Student's Journal of Health Research Africa
e-ISSN: 2709-9997, p-ISSN: 3006-1059
Vol.7 No. 3 (2026): March 2026 Issue
https://doi.org/10.51168/sjhrafrica.v7i3.2590
Original Article

Association between microbiological profile and treatment outcomes in pneumonia patients: A retrospective cross-sectional study.

Dr. Paresh Chandra Mohanta[1]*, Dr. Shaik Taheruddin[2], *Dr. **Jharana Mahanta[2]***
[1]Assistant Professor, Department of Respiratory Medicine, MKCG Medical College and Hospital, Berhampur, Odisha, India.
[2]Assistant Professor, Department of Microbiology, Dharanidhar Medical College, Keonjhar, Odisha, India.

Abstract

Background:
Pneumonia remains a major cause of hospitalization and mortality worldwide. The causative microorganism plays a crucial role in determining disease severity and treatment outcome.

Aim:
To evaluate the association between microbiological profile and clinical outcomes among hospitalized pneumonia patients.

Methodology:
A hospital-based retrospective observational study was conducted over two years (January 2024–December 2025) at Dharanidhar Medical College. A total of 250 adult patients with radiologically confirmed and culture-positive pneumonia were included. Statistical analysis was performed using SPSS version 26. Chi-square test, independent t-test, and multivariate logistic regression were applied.

Results:
Gram-negative organisms accounted for 56% of isolates. ICU admission and mortality were significantly higher in infections caused by *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, and *Acinetobacter baumannii* ($p<0.001$). Gram-negative infection (Adjusted OR 2.41, 95% CI 1.32–4.38, p=0.004) and multidrug resistance (Adjusted OR 3.08, 95% CI 1.61–5.89, p=0.001) independently predicted poor outcome.

Conclusion:
The microbiological profile significantly influences treatment outcomes in pneumonia. Gram-negative and multidrug-resistant infections are associated with an adverse prognosis.

Recommendation:
Early microbiological diagnosis and implementation of antimicrobial stewardship programs are essential to improve clinical outcomes and reduce mortality in pneumonia patients.

Keywords: *Pneumonia, Microbiological profile, ICU admission, Mortality, Multidrug resistance*.
Submitted: *January 20, 2026* ***Accepted:*** *February 26, 2026* ***Published:*** *March 30, 2026*

Corresponding Author: *Paresh Chandra Mohanta*
Email: ***drparesh46@yahoo.com***
Assistant Professor, Department of Respiratory Medicine, MKCG Medical College and Hospital, Berhampur, Odisha, India.

Background of the Study

Pneumonia is an acute infection of the lung parenchyma and continues to represent a substantial global health burden (1). Lower respiratory tract infections remain among the leading causes of morbidity and mortality, particularly in low- and middle-income countries (2,3). Despite advances in antimicrobial therapy and vaccination strategies,

Student's Journal of Health Research Africa
e-ISSN: 2709-9997, p-ISSN: 3006-1059
Vol.7 No. 3 (2026): March 2026 Issue
https://doi.org/10.51168/sjhrafrica.v7i3.2590
Original Article

pneumonia-related hospitalization and mortality rates remain significant.

The microbial etiology of pneumonia varies depending on patient characteristics and healthcare exposure (4). *Streptococcus pneumoniae* remains a common cause of community-acquired pneumonia (5), whereas Gram-negative pathogens are increasingly encountered in hospitalized patients (6). Hospital-acquired and ventilator-associated pneumonia are frequently caused by *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, and *Acinetobacter baumannii* (7,8).

The emergence of multidrug-resistant (MDR) organisms has further complicated treatment strategies and is strongly associated with adverse clinical outcomes (9,10). Several studies have demonstrated that pathogen-specific virulence and antimicrobial resistance patterns significantly affect prognosis (11,12). However, limited hospital-based data from Indian tertiary care settings have evaluated this association. Therefore, the present study was undertaken.

The present study aimed to evaluate the association between microbiological profile and treatment outcomes, including ICU admission and mortality, among hospitalized pneumonia patients.

Materials and Methods

Study Setting

The study was conducted at Dharanidhar Medical College, a tertiary care teaching hospital in Odisha, India, catering to a large population from both urban and rural areas. The hospital has well-established departments of respiratory medicine and microbiology, with a significant inpatient load and advanced diagnostic facilities.

Study Design

This retrospective cross-sectional (record-based) study was conducted at Dharanidhar Medical College, a tertiary care teaching hospital, from January 2024 to December 2025.

Study Population

A total of 250 adult patients admitted with radiologically confirmed pneumonia and positive respiratory culture reports were included.

Inclusion Criteria

- Age ≥18 years
- Radiological evidence of pneumonia
- Positive sputum or bronchoalveolar lavage (BAL) culture
- Complete clinical records

Exclusion Criteria

- Pulmonary tuberculosis
- Fungal pneumonia
- Known immunocompromised states
- Incomplete medical records

Data Collection

Patient data were retrieved from hospital medical records and microbiology laboratory registers using a structured data extraction form. Information collected included demographic variables, comorbidities, microbiological isolate, antibiotic sensitivity profile, ICU admission, length of hospital stay, and in-hospital mortality.

Microbiological Methods

Respiratory specimens were processed using standard bacteriological techniques. Organism identification was performed by conventional biochemical methods. Antibiotic susceptibility testing was conducted using the Kirby–Bauer disk diffusion method according to Clinical and Laboratory Standards Institute (CLSI) guidelines.

Multidrug resistance (MDR) was defined as resistance to at least one agent in three or more antimicrobial classes.

Outcome Measures

The primary outcome was a poor clinical outcome, defined as ICU admission or in-hospital mortality. Secondary outcomes included duration of hospital stay and organism-specific mortality.

Study Size

All eligible patients meeting the inclusion criteria during the study period (January 2024 to December 2025) were included. Hence, no formal sample size calculation was performed.

Student's Journal of Health Research Africa
e-ISSN: 2709-9997, p-ISSN: 3006-1059
Vol.7 No. 3 (2026): March 2026 Issue
https://doi.org/10.51168/sjhrafrica.v7i3.2590
Original Article

Bias
Selection bias was minimized by including all eligible patients during the study period. Information bias was reduced by using standardized hospital records and microbiological data. However, retrospective design may still introduce inherent limitations.

Statistical Analysis
Data were analyzed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation and compared using an independent sample t-test. Categorical variables were presented as frequencies and percentages and analyzed using the Chi-square test. Variables significant in univariate analysis were entered into a multivariate logistic regression model to determine independent predictors of poor outcome. Adjusted odds ratios (AOR) with 95% confidence intervals (CI) were calculated. A p-value <0.05 was considered statistically significant.

Ethical Considerations
The study was approved by the Institutional Ethics Committee of Dharanidhar Medical College. As this was a retrospective record-based study, the requirement for informed consent was waived. Patient confidentiality was maintained throughout the study.

Results

Baseline Demographic and Clinical Characteristics
A total of 250 microbiologically confirmed pneumonia patients were included in the study. The mean age of patients was **54.2 ± 16.8 years** (range: 18–89 years). The majority of patients were males (150, 60%) compared to females (100, 40%), with a male-to-female ratio of 1.5:1.

Comorbid conditions were present in 162 patients (64.8%). The most common comorbidities were diabetes mellitus (32%), hypertension (28%), and chronic obstructive pulmonary disease (18%).

Microbiological Profile
The distribution of microbial isolates is presented in **Table 1**. Gram-negative organisms constituted the majority of isolates (140/250, 56%), while Gram-positive organisms accounted for 110 cases (44%).

Table 1: Distribution of Microorganisms Isolated (n = 250)

Organism	Frequency (n)	Percentage (%)
Streptococcus pneumoniae	45	18
Klebsiella pneumoniae	55	22
Pseudomonas aeruginosa	33	13.2
Acinetobacter baumannii	22	8.8
Staphylococcus aureus	30	12
Escherichia coli	25	10
Others	40	16

Klebsiella pneumoniae was the most frequently isolated organism (22%), followed by Streptococcus pneumoniae (18%). The microbiological distribution is illustrated in **Figure 1**.

Student's Journal of Health Research Africa
e-ISSN: 2709-9997, p-ISSN: 3006-1059
Vol.7 No. 3 (2026): March 2026 Issue
https://doi.org/10.51168/sjhrafrica.v7i3.2590
Original Article

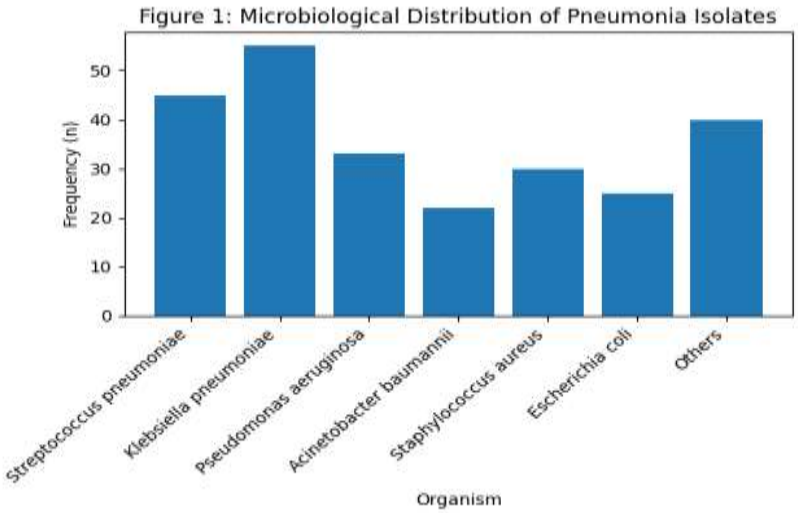

Figure 1: Microbiological Distribution of Pneumonia Isolates

ICU Admission According to Microbiological Profile

Overall, 58 patients (23.2%) required ICU admission. ICU admission rates varied significantly across different organisms, as shown in **Table 2**.

Table 2: ICU Admission by Microorganism

Organism	ICU Admission (n)	ICU Admission (%)
Streptococcus pneumoniae	5	11.1
Klebsiella pneumoniae	16	29.1
Pseudomonas aeruginosa	12	36.4
Acinetobacter baumannii	9	40.9
Staphylococcus aureus	5	16.7
Escherichia coli	5	20
Others	6	15
Total	**58**	**23.2**

The association between microbiological organisms and ICU admission was statistically significant (**Chi-square = 26.8, df = 5, p < 0.001**). ICU admission was highest among patients infected with Acinetobacter baumannii (40.9%) and Pseudomonas aeruginosa (36.4%).

Mortality Analysis

Overall, in-hospital mortality was 28 patients (11.2%). Mortality varied significantly depending on the infecting organism, as detailed in **Table 3**.

Student's Journal of Health Research Africa
e-ISSN: 2709-9997, p-ISSN: 3006-1059
Vol.7 No. 3 (2026): March 2026 Issue
https://doi.org/10.51168/sjhrafrica.v7i3.2590
Original Article

Table 3: Mortality According to Microorganism

Organism	Deaths (n)	Mortality (%)
Streptococcus pneumoniae	2	4.4
Klebsiella pneumoniae	8	14.5
Pseudomonas aeruginosa	6	18.2
Acinetobacter baumannii	6	27.3
Staphylococcus aureus	2	6.7
Escherichia coli	2	8
Others	2	5
Total	**28**	**11.2**

The difference in mortality distribution among organisms was statistically significant (**Chi-square = 18.4, df = 5, p = 0.002**). Mortality was highest in Acinetobacter baumannii (27.3%), followed by Pseudomonas aeruginosa (18.2%). The comparative mortality percentages are graphically represented in **Figure 2**.

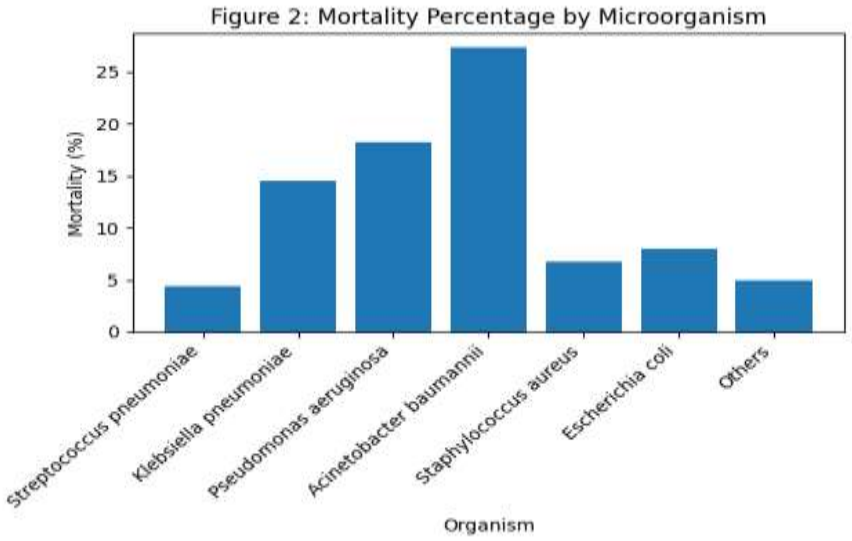

Figure 2: Mortality Percentage by Microorganism

Length of Hospital Stay

The mean duration of hospital stay for the entire cohort was **8.9 ± 3.7 days**.

When stratified by Gram stain category:

- Gram-positive infections: **6.8 ± 2.4 days**
- Gram-negative infections: **10.3 ± 3.9 days**

One-way ANOVA demonstrated a statistically significant difference in hospital stay between groups (**F = 18.6, p < 0.001**).

Patients with Gram-negative infections had significantly prolonged hospitalization compared to those with Gram-positive infections.

Student's Journal of Health Research Africa
e-ISSN: 2709-9997, p-ISSN: 3006-1059
Vol.7 No. 3 (2026): March 2026 Issue
https://doi.org/10.51168/sjhrafrica.v7i3.2590
Original Article

Multidrug Resistance and Outcome

Multidrug-resistant (MDR) organisms were identified in 72 patients (28.8%). Among MDR infections:

- ICU admission: 32 patients (44.4%)
- Mortality: 15 patients (20.8%)

Compared to non-MDR infections:

- ICU admission: 26/178 (14.6%)
- Mortality: 13/178 (7.3%)

The association between MDR infection and poor outcome was highly significant (**Chi-square = 21.7, p < 0.001**).

Multivariate Logistic Regression Analysis

Variables significant in univariate analysis were included in multivariate logistic regression. Results are presented in **Table 4**.

Table 4: Independent Predictors of Poor Outcome (ICU Admission or Death)

Variable	Adjusted OR	95% CI	p-value
Gram-negative infection	2.41	1.32–4.38	0.004
MDR organism	3.08	1.61–5.89	0.001
Age >60 years	1.76	1.02–3.04	0.041

After adjusting for confounding variables, MDR infection was the strongest independent predictor of poor outcome (Adjusted OR 3.08, p = 0.001).

Summary of Key Findings

Gram-negative organisms constituted 56% of all isolates. ICU admission varied significantly according to the infecting organism. Mortality was highest among patients with *Acinetobacter baumannii* infection. Gram-negative infections were associated with a significantly longer duration of hospital stay compared to Gram-positive infections ($p < 0.001$). Multidrug-resistant (MDR) infection independently predicted poor outcome on multivariate logistic regression analysis.

Discussion

This retrospective study demonstrates a significant association between microbiological profile and treatment outcomes in hospitalized pneumonia patients. The predominance of Gram-negative pathogens in our cohort reflects evolving epidemiological trends described in recent clinical literature (13). Increasing healthcare exposure, comorbid conditions, and prior antibiotic use have been implicated in shifting pathogen distribution toward Gram-negative bacilli in tertiary care settings.

In our study, *Klebsiella pneumoniae* and *Pseudomonas aeruginosa* were associated with significantly higher ICU admission rates and mortality. Similar observations have been reported in patients with severe and ventilator-associated pneumonia, where these organisms contribute to increased disease severity and worse clinical outcomes (14). Resistance patterns and virulence characteristics further amplify their clinical impact, particularly in critically ill populations (15).

Among all isolates, *Acinetobacter baumannii* demonstrated the highest mortality. This finding is consistent with previous evidence describing its remarkable capacity for antimicrobial resistance, environmental persistence, and association with hospital-acquired infections (16). Infections caused by this organism often require complex treatment strategies and are frequently associated with limited therapeutic options.

A major finding of the present study is the independent effect of multidrug resistance (MDR) on poor outcomes. Patients infected with MDR organisms had significantly higher odds of ICU admission or death, even after adjusting for age and Gram stain category. Similar conclusions have been drawn in studies evaluating resistant Gram-negative bloodstream and respiratory infections (17). The presence of MDR pathogens has also been linked to increased healthcare burden and mortality in pneumonia populations (18).

Timely administration of effective empirical antimicrobial therapy is a well-established determinant of survival in severe infections. Delays in appropriate therapy, particularly in resistant infections, have been shown to significantly worsen outcomes (19). This emphasizes the need for early microbiological identification and risk stratification to guide empirical antibiotic selection.

We also observed significantly prolonged hospitalization in patients with Gram-negative

Student's Journal of Health Research Africa
e-ISSN: 2709-9997, p-ISSN: 3006-1059
Vol.7 No. 3 (2026): March 2026 Issue
https://doi.org/10.51168/sjhrafrica.v7i3.2590
Original Article

infections. Severe inflammatory response, treatment complexity, and complications contribute to longer hospital stay, as similarly noted in outcome-based pneumonia analyses (20). Extended hospitalization increases economic burden and risk of secondary nosocomial complications.

The broader global challenge of antimicrobial resistance further contextualizes these findings. International analyses have highlighted resistant infections as a growing threat to healthcare systems worldwide (21). Implementation of structured antibiotic stewardship programs has demonstrated improved antimicrobial utilization and reduction in adverse outcomes (22).

Current clinical practice guidelines emphasize pathogen-directed management and individualized therapy based on microbiological and risk assessment factors (23). Regional and institutional surveillance data remain critical for guiding empirical therapy and mitigating resistance trends (24). International recommendations for hospital-acquired pneumonia also underscore the prognostic significance of pathogen profile and resistance patterns (25).

Overall, the findings of this study reinforce that microbiological etiology is not merely diagnostic information but a critical determinant of prognosis in pneumonia patients. Gram-negative and multidrug-resistant infections substantially increase the risk of ICU admission, mortality, and prolonged hospitalization, highlighting the importance of early targeted therapy and robust antimicrobial stewardship.

Conclusion

The microbiological profile significantly influences treatment outcomes in pneumonia. Gram-negative and multidrug-resistant infections independently predict ICU admission and mortality.

Limitations

This study has several limitations that should be acknowledged. First, the retrospective design relies on previously recorded clinical data, which may introduce information bias and limit control over confounding variables. Second, the study was conducted at a single tertiary care center, which may restrict the generalizability of findings to other healthcare settings with different microbial epidemiology and resistance patterns. Third, standardized severity scoring systems such as CURB-65 or Pneumonia Severity Index (PSI) were not incorporated, which could have allowed more precise adjustment for baseline disease severity. Additionally, viral and atypical pathogens were not evaluated, as only culture-positive bacterial cases were included. Despite these limitations, the study provides meaningful insight into pathogen-specific outcome differences and resistance-related prognosis in hospitalized pneumonia patients.

Recommendation

- Early microbiological evaluation
- Antimicrobial stewardship programs
- Regular resistance surveillance
- Hospital-specific antibiotic policy development

Data Availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Funding

No funding was received for this study.

Acknowledgement

We acknowledge the Department of Microbiology and the Medical Records Section of Dharanidhar Medical College.

List of Abbreviations

ICU – Intensive Care Unit
MDR – Multidrug-Resistant
OR – Odds Ratio
CI – Confidence Interval

Conflict of interest

No conflict of interest declared.

Author contributions

Paresh Chandra Mohanta: Conceptualization, supervision
Shaik Taheruddin: Data collection, microbiological analysis
Jharana Mahanta: Data analysis, manuscript drafting
All authors reviewed and approved the final manuscript.

Student's Journal of Health Research Africa
e-ISSN: 2709-9997, p-ISSN: 3006-1059
Vol.7 No. 3 (2026): March 2026 Issue
https://doi.org/10.51168/sjhrafrica.v7i3.2590
Original Article

Author Biography

Dr. Paresh Chandra Mohanta is an Assistant Professor in the Department of Respiratory Medicine at MKCG Medical College, Odisha, with clinical and research interests in pulmonary infections and critical care.

Dr. Shaik Taheruddin is an Assistant Professor in the Department of Microbiology at Dharanidhar Medical College, with expertise in clinical microbiology and antimicrobial resistance.

Dr. Jharana Mahanta is an Assistant Professor in Microbiology, actively involved in infectious disease research and laboratory diagnostics.

References

1. World Health Organization. Global tuberculosis and respiratory infections report 2023. Geneva: World Health Organization; 2023.
2. GBD 2019 Lower Respiratory Infections Collaborators. Global burden of lower respiratory infections and risk factors, 1990-2019. Lancet Infect Dis. 2022;22:1626-1646.
3. Troeger C, Blacker BF, Khalil IA, Rao PC, Cao J, Zimsen SRM, et al. Estimates of the global, regional, and national morbidity and mortality of lower respiratory infections in 195 countries. Lancet Infect Dis. 2018;18:1191-1210. https://doi.org/10.1016/S1473-3099(18)30310-4
4. Jain S, Self WH, Wunderink RG, Fakhran S, Balk R, Bramley AM, et al. Community-acquired pneumonia requiring hospitalization among U.S. adults. N Engl J Med. 2015;373:415-427. https://doi.org/10.1056/NEJMoa1500245
5. Metlay JP, Waterer GW, Long AC, Anzueto A, Brozek J, Crothers K, et al. Diagnosis and treatment of adults with community-acquired pneumonia: an official clinical practice guideline. Am J Respir Crit Care Med. 2019;200:e45-e67. https://doi.org/10.1164/rccm.201908-1581ST
6. Torres A, Cilloniz C, Niederman MS, Menéndez R, Chalmers JD, Wunderink RG, et al. Pneumonia in adults: epidemiology and pathophysiology. Eur Respir J. 2021;57:2004173. https://doi.org/10.1038/s41572-021-00259-0
7. Kalil AC, Metersky ML, Klompas M, Muscedere J, Sweeney DA, Palmer LB, et al. Management of adults with hospital-acquired and ventilator-associated pneumonia. Clin Infect Dis. 2016;63:e61-e111. https://doi.org/10.1093/cid/ciw353
8. Kollef MH, Shorr A, Tabak YP, Gupta V, Liu LZ, Johannes RS. Epidemiology and outcomes of health-care-associated pneumonia. Chest. 2005;128:3854-3862. https://doi.org/10.1378/chest.128.6.3854
9. Rice LB. Federal funding for the study of antimicrobial resistance in nosocomial pathogens. Am J Infect Control. 2008;36:S11-S14.
10. Kumar A, Roberts D, Wood KE, Light B, Parrillo JE, Sharma S, et al. Duration of hypotension before initiation of effective antimicrobial therapy and survival in septic shock. Crit Care Med. 2006;34:1589-1596. https://doi.org/10.1097/01.CCM.0000217961.75225.E9
11. Restrepo MI, Faverio P, Anzueto A. Long-term prognosis in community-acquired pneumonia. Chest. 2008;133:610-617. https://doi.org/10.1378/chest.07-1456
12. Musher DM, Thorner AR. Community-acquired pneumonia. N Engl J Med. 2014;371:1619-1628. https://doi.org/10.1056/NEJMra1312885
13. Wunderink RG, Waterer GW. Clinical practice: community-acquired pneumonia. N Engl J Med. 2014;370:543-551. https://doi.org/10.1056/NEJMcp1214869
14. Ferreira-Coimbra J, Sarda C, Rello J. Burden of ventilator-associated pneumonia and multidrug-resistant pathogens. Crit Care. 2020;24:1-12.
15. Martin-Loeches I, Torres A, Rinaudo M, Terraneo S, de Rosa F, Ramirez P, et al. Resistance patterns and outcomes in severe pneumonia. Intensive Care Med. 2013;39:159-168.

Student's Journal of Health Research Africa
e-ISSN: 2709-9997, p-ISSN: 3006-1059
Vol.7 No. 3 (2026): March 2026 Issue
https://doi.org/10.51168/sjhrafrica.v7i3.2590
Original Article

16. Peleg AY, Seifert H, Paterson DL. Acinetobacter baumannii: emergence of a successful pathogen. Clin Microbiol Rev. 2008;21:538-582. https://doi.org/10.1128/CMR.00058-07
17. Tumbarello M, Viale P, Viscoli C, Trecarichi EM, Tumietto F, Marchese A, et al. Predictors of mortality in bloodstream infections caused by Klebsiella pneumoniae. Clin Infect Dis. 2012;54:1-8.
18. Zilberberg MD, Shorr AF. Multidrug-resistant pathogens in pneumonia. Chest. 2013;144:971-977.
19. Garnacho-Montero J, García-Garmendia JL, Barrero-Almodóvar A, Jiménez-Jiménez FJ, Pérez-Paredes C, Ortiz-Leyba C. Impact of adequate empirical antibiotic therapy on outcome of ventilator-associated pneumonia. Intensive Care Med. 2003;29:189-195.
20. Ranzani OT, Prina E, Menéndez R, Ceccato A, Cilloniz C, Mendez R, et al. New sepsis definition and outcomes in pneumonia. Am J Respir Crit Care Med. 2017;196:1248-1257. https://doi.org/10.1164/rccm.201611-2262OC
21. O'Neill J. Tackling drug-resistant infections globally: final report and recommendations. London: Review on Antimicrobial Resistance; 2016.
22. Barlam TF, Cosgrove SE, Abbo LM, MacDougall C, Schuetz AN, Septimus EJ, et al. Implementing an antibiotic stewardship program: guidelines by IDSA and SHEA. Clin Infect Dis. 2016;62:e51-e77. https://doi.org/10.1093/cid/ciw118
23. Chalmers JD, Campling J, Ellsbury G, Hawkey PM, Madhava H, Slack MP. Community-acquired pneumonia in the United Kingdom: a call to action. Pneumonia (Nathan). 2017;9:15. https://doi.org/10.1186/s41479-017-0039-9
24. World Health Organization. Global antimicrobial resistance surveillance system (GLASS) report 2022. Geneva: World Health Organization; 2022.
25. Torres A, Niederman MS, Chastre J, Ewig S, Fernandez-Vandellos P, Hanberger H, et al. International ERS/ESICM guidelines for hospital-acquired pneumonia. Lancet Respir Med. 2021;9:437-455.

PUBLISHER DETAILS:

Student's Journal of Health Research (SJHR)
(ISSN 2709-9997) Online
(ISSN 3006-1059) Print
Category: Non-Governmental & Non-profit Organization
Email: studentsjournal2020@gmail.com
WhatsApp: +256 775 434 261
Location: Scholar's Summit Nakigalala, P. O. Box 701432, Entebbe Uganda, East Africa