



PREVALENCE OF MULTIDRUG-RESISTANT (MDR) ORGANISMS IN ICU VS. NON-ICU SETTINGS.

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Abstract

Background: Antimicrobial resistance (AMR) is a major global public health threat, with multidrug-resistant (MDR) organisms posing a disproportionate burden in hospital settings, particularly in Intensive Care Units (ICUs). Critically ill ICU patients are uniquely susceptible to MDR infections due to compromised immunity, invasive procedures, and prolonged antibiotic exposure. Despite growing evidence at the global level, comparative data from tertiary care private medical college settings in eastern India remain limited, necessitating institution-specific microbiological and clinical analyses.

Materials and Methods: A retrospective observational study was conducted over six months (Jan 2018 – June 2018) at a tertiary care center in West Bengal, India. A total of 100 adult patients (≥ 18 years) with culture-confirmed bacterial infections were enrolled: 45 from the ICU and 55 from non-ICU general wards. Bacterial identification was performed using standard microbiological methods, and Antimicrobial Susceptibility Testing (AST) was carried out by the Kirby-Bauer disk diffusion method as per CLSI guidelines. MDR was defined as acquired non-susceptibility to at least one agent in three or more antimicrobial categories. Clinical outcomes including hospital length of stay, mechanical ventilation requirement, and progression to sepsis were recorded. Statistical analysis used Chi-square, Fisher's exact test, Student's t-test, and Odds Ratio (OR) with 95% CI; $p < 0.05$ was considered significant.

Results: Gram-negative bacteria accounted for 74.0% of all isolates, with *Klebsiella pneumoniae* (26.0%) and *Escherichia coli* (22.0%) being the most prevalent pathogens. The overall MDR prevalence was 54.0%, with a significantly higher burden in the ICU compared to non-ICU wards (71.1% vs. 40.0%; OR 3.69, 95% CI: 1.58–8.61; $p = 0.002$). *Acinetobacter baumannii* demonstrated alarming carbapenem resistance (75.0% to meropenem), while *K. pneumoniae* showed high-level cephalosporin resistance (73.1% to ceftriaxone). MDR-infected patients had a significantly prolonged mean hospital stay (16.4 ± 6.2 vs. 9.8 ± 4.1 days; $p < 0.001$), greater requirement for mechanical ventilation (44.4% vs. 23.9%; $p = 0.033$), and higher rates of progression to sepsis (35.2% vs. 17.4%; $p = 0.046$).

Conclusion: The present study demonstrates a significantly higher burden of MDR organisms in the ICU compared to non-ICU wards, with *Klebsiella pneumoniae* and *Acinetobacter baumannii* showing alarming resistance to cephalosporins and carbapenems. MDR infections were associated with prolonged hospital stays, increased mechanical ventilation requirements, and higher rates of sepsis, imposing a substantial burden on tertiary care resources. These findings highlight the urgent need for institution-specific antibiograms, robust Antimicrobial Stewardship Programs (AMSP), and stringent Infection Prevention and Control (IPC) protocols in critical care settings.

Keywords: *Multidrug resistance, Intensive Care Unit, Klebsiella pneumoniae, Antimicrobial Stewardship*

Introduction

Antimicrobial resistance (AMR) has emerged as one of the most critical threats to global public health in the twenty-first century. The World Health Organization (WHO), in its landmark 2014 Global Report on Surveillance, highlighted for the first time the alarming magnitude of AMR, documenting high resistance rates in commonly isolated bacteria such as *Escherichia coli*, *Klebsiella pneumoniae*, and *Staphylococcus aureus* across all WHO regions.[1] The report underscored that antimicrobial resistance was no longer a future concern but a present and pervasive reality affecting both community and healthcare settings worldwide. Central to this crisis is the emergence of multidrug-resistant (MDR) organisms, defined by Magiorakos et al. as acquired non-susceptibility to at least one agent in three or more antimicrobial categories. This internationally standardized definition, developed jointly by the European Centre for Disease Prevention and Control (ECDC) and the Centers for Disease Control and Prevention (CDC), also established the concepts of extensively drug-resistant (XDR) and pandrug-resistant (PDR) bacteria, which describe progressively greater degrees of resistance.[2]

The burden of MDR organisms is disproportionately concentrated in hospital settings, particularly within the Intensive Care Unit (ICU). Critically ill patients in ICUs are uniquely vulnerable due to compromised immune defenses, the use of invasive medical devices, prolonged antibiotic exposure, and the close proximity of colonized patients - all of which create a fertile environment for the selection and transmission of resistant pathogens. Nosocomial infections caused by MDR bacteria are therefore found predominantly in ICUs, with organisms of the so-called "ESKAPE" group- *Enterococcus faecium*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Acinetobacter baumannii*, *Pseudomonas aeruginosa*, and *Enterobacter* species - being the most frequently implicated. Studies have consistently reported MDR colonization or infection rates ranging from 13% to 54% in ICU populations, far exceeding rates observed in general hospital wards. [3,4]

In contrast, non-ICU or general ward settings, while also affected by MDR organisms, generally show lower prevalence rates. Patients in these wards typically have fewer invasive procedures and shorter antibiotic exposure; however, inadequate infection control practices and the transfer of colonized patients from ICUs can drive MDR transmission into these settings as well. The movement of patients between ICUs and general wards has been identified as a key vector for the dissemination of resistant organisms across hospital units, particularly when surveillance and contact precautions are inadequate.[5]

Despite advances in diagnostic techniques and infection prevention protocols, the prevalence of MDR organism infections in ICUs continues to rise globally. The most commonly encountered MDR pathogens in ICU settings include methicillin-resistant *Staphylococcus aureus* (MRSA), vancomycin-resistant *Enterococci* (VRE), extended-spectrum beta-lactamase (ESBL)-producing organisms, and carbapenem-resistant *Acinetobacter baumannii*. Comparative analyses between ICU and non-ICU populations highlight consistently higher rates of MDR infection, prolonged hospital stays, increased mortality, and greater healthcare costs in ICU patients. Understanding the differential prevalence of MDR organisms across hospital settings is, therefore, essential for designing targeted antimicrobial stewardship programs and effective infection control strategies to reduce the overall burden of drug-resistant infections.[6]

Materials and Methods

Study Design and Setting A retrospective observational study was conducted over a six-month period, from Jan 2018 – June 2018. The study was carried out at a tertiary care center in West Bengal In India. Institutional Ethics Committee (IEC) approval was obtained prior to the commencement of data collection, and patient confidentiality was strictly maintained throughout the study.

Study Population The study included a total sample of 100 patients who developed clinically significant, culture-positive bacterial infections during their hospitalization. The cohort was divided into two distinct groups based on their admission unit:

- **ICU Group:** Patients admitted to the Intensive Care Unit (n = 45).
- **Non-ICU Group:** Patients admitted to general medical and surgical wards (n = 55).

Inclusion and Exclusion Criteria

- **Inclusion Criteria:** Adult patients (aged 18 years and above) with a confirmed positive bacterial culture from a sterile or non-sterile site (including respiratory secretions, urine, blood, and skin/soft tissue exudates) demonstrating signs of systemic or localized infection.
- **Exclusion Criteria:** Patients with incomplete clinical or microbiological records, instances of polymicrobial growth indicating probable colonization or sample contamination, and patients who were discharged against medical advice within 48 hours of admission.

Microbiological Identification and Susceptibility Testing Clinical specimens were collected using aseptic precautions and transported to the microbiology laboratory. Samples were inoculated onto standard culture media (such as Blood agar and MacConkey agar) and incubated at 37°C for 24 to 48 hours.

Isolates were identified based on standard microbiological procedures, including colony morphology, Gram staining, and conventional biochemical reactions. Antimicrobial Susceptibility Testing (AST) was performed using the Kirby-Bauer disk diffusion method on Mueller-Hinton agar, and results were interpreted according to the prevailing Clinical and Laboratory Standards Institute (CLSI) guidelines for the year of the study.

Definitions Isolates were categorized as Multidrug-Resistant (MDR) if they demonstrated acquired non-susceptibility to at least one agent in three or more different antimicrobial categories. For *Staphylococcus aureus*, resistance to ceftazidime was used as a surrogate marker for methicillin resistance (MRSA), automatically classifying the isolate as MDR.

Data Collection Clinical and demographic data were systematically extracted from electronic medical records and physical patient files. The extracted variables included patient age, gender, underlying comorbidities (e.g., Diabetes Mellitus, Hypertension, Chronic Kidney Disease, COPD/Asthma), source of infection, length of hospital and ICU stay, requirement for mechanical ventilation, progression to sepsis or septic shock, and in-hospital mortality.

Statistical Analysis Data were entered into a standard spreadsheet and analyzed using statistical software. Descriptive statistics were used to summarize the data. Continuous variables (such as age and length of stay) were presented as mean $\pm$ standard deviation (SD) and compared using the Student's independent t-test. Categorical variables (such as gender, presence of specific pathogens, and resistance patterns) were presented as frequencies and percentages, and compared using the Pearson Chi-square test or Fisher's exact test, as appropriate. Odds Ratios (OR) with 95% Confidence Intervals (CI) were calculated to assess the risk of MDR acquisition in the ICU versus non-ICU setting. A two-tailed *p*-value of < 0.05 was considered statistically significant.

Results- of the 100 patients included in the study, those admitted to the intensive care unit (ICU, n=45) were significantly older and had a higher prevalence of respiratory tract infections compared to non-ICU patients (n=55) (Table 1). Gram-negative bacteria constituted the majority of the isolates (74.0%), with *Klebsiella pneumoniae* and *Escherichia coli* being the most frequently identified pathogens across both clinical settings (Table 2). The overall prevalence of multidrug-resistant (MDR) organisms was 54.0%, with a significantly higher burden observed in the ICU compared to non-ICU wards (71.1% vs. 40.0%, *p*=0.002) (Table 3). Antimicrobial susceptibility testing revealed alarming rates of resistance among high-burden isolates, particularly concerning cephalosporin and carbapenem resistance in Gram-negative strains, as well as significant methicillin resistance in *Staphylococcus aureus* (Table 4). Consequently, patients harboring MDR infections experienced significantly worse clinical outcomes, including a prolonged hospital length of stay (16.4 ± 6.2 days), an increased requirement for mechanical ventilation, and a higher rate of progression to sepsis (Table 5).

Table 1: Baseline Demographic and Clinical Characteristics of the Study Population (N = 100)

Characteristic	Total (N = 100)	ICU (n = 45)	Non-ICU (n = 55)	p-value*
Age (years), Mean $\pm$ SD	58.4 $\pm$ 14.2	62.1 $\pm$ 12.5	55.3 $\pm$ 15.1	0.018
Gender, n (%)				
Male	62 (62.0%)	29 (64.4%)	33 (60.0%)	0.648
Female	38 (38.0%)	16 (35.6%)	22 (40.0%)	
Comorbidities, n (%)				
Diabetes Mellitus	45 (45.0%)	24 (53.3%)	21 (38.2%)	0.134
Hypertension	38 (38.0%)	22 (48.9%)	16 (29.1%)	0.045
Chronic Kidney Disease	18 (18.0%)	12 (26.7%)	6 (10.9%)	0.042
COPD/Asthma	15 (15.0%)	9 (20.0%)	6 (10.9%)	0.207
Source of Infection, n (%)				
Respiratory Tract	38 (38.0%)	25 (55.6%)	13 (23.6%)	0.001
Urinary Tract	30 (30.0%)	10 (22.2%)	20 (36.4%)	0.125
Bloodstream (BSI)	16 (16.0%)	7 (15.6%)	9 (16.4%)	0.913
Skin/Soft Tissue	16 (16.0%)	3 (6.7%)	13 (23.6%)	0.023

*p-values calculated using Chi-square test for categorical variables and Student's t-test for continuous variables. Significance set at $p < 0.05$.

Table 2: Distribution of Isolated Pathogens in ICU vs Non-ICU Settings

Isolated Pathogen	Total Isolates (N = 100)	ICU (n = 45)	Non-ICU (n = 55)	p-value
Gram-Negative Bacteria	74 (74.0%)	38 (84.4%)	36 (65.5%)	0.031
<i>Klebsiella pneumoniae</i>	26 (26.0%)	15 (33.3%)	11 (20.0%)	0.135
<i>Escherichia coli</i>	22 (22.0%)	8 (17.8%)	14 (25.5%)	0.354
<i>Acinetobacter baumannii</i>	16 (16.0%)	11 (24.4%)	5 (9.1%)	0.038
<i>Pseudomonas aeruginosa</i>	10 (10.0%)	4 (8.9%)	6 (10.9%)	0.738
Gram-Positive Bacteria	26 (26.0%)	7 (15.6%)	19 (34.5%)	0.031
<i>Staphylococcus aureus</i>	18 (18.0%)	4 (8.9%)	14 (25.5%)	0.034
<i>Enterococcus</i> spp.	8 (8.0%)	3 (6.7%)	5 (9.1%)	0.655

Table 3: Prevalence of Multidrug-Resistant (MDR) Organisms

Setting	Total Isolates (n)	MDR Positive n (%)	Non-MDR n (%)	Odds Ratio (95% CI)	p-value
ICU	45	32 (71.1%)	13 (28.9%)	3.69 (1.58 - 8.61)	0.002
Non-ICU	55	22 (40.0%)	33 (60.0%)	Reference	-
Pathogen Type					
Gram-Negative	74	45 (60.8%)	29 (39.2%)	2.65 (1.02 - 6.89)	0.041
Gram-Positive	26	9 (34.6%)	17 (65.4%)	Reference	-
Overall Total	100	54 (54.0%)	46 (46.0%)		

Note: MDR defined as acquired non-susceptibility to at least one agent in three or more antimicrobial categories.

Table 4: Antimicrobial Resistance Profile of Selected High-Burden Isolates

Antimicrobial Agent	<i>K. pneumoniae</i> (n = 26)	<i>E. coli</i> (n = 22)	<i>A. baumannii</i> (n = 16)	<i>S. aureus</i> (n = 18)
Beta-lactams / Cephalosporins				
Ceftriaxone	19 (73.1%)	16 (72.7%)	14 (87.5%)	-
Cefepime	17 (65.4%)	14 (63.6%)	13 (81.3%)	-
Carbapenems				
Meropenem	11 (42.3%)	4 (18.2%)	12 (75.0%)	-
Imipenem	10 (38.5%)	3 (13.6%)	11 (68.8%)	-
Aminoglycosides				
Amikacin	8 (30.8%)	5 (22.7%)	9 (56.3%)	4 (22.2%)

Fluoroquinolones				
Ciprofloxacin	15 (57.7%)	14 (63.6%)	12 (75.0%)	10 (55.6%)
Others				
Cefoxitin (MRSA screen)	-	-	-	7 (38.9%)
Linezolid	-	-	-	0 (0.0%)
Colistin	1 (3.8%)	0 (0.0%)	2 (12.5%)	-

(Data presented as n (%) of isolates resistant to the specified agent).

Table 5: Clinical Outcomes and Length of Stay (LOS)

Clinical Outcome	MDR Infection (n = 54)	Non-MDR Infection (n = 46)	p-value
Hospital Length of Stay (days), Mean $\pm$ SD	16.4 $\pm$ 6.2	9.8 $\pm$ 4.1	< 0.001
ICU Length of Stay (days), Mean $\pm$ SD*	8.2 $\pm$ 3.5	4.6 $\pm$ 2.1	0.003
Need for Mechanical Ventilation, n (%)	24 (44.4%)	11 (23.9%)	0.033
Progression to Sepsis/Septic Shock, n (%)	19 (35.2%)	8 (17.4%)	0.046
In-Hospital Mortality, n (%)	12 (22.2%)	4 (8.7%)	0.065

*Calculated only for patients who required ICU admission at any point during their stay.

Discussion

The present study was undertaken with the primary objective of evaluating the comparative burden of multidrug-resistant (MDR) organisms in ICU versus non-ICU settings at a tertiary care medical college hospital. The principal finding of this study — a significantly higher prevalence of MDR infections among ICU patients compared to those in non-ICU general wards — is consistent with the well-established understanding that critical care environments serve as major reservoirs and amplifiers of antimicrobial resistance. Vincent et al., [6] in the landmark EPIC II study, reported that 51% of patients across 1,265 ICUs worldwide were considered infected on any given day, with infection independently associated with an increased hospital mortality rate of 33% versus 15% in non-infected patients — underscoring that ICU populations carry a distinctly higher infectious burden. The broader global context of this crisis was delineated by the World Health Organization, whose 2014 Global Report on Antimicrobial Resistance demonstrated that resistance to first-line and last-resort antibiotics was alarmingly widespread, with low- and middle-income countries disproportionately affected.[2]

In the present study, ICU patients were notably older and presented predominantly with respiratory infections compared to non-ICU patients. Advanced age is a well-recognized risk factor for MDR colonization and infection, as older patients frequently carry comorbidities, have diminished immune competence, and are often subjected to repeated antibiotic courses prior to ICU admission. These observations align with findings reported by Rosenthal et al.,[7] who identified older age and prolonged hospitalization among the leading independent risk factors for healthcare-associated MDR infections in developing nations. The preponderance of respiratory infections in the ICU cohort of this study is similarly consistent with the EPIC II findings, in which respiratory infections accounted for 64% of all ICU infections globally, with Gram-negative organisms predominating. Such respiratory foci inherently necessitate mechanical ventilation, which in turn extends ICU stays and escalates antibiotic exposure — a self-reinforcing cycle that significantly amplifies MDR selection pressure.

The microbiological findings of this study revealed an overwhelming dominance of Gram-negative pathogens, with *Klebsiella pneumoniae* and *Acinetobacter baumannii* emerging as the most frequently isolated MDR organisms in the ICU. *K. pneumoniae* has emerged as a formidable nosocomial pathogen across India, with carbapenem resistance increasing dramatically from 2% in 2002 to over 52% in a New Delhi tertiary care hospital by 2009, and continuing to rise thereafter, as documented by Laxminarayan et al.[8] in their comprehensive review of antibiotic resistance drivers in India. This epidemiological trajectory is deeply concerning, as carbapenems represent the last-resort treatment option for many Gram-negative infections. The high rates of cephalosporin

resistance observed in *K. pneumoniae* isolates in this study further mirror the national trend reported by Laxminarayan et al., [8] wherein third-generation cephalosporin resistance among *K. pneumoniae* isolates reached 80–90% in Indian tertiary centers. Similarly, *Acinetobacter baumannii* demonstrated near-universal resistance to carbapenems in ICU isolates. Garnacho-Montero et al.[9] established that MDR *A. baumannii* colonization at ICU admission was associated with a 1.4-fold increased risk of in-hospital mortality, and that colonized patients were 15.2 times more likely to develop a subsequent positive clinical culture for *A. baumannii*. These findings demonstrate that MDR *A. baumannii* is not merely a colonizer but an active driver of adverse outcomes.

The local drivers of this resistance pattern require careful institutional scrutiny. Indiscriminate and empirical use of broad-spectrum antibiotics without microbiological guidance, inadequate adherence to hand hygiene protocols, high patient-to-nurse ratios, and inter-ward patient transfers all contribute to cross-transmission dynamics within the hospital ecosystem. Choudhuri et al. [10] reported that among 134 patients transferred between ICUs in India, 21.6% harbored MDR infections, with *Klebsiella* being the most prevalent MDR organism — a finding strikingly parallel to the current study's microbiological profile. These institutional patterns of transmission reinforce the urgent need for localized, institution-specific antibiograms to guide empirical therapy, particularly in high-volume government medical facilities where protocol-driven prescribing is often the norm in the absence of real-time culture data.

The microbiological findings of this study translated directly into measurable and statistically significant clinical consequences. ICU patients with MDR infections demonstrated considerably longer hospital lengths of stay, a heightened requirement for mechanical ventilation, and significantly higher rates of progression to sepsis compared to non-ICU patients with non-MDR infections. These outcomes are corroborated by Choudhuri et al.,[10] who found that a mechanical ventilation duration and ICU stay exceeding seven days were independent predictors of mortality specifically in the MDR group, while no such association was observed in non-MDR patients. The clinical cascade of MDR infection — from initial colonization to sepsis to organ failure — was similarly validated in a large prospective ICU study by Garnacho-Montero et al.[9], in which prolonged ICU stay exceeding 14 days was associated with a six-fold increase in the risk of acquiring *A. baumannii* infection. Beyond the clinical realm, these extended ICU stays, increased ventilator days, and escalating antimicrobial costs represent a substantial socioeconomic burden on tertiary care infrastructure. In a resource-constrained government hospital setting, each additional day of ICU occupancy reduces bed availability for incoming critically ill patients, strains nursing capacity, and inflates pharmaceutical expenditure — particularly when reserve agents such as colistin or polymyxins must be deployed against XDR organisms.

This study must be contextualized within its inherent methodological limitations. The sample size of 100 patients, while sufficient for exploratory analysis, constrains statistical power for subgroup analyses and reduces the generalizability of findings across diverse clinical settings. The single-center design of this study, conducted at one tertiary care medical college hospital, may further limit the applicability of these results to other institutions with differing patient demographics, antibiotic prescribing practices, and infection control capacities. Multicentric, prospective studies with larger sample sizes are warranted to validate these findings at a regional and national level.[11]Notwithstanding these limitations, the findings of this study carry an unambiguous and urgent public health mandate. The dramatic burden of MDR organisms in the ICU demands the immediate and systematic implementation of Antimicrobial Stewardship Programs (AMSP) tailored specifically to critical care environments. Evidence consistently demonstrates that formal ASPs reduce antibiotic resistance rates, shorten duration of mechanical ventilation, and decrease overall healthcare costs in critically ill patients. Equally imperative is the reinforcement of Infection Prevention and Control (IPC) protocols — including contact precautions, active surveillance cultures, and structured hand hygiene auditing — to interrupt the chain of MDR transmission within and between hospital units. As Rice et al.[3] warned, the neglect of ESKAPE pathogen stewardship in nosocomial settings would perpetuate a cycle of untreatable infections with grave consequences for patient safety.

Conclusion

The present study demonstrates a significantly higher burden of MDR organisms in the ICU compared to non-ICU wards, with *Klebsiella pneumoniae* and *Acinetobacter baumannii* showing alarming resistance to cephalosporins and carbapenems. MDR infections were associated with prolonged hospital stays, increased mechanical ventilation requirements, and higher rates of sepsis, imposing a substantial burden on tertiary care resources. These findings highlight the urgent need for institution-specific antibiograms, robust Antimicrobial Stewardship Programs (AMSP), and stringent Infection Prevention and Control (IPC) protocols in critical care settings.

References

1. World Health Organization. Antimicrobial resistance: global report on surveillance. Geneva: WHO Press; 2014.
2. Magiorakos AP, Srinivasan A, Carey RB, Carmeli Y, Falagas ME, Giske CG, et al. Multidrug-resistant, extensively drug-resistant and pandrug-resistant bacteria: an international expert proposal for interim standard definitions for acquired resistance. Clin Microbiol Infect. 2012;18(3):268–81.
3. Rice LB. Federal funding for the study of antimicrobial resistance in nosocomial pathogens: no ESKAPE. J Infect Dis. 2008;197(8):1079–81.
4. Cassini A, Plachouras D, Eckmanns T, Abu Sin M, Blank HP, Ducomble T, et al. Burden of six healthcare-associated infections on European population health: estimating incidence-based disability-adjusted life years through a population prevalence-based modelling study. PLoS Med. 2016;13(10):e1002150.
5. Kola A, Schwab F, Bärwolff S, Eckmanns T, Gastmeier P, Piening B. Is there an association between the use of resident care beds and the prevalence of multidrug-resistant organisms in German long-term care facilities? J Hosp Infect. 2014;88(2):91–5.
6. Vincent JL, Rello J, Marshall J, Silva E, Anzueto A, Martin CD, et al. International study of the prevalence and outcomes of infection in intensive care units. JAMA. 2009;302(21):2323–9.
7. Rosenthal VD, Maki DG, Mehta Y, Leblebicioglu H, Memish ZA, Al-Mousa HH, et al. International Nosocomial Infection Control Consortium (INICC) report, data summary of 43 countries for 2007-2012. Am J Infect Control. 2014;42(9):942–56.
8. Laxminarayan R, Chaudhury RR. Antibiotic resistance in India: drivers and opportunities for action. PLoS Med. 2016;13(3):e1001974.
9. Garnacho-Montero J, Amaya-Villar R, Ortiz-Leyba C, León C, Aldabó-Pallás T, Cisneros JM, et al. Risk factors and outcomes associated with multidrug-resistant *Acinetobacter baumannii* colonization at ICU admission. Crit Care Med. 2017;46(1):73–80.
10. Choudhuri AH, Ahuja B, Biswas PS, Uppal R. Epidemiology of multidrug resistant infections after inter-ICU transfer in India. Indian J Crit Care Med. 2019;23(1):1–6.
11. Dellit TH, Owens RC, McGowan JE Jr, Gerding DN, Weinstein RA, Burke JP, et al. Infectious Diseases Society of America and the Society for Healthcare Epidemiology of America guidelines for developing an institutional program to enhance antimicrobial stewardship. Clin Infect Dis. 2007;44(2):159–77.