

# Bacterial Profile and Antibiogram of Hospital-Acquired Pneumonia and Ventilator-Associated Pneumonia Patients in ICU of Raden Mattaher Hospital Jambi

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## ABSTRACT

Pneumonia is defined as an inflammation of the lungs caused by microorganisms (bacteria, viruses, fungi, parasites). This research aimed to determine the pneumonia-causing bacteria along with the sensitivity and the antibiotic resistance test. This research was a descriptive study with samples of ICU pneumonia patients at Raden Mattaher Regional Hospital during the study period. All samples were consecutively selected. Samples for blood culture were incubated in the BactAlert device, whereas the sensitivity test was then performed using Vitex instruments. Sputum was previously enriched with BHI media and then cultured on culture media, and sensitivity test with the Vitex instruments was carried out. Of the 354 ICU patients during the study period, 30 patients (11.8%) had pneumonia, but only 19 patients could undergo sputum culture. Five of 19 patients were infected with Gram-positive bacteria, and 14 patients were infected with Gram-negative bacteria. The most commonly found bacteria were *Klebsiella pneumoniae* (36.84%), followed by *Acinetobacter baumannii* (21.05%) and *Pseudomonas aeruginosa* (10.53%). Gram-negative bacteria obtained from sputum culture in this study were resistant to almost all antibiotic groups, especially Penicillin, Cephalosporin, Quinolone, and Tetracycline groups. Gram-positive bacteria obtained from sputum culture in this study were resistant to the penicillin antibiotic. The most commonly found bacteria were *Klebsiella pneumoniae* (36.84%), followed by *Acinetobacter baumannii* (21.05%) and *Pseudomonas aeruginosa* (10.53%). The bacteria cultured from the sputum showed multidrug resistance mainly to the Penicillin and Cephalosporin antibiotic. This research data can be used to consider the treatment of pneumonia Patients to decide more appropriate therapy.

**Keywords:** Hospital-acquired pneumonia, ventilator-associated pneumonia

## INTRODUCTION

Pneumonia is defined as an inflammation of the lungs caused by microorganisms (bacteria, viruses, fungi, parasites). Pneumonia is frequently found in hospitalized patients. Pneumonia can be divided into Community Pneumonia (CAP) or Hospital Acquired Pneumonia (HAP). Also, when associated with mechanical ventilation, it is called Ventilator-Associated Pneumonia (VAP).<sup>1</sup> Hospital-acquired pneumonia is pneumonia which occurs only 48 hours after admission to the hospital, whereas VAP can occur 48 hours after endotracheal intubation.<sup>2</sup> Mortality of pneumonia patients in Asia according to the study is relatively high and ranges from 25-58%.<sup>3</sup>

The ideal therapy for pneumonia is the use of definitive antibiotics; however, bacteria culture and antibiotic resistance testing take much time; therapy can be started using empirical broad-spectrum antibiotics. By recognizing the microbial pattern in

the hospital and selecting to use correctly, especially in the initial phase of the disease, the treatment of pneumonia is expected to be more productive.

## METHODS

This research was a descriptive study with samples of ICU pneumonia patients at Raden Mattaher Regional Hospital from January to December 2018. All samples were consecutively selected. The patients or family members were asked for written consent to participate in the study. Research permission was obtained from the Health Research Ethics Committee of the Raden Mattaher Regional Hospital, Jambi, with number 1241/UN21.6/LT/2018.

The diagnosis of nosocomial pneumonia was made based on criteria from Infectious Diseases Society of America and the American Thoracic Society, including the onset of pneumonia, which occurred 48 hours after being hospitalized and

excluded from all infections with incubation happened at the time of hospital admission. The diagnosis of nosocomial pneumonia was made based on a chest X-ray with new or progressive infiltrates. It was added to two of the following criteria: body temperature > 38°C, purulent secretions, and leukocytosis.

All sputum samples were taken for sputum culture. Sputum culture was carried out on BHI media and incubated for 24 hours at 37°C. If there was bacteria growth, the bacteria were transferred to Mac Conkey and Blood agar to enable visualization of bacteria. Bacteria were identified as Gram-positive and negative by Gram staining. Identification of bacterial species and antibiotic sensitivity tests were carried out with Vitek2 (bioMérieux).

Of the 354 ICU patients during the study period, there were 30 patients (11.8%) with pneumonia, but only 19 patients could undergo sputum culture. The age of the patient ranged from 16-90 years, with a median value of 51 years. Male and female patients were accounted for 13 (68.42%) and 6 (31.58%) people, respectively. Ventilator-associated pneumonia occurred in 10 patients (52.63%), while HAP occurred in 9 patients (47.37%). A total of 10 patients (52.63%) died, and nine patients (47.37%) were discharged from the ICU due to clinical improvement. The length of stay ranged from 1-35 days, with an average of 11.459.58 days.

During the sputum culture of 19 patients, five patients were infected with Gram-positive bacteria, and 14 patients were infected with Gram-negative bacteria (Table 1 and 2). The most commonly found bacteria were *Klebsiella pneumoniae* obtained from 7 patients (36.84%) followed by *Acinetobacter baumannii* obtained from 4 patients (21.05%) and *Pseudomonas aeruginosa* obtained from 2 patients (10.53%).

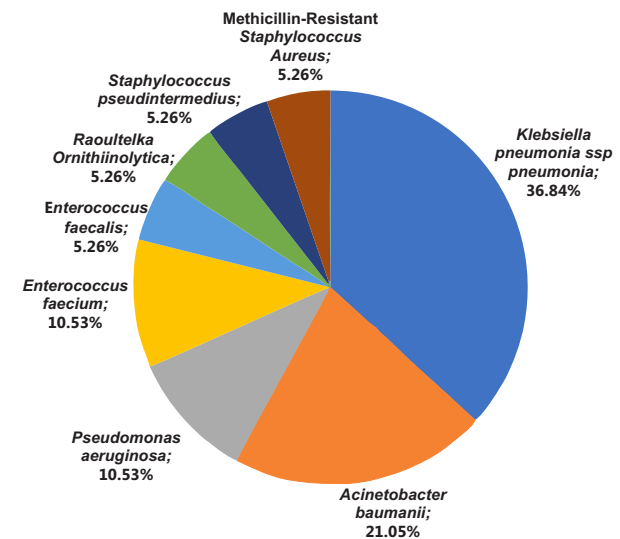
Gram-negative bacteria obtained from sputum culture in this study were resistant to almost all antibiotic types, especially those from the Penicillin, Cephalosporin, Quinolone, and Tetracycline groups. The best antibiotic sensitivity was obtained from Amikacin (42.85%), Cefoperazone/Sulbactam (28.57%), and Meropenem (28.57%).

Gram-positive bacteria obtained from sputum culture in this study were resistant to the penicillin group of antibiotics. The best antibiotic sensitivity was obtained from Linezolid and Vancomycin, with a sensitivity of 100% for both.

**RESULTS AND DISCUSSION**

The results of this study indicated that Gram-negative bacteria caused greater cases of HAP

and VAP compared to Gram-positive bacteria. This was in line with recent studies showing that Gram-negative bacteria, especially *Pseudomonas aeruginosa*, *Acinetobacter baumannii*, *Haemophilus influenzae* and Enterobacteriaceae (*Klebsiella pneumoniae*, *E.coli*, *Enterobacter species*, *Serratia species*, *Proteus species*, etc.) were responsible for 50% to 80% cases of HAP in intensive care room (Figure 1).<sup>4</sup>



**Figure 1.** Bacteria found in the sputum of patients with pneumonia at Raden MattaHer Hospital, Jambi

*Klebsiella pneumoniae* is known as one of the microorganisms, which commonly causes nosocomial infections, especially pneumonia, and has a high level of antibiotic resistance, especially to the β-lactam group. Research at Sanglah Hospital also found that *K.pneumoniae* was the most common Gram-negative bacteria in the sputum culture of patients with pneumonia.<sup>5</sup> *K.pneumoniae* are encapsulated and non-motile Gram-negative bacteria that are widely found in soil, water surfaces or even medical equipment. *K.pneumoniae* was originally thought to be an opportunistic bacterium that causes infections in immunocompromised patients; however, recent studies have shown the development of hypervirulent bacterial strain that causes severe infections. *K.pneumoniae* can encounter antibiotics by expressing Extended-Spectrum β-Lactamase (ESBL) and has even been able to encounter Carbapenem by utilizing Carbapenemase.<sup>6</sup> Extended-spectrum β-lactamase is a β-lactamase, which causes resistance to Penicillin and first-, second- and third-generation Cephalosporins and Aztreonam.<sup>7</sup> According to CLSI, ESBL can be observed based on the resistance

patterns of Cefotaxime and Ceftazidime antibiotics.<sup>8</sup> This research finding results showed that all *K.pneumoniae* cultures were resistant to Cefotaxime and Ceftazidime and were categorized as ESBL. This might affect the high mortality in this study.

*Acinetobacter baumannii* is a non-fermenting, non-forming spores, non-motile and aerobic Gram-negative coccobacillus. *A.baumannii* lives ubiquitously in nature and can be found in soils and water. *A.baumannii* can also be found in hospital food, ventilator equipment, pillows, mattresses, tap water, and another area in the hospital. *A.baumannii* infection is most commonly found in the airways, and it generally only affects patients with low immune status. Reports of antibiotic resistance to *A.baumannii* continue to emerge through various mechanisms, such as AmpC cephalosporinase, topoisomerase DNA mutations, aminoglycoside modified enzymes and other mechanisms.<sup>9</sup>

*Pseudomonas aeruginosa* is an aerobic Gram-negative bacillus that is commonly found in soil and water. *P.aeruginosa* can spread from patient

to patient through droplets or contaminated food and drinks. *P.aeruginosa* is an opportunistic bacterium with the ability to cause severe infections, especially in cancer, cystic fibrosis, and burn-injured patients.<sup>10</sup> *P.aeruginosa* can also cause endocarditis, pneumonia, and urinary tract infections. *P.aeruginosa* is known as one of the bacteria with a high level of resistance, especially to Aminoglycosides, Quinolone, and  $\beta$ -lactam, even the World Health Organization has stated that *P.aeruginosa* is resistant to Carbapenem and is listed as one of three bacterial species requiring the development of new antibiotics.<sup>11</sup> This study also showed a high level of resistance of *P.aeruginosa* to antibiotics from the aminoglycoside, quinolone, and  $\beta$ -lactam groups (Table 1).

This research found *Enterococcus faecalis* and *Enterococcus faecium* as the most common Gram-positive bacteria. *Enterococcus* is an anaerobic, facultative Gram-positive coccus bacterium with negative catalase that does not form spores. Based on Lancefield grouping, *Enterococcus*

**Table 1.** Antibiogram of Gram-negative bacteria resistant

Organism Gram-negative	Ampicillin	Ampicillin/Clavulanic Acid	Ampicillin/Sulbactam	Amikacin	Cefoxim	Cefalotin	Cefotaxime	Ceftazidime	Ceftazone	Cefoperazone/Sulbactam	Ciprofloxacin	Doripenem	Doxycycline	Gentamicin	Imipenem	Levofloxacin	Meropenem	Piperacillin/Tazobactam	Tobramycin	Tetracyclin	Trimethoprim/Sulfamethoxazole	
<i>Pseudomonas aeruginosa</i>	2	2		1	2		2	0	2	2		2	2	2	2	2	2	2				
<i>Acinetobacter baumannii</i>	2		2	2	2	2	2	2			2			2		2	2	2	2	2	2	2
<i>Klebsiella pneumoniae ss. pneumoniae</i>	2	2		0	2		2	2	2	2			2	2	2	2	2	2	2			
<i>Klebsiella pneumoniae ss. pneumoniae</i>	2	2		0	2		2	2	2	2			2	2	2	2	2	2	2			0
<i>Klebsiella pneumoniae ss. pneumoniae</i>	2	0		0	0		2	2	2	0			2	0	0	0	0	1	0			
<i>Raoultella ornithinolytica</i>	2	0		0	0		2	2	2	0			2	0	0	0	0	1	0			
<i>Pseudomonas aeruginosa</i>	2	2		2	2		2	2	2	1		2	2	2	1	2	1	2	2			
<i>Acinetobacter baumannii</i>	2	2		0	2		2	2	2	2			2	2	2	2	2	2	2			
<i>Klebsiella pneumoniae ss. pneumoniae</i>	2	1		2	2		2	2	2	2			2	2	2	2	2	2	2			
<i>Acinetobacter baumannii</i>	2	2		0	2		2	2	2	0			2	2	2	2	2	2	2			
<i>Acinetobacter baumannii</i>	2	2		2	2		1	0	1	0		0	0	0	0	0	0	0	0			
<i>Klebsiella pneumoniae ss. pneumoniae</i>	2	2		2	2		2	2	2	2			2	2	2	2	0	2	2			
<i>Klebsiella pneumoniae ss. pneumoniae</i>	2	2		2	2		2	2	2	2			2	2	2	2	2	2	2			
<i>Klebsiella pneumoniae</i>	2	2		2	2		2	2	2	2			2	2	2	2	2	2	2			

0= sensitive; 1= intermediated; 2= resistant

**Table 2.** Antibiogram of Gram-positive bacteria

Gram-positive bacteria	Amoxicillin	Ampicillin	Amoxicillin/Clavulanic Acid	Ampicillin/Sulbactam	Benzylpenicillin	Clindamycin	Ciprofloxacin	Doxycycline	Erythromycin	Gentamicin	Imipenem	Linezolid	Levofloxacin	Moxifloxacin	Minocycline	Nitrofurantoin	Oxacillin	Piperacillin	Piperacillin/Tazobactam	Rifampicin	Tigecycline	Tetracyclin	Trimethoprim/Sulfamethoxazole	Quampistin/Dalofistin/fluoxime	Vancomycin	
<i>Enterococcus faecalis</i>	2	2	2	2	2	2	2	0	2			0	2	2	0	2		2	2		0	0		1	0	
<i>Enterococcus faecalis</i>	0	0	0	0	0	2	0		1		0	0	0	0		0		0	0		0	2		2	0	
<i>Staphylococcus pseudintermedius</i>					2	0	0		0	0			0	0		0	0			0	0	0	0	0	0	0
<i>Staphylococcus aureus (MRSA)</i>	2	2	2	2	2				0	0	2	0	0	0		0	2	2	2	0	0	2	0	0	0	0
<i>Enterococcus faecalis</i>	2	2	2	2	2	2	2		2	0		0	2	2		1		2	2		0	2		0	0	0

0= sensitive; 1= intermediated; 2= resistant

belongs to the *Streptococcus* group D. *Enterococcus* is usually found as normal flora in the digestive tract of humans and animals. It can sometimes be found in the oral cavity in small amounts. *Enterococcus* is usually an opportunistic bacterium and can cause urinary tract infections, intra-abdominal infections, bacteremia, and endocarditis. In a rare condition, *Enterococcus* can cause pneumonia in patients with low immune systems who receive broad-spectrum antibiotics. *Enterococcus* infection was initially thought to originate from normal flora of patients; however, further research, especially in hospitals, showed that the primary mode of transmission between patients occurs through the hands of medical personnel. *Enterococcus* has also been reported to be a strain of bacteria that is resistant to Vancomycin.<sup>12</sup>

*Staphylococcus aureus*, especially Methicillin-resistant *Staphylococcus aureus* (MRSA), is known as one of the most common causes of nosocomial pneumonia and is estimated to be responsible for 20–40% cases of HAP or VAP. *S.aureus* is a Gram-positive coccus which usually forms grape-like clusters with positive catalase and positive coagulase test. *S.aureus* is commonly found on the surface of human skin and mucosa.<sup>13</sup> Transmission of MRSA infections mainly occurs due to contact with contaminated hands or clothing (Table 2).<sup>14</sup>

## CONCLUSIONS AND SUGGESTIONS

The prevalence of pneumonia in the Intensive Care Unit of Raden Mattaher Regional Hospital was approximately 11.8%, with merely 19 patients underwent sputum culture. The bacteria that commonly caused pneumonia in this study were mainly *Klebsiella pneumoniae* and *Acinetobacter baumannii*, which were resistant to  $\beta$ -lactam, Quinolone, and Carbapenem.

Pneumonia can be prevented by applying a VAP bundle and to preventing the misuse of antibiotics. It was also suggested to use empiric antibiotics, which can act against a wide range of pneumonia-causing microorganisms.

Further suggestions are as follows: Improvement of hand hygiene of health staffs by implementing six-step hand washing at five washing times according to WHO recommendations; Maintenance of patients' oral hygiene, head-up position, nebulizer, and chest physiotherapy to minimize the incidence of bronchopneumonia; Improvement of CSSD's ability to maintain the stability of medical

devices, including the use of plasma techniques which can sterilize rubber and plastic.

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