this study were taken from 131 adult patients who stayed more than 48 h in the medical and surgical ICUs with a total of 1,654 patient-days (median length of stay: 9 days; range: 1 - 75). One hundred and nine (83.2%) patients were followed in the surgical ICU, and 22 (16.8%) patients were followed in the medical ICU. Of the 131 patients, 69 (52.7%) were male and 62 (47.3%) were female. Their ages ranged from 18 to 91 years (median 53 years). The median APACHE II score was 16 (standard deviation [SD]: 16.6 ± 8.08; range: 0 - 36).

The most frequent primary reasons for admission were respiratory failure (26.7%), neurologic (16.8%) and cardiovascular emergencies (15.2%). Surgical patients accounted for 41.2% of ICU admissions. At the ICU admission, infection was present in 47 (35.9%) patients; 53.6% of these had NI and 46.4% had community-acquired infections. The most common infection site was the respiratory system (42.9%).

ICU-acquired infections were detected in 52 patients (39.7%). Median time to the first ICU-acquired infection was 8 days (SD: 8.75 ± 5.62; range: 3 - 29). Ninety-three NI attacks were identified in these 52 patients. Nine patients

(17.3%) who stayed ≤7 days in the ICU had only one ICU-acquired infection, while 26 of 43 patients who stayed more than 7 days in the ICU had two or more infections. The median lengths of stay in the ICU with and without ICU-acquired infection were 20 and 7 days, respectively ($P < 0.0001$). Twenty-six patients (50%) had one ICU-acquired infection, 17 patients (32.6%) had two, 7 patients (13.4%) had three and 2 patients (3.8%) had six. The infection rates were 56.2 in 1,000-patient days and 70.9 in 100 patients nursed >48 h. Pneumonia, bloodstream, skin and soft tissue infections accounted for the majority of the ICU-acquired infections (35.4, 18.2 and 13.9%, respectively). The distributions of isolated microorganisms by infection sites are shown in Table 1.

The difference between the ICU mortality rates for patients with and without ICU-acquired infection was not statistically significant ($P > 0.05$) (mortality rates: 42.3 and 45.6%, respectively).

Possible infection and mortality risk factors detected by univariate analyses are shown in Tables 2 and 3. The results of univariate analyses showed that cause of admission, infection on admission to ICU, operation (before or after admission to ICU), antibiotic usage before admission, an ICU stay of more than 7 days, sedative medication, and use of tracheotomy, urinary catheterization and CVC were significantly associated with ICU-acquired infections. Also, age, high APACHE II scores (>15), more than two underlying diseases, cause of admission, horizontal position (<30°), parenteral nutrition, use of endotracheal intubation, mechanical ventilation and CVC were found to be significantly associated with mortality.

Final logistic regression analysis showed that >7 days stay in ICU, pulmonary cause of admission, sedative medication, and operation (before or after admission) were statistically significant risk factors for ICU-acquired infection. Age (>60 years), APACHE II (>15), endotracheal intubation, and use of CVC were risk factors for mortality (Table 4).

Table 1. Distribution of causative microorganisms by the sites of ICU-acquired infection

| | Pneumonia *n* (%) | Bloodstream *n* (%) | Skin-soft tissue *n* (%) | Urinary tract *n* (%) | Surgical *n* (%) | Other *n* (%) | Total |
|---|---|---|---|---|---|---|---|
| *S. aureus* | 16 (42.1) | 5 (33.3) | 5 (33.3) | 1 ( 9.1) | 3 (33.4) | – | 30 (30.9) |
| *Acinetobacter* spp. | 11 (28.9) | – | 7 (46.7) | 1 ( 9.1) | 2 (22.2) | 5 (55.5) | 26 (26.8) |
| *P. aeruginosa* | 9 (23.6) | 1 ( 6.7) | – | 1 ( 9.1) | 1 (11.1) | – | 12 (12.4) |
| *Enterococcus* spp. | – | 3 (20.0) | 2 (13.3) | 4 (36.3) | 2 (22.2) | – | 11 (11.3) |
| *E. coli* | – | – | 1 ( 6.7) | 4 (36.3) | 1 (11.1) | 1 (11.1) | 7 ( 7.2) |
| *Candida* spp. | – | 2 (13.3) | – | – | – | 3 (33.4) | 5 ( 5.2) |
| *K. pneumoniae* | 1 ( 2.6) | 1 ( 6.7) | – | – | – | – | 2 ( 2.1) |
| Coagulase-negative staphylococci | – | 2 (13.3) | – | – | – | – | 2 ( 2.1) |
| *Enterobacter* spp. | – | 1 ( 6.7) | – | – | – | – | 1 ( 1.0) |
| α-hemolytic streptococci | 1 ( 2.6) | – | – | – | – | – | 1 ( 1.0) |
| Total | 38 (100) | 15 (100) | 15 (100) | 11 (100) | 9 (100) | 9 (100) | 97 (100) |

Table 2. Intrinsic factors for ICU-acquired infection and mortality (univariate analyses)

| Factors | Infected *n* = 52 (%) | Uninfected *n* = 79 (%) | *P*-value | Survived *n* = 73 (%) | Died *n* = 58 (%) | *P*-value |
|---|---|---|---|---|---|---|
| Age | | | >0.05 | | | <0.05 |
| <20 | 5 ( 9.7) | 4 ( 5.1) | | 6 ( 8.2) | 3 ( 5.2) | |
| 20-39 | 11 (21.1) | 16 (20.2) | | 20 (27.4) | 7 (12.1) | |
| 40-59 | 13 (25.0) | 17 (21.5) | | 20 (27.4) | 10 (17.2) | |
| ≥60 | 23(44.2) | 42 (53.2) | | 27 (36.9) | 38 (65.5) | |
| Gender | | | >0.05 | | | >0.05 |
| male | 29 (55.7) | 40 (50.7) | | 39 (53.4) | 30 (51.7) | |
| female | 23 (44.3) | 39 (49.3) | | 34 (46.6) | 28 (48.3) | |
| APACHE II | | | >0.05 | | | 0.0001 |
| ≤15 | 28 (53.9) | 36 (45.6) | | 50 (68.5) | 14 (24.1) | |
| >15 | 24 (46.1) | 43 (54.4) | | 23 (31.5) | 44 (75.9) | |
| Cause of admission | | | 0.001 | | | 0.01 |
| respiratory | 22 (42.3) | 13 (16.4) | | 23 (31.5) | 12 (20.6) | |
| neurologic | 6 (11.5) | 16 (20.2) | | 10 (13.6) | 12 (20.6) | |
| cardiac | 2 ( 3.8) | 18 (22.7) | | 6 ( 8.2) | 14 (24.1) | |
| infectious | 9 (17.3) | 6 ( 7.5) | | 6 ( 8.2) | 9 (15.5) | |
| other | 13 (25.0) | 26 (32.9) | | 28 (38.3) | 11 (18.9) | |
| Underlying disease | 39 (75.0) | 49 (62.1) | >0.05 | 45 (61.6) | 43 (74.1) | >0.05 |
| ≥2 underlying diseases | 15 (28.8) | 20 (25.3) | >0.05 | 13 (17.8) | 22 (38.0) | <0.05 |
| Infection on admission | 24 (46.1) | 23 (29.2) | <0.05 | 31 (42.5) | 23 (39.6) | >0.05 |

Table 3. Extrinsic factors for ICU-acquired infection and/or mortality (univariate analyses)

| Factors | Infected $n = 52$ (%) | Uninfected $n = 79$ (%) | $P$-value | Survived $n = 73$ (%) | Died $n = 58$ (%) | $P$-value |
|---|---|---|---|---|---|---|
| Origin of patients | | | >0.05 | | | >0.05 |
| home | 9 (17.3) | 11 (13.9) | | 12 (16.4) | 8 (13.8) | |
| other hospital unit | 34 (65.4) | 40 (50.6) | | 41 (56.2) | 33 (56.9) | |
| other hospital | 9 (17.3) | 28 (35.4) | | 20 (27.4) | 17 (29.3) | |
| Length of stay in other departments | | | | | | |
| median (range) days | 5 (1 - 43) | 5 (1 - 90) | >0.05 | 7 (1 - 90) | 4 (1 - 37) | >0.05 |
| Length of stay in ICU | | | 0.0001 | | | >0.05 |
| ≤7 days | 9 (17.3) | 49 (62.0) | | 30 (41.1) | 28 (48.2) | |
| >7 days | 43 (82.7) | 30 (38.0) | | 43 (58.9) | 30 (51.7) | |
| Type of ICU | | | >0.05 | | | >0.05 |
| surgical | 43 (82.6) | 66 (83.5) | | 61 (83.6) | 48 (82.8) | |
| medical | 9 (17.4) | 13 (16.5) | | 12 (16.4) | 10 (17.2) | |
| Operation(before or after admission) | 28 (53.9) | 26 (32.9) | <0.05 | 31 (42.5) | 23 (39.6) | >0.05 |
| Antibiotic usage before admission | 29 (55.7) | 24 (30.4) | 0.004 | 32 (43.9) | 21 (36.2) | >0.05 |
| Sedative medication | 23 (44.2) | 14 (17.7) | 0.001 | 24 (32.8) | 13 (22.4) | >0.05 |
| Imunosuppressive therapy | 22 (42.3) | 28 (35.4) | >0.05 | 27 (36.9) | 23 (39.6) | >0.05 |
| Mechanical ventilation | 49 (94.2) | 66 (83.5) | >0.05 | 58 (79.4) | 57 (98.2) | 0.001 |
| Intubation | 41 (78.8) | 60 (75.9) | >0.05 | 53 (72.6) | 48 (82.7) | 0.001 |
| Tracheotomy | 23 (44.2) | 12 (15.1) | 0.0001 | 22 (30.1) | 13 (22.4) | >0.05 |
| Urinary catheterization | 52 (100) | 74 (93.6) | <0.05 | 69 (94.5) | 57 (98.2) | >0.05 |
| Nasogastric tube | 47 (37.0) | 79 (100) | >0.05 | 72 (98.6) | 54 (93.1) | >0.05 |
| Hemodialysis | 4 (76.0) | 2 ( 2.5) | >0.05 | 4 ( 3.2) | 2 ( 3.4) | >0.05 |
| Surgical drainage | 20 (38.4) | 14 (17.7) | >0.05 | 24 (32.8) | 14 (24.1) | >0.05 |
| Central intravenous catheterization | 48 (92.3) | 59 (74.6) | <0.05 | 52 (71.2) | 55 (94.8) | 0.001 |
| Blood transfusion | 9 (17.3) | 16 (20.2) | >0.05 | 13 (17.8) | 12 (20.6) | >0.05 |
| Endoscopy | 3 ( 5.7) | 6 ( 7.5) | >0.05 | 6 ( 8.2) | 3 ( 5.1) | >0.05 |
| Horizontal position (<30°) | 4 ( 7.6) | 13 (16.4) | >0.05 | 3 ( 4.1) | 14 (24.1) | 0.001 |
| Parenteral nutrition | 14 (26.9) | 25 (31.6) | >0.05 | 13 (17.8) | 26 (44.8) | 0.001 |
| Enteral nutrition | 44 (84.6) | 57 (72.1) | >0.05 | 65 (82.2) | 36 (62.0) | >0.05 |
| ICU-acquired infection | – | – | – | 30 (41.1) | 22 (37.9) | >0.05 |

Table 4. The results of multivarite analyses

a. Significant risk factors for mortality

| Factors | Odds ratio | 95% confidence interval |
|---|---|---|
| Age (>60 years) | 3.65 | 1.48 - 9.0 |
| APACHE II score (>15) | 4.67 | 1.92 - 11.31 |
| Intubation | 3.60 | 1.05 - 12.39 |
| Central intravenous catheterization | 7.85 | 1.61 - 38.32 |

b. Significant risk factors for ICU-acquired infection

| Factors | Odds ratio | 95% confidence interval |
|---|---|---|
| Length of stay in ICU (>7 Days) | 7.02 | 2.80 - 17.56 |
| Respiratory failure | 3.70 | 1.41 - 9.70 |
| Sedative medication | 3.34 | 1.27 - 8.79 |
| Operation (before or after admission) | 2.56 | 1.06 - 6.18 |

## DISCUSSION

The prevention of ICU-acquired infections demands a thorough knowledge of the infection rates and of the source, type and nature of the infection and invading organisms, as well as knowledge of risk factors for infection and mortality (8). We planned this prospective surveillance study to determine the epidemiology and risk factors for NI and mortality in ICU patients at the Kocaeli University Hospital, Turkey.

NI rates from different ICUs are difficult to compare because of differences in surveillance methods and lack of standardized diagnostic criteria. We used the CDC criteria for the diagnosis of NI (5). The time interval between admission and diagnosis of ICU-acquired infection can vary from 0 to 72 h (3,9). We used >48 h, as this is the most commonly cited time interval. In our study, 131 patients stayed longer than 48 h in the ICU, for a total of 1,654 patient-days. ICU-acquired infections were detected in 52 patients (39.7%). The infection rates for 1,000 patient-days and 100 patients nursed >48 h were 56.2 and 70.9, respectively. A large

cohort multicenter study showed that at least one ICU-acquired infection developed in 18.9% of patients, with the incidence ranging from 2.3 to 49.2% across the ICUs (10). Legras et al. (11) found an incidence of NI of 21.6% for patients admitted to the ICU, and Vaque et al. (12) found an NI incidence rate of 22.8% in ICU patients. In another study, the incidence of NI was 34% in patients treated in an ICU for at least 48 h (13). These different findings may be related to the differences in criteria for patient selection, severity of illness, case mix, ICU type, length of stay, rates of device utilization, discharge criteria and quality of care (11,14).

Gender was not a risk factor for infection and mortality in our study, as it was in other studies (13-15).

In our study, age was not a risk factor for ICU-acquired infection by final logistic regression analysis, as it was in other studies (13,14); however, age was a risk factor for mortality in our study, and this finding was in agreement with previous studies (9,11).

It has been reported that a high APACHE II score is related to mortality (13,14,16) but not to infection (9,13,17). On the other hand, it has been reported that the risk of developing ICU-acquired infection increased with high APACHE II score (14,15,18). In our study, a high APACHE II score was a statistically significant risk factor for mortality, but not for NI in ICU patients (Table 4).

Many studies have reported that underlying diseases and comorbidity are associated with mortality (9,13,19) but not with infection (13,19). In our study, underlying diseases and comorbidity were not associated with infection or mortality.

Neurologic failure and trauma as primary reasons for admission to ICUs have been reported as risk factors for subsequent ICU-acquired infections and mortality (13-15,20). In our study, respiratory failure as one of the primary reasons for admission was found to be a significant risk factor for ICU-acquired infection. Mechanical ventilation is widely used in patients with respiratory failure, and this might be explained the increased ICU infection rate in this group.

There have been reports of a positive correlation between overall infection rates and average length of ICU stay (15, 20,21); but not between overall infection rates and mortality (15,21). In our study, an ICU stay of more than 7 days was found to be a significant risk factor only for ICU-acquired infection by multivariate analysis. It was found that the median time to the first ICU-acquired infection was 8 days, and that patients who stayed in the ICU more than 7 days became reinfected during their ICU stay. We therefore believe that increased duration of stay in the ICU might be a risk factor.

Operation and sedative medications increased the risks for ICU-acquired infections by multivariate analysis as in another study (15). Infection on admission and antibiotic usage before ICU admission were found to be risk factors for subsequent infection by univariate analysis, but were not statistically significant in the final logistic regression analysis. These findings were in disagreement with previous studies, in which both these parameters were significant (13-15,20).

Invasive procedures such as CVC and mechanical ventilation have been reported as the most significant risk factors for infection and mortality in many studies (13-15,18-22). In our study, tracheotomy, urinary catheterization and CVC were associated with ICU-acquired infections by univariate analysis, but not by multivariate analysis (Table 3). In univariate analysis, mechanical ventilation, CVC, horizontal position (<30°) and parenteral nutrition were associated with mortality; however, intubation and CVC were statistically significant risk factors for mortality by multivariate analysis.

ICU-acquired infections have been reported to be one of the risk factors for mortality (9,13,20,23); in our study, however, mortality rates were similar in patients with ICU-acquired infection (42.3%) and non-infected patients (45.6%). We think that the insufficient number of patients was responsible for the absence of any significant relationship between mortality and ICU-acquired infection in this study.

The results of different ICU studies have yielded different rates or types of NI. In a multicenter study in Europe, the most frequently reported sites for NI in ICUs were the lungs (47%), lower respiratory tract (18%), urinary tract (18%) and bloodstream (12%) (19), and Trilla (24) reported a similar distribution of infection sites in ICU patients. Richards et al. (25) reported that pneumonias, urinary tract infections and bloodstream infections constituted 77% of all NIs in the United States. In another study, pneumonias (39.7%), urinary tract infections (20.5%) and wound infections (13.3%) were the most common ICU-acquired infections (15). In our study, pneumonias (35.4%), bloodstream infections (18.2%), skin and soft tissue infections (13.9%), urinary tract infections (11.8%) and surgical site infections (9.6%) were the most frequent types of ICU-acquired infections. The rates of ICU-acquired infections were generally in accordance with the results of other studies.

More than half of infections occurring in ICUs are due to Gram-negative bacteria (15,19,25,26) and our data is consistent with these findings. However, the distribution of pathogenic microorganisms tends to vary among the different ICU studies. Vincent et al. (19) reported that the most frequent isolated microorganisms were *Enterobacteriaceae* (34.4%), *Staphylococcus aureus* (30.1%) and *Pseudomonas aeruginosa* (28.7%), de Leon-Rosales et al. (15) reported that they were *Enterobacteriaceae* (25.9%), *P. aeruginosa* (17.2%) and *S. aureus* (10.9%), and in Turkey Erbay et al. (14) reported that they were *P. aeruginosa* (22.6%), methicillin-resistant *S. aureus* (MRSA) (22.2%) and *Acinetobacter* spp. (11.9%). MRSA (30.9%) was the most frequently isolated microorganism in our ICU, and the relatively high rates of MRSA mainly represented ICU-acquired pneumonia (Table 1). In our study, the rate for *Acinetobacter* spp. (26.8%) was higher than in other studies (14,15,19).

Several limitations of the present study should be mentioned the numbers of ICU beds were too few to compare the risk factors for infection separately in the medical and surgical ICUs. Because of the insufficient number of total ICU beds, medical or surgical patients were admitted to the ICU bed available at that moment. Furthermore, if no surgical bed was available, surgical patients were admitted to a bed in the medical ICU and vice versa for medical patients.

In conclusion, the most important risk factors for ICU-acquired infections in our study were an ICU stay of more than 7 days, respiratory failure, sedative medication and operation (before or after admission to ICUs). The patients with respiratory failure were the most at risk for ICU-acquired infections. The significant risk factors for mortality in this study were increasing age (>60 years), elevated APACHE II score (>15), use of endotracheal intubation and CVC.

## REFERENCES

1. Ewans, T. M., Ortiz, C. R. and LaForce, F. M. (1999):

Prevention and control of nosocomial infection in the intensive care unit. p. 1074-1080. *In* R. S. Irwin, F. B. Cerra and J. M. Rippe (eds.), Intensive Care Medicine. 4th ed. Lippincot-Raven, New York.
2. Wenzel, R. P., Thompson, R. L., Lary, S. M., Landry, S. M., Russell, B. S., Miller, P. J., Ponce de Leon, S. and Miller, G. B., Jr. (1983): Hospital-acquired infections in intensive care patients: an overview with emphasis on epidemics. Infect. Conrol, 4, 371-375.
3. Haley, R. W., Culver, D. H., White, J. W., Morgan, W. M., Emori, T. G., Munn, V. P. and Hooton, T. M. (1985): The efficacy of infection surveillance and control programs in preventing nosocomial infections in US hospitals. Am. J. Epidemiol., 121, 182-205.
4. Gardner, J. S., Jarvis, W. R., Emori, T. G., Horan, T. C. and Hughes, J. M. (1988): CDC definitions for nosocomial infections. Am. J. Infect. Control, 16, 128-140.
5. Knaus, W. A., Draper, E. A., Wagner, D. P. and Zimmerman, J. E. (1985): APACHE II: a severity of disease classification system. Crit. Care Med., 13, 818-829.
6. Horan, T. C., Gaynes, R. P., Martone, W. J., Jarvis, W. R. and Emori, T. G. (1992): CDC definitions of nosocomial surgical site infections, 1992: a modification of CDC definitions of surgical wound infections. Infect. Control Hosp. Epidemiol., 13, 606-608.
7. Gaynes, R. P. (1998): Surveillance of nosocomial infections. p. 65-84. *In* J. V. Bennett and P. S. Brachman (eds.), Hospital Infections. Section 4. Lippincott-Raven Publishers, Philadelphia.
8. Weinstein, R. A. (1991): Epidemiology and control of nosocomial infections in adult intensive care units. Am. J. Med., 91, 179-184.
9. Craven, D. E., Kunches, L. M., Lichtenberg, D. A., Kollisch, N. R., Barry, M. A., Heeren, T. C. and McCabe, W. R. (1988): Nosocomial infection and fatality in medical and surgical intensive care unit patients. Arch. Intern. Med., 148, 1161-1168.
10. Alberti, C., Brun-Buisson, C., Burchardi, H., Martin, C., Goodman, S., Artigas, A., Sicignano, A., Palazzo, Z., Moreno, R., Boulme, R., Lepage, E. and Le Gall, R. (2002): Epidemiology of sepsis and infection in ICU patients from an international multicentre cohort study. Intensive Care Med., 28, 108-121.
11. Legras, A., Malvy, D., Quinioux, A. I., Villers, D., Bouachour, G., Robert, R. and Thomas, R. (1998): Nosocomial infections: prospective survey of incidence in five French intensive care units. Intensive Care Med., 24, 1040-1046.
12. Vaque, J., Rosello, J., Trilla, A., Monge, V., Garcia-Caballero, J., Arribas, J. L., Blasco, P., Saenz-Dominiquez, J. R., Albero, L., Calbo, F., Barno, J., Herruzo, R., Saenz-Gonzales, C. and Arevalo, J. M. (1996): Nosocomial infections in Spain: results of five nationwide serial prevalance surveys (EPINE Project, 1990-94). Nosocomial Infections Prevalence Study in Spain. Infect. Control Hosp. Epidemiol., 17, 293-297.
13. Appelgren, P., Hellstrom, I., Weitzberg, E., Soderlund, V., Bindsley, L. and Ransjo, U. (2001): Risk factors for nosocomial intensive care infection: a long-term prospective analysis. Acta Anesthesiol. Scand., 45, 710-719.
14. Erbay, H., Yalcin, A. N., Serin, S., Turgut, H., Tomatir, E., Cetin, B. and Zencir, M. (2003): Nosocomial infections in intensive care unit in a Turkish university hospital: a 2-year survey. Intensive Care Med., 29, 1482-1488.
15. de Leon-Rosales, S. P., Molinar-Ramos, F., Dominguez-Cherit, G., Rangel-Frausto, M. S. and Vazquez-Ramos, V. G. (2000): Prevalence of infections in intensive care units in Mexico: A multicenter study. Crit. Care Med., 28, 1316-1321.
16. Kollef, M. H., Sherman, G., Ward, S. and Fraser, V. J. (1999): Inadequate antimicrobial treatment of infections: a risk factor for hospital mortality among critically ill patients. Chest, 115, 462-474.
17. Bueno-Cavanillas, A., Rodrigues-Contreras, R., Lopes-Luque, A., Delgado-Rodriquez, M. and Galves-Vargas, R. (1991): Usefulness of severity indices in intensive care medicine as a predictor of nosocomial infection risk. Intensive Care Med., 17, 336-339.
18. Fernandez-Crehuet, R., Diaz-Molina, C., de Irala, J., Martinez-Concha, D., Salcedo-Leal, I. and Masa-Calles, J. (1997): Nosocomial infection in an intensive-care unit: identification of risk factors. Infect. Control Hosp. Epidemiol., 18, 825-830.
19. Vincent, J. L., Bihari, D. J., Suter, P. M., Bruining, H. A., White, J., Nicolas-Chanoin, M. H., Wolff, M., Spencer, R. C. and Hemmer, M. (1995): The prevalance of nosocomial infection in intensive care units in Europe. Result of the European Prevalance of Infection in Intensive Care (EPIC) study. JAMA, 274, 639-644.
20. Vincent, J. L. (2003): Nosocomial infections in adult intensive care units. Lancet, 361, 2068-2077.
21. Richards, M. J., Edwards, J. R., Culver, D. H. and Gaynes, R. P. (1999): Nosocomial infections in medical intensive care units in United States: nosocomial infections surveillance system. Crit. Care Med., 27, 887-892.
22. Wezel, R. P., Osterman, C. A., Dobowitz, L. G., Hoyt, J. W., Sande, M. A., Martone, W. J., Peacock, J. E., Jr., Levine, J. I. and Miller, G. B., Jr. (1981): Identification of procedure-related nosocomial infections in high-risk-patients. Rev. Infect. Dis., 3, 701-707.
23. Vosylius, S., Sipylaite, J. and Ivaskevicius, J. (2003): Intensive care unit acquired infection: a prevalance and impact on morbidity and mortality. Acta. Anaesthesiol. Scand., 47, 1132-1137.
24. Trilla, A. (1994): Epidemiology of nosocomial infections in adult intensive care units. Intensive Care Med., 20, 1-4.
25. Richards, M. J., Edwards, J. R., Culver, D. H. and Gaynes, R. P. (2000): Nosocomial infections in combined medical-sugical intensive care units in the United States. Infect. Control Hosp. Epidemiol., 21, 510-515.
26. National Nosocomial Infections Surveillance (NNIS) System Report (1999): Data summary from January 1990-May 1999. Am. J. Infect. Control., 27, 520-532.