Causes of nosocomial pneumonia and evaluation of risk factors in a university hospital in Turkey

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ABSTRACT

Objective: To determine the incidence, risk factors, mortality rate, and organisms causing nosocomial pneumonia (NP).

Methods: We carried out this study in the Intensive Care Units (ICUs), General Medical and Surgical wards of Baskent University, Training and Research Hospital in Adana, Turkey, between November 2000 and August 2002. Patients were observed from the time of admission until 48 hours after discharge from the hospital.

Results: In this study, 618 (2.1%) nosocomial infections (NIs) were detected in 29778 patients. One hundred and fifteen of these infections were NP and investigated with surveillance prospectively. The most frequently isolated microorganisms in NP were methicillin-resistant *Staphylococcus aureus* (MRSA) 32.8%, *Pseudomonas* species 21.5%, methicillin-sensitive *Staphylococcus aureus* (MSSA) 10.2%, *Klebsiella* species (9.1%) and *Acinetobacter* species 5.9%, *E. coli*; 5.4% (10/186), *Streptococcus species*; 4.8% (9/186), *Candida species*; 4.8% (9/186), *Enterobacter species*; 2.7% (5/186) and the other bacteria; 2.7%. The predominant pathogens isolated in this study were MRSA (33.8%), *Pseudomonas species* (16.9%) and MSSA (16.9%) in early-onset pneumonias and MRSA (32.2%), *Pseudomonas species* (24.0%), and *Klebsiella species* (10.7%) in late-onset pneumonias.

Conclusion: This study demonstrated that the possibility of developing NP, significantly increases with such risk factors as decreased level of consciousness, respiratory failure, mechanical ventilation and tracheostomy. Each center should know its patients' profile, the factors that increase the infection, the antibiotic resistance patterns of microorganisms, and the distribution of hospital infections in every department. Strategies to prevent both development of antibiotic resistance and spread of resistant organisms are necessary.

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Nosocomial pneumonia (NP) which is an important part of all nosocomial infections (NIs) is a serious illness with substantial morbidity and mortality. Nosocomial pneumonia is defined as pneumonia that develops within 48 hours or more of hospital admission, but not at the time of admission. It is also known as hospital-acquired pneumonia.[1,2] The pneumonias are classified as early- and late-onset. The former develops within 4 days after hospital admission, and the latter on the fifth or more days after hospitalization. The pathogens responsible for early-onset NP are generally endogenous community-acquired pathogens. The microbes responsible for late-onset NP include potentially multi-drug-resistant nosocomial organisms residing in oropharyngeal or gastric contents.[1]

The risk factors for NP include mechanical ventilation of more than 48 hours, stay in intensive care unit (ICU), the duration of stay in ICU or hospital, the severity of underlying illnesses, and the presence of comorbidities. *Pseudomonas aeruginosa (P. aeruginosa)*, *Staphylococcus aureus (S. aureus)*, and *Enterobacter* species are the most common causes of NP.[3] Emphasis has been placed on comparisons of infection surveillance data from various countries to prevent nosocomial infections and achieve an efficient quality of care.[4]

In this study, we aimed to determine the incidence, risk factors, mortality rates, organisms causing NP, and antibiotic susceptibilities at Adana Training and Research Centre of Baskent University.

Methods. This prospective study included patients with NI, which was acquired in the ICUs, general medical and surgical wards of Baskent University, Training and Research Hospital in Adana, Turkey, between November 2000 and August 2002. Patients were observed from admission until 48 hours after discharge from the hospital. Each patient was examined daily by an infectious diseases physician. An infection control nurse collected data from the

patients daily and recorded them on standard surveillance charts, which included name and surname, age, folder numbers, admission and discharge dates, admission service, underlying disease(s), risk factors (malignancy, burn, liver deficiency, general body trauma, diabetes mellitus, decreased levels of consciousness, foreign body/prosthesis, immunosuppression, transplantation, respiratory failure, H2 blockers, neutropenia, renal failure, transfusion), invasive procedures (urinary catheterization, peritoneal catheterization, hemodialysis, intubation, mechanical ventilation, tracheostomy, peripheral and central intravenous catheter, surgical drainage, endoscopic procedure), the site of culture (sputum, blood, nasopharynx, tracheal aspirate, urine and wound), culture results, and administered antibiotic.

During hospitalization, routine tests such as hematological and biochemical tests (daily), chest radiographs (2-4 times in a week), and sputum, blood, nasopharynx, tracheal aspirate, urine and wound (on admission and twice a week) cultures were performed. In case of any change in patients' status including high fever, purulent sputum, change in composition of tracheal secretion, leukocyte counts, appearance of new infiltration on chest radiographs, we obtained sputum and blood samples from all patients, and further took pleural fluid, tracheal aspirates and bronchoalveolar lavage samples from some patients to determine the etiological agents. Each sputum sample was directly examined through gram staining. Mini Api (BioMeriux, France) as well as traditional culturing methods was used to identify infectious agents. Isolation of agents was performed by subculturing samples on chocolate agar, 5% sheep blood agar and Eosin Methylene Blue (EMB) agar.

Diagnosis of NP or colonization was based on laboratory and clinical findings. Appropriate antimicrobial therapy was given to the patients when necessary. Infection control measures and guidelines on prevention of nosocomial infections were applied according to the Centers for Disease Control and Prevention.[5] Microorganism identification and antimicrobial susceptibility tests were performed according to the guidelines of the National Committee for Clinical Laboratory Standards (NCCLS) using Kirby-Bauer disc diffusion method.[6]

Statistical analysis was performed in 2 steps using the Statistical Package for Social Sciences version 10.0 (SPSS Inc., Chicago, USA). We used chi-square and Fisher's exact test (when necessary) to compare several characteristics of NP and other NIs such as gender, underlying illness, procedures and treatments applied. A p value of <0.05 was considered significant. The difference of mean ages between patients with NP

and other NIs was evaluated with t-test. In addition, all significant risk factors ($p<0.05$) in chi square test in patients with NP were included in a model using Backward Logistic Regression. Therefore, this study aimed to find the main risk factors in patients having more than one significant independent variable factor together. In the Backward Logistic Regression test, the patients were considered at no risk if the patients had no other illnesses, no other treatments were applied, and the ages were 40 or below.

Results. In this study, 29778 patients were enrolled, where 5527 of them (18.6%) were in ICUs and 24251 (81.4%) in general services. A total of 618 (2.1%) NIs was detected in 29778 patients. One hundred and fifteen (115/618, 18.6%) of these infections were NP. Of the 115 patients who developed NP, 100 were in ICUs and 59 (51.3%) of them were administered one or more antibiotics before developing NP. Four (3.5%) of other 15 patients, followed in the general services were on medication of one or more antibiotics before developing NP. The others NIs are presented in **Table 1**.

Four hundred and fifteen (415/618, 67.2%) NIs were developed in ICUs, 139 (139/618, 22.5%) in internal services, and 64 (64/618, 10.3%) in surgical services. The length of stay in ICUs was 4.70 ± 0.94 days in the internal intensive care unit, 3.25 ± 0.56 days in the surgical intensive care unit, 2.89 ± 1.06 days in the cardiovascular surgery intensive care unit and 2.08 ± 0.37 days in the coronary intensive care unit. The mean age of the patients who developed NP was 57.26 ± 19.80 years and the mean age of the patients who developed NI except for NP was 48.24 ± 24.36 years ($p<0.01$). Of the patients who developed NP, 45 (45/115, 39.1%) were females and 70 (70/115, 60.9%) were males. Fifty-nine (59/115, 51.3%) patients with NP were over 60 years old, 41 (41/115, 35.7%) were 41-60 years old, and 15 (15/115, 13.0%) were 40 years old or below.

Forty-three (43/115, 37.4%) of the patients who developed NP died and the mean age of these patients was 60.8 ± 17.3 years. Twenty-seven (27/115, 23.5%) of them were aged over 60 years, 13 (13/115, 11.3%) of them were between 41-60 years, 3 (3/115, 2.6%) of them were 40 years or below. Of all the patients who died; 32 (32/43, 77.4 %) had mechanical ventilation, 29 (29/43, 67.4%) had respiratory failure, 26 (26/43, 60.5%) had decreased level of consciousness, and 13 (13/43, 30.2%) had tracheostomy. The ward distribution of the patients with NP and the patients who died due to NP are shown in **Table 2**.

Some characteristics of the patients with NP and other NIs such as malignancy, liver deficiency,

diabetes mellitus, immunosuppression, decreased level of consciousness, respiratory failure, and gender were compared using the chi-square and Fisher's exact test when necessary (**Table 3**). In addition to the factors that were found significant in the 2 tests mentioned above, patients with NP rather than NIs including immunosuppression, respiratory failure, and decreased level of consciousness, catheter, nasogastric tube, urinary catheterization, intubation, mechanical ventilation, tracheostomy, transfusion and age were analyzed using the Backward Logistic Regression test. The risk factors associated with NP were tracheostomy, mechanical ventilation, respiratory failure, age (<60), and decreased level of consciousness (**Table 4**).

A total of 186 microorganisms were isolated in 115 NPs. While only one microorganism was isolated in 66 (57.4%) patients, 2 microorganisms were isolated in 27 (23.5%) patients and 3 microorganisms were isolated in 22 (19.1%) patients. The most frequent isolated microorganisms from patients were as follows:

methicillin-resistant *S. aureus* (MRSA); 32.8% (61/186), *Pseudomonas species*; 21.5% (40/186), Methicillin-Sensitive *S. aureus* (MSSA); 10.2% (19/186), *Klebsiella* species; 9.1% (17/186), *Acinetobacter* species; 5.9% (11/186), *Escherichia coli (E. coli)*; 5.4% (10/186), *Streptococcus* species; 4.8% (9/186), *Candida* species; 4.8% (9/186), *Enterobacter* species; 2.7% (5/186), the other gram negative bacteria; 1.6% (3/186) and the other gram (positive) bacteria; 1.1% (2/186). Of all the microorganisms mentioned above, only 3 (3/186, 1.6%) *Klebsiella* species, 1 (1/186, 0.5%) MRSA, 1 (1/186, 0.5%) *Streptococcus* species and 1 (1/186, 0.5%) *E. coli* was observed in newborn babies.

The sixty-five (34.9%) of NPs were developed in the first 4 days and 121 (65.1%) after the fifth day. In early-onset pneumonias, the predominantly isolated pathogens were MRSA 22 (33.8%), *Pseudomonas* species 11 (16.9%), MSSA 11 (16.9%) and in late-onset pneumonias the most frequently isolated pathogens were MRSA 39 (32.2%), *Pseudomonas* species 29

Table 1 - Distributions of nosocomial infections by services.

Nosocomial infections	Intensive Care Units		Surgical Services		Internal Services		Total**	
	Number (%)*							
Urinary tract infections	109	(61.2)	13	(7.3)	56	(31.5)	178	(28.8)
Bacteriemia	89	(61.4)	12	(8.3)	44	(30.3)	145	(23.5)
Pneumonia	98	(85.2)	5	(4.4)	12	(10.4)	115	(18.6)
Sepsis	52	(83.9)	1	(1.6)	9	(4.5)	62	(10)
Surgical wound infections	7	(7.5)	30	(75)	3	(7.5)	40	(6.5)
Surface wound infections	34	(89.5)	-	-	4	(0.5)	38	(6.1)
Catheter infections	12	(60)	1	(5)	7	(35)	20	(3.2)
Other infections	14	(70)	2	(10)	4	(20)	20	(3.2)
Total	**415**	**(67)**	**64**	**(10.3)**	**139**	**(22.5)**	**618**	**(100)**

*row percentage, **column percentage

Table 2 - Distributions of the patients with nosocomial pneumonia (NP) and the patients who died due to NP according to wards.

Wards	Patients		Nosocomial Pneumonia		Death	
			Number (%)			
Newborn unit	590	(2)	6	(5.2)	-	-
Burn center	127	(0.4)	-	-	-	-
Surgical intensive care unit	1293	(4.3)	35	(30.4)	15	(34.9)
Internal intensive care unit	805	(2.7)	21	(18.3)	10	(23.3)
Cardiovascular surgery intensive care	1069	(3.6)	24	(20.9)	7	(16.3)
Coronary intensive care unit	1643	(5.5)	14	(12.2)	5	(11.6)
Services other than intensive care unit	24251	(81.4)	15	(13)	6	(13.9)
Total	**29778**	**(100)**	**115**	**(100)**	**43**	**(100)**

Table 3 - Distributions of nosocomial pneumonia (NP) and other nosocomial infections (NI) according to some characteristics and type of procedures.

Wards	Other NI			NP		
			Number (%)[†]			
	No		Yes	No	Yes	p[§]
Malignancy	327	(74.5)	19 (86.4)	112 (25.5)	3 (13.6)	>0.05
Liver deficiency	331	(75.1)	15 (75.0)	110 (24.9)	5 (25)	>0.05*
Diabetes mellitus	343	(73.4)	103 (79.2)	88 (26.6)	27 (20.8)	>0.05
Immunosuppression	272	(77.5)	74 (67.3)	79 (22.5)	36 (32.7)	<0.05
Renal failure	291	(73.7)	55 (83.3)	104 (26.3)	11 (16.7)	>0.05
Body trauma	338	(75.8)	8 (53.3)	108 (24.2)	7 (46.7)	>0.05*
Respiratory failure	298	(85.4)	48 (42.9)	51 (14.6)	64 (57.1)	<0.001
Decreased level of consciousness	288	(81.6)	58 (53.7)	65 (18.4)	50 (46.3)	<0.001
Neutropenia	243	(75.1)	3 (75)	114 (24.9)	1 (25)	>0.05*
Hemodialysis	296	(74.2)	50 (80.6)	103 (25.8)	12 (19.4)	>0.05
Vascular procedure	7	(77.8)	339 (75)	2 (22.2)	113 (25)	>0.05*
Catheter	274	(78.5)	72 (64.3)	75 (21.5)	40 (35.7)	<0.05
Endoscopy	317	(74.9)	29 (76.3)	106 (25.1)	9 (23.7)	>0.05
Nasogastric tube	262	(84)	84 (56.4)	50 (16)	65 (43.6)	<0.001
Urinary catheterization	100	(88.5)	246 (70.7)	13 (11.5)	102 (29.3)	<0.001
Intubation	270	(86.8)	76 (50.7)	41 (13.2)	74 (49.3)	<0.001
Mechanical ventilation	274	(87)	72 (49.3)	41 (13)	74 (50.7)	<0.001
Tracheostomy	336	(79.6)	10 (25.6)	86 (20.4)	29 (74.4)	<0.001
Transfusion	242	(79.6)	104 (66.2)	62 (20.4)	53 (33.8)	<0.05
Surgical operation	209	(73.9)	137 (77)	74 (26.1)	41 (23)	>0.05
H2 blockers	220	(73.3)	126 (78.3)	80 (26.7)	35 (21.7)	>0.05

[§]Chi-square test; *Fisher's Exact test; [†]row percentage

Table 4 - The risk factors causing of nosocomial pneumonia (NP) (Backward Logistic Regression).

Features	B	p	OR	95% CI
Decreased level of consciousness	0.672	0.024	1.958	1.092-3.511
Respiratory failure	1.053	0.001	2.866	1.571-5.228
Mechanical ventilation	1.167	0.000	3.212	1.824-5.654
Tracheostomy	1.575	0.001	4.831	1.975-11.818
Age group (<60)	0.982	0.009	2.669	1.279-5.57
NP (constant)	-3.126	0.000	0.044	

(24.0%), and *Klebsiella* species 13 (10.7%), (**Table 5**). The resistance patterns of the main pathogens isolated from patients with NPs are shown in **Table 6**. In our study, imipenem and meropenem and piperacillin/tazobactam were the most effective antibiotic against *E. coli* (100%), this was followed by ceftazidime (80.0%), Aztreonam (70.0%) and ciprofloxacin (60%). In the present study *Pseudomonas* isolates had a higher pattern of resistance. While the most effective antibiotics were piperacillin/tazobactam (85%) and imipenem (80%); and gentamicin (77.5%) was the antibiotic with the highest level of resistance (**Table 6**).

Sixty-eight microorganisms were isolated in the respiratory systems of 43 patients who died due to NP. The most frequently isolated microorganisms from dead patients are as follows: MRSA; 30.9% (21/68), *Pseudomonas* species; 14.7% (10/68), *Klebsiella* species; 7.4% (5), *Acinetobacter* species; 5.9% (4/68), and MSSA; 5.9% (4/68).

Discussion. Nosocomial pneumonia accounts for 15% of all NIs[7] and affects 0.5-2% of hospitalized patients.[7,8] The mortality rate for NP exceeds 30%, though the attributable mortality rate is lower. The etiologic agents responsible for NP have been elucidated in numerous studies.[8]

Although NPs are the second or the third most frequent infections in our country as is all over the world, morbidity and mortality associated with NPs are high. The rates of NP vary between different clinics and hospitals. Nosocomial pneumonias occurs relatively frequently and is associated with a high rate of mortality; therefore, it is important to prevent, promptly diagnose, and effectively treat.[9,10]

Klavs et al[11] from Slovenia, Lizioli et al[12] from Italy, Mamikoglu et al[13] from Turkey reported that NP accounts for the second most frequent cause of all NIs and accounts for 21.7%, 22.4%, 20.6% of all NIs

respectively. In our study, we found out that NP was the third most frequent cause of all NIs and accounted for 18.6% of all NIs and 0.004% of all hospitalized patients.

Rello et al[14] reported that NP was developed in patients with an average age of 62 years and that 75% of them were males. In our study, the mean age of the patients was 57.26 ± 19.80 years and 61% of them were male. Although the mortality rate related to NP is over 30%, directly definable mortality is lower than that.[15] Rello et al[14] reported that 34.3% of the patients who developed NP died, which yields similar results to those found in our study (37.4%).

Table 5 - Microorganisms isolated during early and late-onset pneumonia.

Features	Number (%)			
	1-4 Days		5 and Upper Days	
MRSA	22	(33.8)	39	(32.2)
Pseudomonas species	11	(16.9)	29	(24)
Klebsiella species	4	(6.2)	13	(10.7)
Acinetobacter species	3	(4.6)	8	(6.6)
Escherichia coli	5	(7.7)	5	(4.1)
MSSA	11	(16.9)	8	(6.6)
Streptococcus species	4	(6.2)	5	(4.1)
Enterobacter species	1	(1.5)	4	(3.3)
The other gr (-) bacteria	2	(3.1)	1	(0.8)
The other gr (+) bacteria	1	(1.5)	1	(0.8)
Candida species	1	(1.5)	8	(6.6)
Total	**65/186**	**(34.9)**	**121/186**	**(65.1)**

MRSA - methicillin-resistant *Staphylococcus aureus,*
MSSA - methicillin-sensitive *Staphylococcus aureus*

Gram negative bacteria, including *P. aeruginosa, Enterobacter* species, *Acinecobacter* species and enteric gram negative bacilli are responsible for 55-85% of NPs; gram positive cocci, especially *S. aureus* accounts for 20-30%; and 40-60% of these cases are polymicrobial.[3] An analysis of 112 medical ICUs from 97 National Nosocomial Infections Surveillance System hospitals from 1992 to 1997 cited *S. aureus* as a cause of 20% of NPs.[16] Today, 30% of the nosocomial *S. aureus* isolates have resistance to methicillin in the United States.[17]

Jones et al[18] in their study in the USA and Canada, showed that *S. aureus* (22.9%) was the most frequent bacterium in NPs, followed by *P. aeruginosa* (18.1%), *Haemophilus influenza (H. influenza)* (10.3%), *Klebsiella* species (8.7%), *S. pneumonia* (7.7%), *Enterobacter* species (7.4%). Balaban et al[19] found the most frequent isolated microorganisms in NPs were *Acinecobacter* species (35.8%), *P. aeruginosa* (30.7%), MRSA (28.2%), *Klebsiella pneumoniae* (17.9%), *E. coli* (12.8%), MSSA (7.6%). In our study, the most frequently isolated microorganisms were MRSA (32.8%), *Pseudomonas* species (21.5%), MSSA (10.2%), *Klebsiella* species (9.1%) and *Acinetobacter* species (5.9%) and 42.6% of our cases were polymicrobial.

Prodhom et al[20] noted that *S. aureus*, *Streptococcus pneumoniae* and *H. influenzae*, alone or in combination, accounted for 54% of the cases of early-onset pneumonias, whereas gram-negative bacilli were present in only 17% of these episodes. It was reported in a study by George et al[21] that *S. pneumoniae* and *H. influenzae* were responsible for the cases of early-onset NPs. The most frequently isolated microorganisms responsible for early-onset NPs in our study were MRSA (33.8%), MSSA (16.9%) and *Pseudomonas* species (16.9%).

Table 6 - The susceptibility patterns of different antibiotics to the main pathogens isolated from patients with nosocomial pneumonia.

Antibiotics	Number (%)							
	Pseudomonas species		*Klebsiella* species		*Acinetobacter* species		*Escherichia coli*	
Amikacin	21	(47.5)	5	(70.6)	9	(18.2)	2	(80)
Netilmicin	19	(52.5)	4	(76.4)	1	(90.9)	2	(80)
Tobramycin	28	(30)	7	(58.8)	6	(45.5)	3	(70)
Gentamicin	31	(22.5)	8	(52.9)	11	(0)	4	(60)
Imipenem	8	(80)	1	(94.1)	0	(100)	0	(100)
Meropenem	13	(67.5)	1	(94.1)	0	(100)	0	(100)
Aztreonam	30	(25)	5	(70.6)	10	(90.1)	3	(70)
Piperacillin/Tazobactam	6	(85)	6	(64.7)	7	(36.4)	0	(100)
Ciprofloxacin	14	(65)	3	(82.4)	7	(36.4)	4	(60)
Norfloxacin	9	(77.5)	11	(35.3)	1	(90.9)	3	(70)
Ceftazidime	22	(45)	1	(94.1)	4	(63.7)	2	(80)
Cefepime	16	(60)	5	(70.6)	0	(0)	3	(70)

After hospitalization, generally early-onset nosocomial pneumonia has been mainly caused by *S. pneumoniae* and *H. influenzae*. Our results, however, showed that MRSA and *Pseudomonas* species were the major causes of the early-onset NP although they were the major causes of late-onset pneumonia agents. This could be attributed to the physical conditions of ICUs and its staff who is not as cautious about the hygiene on the nursing instruments. Therefore, nursing staff should be frequently educated about hygiene conditions in ICUs.

The *P. aeruginosa, Acinetobacter* species, and MRSA account for 30 to 71% of the causes of late-onset NP.[3] In our study, late-onset NPs were due to MRSA (32.2%), *Pseudomonas* species (24%), *Klebsiella* species (10.7%). As a result, the rates of isolated microorganisms vary from one center to another, and MRSA, *P. aeruginosa, Acinetobacter* species, and *Klebsiella* species are most frequently isolated microorganisms. It has been reported that certain pathogens, such as *P. aeruginosa, Acinetobacter baumannii*, and MRSA, are particularly lethal.[22] One study revealed that *P. aeruginosa*, MRSA and *Acinetobacter* species were responsible for 20-43%, 15-28% and 6-25% of the cases respectively and that the mortality rate in these patients was over 50%.[23] In our study, it has been found that 43 (37.4%) of the patients who developed NP died. Isolated from the patients who were already dead were MRSA and *Pseudomonas* species.

We compared some characteristics of patients with NP and NIs with chi-square and Fisher's exact test. The NP was more frequent than NIs in patients with immunosuppression ($p<0.05$), decreased level of consciousness, ($p<0.001$) and respiratory failure. The rate of transfusion, drain/catheter application ($p<0.005$) nasogastric tube insertion ($p<0.001$), urinary catheter ($p<0.001$), intubation ($p<0.001$), mechanical ventilation ($p<0.001$) and tracheostomy ($p<0.001$) was higher in the patients with NPs than those with NIs. There was no significant difference in gender, malignancy, liver deficiency, diabetes mellitus, renal failure, body trauma and neutropenia between the patients with NPs and other patients with NIs ($p>0.05$) (**Table 2**).

In addition, the factors that were found to have meaningful difference through chi-square and Fisher's exact test in **Table 2** for developing NP were analyzed with Backward Logistic Regression test and it was determined that some factors increased the development of NP. The results of this analysis have shown that decreased levels of consciousness, respiratory failure, mechanical ventilation, tracheostomy, and aged over 60 years aggravated NP development 1.96, 2.87, 3.21, 4.83, 2.67 times respectively (**Table 3**). Torres et al[24] investigated the risk factors for NP in their study, and found that NP increased by 2.7 times due to respiratory

failure, 2.67 times due to interventional procedures to respiratory tract, 1.92 times due to chronic obstructive lung diseases, 2.45 times due to mechanical ventilation and 3.05 times due to tracheostomy. Celis et al[25] determined that NP increased by 5-8 times due to depressed consciousness, by 3.7 times due to chronic lung disease and by 2.3 times due to being 70 years old or over. The findings of the present study were consistent with those reported by Torres et al[24] and Celis et al.[25]

In previous studies were conducted in Turkey, the percentage of ESBL producers were 19.5% and 50%.[26,27] In a study studies, the percentages of *E. coli* isolates producing ESBL were 6.7%. In *Klebsiella* isolates, these percentages were 50% and 60%.[27] In the study Yaman et al[28] the average percentage of ESBL producing isolates was 36.4% for *E. coli, Klebsiella* species and *S. marcescens* combined; but 20.9% for *E. coli* and 50% for *K. pneumoniae* and 46.7% for *S. marcescens*. In their study, meropenem was 100% effective against these isolates and imipenem was 98.5%.[28] In previous studies in our country, the carbapenems were found to be the most effective antibiotics.[29,30] Similarly to these results,[26-30] in our study, carbapenems were found to be the most effective antibiotics against Gram negative bacteria such as *Acinetobacter* species, *E. coli* and *Klebsiella* species.

As a result, NP is still a serious problem like all other NIs. The NP poses a considerable risk for morbidity, mortality, and increase residence in ICU or hospital and costs. In this study, we determined that NP development significantly increased the risk factors such as decreased levels of consciousness, respiratory failure, mechanical ventilation and trachaeostomy. Each center should know its patients' profile, the factors that increase the infection, antibiotic resistance patterns of patients, and distribution of hospital infections in each department. Strategies to prevent both the development of antibiotic resistance and spread of resistant organisms are necessary.

Infection control programmes are necessary to monitor and to prevent nosocomial infections. It has known that implementation of infection control measures directed towards limiting person-to-person spread is effective in controlling nosocomial infections. Also, proper collaboration between hospital staff, and especially hand hygiene is of paramount importance.

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