Incidence of nosocomial pneumonia and causative bacteria among chronically ill patients admitted in a general hospital

Klairoong Sangsawang*  Pipat Luksamijarulkul**
Sukhontha Siri***  Supachai Pitikultang****


Background : Nosocomial pneumonia (NP) is ranked high among all health care associated infections. The incidence and causative bacteria may be different from studied hospital to the others.

Objective : To investigate incidence of NP and its causative bacteria among chronically ill patients who were admitted at a general hospital in the central region of Thailand.

Methods : A prospective study, which was carried out in department of medicine of a general hospital in the central region of Thailand from April to September 2016. A total of 330 chronically ill patients who were admitted to the department of Medicine. NP is defined as pneumonia with onset no less than 48 hours after hospital admission and NP diagnosed by doctors. The causative bacteria were cultured from sputum of NP patients. Identification was carried out by standard biochemical profile and to test the multi-drug resistance of the bacteria from the microbiological laboratory of the study hospital. The descriptive statistics were used to analyze data.

* A part of M.Sc. Thesis entitled “Incidence of nosocomial pneumonia and related factors among chronically ill patients admitted in a provincial hospital”
* Candidate of Master of Science (Public Health), Program in Infectious Disease and Epidemiology, Faculty of Public Health/ Graduate Studies, Mahidol University
** Department of Microbiology, Faculty of Public Health, Mahidol University
*** Department of Epidemiology, Faculty of Public Health, Mahidol University
**** Department of Family Health, Faculty of Public Health, Mahidol University
Results: Among 330 chronically ill patients, 50% were female, and 58.2% were over 60 years of age. The incidence of NP was 16.4% (54/330) or 17.0 per 1,000 patient-days. The incidence of ventilator associated pneumonia (VAP) was 43.5% (40/92) or 32.7 per 1,000 ventilator days and the incidence of hospital-acquired pneumonia (HAP) was 5.9% (14/238) or 8.0 per 1,000 patient-days. Female patients, with age > 60 years, with underlying diseases such as cardiovascular and metabolic syndrome, patients with subconscious and unconscious, those with total dependence, those with long admission days, and those with medical instrument uses had relatively higher incidence of NP. The most predominant causative bacteria was A. baumannii (34.3%). Among sputum with A. baumannii, 79.2% were multiple-drug resistance A. baumannii (MDR - A. baumannii).

Conclusion: Chronically ill patients admitted at the hospital, especially, those with long duration of admission and/or receiving medical instrument had relatively higher incidence of NP. Among them, the predominant causative bacteria was A. baumannii with multiple-drug resistance.

Keywords: Nosocomial pneumonia, chronically ill patients, Incidence, A. baumannii.
โอกาสของปอดอักเสบจากการติดเชื้อในโรงพยาบาลและแบคทีเรียที่เป็นสาเหตุในผู้ป่วยโรคเรื้อรังในโรงพยาบาลทั่วไปแห่งหนึ่ง จุฬาลงกรณ์เวชสาร 2560 ก.ย. – ธ.ค.;61(5): 563 – 76

เหตุผลของการทำวิจัย: การเกิดปอดอักเสบจากการติดเชื้อในโรงพยาบาลจัดว่าเป็นการติดเชื้อลำดับต้นๆ ของการติดเชื้อในโรงพยาบาล อาจมีความแตกต่างของอุบัติการณ์การเกิดปอดอักเสบจากการติดเชื้อในโรงพยาบาลและแบบที่เรียกเป็นสากลในโรงพยาบาลแต่ละระดับ

วัตถุประสงค์: เพื่อศึกษาอุบัติการณ์การเกิดปอดอักเสบจากการติดเชื้อในโรงพยาบาล และแบบที่เรียกเป็นสากลในผู้ป่วยที่เจ็บป่วยด้วยโรคเรื้อรังในโรงพยาบาลทั่วไปแห่งหนึ่งที่ตั้งอยู่ภาคกลางของประเทศไทย

วิธีการทำวิจัย: การศึกษาแบบติดตามไปจนถึงในผู้ป่วยที่เจ็บป่วยด้วยโรคเรื้อรังจำนวน 330 ราย ที่พักพักในแผนกอายุรกรรมโรงพยาบาลทั่วไปแห่งหนึ่งที่ตั้งอยู่ภาคกลางของประเทศไทย ดังนั้นจะมีผู้ป่วย 330 รายที่บันทึกและเพาะชีววิทยาและทดสอบทางชีวเคมีและทดสอบเชื้อดื้อยาโดยห้องปฏิบัติการทางจุลชีววิทยาของโรงพยาบาลที่ศึกษา วิเคราะห์และนำเสนอผลการวิจัยโดยใช้สถิติเชิงพรรณนา

ผลการศึกษา: ผู้ป่วยด้วยโรคเรื้อรังที่ทำการศึกษาจำนวน 330 ราย เป็นเพศหญิง ร้อยละ 50 อายุมากกว่า 60 ปี ร้อยละ 58.2 อุบัติการณ์การเกิดปอดอักเสบจากการติดเชื้อในโรงพยาบาลคิดเป็นร้อยละ 16.4 (54/330) หรือ 17 ครั้งต่อ 1,000 patient-days โดยที่อุบัติการณ์การเกิดปอดอักเสบจากการใช้เครื่องช่วยหายใจ คิดเป็นร้อยละ 43.5 (40/92) หรือ 32.7 ครั้งต่อ 1,000 ventilator days และอุบัติการณ์ของปอดอักเสบที่ไม่ได้ใช้เครื่องช่วยหายใจ คิดเป็นร้อยละ 5.9 (14/238) หรือ 8.0 ครั้งต่อ 1,000 patient-days ผู้ป่วยเพศหญิง, อายุมากกว่า 60 ปี, มีประสบการณ์เป็นโรคเรื้อรังทั้งหมดและหลอดเลือดและกลุ่มอาการทางเมแทบอลิก, ผู้ป่วยที่มีระดับความสูงตัวต่ำเกินแปลง, ไปจนถึง fen...
ผู้ป่วยที่ช่วยเหลือตนเองไม่ได้, ผู้ป่วยที่พักผ่อนในโรงพยาบาลเป็นเวลานาน, และผู้ป่วยที่ได้รับการรักษาด้วยอุปกรณ์ทางการแพทย์รวมถึงเครื่องช่วยหายใจ, มีอุบัติการณ์ติดเชื้อสูงกว่า สำหรับแบคทีเรียที่เป็นสาเหตุส่วนใหญ่ที่พบประกอบด้วย A. baumannii โดยชื่อ A. baumannii ที่พบประมาณ 34.3 เปอร์เซ็นต์, และชื่อ A. baumannii ที่พบประมาณ 79.2 เปอร์เซ็นต์ของกลุ่ม

สรุป:
ผู้ป่วยที่เจ็บป่วยด้วยโรคเรื้อรังที่พักผ่อนในโรงพยาบาล โดยเฉพาะอย่างยิ่งผู้ป่วยที่พักผ่อนในโรงพยาบาลเป็นเวลานาน, และ/หรือ ผู้ป่วยที่ได้รับการรักษาด้วยเครื่องช่วยหายใจมีอุบัติการณ์อาการเกิดปอดอักเสบจากการติดเชื้อในโรงพยาบาลที่สูง แบคทีเรียที่เป็นสาเหตุของอาการติดเชื้อที่พบส่วนใหญ่เป็นชื่อ A. baumannii ด้ว

คำสำคัญ:
ปอดอักเสบจากการติดเชื้อในโรงพยาบาล, ผู้ป่วยด้วยโรคเรื้อรัง, อุบัติการณ์, A. baumannii.
Nosocomial pneumonia (NP) is the first or second of nosocomial infection ranked among all health care associated infections.\textsuperscript{(1,2)} It is defined as pneumonia that has the onset no less than 48 hours after hospital admission.\textsuperscript{(3)} NP is common in those who receive mechanical ventilation but it can also develop in non-ventilated patients. Previous studies have identified NP in general wards and found that an incidence ranged from 2.45 to 4.5 per 1,000 patient-days.\textsuperscript{(4,5)} The international Nosocomial Infection Control Consortium (INICC) reported the overall rate of ventilator-associated pneumonia (VAP) was 0.9 to 13.1 per 1,000 ventilator days.\textsuperscript{(1)} In Thailand, the incidence rate of NP was 21.8 per 1,000 patient-days and VAP was 28.3 per 1,000 ventilator days.\textsuperscript{(6)} A causative bacterial pathogen of NP included 60% of gram-negative bacilli, representing most frequently identified pathogens: \textit{Pseudomonas aeruginosa}, \textit{Enterobacteriaceae}, \textit{Klebsiella} spp., \textit{Escherichia coli} and \textit{Acinetobacter} spp.\textsuperscript{(7,8)} Many studies on NP have been performed in Intensive Care Units, but few have focused on patients in general wards including Thailand. Additionally, the incidence and causative bacteria may vary by the studied hospitals depending on the hospital environments and health care worker practices. Most studies demonstrated that NP was associated with the risk factors of respiratory tract colonization and patient-related conditions due to impairments in host defensive function.\textsuperscript{(3)} The conditions included chronic diseases, coma, malnutrition, hypotension, metabolic acidosis, cigarette smoking, and the presence of a number of comorbid illness, such as central nervous system (CNS) dysfunction, diabetes mellitus and alcoholism.\textsuperscript{(9)} Chronic diseases are defined as long-term diseases that develop slowly over time, often progressing in severity, and can often be controlled, but rarely cured.\textsuperscript{(10)} Accordingly, this study focuses on finding out the incidence of NP and its causative bacteria in admitted chronically ill patients in a general hospital, in the central area of Thailand.

**Materials and Methods**

**Study design, subjects, sample size calculation**

A prospective study was conducted on chronically ill patients admitted to male and female medical wards and sub-intensive care unit (sub-ICU) from April to September, 2016. As for the male and female medical wards and sub-ICU, these wards were the place to support the whole medical patients included chronically ill patients. The most of patients in sub-ICU received mechanical ventilator and no coma. Additionally, the environments and arrangement of three units were similarly condition such as open air unit, no air condition, and arrangement in units. Moreover, total of 330 studied patients were all patients who met the inclusion criteria and were admitted in the three units in the period of studied time. Quantitative data from surveillance form and patient’s records were included. The causative bacteria were investigated from patient’s sputum and reported from laboratory unit of studied hospital. Totally, 330 chronically ill patients were included due to the sample size calculated from the formula:\textsuperscript{(11)}

\[
n = \frac{Z^{2} \alpha/2 \ PQ}{d^2}
\]

Where: $Z_{\alpha/2}$ = alpha error at alpha 0.05 = 1.96  
$P$ = proportion of incidence of NP from a previous study = 0.28 \textsuperscript{(6)}  
$Q$ = 1-P  
$d$ = allow able error 0.05
Patients who voluntarily participated were included. The inclusion criteria were patients with chronic diseases, both sex, aged \( \geq 18 \) years, and admitted in 3 studied units (male, female medical wards and sub-ICU) within 48 hours. Consequently, patients with NP before 48 hours after admitted in studied wards were excluded. These studied only patients who were full consciousness and able to sign their informed consent forms. However, for those who were not full consciousness and/or patients who could not read or write, the consent form was signed by a family member after receiving study information. After signing informed consents, these patients were followed-up and observed. Studied patients and their family members were interviewed using a surveillance form including socio-demographic characteristics. The patients’ health status, medical instrument use, respiratory secretion specimens from patients with NP and NP diagnosis by doctors were recorded. All studied patients were observed until discharge or dead or referred to other units. As for patients who were referred to other units, a 48-hours follow-up was done to observe whether or not the patient develop NP. NP is defined as an infection of lung parenchyma that is neither present nor incubation at the time of hospital admission and which develops after 48 hours of hospital admission. Additionally, VAP is defined as pneumonia that occurs after 48 hours of endotracheal intubation and initiation of mechanical ventilation or within 48 hours after endotracheal tube removal. NP and VAP were diagnosed by doctors.

Research tools

Surveillance form and record forms

A surveillance form and record forms were followed Augsornsri C. (2014)[12], however, the content validity of the forms was re-checked by 3 experts on infectious diseases prevention and epidemiology. These involve patients’ health status and medical instrument use such as: sex, age, body weight, height, history of underlying diseases, level of consciousness, functional status, duration of admission, receiving mechanical ventilator, receiving nasogastric tube, aerosol therapy, antibiotic use before NP and steroid use. Sputum specimens were collected from all observed patients to culture the causative bacteria and to test the multi-drug resistant bacteria at microbiological laboratory of the study hospital.

Statistical analysis

Data were analyzed using descriptive statistics with SPSS program version 18.

Ethical approval

The research protocol was approved by the Ethics Committee for Human Research, Faculty of Public Health, Mahidol University (COA. No. MUPH 2016-027) and the Ethics Committee of the studied hospital (Reference No. 2/2559) before data collection.

Results:

Socio-demographic characteristics of studied chronically ill patients

Among 330 chronically ill patients, 50% were female. Approximately, 40.9% were admitted in a male medical unit, 38.2% were admitted in a female medical unit and 20.9% were admitted in sub-ICU. The majority of studied chronically ill patients aged over 60 years, had normal body mass index (BMI) 18.5 - 24.9, and finished their primary school and had no income. (Table 1)
Incidence of NP classified by some socio-demographic characteristics

The incidence rate of NP was 16.4% (54/330) or 17.0 per 1,000 patient-days. When the incidence was classified by some socio-demographic characteristics, it showed that the incidence of NP in female, that in age group > 60 years and that in BMI ≥ 30 was relatively higher than that in male, that in age group ≤ 60 years and with BMI < 30, respectively. (Table 2)
mechanical ventilator or received nasogastric tube and others were relatively higher than that those with consciousness, those with partial dependence or complete independence, and those admitted to hospital $\leq 20$ days, those without mechanical ventilator or nasogastric tube, and others, respectively. (Table 3)

### Table 2. Incidence of NP among studied chronically ill patients classified by some socio-demographic characteristics and admitted units.

<table>
<thead>
<tr>
<th>Socio-demographic characteristics and admitted units</th>
<th>No. of studied patients</th>
<th>Incidence of NP</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sex</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>165</td>
<td>32 19.4</td>
</tr>
<tr>
<td>Male</td>
<td>165</td>
<td>22 13.3</td>
</tr>
<tr>
<td><strong>Age (years)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$&gt; 60$</td>
<td>192</td>
<td>39 20.3</td>
</tr>
<tr>
<td>$\leq 60$</td>
<td>138</td>
<td>15 10.9</td>
</tr>
<tr>
<td><strong>Body Mass Index (BMI, kg/m$^2$)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\geq 30$ (obese)</td>
<td>25</td>
<td>5 20.0</td>
</tr>
<tr>
<td>$25.0 - 29.9$ (overweight)</td>
<td>81</td>
<td>15 18.5</td>
</tr>
<tr>
<td>$18.5 - 24.9$ (healthy)</td>
<td>164</td>
<td>24 14.6</td>
</tr>
<tr>
<td>$&lt; 18.5$ (underweight)</td>
<td>60</td>
<td>10 16.7</td>
</tr>
<tr>
<td><strong>Admitted units</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male medical ward</td>
<td>135</td>
<td>10 7.4</td>
</tr>
<tr>
<td>Female medical ward</td>
<td>126</td>
<td>10 7.9</td>
</tr>
<tr>
<td>Sub-ICU</td>
<td>69</td>
<td>34 49.3</td>
</tr>
</tbody>
</table>

### Table 3. Incidence of NP among studied chronically ill patients classified by patients' health and medical instrument use.

<table>
<thead>
<tr>
<th>Patients' health status</th>
<th>No. of studied patients (n = 330)</th>
<th>Incidence of NP</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>History of underlying diseases</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cerebrovascular and metabolic syndrome</td>
<td>236</td>
<td>50 21.2</td>
</tr>
<tr>
<td>Other diseases</td>
<td>94</td>
<td>4 4.3</td>
</tr>
<tr>
<td><strong>Level of consciousness</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subconscious and unconscious</td>
<td>84</td>
<td>29 34.5</td>
</tr>
<tr>
<td>Consciousness</td>
<td>246</td>
<td>25 10.2</td>
</tr>
</tbody>
</table>
**Causative bacteria isolated from chronically ill patients with NP**

Totally, 70 sputum specimens were collected from 54 patients with NP to identify causative bacteria. The most predominant causative bacteria of NP were *Acinetobacter baumannii* 34.3%, *Pseudomonas aeruginosa* 24.3%, *Klebsiella pneumonia* 14.3%, normal flora 14.3%, *Escherichia coli* 4.3% and *Staphylococcus aureus* 4.3%. Additionally, some NP patients were infected with more than one types of microorganisms and most of *A. baumannii* isolated from NP patients (79.2%) were multiple-drug resistance. (Table 4)
In this study, incidence of NP among chronically ill patients was 16.4% or 17.0 per 1,000 patient-days. The incidence is higher than that of a previous study done in the United Kingdom which showed 10.9% of NP or 5.2 per 1,000 patient-days.\(^{(14)}\) However, the incidence of NP in this study was lower than a study in Asia which reported the NP incidence of 28.3% or 21.8 per 1,000 patient-days.\(^{(6)}\)

All NP cases were divided into 2 groups: 40 patients with mechanical ventilator associated pneumonia from 92 observed patients (incidence rate = 43.5% or 32.7 per 1,000 ventilator day) and 14 NP patients who did not receive mechanical ventilator from 238 observed patients (incidence rate = 5.9% or 8.0 per 1,000 patient-days). The peak incidence was in those over 60 years old (20.3%) similar to studies of Burton LA, et al., (2016).\(^{(14)}\) It might be due to the fact that older patients with several physiological and immunological changes are inherent to aging process. Moreover, most of them often spend a long time in hospital, they have relative immune compromise and are commonly exposed to multiple courses of antibiotics. This evidence occurred in the present study which demonstrated that patients with longer duration of admission or receiving the antibiotics having higher incidence of NP. Furthermore, older patients are more likely to have swallowing dysfunction leading to aspiration.\(^{(15,16)}\)

A previous study found that factors reducing host defense function predispose patients to colonization and development of pneumonia related to patients who presence of chronic diseases.\(^{(17)}\) Likewise, the present study also found higher NP incidence in those with chronic

### Table 4. Causative bacteria isolated from sputum of NP patients.

<table>
<thead>
<tr>
<th>Causative pathogens</th>
<th>NP (n = 70 specimens)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HAP (n, %)</td>
</tr>
<tr>
<td>Acinetobacter baumannii</td>
<td>6 (8.6%)</td>
</tr>
<tr>
<td>Pseudomonas aeruginosa</td>
<td>3 (4.3%)</td>
</tr>
<tr>
<td>Normal flora</td>
<td>3 (4.3%)</td>
</tr>
<tr>
<td>Klebsiella pneumoniae</td>
<td>3 (4.3%)</td>
</tr>
<tr>
<td>Escherichia coli</td>
<td></td>
</tr>
<tr>
<td>Staphylococci Aureus</td>
<td>1(1.4%)</td>
</tr>
<tr>
<td>Non-fermentative Gram negative bacilli</td>
<td>1 (1.4%)</td>
</tr>
<tr>
<td>Staphylococcus spp.</td>
<td>1(1.4%)</td>
</tr>
</tbody>
</table>

*Remark:* 79.2% of A. baumannii positive were MDR (19/24)
47.1% of P. aeruginosa positive were MDR (8/17)
33.3% of E. coli positive were MDR (1/3)
20.0% of K. pneumoniae positive were MDR (2/10)

Some patients with NP had more than 1 pathogens due to more than 1 specimen collection.
diseases. Additionally, the present study showed higher incidence of NP in those with duration of admission > 20 days (72.4%). It was similar to a study of Karatas M, et al. (2016) which reported a greater risk of NP in patients who were admitted to hospitals with 26.7 ± 16.3 days. Our study found higher incidence of NP in female patients (19.4%) which was different from previous studies of Golia S, et al. (2013) and Zhang Z, et al. (2015) that reported a greater NP incidence in the male. This may be the female cases in this study were underlying as cerebrovascular and metabolic syndrome (76.4%: 126/165), age > 60 years (61.8%: 102/165), loss of consciousness (29.7%: 49/165) and impaired functional status (64.9%: 107/165). Additionally, the present study revealed that higher incidence in patients receiving mechanical ventilator and longer duration of admission. It was similar to the study of Rodriguez MH, et al. (2016) which found that patients who have total duration of mechanical ventilator (days ± SD) 8.91 ± 14.49 can develop ventilator-associated pneumonia and have statistical significance (P < 0.001). The study of Lee JM. (2012) found that those who had been endotracheal tube intubated for 6 days or longer had a higher level of bacterial biofilm compared with those intubated for less than 6 days. The reason of endotracheal-tube (ETT) intubation promotes the aspiration of colonized oropharyngeal secretions across the ETT cuff. It disrupts the cough reflex, promotes accumulation of tracheobronchial secretions and mucus, and provides a direct of pathogenic microorganisms to reach the lower respiratory tract increasing the risk of respiratory infection. Moreover, a previous study found that VAP was associated to colonization of the ventilator circuit from collecting and contamination from patient’s secretion. Humidifier is also a device condensing steam into droplets accumulating inventilator circuit. These droplets serve as a reservoir of bacteria particularly gram negative bacilli. The droplets may directly enter into the lungs. For aerosol therapy, the present study showed that the incidence in patients with receiving aerosol therapy (53.2%) were higher than those without aerosol therapy (5.1%). This was similar to a study of Sopena N, et al. (2014) which showed higher incidence in patients with aerosol therapy (39.1%). It might be reason of microbial organisms invading to the lower respiratory tract by major routes, such as inhalation of infected aerosol from contamination of medical therapy equipment as well as aerosol nebulizer. Aerosol nebulizers are reservoirs of bacteria particularly gram negative bacilli, likely A. baumannii in this study, they can contaminate with high levels of microorganisms if used repeatedly in the same patient. The isolated bacteria from NP patients in our study were similar to studies of Zhang Z, et al. (2015) and Walaszek M, et al. (2016) which showed A. baumannii was the most common isolated pathogen, and other common isolated pathogens were P. aeruginosa, K. pneumoniae, S. aureus, and E. coli but most drug-resistance bacteria were Methicillin-Resistance Staphylococcus Aureus (MRSA) only. A study of Lagamayo EN. (2008) in 10 Asian countries found the most common pathogens causing NP and VAP were Acinetobacter spp., E. coli, Klebsiella spp., and P. aeruginosa which was similar to this study.

In this study, incidence of NP in sub-ICU was quite high as compared with male and female medical
units it might be due to the most of patients in sub-ICU were received mechanical ventilator. Additionally, sub-ICU might be similar to ICU not medical wards.

**Conclusion**

The present study demonstrates that 16.4% (54/330 patients) developed NP. Incidence rate was 17.0 per 1,000 patient-days. Female patients, patients with age > 60 years, patients with underlying disease such as cardiovascular and metabolic syndrome, those with subconscious and unconscious, those with total dependence, those with longer admission and those with medical instrument used had relatively higher incidence of NP. Totally, 70 sputum specimens were collected from 54 patients with NP to identify the causative bacteria. The most predominant causative bacteria of NP were 34.3% of *A. baumannii*, and most of isolated *A. baumannii* (79.2%) were multi-drug resistance.

**Acknowledgements**

We would like to offer our appreciation to Augsornsri C. for surveillance and record form. Thank you very much extends to all studied patients and their family members for participating in this study. Thank you very much to nurse staff, nurses and nurse aids in studied wards for their support during data collection.

**References**

9. Craven DE, Steger KA. Epidemiology of nosocomial


23. Pneumatikos IA, Dragoumanis CK, Bouros DE. Ventilator-associated pneumonia or endotracheal tube-associated pneumonia? An approach to the pathogenesis and preventive strategies emphasizing the importance of endotracheal tube.


