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Nosocomial infections and risk factors in intensive care unit of a university hospital in Turkey

Research Article

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Abstract: The aim of this study was to determine the types nosocomial infections (NIs) and the risk factors for NIs in the central intensive care unit (ICU) of Trakya University Hospital. The patients admitted to the ICU were observed prospectively by the unit-directed active surveillance method based on patient and the laboratory over a 9-month-period. The samples of urine, blood, sputum or tracheal aspirate were taken from the patients on the first and the third days of their hospitalization in ICU; the patients were cultured routinely. Other samples were taken and cultured if there was suspicion of an infection. Infections were considered as ICU-associated if they developed after 48 hours of hospitalization in the unit and 5 days after discharge from the unit if the patients had been sent to a different ward in the hospital. The rate of NIs in 135 patients assigned was found to be 68%. The most common infection sites were lower respiratory tract, urinary tract, bloodstream, catheter site and surgical wound. Hospitalization in ICU for more than 6 days and colonization was found to be the main risk factor for NIs. Prolonged mechanical ventilation and tracheostomy, as well as frequently changed nasogastric catheterization, were found to be risk factors for lower respiratory tract infections. For bloodstream infections, both prolonged insertion of and frequent change of arterial catheters, and for urinary tract infections, female gender, period and repeating of urinary catheterization were risk factors. A high prevalence rate of nosocomial infections was found in this study. Invasive device use and duration of use continue to greatly influence the development of nosocomial infection in ICU. Important factors to prevent nosocomial infections are to avoid long hospitalization and unnecessary device application. Control and prevention strategies based on continuing education of healthcare workers will decrease the nosocomial infections in the intensive care unit.

Keywords: *Intensive care unit • Nosocomial infection • Risk factors*

1. Introduction

Patients in the intensive care units (ICUs) are 5 to 10 times more likely to acquire nosocomial infections (NIs) than other hospitalized patients. This increased risk of nosocomial infection (NI) is the result of 3 major factors: (a) intrinsic risk factors related to the need for intensive care, such as severe underlying disease, multiple illnesses, malnutrition, extremes of age, and immunosuppression; (b) invasive medical devices, such as endotracheal tubes for mechanical ventilation, intravascular catheters, and urinary tract catheters; and (c) crowding and animate reservoirs (*e.g.,* colonized or infected patients), which increases the risk of cross-infection in the ICU [1].

The high rate of infections in the ICU results in the use of broad spectrum antibiotics and ultimately, the emergence of antibiotic-resistant microorganisms [2]. Antimicrobial resistance results in increased morbidity,

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mortality, and costs of health care. Therefore, the surveillance and control of infections in ICUs are important [3,4]. The surveillance programs provide data useful for identifying patients, determining the site of infection, and for identifying the factors that contribute to NIs [5].

This study was designed to investigate the NIs and risk factors occurring in the central ICU of Trakya University Hospital.

2. Material and Methods

The study was conducted over 9-month-period at the 6-bed central (medical/surgery) adult ICU of 857-bed Trakya University Hospital in Edirne, Turkey. The patients hospitalized in the ICU were evaluated prospectively with a unit-directed, active surveillance method based on laboratory and the clinical examinations. Patients with an ICU stay less than 2 days were excluded. The APACHE II scores were computed for evaluating the illness severity on admission. The patients were monitored for NIs at all body sites. Samples of urine, blood, sputum, or tracheal aspirate were taken from the patients on the first and the third day of their hospitalization; patients were cultured routinely. Other samples were taken and cultured if there was suspicion of an infection. Infections were considered as ICU-associated if they developed after 48 hours of hospitalization in the unit and 5 days after discharge from the unit if the patients had been sent to a different ward in the hospital. NIs was defined in accordance with the NI definition of US Centers for Disease Control and Prevention [5]. The device utilization ratios and the device-association infection rates were calculated [6]. This study was approved by the Ethics Committee of Trakya University Hospital.

Student's t test, Mann-Whitney U test, χ^2, and Fisher's exact χ^2 tests were used for statistical analysis. $P<0.05$ was considered significant. Also a logistic regression model was used in order to evaluate the risk factors of infections.

3. Results

Over the 9 month-period, 135 patients (63 female and 72 male) with a mean age of 57.8±17.5 (min 16-max 84) were involved in the study. The characteristics of patients are shown in Table 1. They remained a mean 9.2±7.5 (range 2 - 43) days in ICU. A mean of APACHE II scores was found as 14.3±4.8 (range 4 - 24). We could not find any relation between the nosocomial infection and the risk factors belonged to the patients (respiratory deficiency, unconsciousness, usage of H_2 receptor blocker, usage of steroid, usage of immunosuppressive drug, general body trauma, malignity, diabetes mellitus, neutropenia, renal failure, liver failure) (χ^2, $P>0.05$). Overall, 31% of the patients had multiple underlying diseases, 22% of them did not have an underlying disease. Diseases observed frequently included cerebrovascular, cardiovascular, malignancies from cancer, and chronic obstructive lung disease. Sex, age, APACHE II score, and underlying disease were not significant risk factors for NI (Student's t test, χ^2, $P>0.05$).

A total of 92 NI episodes were observed in 58 patients. The mean acquiring time of NI was 8.4±7.1 (range 2 - 38) days after acceptance to ICU. The risk was increased 2.13 folds after six days of hospitalization (%95 CI: 1.51-3.01). The infection sites were the lower respiratory tract (50%), urinary tract (23%), bloodstream (21%), catheter site (3%), and the surgical site (3%).

All the patients had urinary catheterization and most of the patients had mechanical ventilation (93%) and nasogastric catheterization (92%). The relationship between invasive procedures and NIs are shown in Table 2. Tracheostomy and mechanic ventilation were found as the risk factors for lower respiratory tract infection (LRTI) (χ^2, $P<0.05$). An intubation period ≥1 day and tracheostomy period ≥1 day increased the risk for lower respiratory tract infection, respectively 1.23 folds (95% CI: 1.106-1.370) and 1.13 folds (95% CI: 1.046-1.221). Ventilator utilization ratio was 0.96 and ventilator-associated pneumonia rate was found as 3.9/1000 ventilator-days. Frequent changing of the nasogastric catheter was also a risk factor for LRTI (Student's t test, $p<0.05$).

The catheter-associated urinary tract infection rate couldn't be calculated as all the patients had a urinary catheter. Female sex was the main risk factor for urinary tract infection (UTI). The UTI risk was increased 1.1-fold by the urinary catheterization period ≥1 day (95% CI: 1.049-1.188) and 2.3-fold by female sex (OR: 2.32, 95% CI: 0.782-6.890). Renal failure, diabetes mellitus, and the older age were found not significant for UTI (χ^2, $P>0.05$).

The presence of arterial catheters and hemodialysis did not increase the risk of bloodstream infections (χ^2, $p>0.05$). However, the bloodstream infection risk was increased 1.2-fold by the arterial catheterization period ≥1 day (95% CI: 1.106-1.370). Catheter utilization ratio was found as 0.95, catheter associated bloodstream infection rate was found as 5.64 / 1000 catheter days.

38 patients were colonized by the microorganisms during their stay. Mechanical ventilation and prior antibiotic usage did not affect the colonization rate (χ^2, $p>0.05$). The colonization was established in the

Table 1. Characteristics of patients involved in the study.

Characteristics		Patients with NI (n)	Non-infected Patients (n)	P value
Gender	Female	29	34	>0.05
	Male	29	43	
Age (mean)		55.9±18.5	59.3±16.7	>0.05
APACHE II score on admision (mean)		13.6±4.7	14.8±4.8	>0.05
Length of stay (mean)		13.4±8.7 days	6.1±4.4 days	<0.05
Length of stay	≥6 days	43	24	<0.05
	<6 days	16	52	
Mortality		38	47	>0.05
Underlying disease				>0.05
General body trauma		9	9	
Malignancy		9	14	
Diabetes mellitus		4	2	
Neutropenia		4	3	
Renal failure		4	8	
Liver failure		0	2	
Cerebrovascular disease		10	11	
Cardiovascular disease		11	16	
Chronic obstructive lung disease		7	5	
Tuberculosis		1	3	
Admission diagnosis				>0.05
Unconsciousness		50	66	
Respiratory deficiency		58	75	
Postoperative		19	24	
Cardiopulmoner arrest		8	13	
Intoxication		2	6	
Aspiration pneumonia		6	1	
Emergency surgery		13	13	
Elective surgery		5	13	
Preeclampsia		0	2	
Other risk factors				>0.05
Usage of H_2 receptor blocker		48	56	
Usage of steroid		12	12	
Usage of immunosuppressive drug		12	13	
History of hospitalization		43	54	

patients' 7.6±7.7th (1-38) days after admission and the duration of hospitalization was related to the colonization rate. NI rate was 60% (23 of 38) at colonized patients while it was 36% (35 of 97) at non-colonized patients (χ^2, $p<0.05$). In ten (26%) patients NI developed with the same microorganisms and at the same system where the colonization was determined.

A total of 85 (63%) patients died. NI developed in 38 (44.7%) of these patients. No significant relationship with death and NI was found (χ^2, $p>0.05$).

4. Discussion

NIs can vary between countries according to the establishment of preventive measures and developmental status, between the hospitals according to the spectrum of their patients, between the wards of the hospitals according to treatment and intervention.

In this study, the NI rate (68%) in ICU is higher than the NI rates in many university hospitals in Turkey [7,8] and in the other countries [9,10]. Using active surveillance method not only based on the patient but also on laboratory and monitoring the patients 5 days

Table 2. The invasive procedures and their relation with the nosocomial infections.

Invasive procedures	Patients who had nosocomial infection**		Patients who didn't have nosocomial infection		Total	χ^2	p
	n	%	n	%			
Urinary catheter*	58	43	77	57	135	-	-
Mechanical ventilation	46	37	79	63	125	5.582†	<0.05
Nasogastric catheter	44	35	80	65	124	1.346	>0.05
Tracheostomy	27	57	20	43	47	17.534	<0.05
Arterial catheter	56	44	72	56	128	0.595†	>0.05
Perfusion catheter	42	45	52	55	94	0.748†	>0.05
Hemodialysis	2	50	2	50	4	0.054†	>0.05
Peritoneal dialysis	1	13	7	87	8	0.21†	>0.05
Drainage catheter	5	83	1	17	6	0.164†	>0.05

**; The catheter-associated urinary tract infection rate couldn't be calculated as all of the patients had urinary catheter*
***; The infections related with the invasive procedures*
†; Fisher's exact χ^2

after discharge of the unit might have been the reason of the higher NI rate. The distribution of infection sites were reported different in some of these studies from the other countries and the same in some [11-13]. NIs acquired frequently in ICU is lower respiratory tract, urinary tract, bloodstream, surgical wound and catheter associated infections [13]. As mentioned above, the NI frequency and distribution of infection sites are different. So every hospital must take precaution according to their data.

In this study, the ratios of ventilator, catheter and urinary catheter utilization were found higher than those of the other studies. Ventilator associated pneumonia rate in 1000 ventilator days and catheter associated bacteremia rate in 1000 catheter days were found lower than the others [14]. Yet the bacteremia rate was found higher than the bacteremia rate which was reported by McCusker et al. [13]. In this study, although the utilization of these invasive devices were high and prolonged invasive procedure was found as the risk factor for NIs, it was positive that the infection rates in 1000 patient days were low. We could not determine the frequency of catheter associated with urinary tract infections because urinary catheters were carried out to the all patients. Yet urinary catheter was probably the most important risk factor for urinary tract infection and this data was propped up by the invention of the relation between the urinary tract infection with the prolonging urinary catheterization and changing them frequently [15].

Determining the risk factors for NIs was important to control them. Raad et al. [16] reported that the dressing the entrance of catheter site and changing the infusion tube in every 24 hours were more effective than changing the catheter once in every three days. In this study, duration of arterial catheter and changing them frequently were found to be risk factors for bloodstream infection.

In the studies which the investigators examined the risk factors for NIs in ICU and were carried out in the other countries; Girou et al. [12] reported the urinary catheter, McCusker et al. [13] and Gusmào et al. [17] reported mechanical ventilation as risk factors for NIs. Tissot et al. [18] found the catheterization period >11 days and female sex as risk factors for catheter associated bacteriuria. And also Leone et al. [19] reported that female sex, length of ICU stay and duration of catheterization were associated with an increased risk of catheter associated bacteriuria. Apostolopoulou et al. [20] reported that duration of mechanical ventilation ≥5 days was risk factor for ventilator associated pneumonia. In our study, finding the hospitalization in ICU more than 6 days and colonization to be the main risk factors for nosocomial infections showed that severely ill patients tend to have longer hospitalizations and thus have a greater risk of developing a nosocomial infection. And the study from our country, Meric et al. [21] reported length of stay in ICU (>7 days), respiratory failure as a primary cause of admission, sedative medication, and operation (before or after admission to ICU) as significant risk factors for nosocomial infections in intensive care unit.

We did not find a significant relationship between APACHE II score and NI in contrast to Girou et al. [12] and Apostolopoulou et al. [20].

In this study, we found a relationship between colonization and NIs. So it is important to prevent colonization by giving importance to hand washing. In addition, if a bacterial infection has been determined, invasive devices must be changed and an infected patient must be insulated from the other patients to prevent transmission of the microorganisms.

5. Conclusion

A high prevalence rate (68%) of nosocomial infections was found. The main risk factor for Nis were hospitalization in ICU for more than six days and colonization. Prolonged mechanical ventilation and tracheostomy, as well as frequently changed nasogastric catheterization, were found to be risk factors for lower respiratory tract infections. For bloodstream infections, prolonged and frequently changed arterial catheters, and for urinary tract infections, female gender, the period and repeating of urinary catheterization were the risk factors.

This study shows that prevalence rates of intensive care unit-acquired infections are high and suggests that important factors to prevent nosocomial infections are to avoid long hospitalization and unnecessary device application.

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Competing interests

The author(s) declare that they have no competing interests.

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