

INCIDENCE AND RISK FACTORS FOR NOSOCOMIAL PNEUMONIA AMONG INTUBATED PATIENTS IN A PROVINCIAL HOSPITAL, EASTERN THAILAND

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Abstract. The present study was conducted to determine the incidence and risk factors for nosocomial pneumonia (NP) among intubated patients in a provincial hospital, eastern Thailand. Three hundred five intubated patients who voluntarily participated and signed informed consent were observed and medical records were collected. The respiratory secretion specimens from NP patients, diagnosed by doctors under the definition of the International Statistical Classification of Disease and Related Health Problems Tenth Revision (ICD-10), were collected for bacterial culture. Data from patients with and without NP were analyzed to identify risk factors. The results revealed that the incidence of NP was 38.4% (117/305 cases). Of 117 NP patients, 35% were positive on bacterial culture. The most frequently isolated bacteria were *Klebsiella pneumoniae* and *Klebsiella* spp (32%), and the incidence of methicillin resistant *Staphylococcus aureus* (MRSA) was 6%. Risk factors for NP from univariate analysis were (a) age more than 60 years (OR=9.2, p<0.001), (b) admitted to the ICU (OR=1.7, p=0.042), (c) comatose (OR=12.2, p<0.001), (d) chronic pulmonary disease (OR=5.3, p<0.001), tuberculosis (OR=14.3, p<0.001), (e) smoking (OR=7.1, p<0.001), and (f) duration of intubation greater than 5 days (OR=8.8, p<0.001). After controlling for confounders using multivariate analysis, the significant risk factors were (a) age greater than 60 years (OR=9.9, p<0.001), (b) comatose (OR=9.4, p=0.031), (c) chronic pulmonary disease (OR=5.2, p<0.001), tuberculosis (OR=11.4, p=0.003), (d) smoking (OR=3.6, p<0.001), and (e) duration of intubation more than 5 days (OR=18.9, p<0.001). When an intubated patient has these risk factors, they should be considered a potential risk for NP and preventive measures should be taken to reduce the risk.

INTRODUCTION

Nosocomial infection in hospital is a common health problem throughout the world. Patients with chronic diseases or accidents may have to be admitted for long periods of time, therefore, they are at greater risk for nosocomial infection. The infections may be severe even causing the fatalities (Gross *et al*, 1980).

Nosocomial infections may also be resistant to antibiotics making treatment difficult (Boyce *et al*, 1993; Goldmann *et al*, 1996). A WHO survey in 1987 reported a nosocomial infection rate of 8.7%, or 14 million cases in 55 hospitals in 14 countries (Danchaivijitr, 1988). Another study found nosocomial pneumonia (NP) was the second most common type of infection after urinary tract infection (The National Nosocomial Infection Surveillance System, 1993). The infection rate increases 6-21 fold in intubated patients, while non-intubated patients have only 0.3% of this number (Cross and Roup, 1981; Grap and Munro, 1997).

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Patients intubated for greater than 48 hours had 25-40% rate of NP. The risk for NP depended on the length of time intubated, and the mortality rate was approximately 5% (George, 1993; Heyland *et al*, 1999). Analyses of pneumonia-associated morbidity have shown that pneumonia can prolong hospitalization by 4-9 days (Craven and Steger, 1995; Bonten and Bergmans, 1999; Heyland *et al*, 1999; Kollef, 1999). Because of its frequency, high fatality rate, and attendant costs, NP is a major infection control problem in the hospital.

In Thailand, nosocomial infection surveillance in 1988 reported an 11.7% incidence rate and a 7% mortality rate for 14,000 cases. About 1,000 million baht is lost to this problem per year (Danchavijitr and Choklokaew, 1989). A second national study in 1992 found 21.1% of lower respiratory tract infections, 19.7% of urinary tract infections and 16.6% of surgical site infections were nosocomial (Danchavijitr *et al*, 1995). Trat Hospital is a provincial hospital in eastern Thailand containing 350 patient beds. The hospital cares for patients with numerous health problems, including infectious diseases, chronic diseases and accidents. It also cares for patients with respiratory failure who are intubated and on mechanical ventilation. A Trat Hospital report for October 2002 - September 2003 showed the hospital had cared for 1,800 intubated patients and the trend for NP increasing (Planning and Information Division, 2003). Investigations of the incidence of NP and identification of preventable risk factors are valuable for developing preventive measures to reduce the incidence and the risk of NP in the hospital.

MATERIALS AND METHODS

Study design and subjects

A cross-sectional study of 305 intubated patients was conducted to assess the incidence of nosocomial pneumonia and risk fac-

tors in Trat Hospital between July 2004 and June 2005. These studied patients voluntarily participated and signed informed consents. For patients in coma and/or patients who could not read or write, the consent form was signed by a family member after receiving study information. The medical ward, surgical ward and ICU were selected for this study because most patients who were intubated were on these three wards. All studied patients and their family members were interviewed using a structured questionnaire including socio-demographic factors and current patient's illnesses. The treatment procedure was recorded and respiratory secretion specimens from the patients with NP diagnosed by doctors under the definition of the International Statistical Classification of Disease and Related Health Problems Tenth Revision (ICD-10) were collected for bacterial culture. After diagnosis of NP, the studied patients were divided into two groups: the first group was patients with NP and the second group was patients without NP. Information form for the interviews and medical records in the two groups were analyzed to search risk factors for NP.

Sample size calculation

The sample size of studied patients was calculated using the formula: $n = (Z^2_{\alpha/2} PQN) / (Z^2_{\alpha/2} PQ + Nd^2)$. With P=proportion of NP incidence from previous observations=0.4 (Planning and Information Division, 2003), $Z_{\alpha/2}=1.96$ at $\alpha=0.05$, $Q=1-P$, N=number of intubated patients at Trat Hospital in 2004=1,800 cases, $d=0.05$; the calculated sample size was approximately 305 cases. All cases who voluntarily participated were included until the total number was 305 cases.

Laboratory methods

Approximately 50% of patients with NP were randomly selected for collecting respiratory secretion specimens depending on the doctor's decision. Respiratory secretion speci-

mens including endotracheal or bronchial secretions were collected for Gram stain and bacterial culture. Bacteria were cultured on blood agar, chocolate agar, MacConkey agar and the FTM broth (Fluid Thioglycolate medium). All plates were incubated at 35-37°C for 24-72 hours. Suspected colonies were identified by biochemical tests.

Data analysis

Data from interviews and laboratory tests were analyzed using descriptive statistics including percentage, mean and standard deviation. The risk factors for NP were analyzed using χ^2 test, odds ratio (OR) and 95% confidence interval of OR. For controlling confounders and for evaluating the effect of risk factors for NP on univariate analysis, multiple logistic regression was applied. The critical level of $\alpha=0.05$ was used for statistical significance.

Ethical approval

The study protocol was approved by the Ethics Committee of Mahidol University (Ref No. 167/2003) and of Trat Hospital.

RESULTS

General characteristics of the studied patients

Almost 50% of studied patients were more than 60 years of age and 44.6% were 21-60 years. The mean age was 56.8 years. Approximately 56% were males and 65.3% were married. A majority (59.4%) were in the intensive care unit (ICU); 22.6% in the medical ward and 18% in the surgical ward. About 43.9% had finished the primary level of education and 16.7% had finished a vocational level or higher. Almost 39% had an occupation in commerce or as a skilled worker, 26.9% were laborers and 20.3% were agriculture workers. The mean monthly income for the family was 5,674.1 baht (\approx US\$ 167).

Incidence of nosocomial pneumonia

Of the 305 studied patients (Table 1), 117 developed NP (incidence rate 38.4%). The in-

cidence was relatively higher in patients older than 60 years (61.8%) and in patients admitted to the ICU (43.1%). When the incidence was analyzed by consciousness levels, there was a higher incidence found in patients in semi-coma or coma (36.5% and 77.3%, respectively). Respiratory secretion cultures collected from 117 NP patients were positive for bacteria in 35% (41/117) (Table 2). The most frequently isolated bacteria were *Klebsiella pneumoniae* and *Klebsiella* spp (32%), *Acinetobacter anitratus* and *Acinetobacter* spp (24%), *Pseudomonas aeruginosa* and *Pseudomonas* spp (10%) and methicillin resistant *Staphylococcus aureus* (MRSA) (6%) (Table 2).

Risk factors for nosocomial pneumonia

On univariate risk analysis, the risk factors for NP were: (1) age of patient greater than 60 years (OR=9.2; $p<0.001$), (2) admitted to ICU (OR=1.7; $p=0.042$), (3) comatose (OR=12.2; $p<0.001$), (4) patient has chronic pulmonary disease (OR=5.3; $p<0.001$), tuberculosis (OR=14.3; $p<0.001$), (5) smoker (OR=7.1; $p<0.001$), and (6) duration of intubation more than 5 days (OR=8.8; $p<0.001$) (Table 3).

Multiple logistic regression was applied to control for confounders and evaluate the effect of risk variables on NP. The variables which were significant ($p<0.05$) in Table 3 were entered into the logistic regression model. The significant risk factors were: (1) age greater than 60 years (OR=9.9; $p<0.001$), (2) comatose (OR=9.4; $p=0.031$), (3) chronic pulmonary disease (OR=5.2; $p<0.001$), tuberculosis (OR=11.4; $p=0.003$), (4) smoking (OR=3.6; $p<0.001$), and (5) duration of intubation more than 5 days (OR=18.9; $p<0.001$) (Table 4).

DISCUSSION

The results show the incidence of NP among intubated patients was 38.4%. This incidence is lower than a previous study in

Table 1
Incidence of nosocomial pneumonia among studied patients classified by some variables.

Variables	Number of studied patients	Incidence of NP	
		Number	Percentage
Age group (years)			
≤ 40	73	5	6.6
41-60	80	18	22.5
> 60	152	94	61.8
Gender			
Male	171	66	38.6
Female	134	51	38.1
Wards			
Intensive Care Unit	181	78	43.1
Surgical ward	55	13	23.6
Medical ward	69	26	37.7
Conscious levels			
Good conscious	23	5	21.7
Semi-coma	260	95	36.5
Coma	22	17	77.3
Total	305	117 ^a	38.4

^a41 cases (35%) were positive for bacterial isolation

NP: Nosocomial pneumonia

Table 2
Results of bacterial isolation from 50 secretion specimens in 41 nosocomial pneumonia patients with positive culture.^a

Bacterial isolation results	Secretion specimens with positive bacterial isolation	
	No.	(%)
<i>Klebsiella pneumoniae</i> and <i>Klebsiella</i> spp	16	(32)
<i>Acinetobacter anitratus</i> and <i>Acintobacter</i> spp	12	(24)
<i>Enterobacter</i> spp	5	(10)
<i>Pseudomonas aeruginosa</i> and <i>Pseudomonas</i> spp	5	(10)
<i>Staphylococcus aureus</i>	4	(8)
<i>Staphylococcus epidermidis</i>	5	(10)
Methicillin resistant <i>Stapylococcus aureus</i>	3	(6)

^aSecretion specimens from some nosocomial pneumonia patients were collected more than 1 time

Thailand (Siriwat, 1998). The peak incidence was in patients age greater than 60 years old (61.8%). This is similar to a study by the American Thoracic Society (ATS) which reported a greater risk for NP in patients age greater than

60 years (American Thoracic Society, 1996). This may be due to the patient's immunity, which is relatively lower among older individuals. Our study demonstrated the incidence of NP in males was equal to females (38.6% vs

Table 3
Significant risk factors for nosocomial pneumonia (NP) on univariate analysis.

Studied factors	Patients with NP	Patients without NP	Odds ratio (OR) (95% CI of OR)	p-value from χ^2 test
Age (years): > 60	94	51	9.2 (5.3-15.9)	< 0.001 ^a
≤ 60	23	130	1.0	
Gender : Male	66	105	1.0 (0.6-1.6)	1.000
Female	51	83	1.0	
Studied ward: ICU	78	103	1.7 (1.1-2.7)	0.042 ^a
Medical/Surgical wards	39	85	1.0	
Income (Baht): <math>< 5,000</math>	64	107	1.1 (0.7-1.7)	0.723
$\geq 5,000$	53	81	1.0	
Conscious levels: Coma	17	5	12.2 (3.0-49.9)	< 0.001 ^a
Semi-coma	95	165	2.1 (0.8-5.8)	0.178
Good conscious	5	18	1.0	
Underlying diseases: Chronic pulmonary disease	94	82	5.3 (3.1-9.1)	< 0.001 ^a
Others	23	106	1.0	
Smoking: Yes	77	40	7.1 (4.3-11.9)	< 0.001 ^a
No	40	148	1.0	
Duration of admission: > 5 days	112	170	2.4 (0.9-6.6)	0.118
≤ 5 days	5	18	1.0	
Duration of intubation: > 5 days	95	62	8.8 (5.0-15.3)	< 0.001 ^a
≤ 5 days	22	126	1.0	
Receiving antibiotics during admission: No	21	37	0.9 (0.5-1.6)	0.765
Yes	96	151	1.0	

^a Statistical significance at $\alpha = 0.05$

Table 4
Summary of important risk factors for nosocomial pneumonia on logistic regression analysis (multivariate analysis).

Risk factors	B	Exp (B) (Adjusted OR)	95% CI of Adjusted OR	p-value
Age: > 60 yrs	2.3	9.9	4.4 - 22.7	< 0.001 ^a
Studied wards: ICU	0.8	2.2	0.9 - 5.3	0.071
Conscious levels: Coma	2.2	9.4	1.2 - 72.7	0.031 ^a
Duration of intubating: > 5 days	2.9	18.9	7.3 - 48.7	< 0.001 ^a
Underlying disease: Chronic pulmonary disease	1.7	5.2	2.3 - 11.9	< 0.001 ^a
Smoking: Yes	1.3	3.6	1.6 - 8.3	< 0.001 ^a

^a Statistical significance at $\alpha = 0.05$

38.1%). The incidence in patients admitted to the ICU was higher than in the medical and surgical wards. It is supported by the finding that a

high incidence is found in patients in semi-coma or coma. This may be due to low activity and decreased immunity in these patients.

Only 50 respiratory secretion specimens from patients with NP were collected for bacterial cultures. This was based on the physician's decisions and could not be controlled for. About 35% of the total respiratory secretion specimens from patients with NP were positive for bacteria. Thirty-two percent was positive for *Klebsiella pneumoniae* or *Klebsiella* spp, 24% were positive for *Acinetobacter anitratus* or *Acinetobacter* spp, 10% were positive for *Enterobacter* spp, 8% were positive for *Pseudomonas aeruginosa* or *Pseudomonas* spp, 8% were positive for *Staphylococcus aureus*, and 6% were positive for methicillin resistant *Staphylococcus aureus* (MRSA). Thirty-six patients were infected with one type of microorganism and 5 patients were infected with more than one type of microorganism. The isolated bacteria in the present study were similar to those from previous studies (Pierce and Sanford, 1974; Laforce, 1981). The isolation rate was relatively low due to the limitations of the hospital laboratory. This hospital laboratory could not culture anaerobic bacteria, fungi, or viruses, which were probably some of the causative organisms.

Data from univariate analysis showed age and patient ward were associated with NP ($p < 0.001$ and 0.042 , respectively). Patients admitted to the ICU had a higher risk for NP because many of these patients were semi-comatose or comatose. However, the patient ward was not a significant risk factor on multivariate analysis. These findings are similar to the results of a previous study (Siriprapapon, 1995). Other studied socio-demographic variables, such as gender, marital status, education, occupation and income per month were not associated with NP in the present study ($p > 0.05$).

Concurrent patient illness, such as chronic pulmonary disease and tuberculosis, were associated with NP, because disruption of the pulmonary parenchyma is a primary

cause of bacterial colonization. Smoking was a risk factor on both univariate and multivariate analyses. Comatose level of consciousness was a risk factor since those patients are more likely to aspirate colonized bacteria around the oral or tracheal tubes. The duration of intubation has also been reported to be a risk factor in other studies (Celis *et al*, 1988; Kollef, 1993), especially a duration of intubation greater than 5 days is associated with NP ($p < 0.001$). On multivariate analysis, age greater than 60 years, comatose level of consciousness, duration of intubation greater than 5 days, chronic pulmonary disease, tuberculosis and smoking were associated with higher rates of NP ($p < 0.001$, $p = 0.031$, $p < 0.001$, $p < 0.001$, $p = 0.003$, and $p < 0.001$, respectively). Age greater than 60 years may be associated with lower immunity. Comatose patients are more likely to aspirate colonized bacteria. Longer duration of intubation is associated with colonization with bacterial pathogens (Celis *et al*, 1988; Kollef, 1993). Patients with chronic pulmonary disease, tuberculosis or other immunocompromising diseases had a higher risk for NP. We found that smoking increased the risk for NP probably due to the effects of nicotine on the vascular wall. Arteries and subcutaneous tissues are more likely to lack oxygen as has been seen in other studies (Vinton *et al*, 1991; Sirensen *et al*, 1999). Smoking delays wound healing as was found in a study of risk factors for nosocomial surgical site infections (Luksamijarulkul *et al*, 2006). Our findings confirmed some factors were preventable, such as the level of consciousness of the patient and smoking. The patient and family members should be educated regarding these factors while in the hospital. When individuals, especially the elderly, are sick and have chronic disease or signs of lower respiratory disease, they should be taken to the hospital to receive early medical treatment. Education regarding the effects of direct and passive smoking

should be integrated into routine health education in the hospital.

Our observations showed the standard precautions (SP) of nurses were at relatively low and middle levels, and some nurses were not aware of SP. Many reasons, such as heavy work-load, over confidence of some nurses and ignorance have been reported as risk factors for NP (Simmons and Wong, 1982; Conly *et al*, 1989). A training program emphasizing standard precautions should be provided to reduce the incidence of NP.

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