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Demographic, Clinical, and Antibiotic Exposure Factors Associated with Carbapenem-Resistant Acinetobacter baumannii: An Eight-Year Retrospective Study

Angky Budianti[1*] Dzaki Fadlurrahman Ayyasy[2,] Mubarokah[3], Victor Sitorus[4], Yulia Rosa Saharman[5,] Budiman Bela[6], Anis Karuniawati[7]

[1]Departemen Mikrobiologi, Fakultas Kedokteran, Universitas Indonesia, Jakarta, Indonesia

[2]Program Studi Pendidikan Dokter, Universitas Indonesia, Jakarta, Indonesia

[3]UKK PPM Laboratorium Mikrobiologi Klinik, Fakultas Kedokteran, Universitas Indonesia, Jakarta, Indonesia

[4]Program Studi Pendidikan Dokter Spesialis Mikrobiologi Klinik, Fakultas Kedokteran, Universitas Indonesia, Jakarta, Indonesia

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Corresponding author*:

angky_01@yahoo.com

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Abstract: Antimicrobial resistance is a major global health challenge, and carbapenem-resistant *Acinetobacter baumannii* (CRAB) is of particular concern because of its high level of resistance, limited therapeutic options, and substantial burden in healthcare-associated infections. Identifying patient characteristics and antibiotic exposure associated with CRAB is essential to support effective antimicrobial stewardship and infection prevention strategies. **Objective:** This study aimed to analyze the association of demographic factors, including age and comorbidities, clinical diagnosis or manifestations, and a history of carbapenem use within the previous month with CRAB among clinical isolates examined at the Clinical Microbiology Laboratory, Faculty of Medicine, Universitas Indonesia, during 2017–2024. **Methodology:** This quantitative study employed a retrospective cross-sectional design using secondary laboratory and clinical data. Samples were selected through total sampling from patients with clinical specimens yielding *A. baumannii*. Descriptive analysis was used to characterize the study population, while Chi-square tests were applied to assess associations between the investigated factors and carbapenem resistance. **Findings:** A total of 172 *A. baumannii* clinical cultures were identified, of which 118 (68.6%) were CRAB. Age was significantly associated with CRAB (p=0.004), with patients aged >59 years representing the largest CRAB group. Clinical diagnosis or manifestation was also significantly associated with CRAB (p=0.005), with respiratory tract infection being the most frequent manifestation. Previous carbapenem use within one month was significantly associated with CRAB (p=0.009), with an odds ratio of 8.33 (95% CI: 1.48–46.94). In contrast, comorbidity was not significantly associated with CRAB (p=0.665). **Implications:** These findings support strengthening antimicrobial stewardship, particularly the appropriate use and continuous evaluation of carbapenem therapy, alongside enhanced surveillance and infection prevention measures among high-risk patients. **Originality:** This study provides local epidemiological evidence from an eight-year clinical dataset and integrates demographic, clinical, and previous carbapenem-exposure factors to characterize CRAB at a clinical microbiology laboratory in Jakarta, thereby contributing institution-specific evidence for CRAB surveillance and prevention strategies.

Keywords: *Acinetobacter baumannii*; antimicrobial resistance; carbapenem resistance; CRAB; carbapenem exposure

INTRODUCTION

Antimicrobial resistance (AMR) has become one of the most important threats to global public health because it reduces the effectiveness of antimicrobial therapy, prolongs hospitalization, increases healthcare costs, and contributes to morbidity and mortality. The global burden analysis conducted by (Murray et al., 2022) demonstrated the substantial mortality associated with bacterial AMR, while a more recent Global Burden of Disease analysis indicates that the impact of bacterial resistance will remain an important global health challenge in the coming decades (Collaborators, 2024), Indonesia faces a similar problem, particularly because inappropriate and uncontrolled antimicrobial use can accelerate the selection of resistant bacterial populations (Handayani et al., 2018; Marsudi, 2022). Among these resistant pathogens, carbapenem-resistant Acinetobacter baumannii (CRAB) represents a particularly important healthcare-associated pathogen. The World Health Organization includes carbapenem-resistant A. baumannii among bacterial pathogens of critical public-health importance, reflecting its resistance profile, limited therapeutic options, and its ability to persist and spread within healthcare environments (World Health, 2024). Clinical manifestations are particularly prominent among critically ill and intensive care patients, including respiratory infections and ventilator-associated pneumonia (Jiang et al., 2022; Kao et al., 2023).

Existing studies concerning CRAB can broadly be divided into three groups. The first group examines demographic and host-related characteristics, including advanced age, critical illness, and underlying disease, which may influence susceptibility to resistant A. baumannii infection (Du et al., 2019; Ferlicolak et al., 2024; Zhang et al., 2023). The second group focuses on clinical characteristics and healthcare exposures, particularly intensive care treatment, invasive devices, mechanical ventilation, and respiratory tract infections (Jiang et al., 2022; Wang et al., 2023; Xiao et al., 2022). The third group examines antimicrobial exposure, demonstrating that prior exposure to broad-spectrum antibiotics, including carbapenems, may create selective pressure favoring resistant strains (Chusri et al., 2015; Lestari et al., 2020). However, the magnitude and distribution of these factors differ across healthcare institutions and geographic settings. Local longitudinal evidence assessing demographic characteristics, clinical manifestations, and previous carbapenem exposure simultaneously among clinical A. baumannii isolates remains important because institutional antimicrobial-use patterns, patient profiles, referral patterns, and resistance epidemiology may vary considerably.

Based on this gap, the present study aimed to determine the association between demographic characteristics represented by age and comorbidity, clinical diagnosis or manifestation, and history of carbapenem use within the previous month with CRAB among patients whose specimens were examined at the Unit Kerja Khusus Pengabdian dan Pelayanan Masyarakat Laboratorium Mikrobiologi Klinik, Faculty of Medicine, Universitas Indonesia (UKK PPM LMK FKUI), during 2017–2024. The study also sought to describe the distribution of CRAB across the investigated demographic and clinical categories and to quantify the association between previous carbapenem exposure and CRAB using an odds ratio.

The study was based on the argument that CRAB occurrence is not distributed uniformly across patients but is associated with identifiable host, clinical, and antimicrobial-exposure characteristics. Older age was hypothesized to be associated with CRAB because age-related physiological and immune changes may increase susceptibility to opportunistic and healthcare-associated pathogens. Respiratory infection was expected to represent an important clinical manifestation because A. baumannii frequently affects critically ill patients receiving invasive respiratory support. Previous carbapenem exposure was also expected to demonstrate a positive association with CRAB because antimicrobial selection pressure can favor the persistence and proliferation of resistant strains. Conversely, the magnitude of association between comorbidities and CRAB was expected to depend on the distribution and completeness of available clinical information.

RESEARCH METHOD

The unit of analysis in this study consisted of patient records associated with clinical specimens yielding Acinetobacter baumannii that were examined at UKK PPM Laboratorium Mikrobiologi Klinik, Faculty of Medicine, Universitas Indonesia, Jakarta. The source population consisted of patients whose clinical specimens were examined during the 2017–2024 period. Clinical specimens included sputum, bronchial washings, blood, pus, ear secretions, decubitus swabs, urine, and other specimens represented in the laboratory database. The primary outcome was carbapenem resistance of A. baumannii, categorized into CRAB and carbapenem-susceptible A. baumannii.

A quantitative retrospective cross-sectional analytical design was employed. The study was conducted at UKK PPM LMK FKUI, Central Jakarta, during July–September

2025 using laboratory and patient information originating from the 2017–2024 period. This design was selected to evaluate associations between previously recorded demographic, clinical, and antimicrobial-exposure variables and the carbapenem susceptibility status of A. baumannii isolates without introducing experimental intervention.

The data source consisted of secondary data retrieved from the laboratory information system and available associated clinical records. Variables extracted included culture results, antimicrobial susceptibility results, age, comorbid conditions, clinical diagnosis or manifestation, and history of carbapenem use within one month before the relevant episode. Age was classified into 1–18 years, 19–59 years, and >59 years. Clinical manifestations were categorized according to the documented site or form of infection, while previous carbapenem exposure was categorized as yes or no.

Samples were obtained through total sampling of records meeting the study criteria. The initially calculated minimum sample size using a simple random sampling formula, with a 95% confidence level, 10% precision, and assumed CRAB proportion of 73.8%, was 75 subjects. After adding 10% to anticipate incomplete information, the target sample was 83 subjects. A total of 172 clinical cultures yielding A. baumannii were identified in the available dataset. Because completeness differed among variables, statistical analyses were performed using records with available information for the respective variables. Ethical approval was obtained from the Health Research Ethics Committee of FKUI-RSCM under approval number KET-897/UN2.F1/ETIK/PPM.00.02/2025.

Data analysis consisted of descriptive and bivariate statistical analyses. Descriptive analysis was used to summarize the distribution of CRAB and carbapenem-susceptible A. baumannii according to age, comorbidity, clinical manifestation, and previous carbapenem use. Bivariate relationships between categorical variables and carbapenem resistance status were evaluated using the Chi-square test, with statistical significance defined as $p \leq 0.05$. Clinical manifestation categories were regrouped when necessary because more than 20% of cells in the initial contingency table had expected counts below five. For previous carbapenem exposure, the magnitude of association was additionally expressed as an odds ratio (OR) with a 95% confidence interval.

RESULT

A total of 172 clinical cultures of *Acinetobacter baumannii* were identified during the study period. Sputum represented the most frequent specimen type, comprising 58 samples, while other isolates originated from bronchial washings, blood, pus, ear secretions, decubitus swabs, urine, and other clinical specimens. CRAB was identified in 118 cases (68.6%).

Information completeness varied among the investigated variables. Age information was available for 171 observations, clinical diagnosis or manifestation for 41 observations, and carbapenem exposure within the preceding month for 36 observations. The completeness of comorbidity information requires verification against the source database because the descriptive table contains 171 observations whereas the narrative source data indicate substantially fewer complete comorbidity records.

Demographic Characteristics and CRAB

Age and comorbidity were evaluated as demographic or patient-related factors. The largest number of CRAB cases was identified in patients aged >59 years, followed by patients aged 19–59 years and those aged 1–18 years.

Table 1. Distribution of *A. baumannii* According to Demographic Characteristics

Variable	CRAB	Carbapenem-susceptible *A. baumannii*
Age (years)		
1–18	14	12
19–59	46	29
>59	58	12
Total	118	53
Comorbidity		
Cardiovascular disorder	4	1
Diabetes mellitus	1	1
Neurological disorder	2	1
Urinary tract disorder	1	1
Other organ disorders	9	5
No documented comorbidity	101	44
Total	118	53

Among patients aged >59 years, 58 were classified as CRAB compared with 12 patients with carbapenem-susceptible *A. baumannii*. In contrast, the difference between resistant and susceptible isolates was less pronounced in the youngest age category. This distribution suggests an increasing concentration of CRAB among older patients.

Bivariate analysis demonstrated a statistically significant association between age and CRAB status (p=0.004).

Table 2. Bivariate Analysis of Demographic Factors and CRAB

Variable	CRAB	Carbapenem-susceptible *A. baumannii*	p-value
Age (years)			0.004
1–18	14	12	
19–59	46	29	
>59	58	12	
Comorbidity			0.665
With documented comorbidity	17	9	
Without documented comorbidity	101	44	

In contrast to age, the association between comorbidity status and CRAB was not statistically significant (p=0.665). Interpretation of this result requires caution because completeness and classification of comorbidity data remain limited.

Clinical Manifestations and CRAB

Clinical diagnosis or manifestation information was available for 41 observations, consisting of 24 CRAB and 17 carbapenem-susceptible *A. baumannii* cases. Respiratory tract infection was the most frequent manifestation among patients with CRAB, followed by bloodstream infection.

Because more than 20% of cells in the original contingency table had an expected count below five, less frequent manifestations were combined into one category before Chi-square analysis.

Table 3. Bivariate Analysis of Clinical Manifestations and CRAB

Clinical diagnosis/manifestation	CRAB	Carbapenem-susceptible *A. baumannii*	p-value
Respiratory tract infection	14	6	0.005
Bloodstream infection	9	3	
Skin, urinary tract, or other infection	1	8	
Total	24	17	

A statistically significant association was observed between clinical diagnosis or manifestation and CRAB (p=0.005). Within the CRAB group with available clinical data, respiratory infection accounted for 14 of 24 observations (58.3%), while bloodstream infection accounted for nine observations (37.5%). Only one CRAB observation was included in the combined category of skin, urinary tract, or other infection.

The concentration of CRAB among respiratory and bloodstream infections indicates that resistant *A. baumannii* in this dataset was particularly prominent in clinically serious infection categories. Nevertheless, the relatively small number of records with complete clinical information limits the precision of this interpretation.

Previous Carbapenem Exposure and CRAB

Information on carbapenem use within the previous month was available for 36 observations. Among patients with previous carbapenem exposure, 15 had CRAB and two had carbapenem-susceptible *A. baumannii*. Among patients without documented carbapenem exposure, nine had CRAB and ten had susceptible isolates.

Table 4. Association Between Previous Carbapenem Exposure and CRAB

Previous carbapenem use within one month	CRAB	Carbapenem-susceptible *A. baumannii*	OR (95% CI)	p-value
Yes	15	2	8.33 (1.48–46.94)	0.009
No	9	10	Reference	
Total	24	12		

Previous carbapenem exposure was significantly associated with CRAB (p=0.009). Patients with documented carbapenem exposure within the preceding month had 8.33 times the odds of belonging to the CRAB group compared with patients without documented previous carbapenem exposure (OR=8.33; 95% CI: 1.48–46.94).

The wide confidence interval indicates substantial statistical uncertainty regarding the exact magnitude of this association, which is consistent with the relatively small number of observations with complete antimicrobial-exposure data. Nevertheless, both the direction and magnitude of the observed association indicate that previous carbapenem exposure is an important factor requiring further investigation.

DISCUSSION

The present study demonstrated three principal findings. First, age was significantly associated with CRAB, with the largest number of resistant isolates identified among patients aged >59 years. Second, clinical diagnosis or manifestation was significantly associated with resistance status, with respiratory tract infection representing the most frequent manifestation among CRAB cases with complete clinical information. Third, previous carbapenem exposure within one month was strongly associated with CRAB, producing an OR of 8.33. In contrast, documented comorbidity did not show a statistically significant association with CRAB. Together, these findings indicate that demographic characteristics, infection presentation, and previous antimicrobial exposure may contribute differently to the epidemiological profile of CRAB.

The association between older age and CRAB may reflect several overlapping mechanisms. Aging is accompanied by changes in innate and adaptive immune responses, reduced physiological reserve, and increased vulnerability to infectious disease. Older patients are also more likely to experience repeated healthcare contact, hospitalization, invasive procedures, and antimicrobial exposure. These factors can increase opportunities for exposure to healthcare-associated organisms such as A. baumannii. Previous studies among critically ill populations have similarly identified patient-related characteristics and severity-related factors as relevant to CRAB infection and outcome (Du et al., 2019; Ferlicolak et al., 2024). The present data therefore reinforce the importance of older patients as a population requiring increased surveillance. However, because the study employed bivariate analysis, the observed association should not be interpreted as evidence that age independently causes CRAB.

Clinical manifestation was also significantly associated with resistance status. Respiratory infection constituted 58.3% of CRAB cases with available clinical diagnosis information. This pattern is biologically and epidemiologically plausible because A. baumannii is recognized as an important cause of healthcare-associated respiratory infection, particularly among critically ill patients requiring mechanical ventilation (Jiang et al., 2022). Studies of ventilator-associated pneumonia caused by CRAB have demonstrated substantial clinical consequences, including prolonged ventilator dependence and mortality (Kao et al., 2023). Respiratory tract colonization also represents an important component of CRAB epidemiology and may precede or coexist with clinical infection (Xiao et al., 2022). Consequently, microbiological findings from respiratory specimens should ideally be interpreted alongside clinical diagnostic criteria to distinguish colonization from infection.

The strongest observed association concerned carbapenem exposure during the previous month. Patients with documented prior carbapenem exposure had 8.33 times the odds of CRAB compared with those without documented exposure. This finding is consistent with the biological principle of antimicrobial selection pressure. Carbapenem exposure can suppress susceptible bacterial populations and facilitate persistence or expansion of organisms possessing carbapenem-resistance mechanisms. (Chusri et al., 2015) similarly demonstrated an association between antibiotic exposure and nosocomial CRAB infection, while an Indonesian study by (Lestari et al., 2020)reported an association between carbapenem use and CRAB infection. More recent investigations have continued to identify antimicrobial exposure as an important component of CRAB epidemiology (He et al., 2024).

Nevertheless, the OR of 8.33 should be interpreted as a measure of association rather than causation. In addition, the 95% confidence interval ranged from 1.48 to 46.94, indicating low precision in the estimated magnitude of the association. This wide interval is likely related to the small number of observations with complete antibiotic-use information. Furthermore, critically ill patients may be more likely both to receive carbapenems and to acquire resistant pathogens. Severity of illness, intensive care admission, invasive devices, duration of hospitalization, previous antimicrobial exposure from other classes, and mechanical ventilation may therefore act as potential confounding variables. These factors were not included in the available bivariate model.

Comorbidity did not demonstrate a statistically significant association with CRAB (p=0.665). This finding should not immediately be interpreted as evidence that comorbidity has no role in CRAB susceptibility. Chronic illnesses can modify host immunity, healthcare exposure, and antimicrobial use. For example, metabolic disorders such as diabetes can affect neutrophil function and susceptibility to infection (Thimmappa et al., 2023). The absence of a statistically significant association in the present study may instead reflect incomplete clinical information, heterogeneous categorization of comorbid conditions, or insufficient statistical power for individual disease categories. The discrepancy between the reported number of complete comorbidity records and the totals presented in the descriptive table also requires resolution before definitive interpretation.

From a practical perspective, the findings support a combined strategy involving antimicrobial stewardship and targeted infection prevention. Carbapenem prescriptions should be based on clear clinical indications and periodically reassessed according to microbiological results. Where clinically appropriate, de-escalation should be considered once susceptibility information is available. Stewardship measures should operate alongside rigorous infection-prevention programs because CRAB can persist in healthcare environments and spread between vulnerable patients. Previous outbreak investigations have shown that systematic infection-control interventions can contribute to successful containment of CRAB transmission (Lee et al., 2024). Increased surveillance may be particularly relevant among older patients, patients with respiratory infection, and individuals with recent broad-spectrum antimicrobial exposure.

This study contributes local epidemiological evidence derived from clinical A. baumannii data collected over the 2017–2024 period at LMK FKUI. Its main contribution is the simultaneous evaluation of demographic, clinical, and previous carbapenem-exposure variables in relation to CRAB status. Nevertheless, several limitations must be acknowledged. The retrospective use of secondary data resulted in substantial variable-specific missing information. Clinical manifestation information was available for only 41 observations and carbapenem-use information for 36 observations. Comorbidity data also require database verification. The study relied primarily on bivariate analysis and therefore could not determine whether the observed associations remained significant after adjustment for potential confounding variables. Variables such as ICU admission, mechanical ventilation, length of hospitalization, invasive procedures, previous hospitalization, severity of illness, and exposure to other antibiotic classes were not included in the available analysis. Further studies with larger complete datasets and multivariable regression are therefore required to identify factors independently associated with CRAB.

CONCLUSION

This study demonstrates that age, clinical diagnosis or manifestation, and a history of carbapenem use within the previous month were significantly associated with carbapenem-resistant Acinetobacter baumannii (CRAB). Patients aged >59 years represented the largest proportion of CRAB cases, while respiratory tract infection was the most frequently identified clinical manifestation among CRAB patients with available clinical data. Previous carbapenem exposure showed the strongest association with CRAB, with an odds ratio of 8.33 (95% CI: 1.48–46.94; $p=0.009$), indicating that patients with a history of carbapenem use within the previous month had 8.33 times higher odds of having CRAB compared with patients without previous carbapenem exposure. In contrast, comorbidity was not significantly associated with CRAB ($p=0.665$). These findings highlight the importance of increased vigilance for CRAB, particularly among older patients, patients with respiratory tract infections, and those with recent carbapenem exposure.

Scientifically, this study contributes local epidemiological evidence regarding the distribution of CRAB according to demographic characteristics, clinical conditions, and previous antibiotic exposure among clinical isolates examined at the Clinical Microbiology Laboratory, Faculty of Medicine, Universitas Indonesia, during 2017–2024. The findings strengthen existing evidence regarding the important role of carbapenem exposure in CRAB epidemiology and demonstrate the relevance of age and clinical manifestations in surveillance strategies. These results also provide an empirical basis for strengthening antimicrobial stewardship programs, particularly through appropriate assessment of the indication, selection, and duration of carbapenem therapy, integrated with infection prevention and control measures in healthcare facilities.

This study has several limitations, particularly its retrospective design based on secondary data, which resulted in varying levels of data completeness across variables, especially comorbidities, clinical diagnoses or manifestations, and previous carbapenem use. The relatively limited number of complete observations for several variables may also have reduced the precision of the estimated associations, as reflected by the wide confidence interval for the odds ratio of carbapenem exposure. In addition, the analysis was limited to bivariate analysis; therefore, it could not determine whether age, clinical manifestations, and carbapenem exposure were independently associated with CRAB after controlling for potential confounding factors. Future studies should include larger sample sizes, more complete patient-level clinical data, and multivariable analyses incorporating potential determinants such as intensive care unit admission, mechanical ventilation, invasive devices, length of hospitalization, severity of illness, and exposure to other antibiotic classes to identify independent factors associated with CRAB more comprehensively.

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REFERENCES

Chusri, S., Silpapojakul, K., McNeil, E., Singkhamanan, K., & Chongsuvivatwong, V. (2015). Impact of antibiotic exposure on occurrence of nosocomial carbapenem-resistant Acinetobacter baumannii infection: A case control study. *Journal of Infection and Chemotherapy*, *21*(2), 90-95.

Collaborators, G. B. D. A. R. (2024). Global burden of bacterial antimicrobial resistance 1990-2021: A systematic analysis with forecasts to 2050. *The Lancet*, *404*(10459), 1199-1226.

Du, X., Xu, X., Yao, J., Deng, K., Chen, S., & Shen, Z. (2019). Predictors of mortality in patients infected with carbapenem-resistant Acinetobacter baumannii: A systematic review and meta-analysis. *American Journal of Infection Control*, *47*(9), 1140-1145.

Ferlicolak, L., Altintas, N. D., & Yoruk, F. (2024). A retrospective analysis of carbapenem-resistant Acinetobacter baumannii infections in critically ill patients: Experience at a tertiary-care teaching hospital ICU. *Journal of Intensive Medicine*, *4*(2), 181-186.

Handayani, R. S., Siahaan, S., & Herman, M. J. (2018). Antimicrobial resistance and its control policy implementation in hospital in Indonesia. *Jurnal Penelitian dan Pengembangan Pelayanan Kesehatan*, 131-140.

He, X., Tang, J., He, S., & Huang, X. (2024). Analysis of risk factors and different treatments for infections caused by carbapenem-resistant Acinetobacter baumannii in Shaanxi, China. *BMC Infectious Diseases*, *24*(1), 1130.

Jiang, Y., Ding, Y., Wei, Y., Jian, C., Liu, J., & Zeng, Z. (2022). Carbapenem-resistant Acinetobacter baumannii: A challenge in the intensive care unit. *Frontiers in Microbiology*, *13*, 1045206.

Kao, H. H., Peng, C. K., Sheu, C. C., Lin, Y. C., Chan, M. C., & Wang, S. H. (2023). Mortality and ventilator dependence in critically ill patients with ventilator-associated pneumonia caused by carbapenem-resistant Acinetobacter baumannii. *Journal of Microbiology, Immunology and Infection*, *56*(4), 822-832.

Lee, K. H., Kim, J., Lee, J. A., Kim, C. H., Kwon, O. M., & You, E. J. (2024). Carbapenem-resistant Acinetobacter baumannii outbreak in a COVID-19 isolation ward and successful outbreak control with infection control measures. *Infection & Chemotherapy*, *56*(2), 222.

Lestari, Y. E., Andrajati, R., & Nusatia, A. C. M. (2020). Hubungan kejadian infeksi carbapenem resistant Acinetobacter baumannii dengan penggunaan antibiotika golongan karbapenem pada pasien di Rumah Sakit St. Carolus. *Indonesian Journal of Clinical Pharmacy*, *9*(3), 189.

Marsudi, A. (2022). Tingkat pengetahuan dan perilaku masyarakat terhadap penggunaan antibiotik di beberapa apotek di Kota Ternate. *Pharmacy Medical Journal*, *4*(2), 54.

Murray, C. J. L., Ikuta, K. S., Sharara, F., Swetschinski, L., Robles Aguilar, G., & Gray, A. (2022). Global burden of bacterial antimicrobial resistance in 2019: A systematic analysis. *The Lancet*, *399*(10325), 629-655.

Thimmappa, P. Y., Vasishta, S., Ganesh, K., Nair, A. S., & Joshi, M. B. (2023). Neutrophil dysfunction due to altered immuno-metabolic axis in type 2 diabetes: Implications in combating infections. *Human Cell*, *36*(4), 1265-1282.

Wang, S. H., Yang, K. Y., Sheu, C. C., Lin, Y. C., Chan, M. C., & Feng, J. Y. (2023). The prevalence, presentation and outcome of colistin susceptible-only Acinetobacter baumannii-associated pneumonia in intensive care unit: A multicenter observational study. *Scientific Reports*, *13*(1), 140.

World Health, O. (2024). *WHO bacterial priority pathogens list 2024: Bacterial pathogens of public health importance, to guide research, development, and strategies to prevent and control antimicrobial resistance*.

Xiao, T., Guo, Q., Zhou, Y., Shen, P., Wang, Y., & Fang, Q. (2022). Comparative respiratory tract microbiome between carbapenem-resistant Acinetobacter baumannii colonization and ventilator-associated pneumonia. *Frontiers in Microbiology*, *13*, 782210.

Zhang, Y., Xu, G., Miao, F., Huang, W., Wang, H., & Wang, X. (2023). Insights into the epidemiology, risk factors, and clinical outcomes of carbapenem-resistant Acinetobacter baumannii infections in critically ill children. *Frontiers in Public Health*, *11*, 1282413.