
Association Between Sputum Quality and Bacterial Culture Results in Patients with Pneumonia at Klungkung General Hospital

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Abstract

Pneumonia is a lower respiratory tract infection that remains one of the leading causes of morbidity and mortality worldwide, including in Indonesia. Sputum culture examination plays an important role in identifying the bacterial pathogens causing pneumonia; however, its success is highly influenced by sputum quality. This study aimed to determine the association between sputum quality and bacterial culture results in patients with pneumonia. This research was an analytical observational study with a *cross-sectional* design at Klungkung General Hospital, involving 53 spontaneous sputum specimens obtained using the *Consecutive Sampling* method. Sputum quality was assessed based on Bartlett's criteria through gram staining, while culture examination was performed on *MacConkey Agar* and *Blood Agar* media, and identification of pathogenic bacteria was performed using the VITEK 2 Compact system. The results showed that most sputum samples from pneumonia patients had good quality (54.7%) and yielded positive bacterial cultures (72.4%), predominantly *Klebsiella pneumoniae* (43.4%). The Chi-square (χ^2) test demonstrated a significant relationship between sputum quality and bacterial culture results ($p = 0.023$; PR = 4.4; 95% CI: 1.371–13.959). Good quality sputum was 4.4 times more likely to produce pathogenic bacterial growth compared to poor quality sputum. In conclusion, there is a significant association between sputum quality and bacterial culture results in patients with pneumonia at Klungkung General Hospital. It is recommended that laboratory technicians rigorously maintain pre-culture sputum quality assessment utilizing Bartlett's criteria to ensure the validity and accuracy of downstream bacterial identification.

Keywords: bacterial culture; pneumonia; sputum quality

Abstrak

Pneumonia merupakan infeksi saluran pernapasan bawah yang masih menjadi salah satu penyebab utama kesakitan dan kematian di dunia, termasuk di Indonesia. Pemeriksaan kultur sputum berperan penting dalam mengidentifikasi bakteri penyebab pneumonia, namun keberhasilannya sangat dipengaruhi oleh kualitas sputum. Penelitian ini bertujuan untuk mengetahui hubungan antara kualitas sputum dengan hasil kultur bakteri pada pasien pneumonia. Penelitian ini merupakan penelitian observasional analitik dengan desain *cross-sectional* yang dilaksanakan di RSUD Kabupaten Klungkung, menggunakan 53 spesimen sputum spontan yang diperoleh melalui metode *Consecutive Sampling* sebagai sampel penelitian. Penilaian kualitas sputum dilakukan berdasarkan kriteria Bartlett melalui pewarnaan Gram, sedangkan pemeriksaan kultur dilakukan pada media *MacConkey Agar* dan *Blood Agar*, dengan identifikasi bakteri patogen menggunakan alat VITEK 2 Compact. Hasil penelitian menunjukkan bahwa sebagian besar sputum pasien pneumonia memiliki kualitas baik (54,7%) dan menghasilkan kultur positif terhadap bakteri patogen (72,4%), dengan dominasi *Klebsiella pneumoniae* (43,4%). Uji Chi-square (χ^2) menunjukkan adanya hubungan yang bermakna antara kualitas sputum dengan hasil kultur bakteri ($p = 0,023$; PR = 4,4; 95% CI: 1,371–13,959). Sputum berkualitas baik memiliki kemungkinan 4,4 kali lebih besar menghasilkan pertumbuhan bakteri patogen dibandingkan sputum berkualitas buruk. Dengan demikian, dapat disimpulkan bahwa terdapat hubungan yang bermakna antara kualitas sputum dengan hasil kultur bakteri pada pasien pneumonia di RSUD Kabupaten Klungkung. Bagi laboran, standarisasi penapisan kualitas sputum berdasarkan kriteria Bartlett sangat krusial untuk dipertahankan sebelum tahapan kultur guna menjamin akurasi dan validitas hasil identifikasi bakteri.

Kata kunci: kualitas sputum; kultur bakteri; pneumonia

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INTRODUCTION

Pneumonia is one of the most significant lower respiratory tract infections worldwide, including in Indonesia, with high mortality rates, particularly among young children and the elderly.^{11,15,33} This disease can be caused by bacteria, viruses, or fungi, but bacterial infections contribute the most to morbidity.^{20,23} In Indonesia, the prevalence of pneumonia is reported at 10,8%, with the highest risk observed in children aged 1–4 years and adults aged ≥ 75 years, while at Klungkung Regional Hospital, pneumonia has consistently been among the top ten causes of hospitalization and mortality in recent years.^{19,31}

Diagnosis of pneumonia relies not only on clinical and radiological assessment but also on microbiological examinations, such as Gram staining and sputum culture, which are simple, non-invasive, and highly sensitive for identifying causative bacteria.¹⁵ The success of pathogen isolation largely depends on sputum quality, good quality sputum increases the likelihood of detecting clinically relevant pathogens, whereas poor quality specimens usually show only normal flora.¹² Sputum quality can be assessed microscopically using the Bartlett criteria, with the Q-score calculated based on the number of leukocytes and squamous epithelial cells per high power field, where positive values indicate good quality specimens and zero or negative values indicate poor quality specimens.^{6,12} Previous studies have shown that good quality sputum is more likely to yield pathogenic bacteria, compared to poor quality sputum, which frequently reveals normal flora.^{12,17,28}

A preliminary survey at Klungkung Regional Hospital in January 2025 indicated that 58,3% of good quality sputum specimens produced pathogenic isolates in 71,4% of cases, while only 40% of poor quality specimens yielded pathogens.

Despite this, no study has specifically assessed the relationship between sputum quality and bacterial culture results at Klungkung Regional Hospital, although local data are crucial due to variations in epidemiology and bacterial patterns across regions. Therefore, this study aims to investigate the association between sputum quality and bacterial culture results in patients with pneumonia at Klungkung Regional Hospital using the Bartlett criteria to assess sputum quality. The findings are expected to improve diagnostic accuracy, support rational antibiotic therapy, reduce mortality rates, and enhance the quality of hospital microbiology laboratory services. Furthermore, the local data generated from this study are expected to serve as a basis for improving effectiveness, accuracy, and patient safety in hospital healthcare services.

MATERIALS AND METHODS

An analytical observational study with a *cross-sectional* design was conducted in the Clinical Microbiology Laboratory at Klungkung General Hospital from September to October 2025. The study sample consisted of 53 spontaneous sputum specimens collected consecutively from hospitalized patients diagnosed with pneumonia during the study period. The diagnosis of pneumonia was confirmed based on medical records. All spontaneous sputum specimens received in the laboratory were subjected to routine bacteriological processing, including Gram staining and culture on *Blood Agar* and *MacConkey Agar*.

The quality of sputum was assessed according to Bartlett's criteria by microscopically evaluating the relative number of squamous epithelial cells and neutrophils per low power field (LPF). A Q-score was calculated accordingly,

and the scoring criteria are presented in Table 1.

Table 1. Bartlett's scoring criteria for sputum quality assessment

Type of cells	Number of cells per LPF	Score
Neutrophils	< 10	0
	10 – 25	+1
	> 25	+2
Squamous epithelial cells	< 10	0
	10 – 25	-1
	> 25	-2

For each specimen, the Q-score was calculated as the sum of positive (“+”), negative (“-”), or zero values. A positive Q-score indicated material derived from the site of active infection and was categorized as good quality sputum, whereas a zero or negative Q-score indicated low sputum quality with excessive oropharyngeal contamination and was categorized as poor quality sputum.

All sputum specimens, regardless

of

RESULTS AND DISCUSSIONS

A total of 53 spontaneous sputum samples from patients of all ages were included in this study. Patient characteristics, sputum quality distribution, culture results, and the association between sputum quality and bacterial growth are summarized in the tables below.

Table 2. Characteristics of hospitalized patients with pneumonia

Characteristics	Frequent (n)	Percentage (%)
Gender		
Male	30	56,6
Female	23	43,4
Age (years)		
Teenager (10-18)	2	3,8
Adult (19-59)	14	26,4
Older adult (≥ 60)	37	69,8
Total	53	100,0

Table 3. Distribution of sputum quality

Sputum Quality	Frequent (n)	Percentage (%)
Good	29	54,7
Poor	24	45,3
Total	53	100,0

Table 4. Bacterial culture results

Culture Result	Frequent (n)	Percentage (%)
Pathogenic bacteria	30	56,6
Normal Flora	23	43,4
Total	53	100,0

Table 5.

Types of pathogenic bacteria isolated		
Pathogenic Bacteria	Frequent (n)	Percentage (%)
<i>Klebsiella pneumoniae</i>	13	43,4
<i>Escherichia coli</i>	7	23,3
<i>Acinetobacter baumannii</i>	5	16,7
<i>Acinetobacter lwoffii</i>	2	6,7
<i>Enterobacter cloacae</i>	1	3,3
<i>Bordetella bronchiseptica</i>	1	3,3
<i>Pantoea agglomerans</i>	1	3,3
Total	30	100,0

Table 6. Association between sputum quality and bacterial culture results

Sputum Quality	Pathogenic Bacteria		Normal Flora		Total	
	n	%	n	%	n	%
Good	21	72,4	8	27,6	29	100,0
Poor	9	37,5	15	62,5	24	100,0
Total	30	56,6	23	43,4	53	100,0

p - value : 0,023 and PR (95% CI) : 4,4 (1,371-13,959).

DISCUSSION

This study demonstrates that male patients accounted for a slightly higher proportion of pneumonia cases. This finding is consistent with previous studies reporting that men are more susceptible to pneumonia than women.^{9,13,18} Behavioral and environmental factors such as smoking, occupational exposure, and a higher prevalence of comorbidities may contribute to the higher comorbidities such as COPD, diabetes, and cardiovascular disease in this age group further amplifies their susceptibility.³⁰

A notable proportion of sputum samples in this study were categorized as good quality based on Bartlett's criteria, indicating adequate representation of lower respiratory secretions. Good quality sputum typically contains abundant polymorphonuclear leukocytes and minimal squamous epithelial cells, reflecting minimal contamination from the upper airway. This finding is consistent with previous studies demonstrating that

sputum quality significantly affects diagnostic accuracy and is essential for increasing the likelihood of isolating true pathogens.⁸ Poor quality sputum, in contrast, often reflects oropharyngeal contamination and may lead to the predominance of commensal flora, reducing the diagnostic utility of culture.^{22,28}

More than half of the sputum cultures yielded pathogenic bacteria, with *Klebsiella pneumoniae* being the most frequently isolated organism, followed by *Escherichia coli*, *Acinetobacter baumannii*, *Acinetobacter lwoffii*, *Enterobacter cloacae*, *Bordetella bronchiseptica*, and *Pantoea agglomerans*. These findings reflect the increasing predominance of Gram negative bacteria in hospital acquired pneumonia. The predominance of Gram negative organisms observed in this study is also consistent with regional and international trends in lower respiratory tract infections, in which pathogens such as *Klebsiella pneumoniae*, *Escherichia coli*, *Acinetobacter*

baumanii, and *Pseudomonas aeruginosa*. are frequently reported as major etiological agents.^{2,4} The identification of less common organisms, including *Bordetella bronchiseptica* and *Pantoea agglomerans*, indicates that opportunistic or environmental bacteria may contribute to infection, especially in immunocompromised individuals or those with prolonged hospitalization.^{7,16,24,27}

Meanwhile, samples that yielded normal respiratory flora likely represent upper airway contamination, non bacterial causes of pneumonia, or reduced bacterial viability due to prior empirical antibiotic therapy.²¹

A statistically significant association was observed between sputum quality and bacterial culture results in this study ($p = 0,023$), where good quality sputum was 4,4 times more likely to yield pathogenic bacterial growth than poor quality sputum. This finding is consistent with previous evidence showing that specimen adequacy is a key determinant of microbiological detection rates.⁶ Good quality sputum generally provides a more accurate representation of lower respiratory pathogens, thereby improving diagnostic precision in pneumonia.³²

Despite this, not all good quality specimens produced bacterial growth. Several factors may explain such cases, including prior antibiotic exposure, infections caused by fastidious or atypical organisms, or viral

etiologies that cannot be detected through culture.^{1,5,14,22,26} On the other hand, some poor-quality sputum samples yielded pathogenic isolates. This may reflect chronic colonization, altered respiratory microbiota, or repeated healthcare exposure in patients with long-standing comorbidities conditions commonly observed in hospitalized or older adults.³

Overall, these findings confirm that sputum quality strongly affects culture yield, but results must be interpreted alongside clinical factors such as age, comorbidities, immune status, and prior antibiotic use. This study reinforces the importance of routine sputum quality assessment and standardized criteria like the Bartlett score to improve diagnostic accuracy.

CONCLUSIONS

There is a statistically significant association between sputum quality and bacterial culture results in patients with pneumonia at Klungkung General Hospital. Good quality sputum specimens were 4,4 times more likely to yield pathogenic bacterial growth compared to poor quality specimens.

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