Journal of Microbiology and Infectious Diseases / JMID
2013; 3 (1): 3-7
doi: 10.5799/ahinjs.02.2013.01.0070

ORIGINAL ARTICLE

Risk factors for nosocomial pneumonia in intensive care units of a University Hospital

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ABSTRACT

Objective: The evaluation of risk factors in patients with Nosocomial pneumonia (NP) may provide useful guidance for patients who need intensive care. The aim of this study was to identify risk factors of NP in ICU.

Methods: During the six months period of time, patients who stayed in ICUs for at least 48 hours were included in a tertiary medical center. A total of 304 patients were prospectively followed and 78 of them who developed NP made up the NP group. Patients who did not develop any infection were defined as control group. Variables which was thought or detected as a risk factor of NP in univariate analysis were analyzed with multivariate logistic regression analysis.

Results: Among 304 patients, 78 (25.6%) had NP. Multivariate analysis revealed that advanced age (odds ratio [OR] 1, 95% confidence interval [CI] 1.00-1.06), length of stay (LOS) in the ICU (OR 1.3, 95% CI 1.17-1.39), prior infection on admission to ICU (OR 6.7, 95% CI 1.52-29.94), transfusion of blood and blood products (OR 4.0, 95% CI 1.43-11.46) and prior antibiotic usage within the last two weeks before admission (OR 3.3, 95% CI 1.28-8.48) were independent risk factors for NP. Additionally, the mean APACHE II score of cases with NP (16.7±6.7) was significantly higher than that of controls (11.5±8.1; p<0.001).

Conclusion: We must be awake to make the diagnosis earlier in patients with determined risk factors: advanced age, LOS in ICU, prior infection, transfusion of blood products and prior antibiotic usage. . *J Microbiol Infect Dis 2013; 3(1): 3-7*

Key words: Intensive care unit, nosocomial pneumonia, risk factors

Bir Üniversite Hastanesinde yoğun bakım ünitelerinde nozokomiyal pnömoni risk faktörleri

ÖZET

Amaç: Nozokomiyal pnömoni (NP) yoğun bakım ünitesi (YBÜ)'nde en sık karşılaşılan nozokomiyal enfeksiyondur. NP gelişen hastalardaki risk faktörlerinin değerlendirilmesi YBÜ ihtiyacı olan hastalar için yol gösterici olabilir. Bu çalışmanın amacı YBÜ'de gelişen NP risk faktörlerinin belirlenmesidir.

Yöntemler: Altı aylık süre içerisinde, bir üniversite hastanesinin YBÜ'lerinde 48 saatten uzun kalan hastalar çalışmaya alındı. Toplam olarak 304 hasta prospektif izlenirken, bu hastaların NP gelişen 78'i NP grubunu oluşturdu. Herhangi bir enfeksiyon gelişmeyen hastalar ise kontrol grubu olarak tanımlandı. Tek değişkenli analiz ile NP risk faktörü olabileceği düşünülen veya saptanan değişkenler çok değişkenli lojistik regresyon analizi ile incelendi.

Bulgular: 304 hastanın 78'inde (% 25,6) NP gelişti. Çok değişkenli analiz ile ileri yaş (odds ratio [OR] 1, %95 güven aralığı [CI] 1,00-1,06), YBÜ'de yatış süresi (OR 1,3, % 95 CI 1,17-1,39), YBÜ öncesi enfeksiyon varlığı (OR 6,7, %95 CI 1,52-29,94), kan ürünü transfüzyonu (OR 4, %95 CI 1,43-11,46) ve YBÜ yatışından önceki 2 hafta içerisinde antibiyotik kullanım öyküsü (OR 3,3, %95 CI 1,28-8,48) NP için bağımsız risk faktörleri olarak tanımlandı. Ayrıca, NP gelişen hastaların ortalama APACHE II skoru (16,7±6,7) kontrol grubundan anlamlı olarak yüksek bulundu (11,5±8,1; p<0.001).

Sonuç: Nozokomiyal pnömoni özellikle YBÜ'lerde hastanede yatış süresini, maliyeti ve mortaliteyi arttıran önemli bir enfeksiyon hastalığıdır. İleri yaş, yatış öncesi enfeksiyon varlığı, YBÜ'de yatış süresinin uzunluğu, kan ürünü transfüzyonu ve önceden antibiyotik kullanımı gibi tanımlanmış risk faktörleri olan hastalarda erken tanı açısından uyanık olunmalıdır.

Anahtar kelimeler: yoğun bakım ünitesi, nozokomiyal pnömoni, risk faktörü

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Received: 20.09.2012 Accepted: 18.12.2012

INTRODUCTION

Nosocomial pneumonia (NP) is one of the most frequent nosocomial infections (NIs) in intensive care unit (ICU). The frequency varies with the type of hospital, type of ICU, the population of patients and the definition of NP.[1,2] It is associated with a significantly increased length of stay (LOS) in hospital and has a substantial impact on morbidity and mortality.[3-5] One of the most important risk factor of NP is mechanical ventilation (MV) associated with a 3 to 21 fold risk.[6,7] The colonization of the upper airways is the key factor for NP, but there are many other factors implicated NP, such as sedation techniques, inappropriate use of antibiotics and recumbent positioning.[8-10] We believe that detection of risk factors of NP may increase the awareness of the health professionals to prevent NP. Herein, we performed a prospective study to determine the risk factors associated with NP acquired in the adult ICUs in a university hospital in the north-western part of Turkey.

METHODS

Study Population

This prospective study was carried out in a 350-bed referral and tertiary care university hospital, Zonguldak Karaelmas (newly named Bülent Ecevit) University, Turkey. The hospital contains all major services, including medical and surgical subspecialties with approximately 14.000 patients annually. This study was conducted in the surgical ICUs (SICUs) with 14 beds and medical ICU (MICU) with 10 beds. All of the ICUs were located on the same hallway, designed with an open system and each ICU room had 4 or 5 patient beds. During a 6-months period of time, 304 patients older than 16 years of age who stayed in the ICUs for at least 48 hours were evaluated. Among the 304 patients 78 of them who developed NP made up the NP group. Patients who stayed at ICU more than 48 hours and didn't develop any infection were defined as control group.

Local ethical committee approvals were received prior the study.

Surveillance Data

Data collection included identification of patients, physical examination findings, clinical diagnosis on admission to the ICU, LOS in the ICU and in the hospital, APACHE II score on admission, prior surgery, prior antimicrobial use, and underlying and/or concomitant diseases. The invasive procedures were also recorded. Specimens to perform culture tests were obtained according to clinical indications. The collection of culture materials was done under aseptic conditions as per the Centers for Disease Control and Prevention (CDC) guidelines.[11] The patients were followed daily until death or NP cured.

Definitions

NP was defined according to CDC criteria.[11] NP was considered as ventilator-associated pneumonia (VAP) if its onset occurred after 48 h of MV. Respiratory failure was diagnosed when PaO_2 was less than 60 mmHg and/or $PaCO_2$ was equal to or greater than 50 mmHg in room air or when MV required. Empirical antibiotic treatment was started to the patients who developed NP. It was based on previous surveillance cultures and the Gram's stain and modified according to antibiotic susceptibility testing results.

Statistical analysis

Statistical analyses were performed using statistical software SPSS version 11.0 (SPSS Inc., Chicago, IL, USA) for Microsoft Windows. The significance of difference between groups was evaluated using Chi-square test with correction when appropriate and Student's t-test as indicated and significance level was accepted as $p < 0.05$. Variables which was thought or detected as a risk factor of NP in univariate analysis were analyzed with Multivariate logistic regression analysis. These variables are age, primary diagnosis, chronic renal failure, congestive heart failure, immunosupression, prior admission to the hospital in last 3 months, LOS in ICU, having an infection on admission to ICU, APACHE II score and hypoalbuminemia on admission to ICU, invasive catheters applied at ICU, transfusion of blood or blood products, total parenteral nutrition (TPN), enteral nutrition, aspiration, sedation, bronchoscopy, and antibiotic usage within the last two weeks before the admission to ICU.

RESULTS

In this prospective study of 304 patients, NP developed in 78 patients (25.6%) with a density rate of 23.1 cases per 1000 patient-days. Overall, 11.5% of 304 patients developed VAP. Thereby, VAP accounts 44.9% (n= 35) of all patients with NP during the study period. VAP density rate was 28.7 cases of NP per 1000 ventilator-days. The mean time for NP occurrence was 9.1±6.0 days following hospital admissions. The mean time for VAP occurrence was 5.2±3.1 days after MV. Non-invasive MV (NIMV) accounted for 10.3% of all patients with NP, and 9% of control patients (p=0.75).

The demographics of the patients are shown in Table I. The mean age of the patients was 61.4±17.1 (range, 17-89) years. Patients with NP were significantly older than the control patients (p=0.002). The mean APACHE II score was significantly higher in NP patients than in control group (p<0.001). The mean LOS in the ICU was significantly longer in NP patients than that of control patients (p<0.001). The mean time for NP occurrence was 7.4±5.3 days after ICU admission. The crude mortality rate of NP and control group is 62.8% and 20.1% respectively (p <0.001). It was calculated that NP was 6.7 fold increased crude mortality rate.

Univariate analysis suggested the following risk factors for the development of NP: Age, APACHE II score, LOS in ICU, presence of heart failure, renal failure, hemodialysis, prior hospitalization within the last three months, antibiotic usage within the last two weeks, presence of community onset infection on admission to ICU, prior intra-abdominal infection on admission to ICU, sedative therapy, transfusion of blood and blood products, hypoalbuminemia, MV, indwelling of a central venous catheter (CVC), indwelling of an arterial catheter, nasogastric tube and bronchoscopy (Table 1). Lengths of invasive procedures were also an important risk factor of NP (Table 2).

Multivariate logistic regression revealed that advanced age (odds ratio [OR] 1, 95% confidence interval [CI] 1.00-1.06), length of stay (LOS) in the ICU (OR 1.3, 95% CI 1.17-1.39), prior infection on admission to ICU (OR 6.7, 95% CI 1.52-29.94), transfusion of blood and blood products (OR 4, 95% CI 1.43-11.46) and prior antibiotic usage within the last two weeks before admission (OR 3.3, 95% CI 1.28-8.48) were independent risk factors for the development of NP (Table 3).

Table 1. Potential risk factors for nosocomial pneumonia in intensive care units

Risk Factors	Patients (n=78)	Controls (n=189)	P-value
Mean age±SD (year)	66.2 ± 13.0	59.2 ± 17.8	0.002
Male gender, *n* (%)	47 (60.3)	123 (65.1)	0.45
Type of intensive care unit (ICU), *n* (%)			
Surgical	29 (37.2)	85 (44.9)	0.242
Medical	49 (62.8)	104 (55.1)	
Mean APACHE II score±SD	16.7 ± 6.7	11.5 ± 8.1	<0.001
Heart Failure, *n* (%)	17 (21.8)	19 (10.1)	0.01
Renal Failure, *n* (%)	9 (11.5)	9 (4.8)	0.04
Hemodialysis, *n* (%)	12 (15.4)	11 (5.8)	0.011
Mean length of stay in ICU±SD (days)	17.8 ± 15.5	5.6 ± 4.1	<0.001
Previous hospitalization in last 3 months, *n* (%)	31 (39.7)	54 (28.6)	0.05
Previous antibiotic therapy in last 2 weeks, *n* (%)	56 (71.8)	86 (45.5)	<0.001
Community onset infection on admission to ICU, *n* (%)	35 (44.9)	8 (30.7)	0.03
Intra-abdominal infection on admission to ICU, *n* (%)	8 (10.2)	8 (4.2)	0.02
Sedative therapy, *n* (%)	22 (28.2)	17 (9)	<0.001
Blood and blood products transfused patients, *n* (%)	53 (67.9)	89 (47.1)	0.002
Mean blood albumin level±SD (g/dL)	3.0 ± 0.9	3.2 ± 0.8	0.05
Mechanical ventilation, *n* (%)	46 (58.9)	52 (27.5)	<0.001
Central venous catheter, *n* (%)	59 (75.6)	77 (40.7)	<0.001
Arterial catheter, *n* (%)	22 (28.2)	32 (16.9)	0.04
Nasogastric tube, *n* (%)	68 (87.1)	119 (62.9)	<0.001
Bronchoscopy, *n* (%)	9 (11.5)	7 (3.7)	0.014
Crude Mortality, *n* (%)	49 (62.8)	38 (20.1)	<0.001

Table 2. The duration (days) of invasive procedures in intensive care units (mean±SD)

Invasive device type	Patients (n=78)	Controls (n=189)	P-value
Endotracheal intubation	5.95 ± 8.19	0.91 ± 2.15	<0.001
Tracheostomy	3.76 ± 10.56	0.23 ± 2.16	<0.001
Nasogastric tube	11.58 ± 12.54	2.61 ± 3.60	<0.001
Surgical drain	3.50 ± 6.23	1.48 ± 3.59	0.001
Arterial catheter	1.62 ± 3.34	0.61 ± 1.99	0.003

Table 3. Multivariate logistic regression analysis of risk factors for nosocomial pneumonia

Risk factors	Odds Ratio	95% Confidence Interval	P-value
Age (*year*)	1.0	1.00-1.06	0.04
Length of stay in ICU	1.3	1.17-1.39	<0.001
Community-onset infection on admission to ICU	6.7	1.52-29.94	0.01
Transfusion of blood and blood products	4.0	1.43-11.46	0.009
Prior antibiotic usage in last 2 weeks	3.3	1.28-8.48	0.01

DISCUSSION

Despite recent advances in intensive care and antimicrobial therapy, NP rate for ICU patients is still high. In the previous studies the incidence of NP has been reported to be between 6.8% and 27%.[4,8,12,13] In our study the incidence of NP was 25.6% and it was very high, with a density rate of 23.1 cases per 1000 patient-days in our ICUs. It is known that longer duration of tracheostomy has increased the occurrence of NP, especially MV increases the risk of NP by 3- to 10-fold.[7,13,14] In our study 44.9% of the cases with NP occurred in patients who are mechanically ventilated. Additionally NIMV is not detected as a risk factor in our study. Consequently, the use of NIMV should be preferred whenever possible, since it has lower rates of NP.[15-17]

Prolonged stay in an ICU is reported as an important risk factor of NP.[18-20] In our study LOS in ICU was related with NP. The excess LOS in hospital due to NI depends on the type of infection and it has been estimated 7 to 30 days for pneumonia.[21] We found that the mean time of NP occurrence was 7.4 days after ICU admission.

Immunosupression is known to be a risk factor of both community acquired and NIs. But it was determined as a risk factor of mortality not of ventilator associated pneumonia in some studies, similar to our study.[19] Both nasogastric drain and proton pomp inhibitor usage, previously known risk factors for NP, were not risk factors of NP in our multivariate analysis.[6-8] These are essential applications in ICU. Almost all of patients had nasogastric drain and were given proton pomp inhibitors in our ICUs. So we could not detect a relation between these risk factors and NP.

Risk factors for different infections of different organ systems are similar. If the patient has risk factors for another infection, those factors may have caused a risk for NP. We found that prior antibiotic usage for another infection is a risk factor of NP as in similar studies in literature.[8,12]

In conclusion, NP is an important infectious disease especially in ICUs, which increases the LOS in hospital, costs and mortality. Unless we succeed in preventing NP, we have to alert to make the diagnosis earlier in patients with determined risk factors including advanced age, LOS in ICU, prior infection, transfusion of blood and blood products, and prior antibiotic usage. The results of this study should serve as a reference point for greater surveillance and for institution of greater preventive measures.

Conflict of interest: The authors report no conflict of interest.

Financial support: None

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