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# Clinical Predictors of Antimicrobial Treatment Failure Among Hospitalized Patients with Bacterial Infections

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***Abstract:*** **Background:** Treatment failure represents a major clinical problem for hospitalized patients with bacterial infection especially when associated with antimicrobial resistance and delayed effective treatment. **Objective:** To determine the clinical predictors of antimicrobial treatment failure among hospitalized patients with bacterial infections. **Methodology:** A prospective observational cohort study was carried out in the from January to December 2023. Through consecutive sampling, 360 adult patients were hospitalized and were under systemic antimicrobial therapy. Demographic, clinical, microbiological and antimicrobial treatment related information was collected. Descriptive statistics, chi-square tests, independent-samples t-tests and multivariable logistic regression analyses were conducted to analyze data. **Results:** Among 360 patients, 108 (30.00%) experienced antimicrobial treatment failure, while 252 (70.00%) achieved successful treatment. Inappropriate empirical antimicrobial therapy (adjusted OR = 3.12, p less than 0.001), severe infection (adjusted OR = 2.84, p less than 0.001), delayed effective therapy (adjusted OR = 2.46, p = 0.001), elevated CRP (adjusted OR = 2.22, p = 0.005), ICU admission (adjusted OR = 2.15, p = 0.006), comorbidities (adjusted OR = 1.96, p = 0.015), and multidrug resistance (adjusted OR = 1.75, p = 0.035) were independent predictors of treatment failure. **Conclusion:** Early appropriate antimicrobial therapy, timely treatment modification, and identification of high-risk patients are essential for improving treatment outcomes..

***Keywords:*** Antimicrobial treatment failure; bacterial infections; antimicrobial resistance; empirical antibiotic therapy; clinical predictors; hospitalized patients; antimicrobial stewardship.

## INTRODUCTION

Bacterial infections continue to be a significant source of morbidity and mortality in hospitalized populations, especially in high-resistance environments such as delayed diagnosis and inappropriate antibiotic use, which can pose a challenge in clinical management [1]. Multidrug-resistant organisms are becoming more common and are making the treatment of many standard antibiotics less effective, leading to poor treatment outcomes globally [2]. Timely and properly started antimicrobial treatment, based on clinical status and laboratory results, is key to infection control success [3]. Proper initial antibiotic use has been shown in previous

studies to be linked to mortality, longer hospital stay and failure of antimicrobial therapy in severe bacterial infections [4].

Treatment failure can be a complex clinical phenomenon that is affected by patient-related, infection-related, and treatment-related factors [5]. Other factors that have been found to influence treatment outcome are advanced age, underlying comorbidities, immunosuppression, severe illness, and admission to intensive care units [6]. Likewise, treatment may fail to be effective due to resistant bacterial pathogens, incorrect selection of empirical therapy, delayed initiation of effective therapy and inadequate antimicrobial dosing [7,8]. Also, antimicrobial treatment can lead to clinical deterioration if the infection is severe, if there is an anatomical source, if persistent bacteremia is present, and if there is a lack of adequate source control [9,10]. Multiple factors must be taken into consideration when assessing the treatment response in a clinical setting, such as the resolution of fever, improvement in clinical symptoms and normalization of laboratory parameters, as well as the absence of any complications or mortality [9]. Studies conducted in the past have emphasized the need to identify signs of treatment failure at an early stage, in particular in patients with bloodstream infection, pneumonia and other serious bacterial infections [11,12]. Identification of these predictors may assist in determining patients who are likely to benefit from routine antimicrobial treatment from those who do not and who are candidates for re-evaluation or adjustment of treatment.

However, there is still a gap in research on the simultaneous evaluation of demographic, clinical, microbiological and antimicrobial-related factors that predict treatment failure in hospitalized patients with various forms of bacterial infection, despite the presence of some evidence. Findings from specific infection-related research might not reflect the overall hospitalized population.

### Research Objective

To determine the clinical predictors of antimicrobial treatment failure among hospitalized patients with bacterial infections.

## Methodology

### Study Design

To identify clinical predictors of failure of antimicrobial treatment in hospitalized patients with bacterial infections a prospective observational cohort study was carried out.

### Study Duration

The study was done for a period of one year, from January to December 2023.

### Study Population

The study population consisted of all adult patients aged 15 years and more with bacterial infection who were admitted to the hospital and were treated with systemic antibiotics.

### Inclusion Criteria

The study included patients 18 years or older who were hospitalized for an antimicrobial treatment of the systemic bacterial infection confirmed or clinically suspected.

### Exclusion Criteria

Patients who had viral, fungal or non-infectious diseases, had not received systemic antimicrobial treatment and had inadequate clinical data for assessment of antimicrobial treatment were excluded.

### Sample Size Calculation

The single-population proportion formula was used to calculate the sample size to be used, with an expected antimicrobial treatment failure rate of 30%, a 95% level of confidence, and a 5% margin of error. Once 10% incomplete data was factored in, the sample size needed was about 356, and was rounded up to 360 participants.

### Sampling Technique

A consecutive sampling was used and all eligible patients who were admitted during the study period were recruited until the required number of patients were achieved.

### Data Collection Procedure

Patient interviews, clinical examination and review of hospital medical records were used to collect data using a structured data collection form. Data provided consisted of demographic data, presenting symptoms, infections, and infection location, comorbidities, vital signs, lab investigations, microbiological results, antibiotic selection, dose, treatment duration, and clinical outcomes. Relevant microbiological information and antimicrobial susceptibility results were also documented.

### Study Variables

The dependent variable was antimicrobial treatment failure and the independent variables were age, gender, comorbidities, severity of infection, site of infection, laboratory parameters, cause of infection (bacterial organism), antimicrobial resistance, appropriateness of empirical treatment, and timing of appropriate antimicrobial treatment.

### Operational Definition of Antimicrobial Treatment Failure

Antimicrobial treatment failure was defined as failure to achieve clinical improvement after antimicrobial therapy, defined as persistence or worsening of


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signs/symptoms of infection, a worsening clinical condition, a need for escalation or modification of antimicrobial therapy due to failure of therapy, development of infection-related complications, or infection-related death while hospitalized. The evaluation of treatment response was done by using clinical findings, laboratory parameters and microbiological results.

**Data Analysis**

Appropriate statistical software (SPSS version 26) was used to analyse the data. Demographic and clinical data were analyzed using descriptive statistics. Data on categorical variables were summarized as frequencies and percentages and/or as means and standard deviations (or medians and interquartile ranges as appropriate) for continuous variables. The associations between potential predictors and antimicrobial treatment failure were explored by the chi-square test and independent samples t-test or suitable non-parametric tests. Multivariable logistic regression of variables associated with treatment failure was performed to determine independent predictors. Odds ratios with 95% confidence intervals were presented and statistical significance was defined as $p < 0.05$.

## RESULT

In total, 360 hospitalised patients with bacterial infection were included in the study (table 1). The majority were aged 46–60 years (31.67%), followed by those older than 60 years (26.67%), and 56.67% were male. The most common infections were infections of the respiratory tract (34.44%) followed by urinary tract infections (27.22%). A moderate infection was seen in 48.89% of patients and severe infection in 32.22% of patients. The most common comorbidities were hypertension (37.22%) and diabetes mellitus (30.56%), with 26.11% of patients admitted to the intensive care unit (ICU). 68.33% of the patients had positive cultures, and Escherichia coli (30.89%) was the most common organism. 45.53% of culture-positive cases were MDR organisms. Sixty-three out of 63.33% received appropriate empirical anti-microbial therapy.

**Table 1. Sociodemographic, clinical, microbiological and antimicrobial treatment characteristics of hospitalized patients (N = 360)**

| Characteristics | Frequency, n | Percentage (%) |
|---|---|---|
| **Age group (years)** | | |
| 18–30 | 58 | 16.11 |
| 31–45 | 92 | 25.56 |
| 46–60 | 114 | 31.67 |
| >60 | 96 | 26.67 |
| **Gender** | | |
| Male | 204 | 56.67 |
| Female | 156 | 43.33 |
| **Residence** | | |
| Urban | 218 | 60.56 |
| Rural | 142 | 39.44 |
| **Educational status** | | |
| No formal education | 115 | 31.94 |
| Primary | 88 | 24.44 |
| Secondary | 102 | 28.33 |
| Higher education | 55 | 15.28 |
| **Employment status** | | |
| Employed | 196 | 54.44 |
| Unemployed | 164 | 45.56 |
| **Clinical and infection-related characteristics** | | |
| **Type of infection** | | |
| Respiratory tract infection | 124 | 34.44 |
| Urinary tract infection | 98 | 27.22 |
| Bloodstream infection | 62 | 17.22 |
| Skin and soft tissue infection | 38 | 10.56 |
| Intra-abdominal infection | 24 | 6.67 |
| Other infections | 14 | 3.89 |
| **Severity of infection** | | |
| Mild | 68 | 18.89 |
| Moderate | 176 | 48.89 |


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| | | |
|---|---|---|
| Severe | 116 | 32.22 |
| **Comorbidities** | | |
| Diabetes mellitus | 110 | 30.56 |
| Hypertension | 134 | 37.22 |
| Chronic kidney disease | 42 | 11.67 |
| Cardiovascular disease | 54 | 15.00 |
| No comorbidity | 78 | 21.67 |
| **ICU admission** | | |
| Yes | 94 | 26.11 |
| No | 266 | 73.89 |
| **Microbiological characteristics** | | |
| **Culture status** | | |
| Positive culture | 246 | 68.33 |
| Negative culture | 84 | 23.33 |
| Culture not performed | 30 | 8.34 |
| **Identified bacterial organisms (n = 246)** | | |
| Escherichia coli | 76 | 30.89 |
| Klebsiella pneumoniae | 58 | 23.58 |
| Staphylococcus aureus | 44 | 17.89 |
| Pseudomonas aeruginosa | 34 | 13.82 |
| Acinetobacter species | 22 | 8.94 |
| Other organisms | 12 | 4.88 |
| **Antimicrobial resistance pattern (n = 246)** | | |
| Susceptible organism | 108 | 43.90 |
| Multidrug-resistant organism | 112 | 45.53 |
| Other resistant organisms | 26 | 10.57 |
| **Antimicrobial treatment characteristics** | | |
| **Empirical antimicrobial therapy** | | |
| Appropriate | 228 | 63.33 |
| Inappropriate | 132 | 36.67 |
| **Modification of antimicrobial therapy** | | |
| No modification | 152 | 42.22 |
| Escalation | 118 | 32.78 |
| De-escalation | 56 | 15.56 |
| Change due to adverse effects or other reasons | 34 | 9.44 |

**Note:** Comorbidities were not mutually exclusive; patients could have more than one comorbidity. Percentages for identified bacterial organisms and antimicrobial resistance patterns were calculated using culture-positive patients (n = 246) as the denominator. All other percentages were calculated using the total study population (N = 360).

There were 360 hospitalized patients, of whom 108 (30.00%) failed to have a successful antimicrobial treatment; table 2 shows this. Persistent infection (31.48%), clinical deterioration (25.93%) and antimicrobial escalation due to inadequate response (20.37%) were the most common reasons for failure of treatment. Failure due to infection-related complications occurred in 14.81% of the patients and infection-related mortality occurred in 7.41% of the patients.

**Table 2. Antimicrobial treatment outcomes among hospitalized patients (N = 360)**

| Treatment outcomes | Frequency, n | Percentage (%) |
|---|---|---|
| **Overall treatment outcome** | | |
| Successful treatment | 252 | 70.00 |
| Antimicrobial treatment failure | 108 | 30.00 |
| **Reasons for treatment failure (n = 108)** | | |
| Persistent infection | 34 | 31.48 |
| Clinical deterioration | 28 | 25.93 |
| Antimicrobial escalation due to inadequate response | 22 | 20.37 |
| Infection-related complications | 16 | 14.81 |
| Infection-related mortality | 8 | 7.41 |

Note: Percentages for reasons for treatment failure were calculated using patients with treatment failure (n = 108) as the denominator.


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Table 3 shows bivariate analysis results that indicated significant associations of antimicrobial treatment failure with the presence of comorbidities (p = 0.004), severe infection (p less than 0.001), ICU admission (p less than 0.001), multidrug-resistant organisms (p = 0.012), inappropriate empirical antimicrobial therapy (p less than 0.001), and delayed effective antimicrobial treatment (p less than 0.001). Failure of treatment also occurred more often in patients with underlying conditions, severe disease, admission to the intensive care unit (ICU) and presence of a multidrug-resistant organism (MDRO). In the same way, patients who were given improper empirical therapy and patients who were given effective therapy after 24 hours had a higher failure rate. Treatment outcome (culture and infection) was not significantly correlated with any of the following factors: age, gender, diabetes mellitus, or culture status (p > 0.05).

**Table 3. Bivariate analysis of potential predictors associated with antimicrobial treatment failure (N = 360)**

| Variables | Category | Treatment success n (%) | Treatment failure n (%) | p-value |
|---|---|---|---|---|
| Age group | 18–45 years | 104 (68.42) | 48 (31.58) | 0.642 |
| | >45 years | 148 (71.15) | 60 (28.85) | |
| Gender | Male | 140 (68.63) | 64 (31.37) | 0.521 |
| | Female | 112 (71.79) | 44 (28.21) | |
| Comorbidities | Present | 162 (64.80) | 88 (35.20) | 0.004 |
| | Absent | 90 (81.82) | 20 (18.18) | |
| Diabetes mellitus | Yes | 70 (63.64) | 40 (36.36) | 0.088 |
| | No | 182 (72.80) | 68 (27.20) | |
| Infection severity | Mild/moderate | 192 (79.34) | 50 (20.66) | <0.001 |
| | Severe | 60 (50.85) | 58 (49.15) | |
| ICU admission | Yes | 50 (53.19) | 44 (46.81) | <0.001 |
| | No | 202 (75.94) | 64 (24.06) | |
| Infection type | Respiratory | 82 (66.13) | 42 (33.87) | 0.145 |
| | Urinary | 76 (77.55) | 22 (22.45) | |
| | Bloodstream | 38 (61.29) | 24 (38.71) | |
| | Other infections | 56 (73.68) | 20 (26.32) | |
| Culture result | Positive | 168 (68.29) | 78 (31.71) | 0.312 |
| | Negative/not performed | 84 (73.68) | 30 (26.32) | |
| Multidrug resistance | Yes (n=112) | 68 (60.71) | 44 (39.29) | 0.012 |
| | No (n=134) | 100 (74.63) | 34 (25.37) | |
| Empirical antimicrobial therapy | Appropriate | 182 (79.82) | 46 (20.18) | <0.001 |
| | Inappropriate | 70 (53.03) | 62 (46.97) | |
| Time to effective therapy | Within 24 hours | 178 (78.41) | 49 (21.59) | <0.001 |
| | More than 24 hours | 74 (55.64) | 59 (44.36) | |

Note: Values are presented as frequencies and row percentages. Associations were assessed using the chi-square test or Fisher's exact test, as appropriate.

Patients who failed treatment with antimicrobial drugs had significantly longer hospital stays than those who succeeded in treatment (11.82 ± 3.84 compared to 6.45 ± 2.10 days; p < 0.001), as presented in table 4. The mean values of the total number of leukocytes, mean levels of C-Reactive protein (CRP), mean levels of serum creatinine (SCr), and mean body temperature were also higher in patients who failed to make it through treatment than in those who were successfully treated (p<0.001 for all comparisons). Additionally, the mean time to achieve effective antimicrobial therapy was significantly greater for patients with treatment failure (28.60 ± 9.10 hours) than for those with successful treatment (14.20 ± 5.40 hours; p < 0.001). There was no statistically significant difference between mean age of both groups (p = 0.068).


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**Table 4. Comparison of continuous clinical and laboratory parameters according to antimicrobial treatment outcomes**

| Clinical and laboratory variables | Treatment success (Mean ± SD) | Treatment failure (Mean ± SD) | p-value |
|---|---|---|---|
| Age (years) | 48.24 ± 12.65 | 51.12 ± 14.10 | 0.068 |
| Hospital stay (days) | 6.45 ± 2.10 | 11.82 ± 3.84 | <0.001 |
| Total leukocyte count (×10⁹/L) | 11.20 ± 3.15 | 16.85 ± 4.90 | <0.001 |
| C-reactive protein (CRP) (mg/L) | 42.50 ± 15.30 | 98.40 ± 28.60 | <0.001 |
| Serum creatinine (mg/dL) | 1.05 ± 0.32 | 1.72 ± 0.65 | <0.001 |
| Body temperature (°C) | 37.80 ± 0.60 | 38.70 ± 0.85 | <0.001 |
| Time to effective antimicrobial therapy (hours) | 14.20 ± 5.40 | 28.60 ± 9.10 | <0.001 |

Note: Continuous variables are presented as mean ± standard deviation. Independent-samples t-test or the Mann–Whitney U test was used, as appropriate.

Several independent predictors for antimicrobial treatment failure were identified on multivariable logistic regression (table 5). Empirical inappropriate antimicrobial therapy was the greatest predictor with nearly three times higher odds of treatment failure (adjusted OR = 3.12, 95% CI: 1.82–5.35; p less than 0.001). Severe infection (adjusted OR = 2.84, 95% CI: 1.62–4.98; p less than 0.001), delayed effective antimicrobial therapy beyond 24 hours (adjusted OR = 2.46, 95% CI: 1.45–4.18; p = 0.001), elevated CRP (adjusted OR = 2.22, 95% CI: 1.28–3.85; p = 0.005), and ICU admission (adjusted OR = 2.15, 95% CI: 1.25–3.70; p = 0.006) were also significant independent predictors. Other factors significantly linked to treatment failure were the presence of comorbidities (adjusted OR = 1.96, 95% CI: 1.14–3.38; p = 0.015) and MDR organisms (adjusted OR = 1.75, 95% CI: 1.04–2.94; p = 0.035). Age, diabetes mellitus and bloodstream infection were not independently related to treatment failure.

**Table 5. Multivariable logistic regression analysis of independent predictors of antimicrobial treatment failure**

| Potential predictors | Crude OR | Adjusted OR | 95% CI | p-value |
|---|---|---|---|---|
| Age >45 years | 1.12 | 1.18 | 0.72–1.94 | 0.512 |
| Presence of comorbidities | 2.45 | 1.96 | 1.14–3.38 | 0.015 |
| Diabetes mellitus | 1.54 | 1.32 | 0.80–2.18 | 0.280 |
| Severe infection | 3.58 | 2.84 | 1.62–4.98 | <0.001 |
| ICU admission | 2.78 | 2.15 | 1.25–3.70 | 0.006 |
| Bloodstream infection | 1.82 | 1.64 | 0.92–2.92 | 0.092 |
| Multidrug-resistant organism | 1.84 | 1.75 | 1.04–2.94 | 0.035 |
| Inappropriate empirical antimicrobial therapy | 3.52 | 3.12 | 1.82–5.35 | <0.001 |
| Delayed effective antimicrobial therapy (>24 hours) | 2.90 | 2.46 | 1.45–4.18 | 0.001 |
| Elevated CRP | 3.10 | 2.22 | 1.28–3.85 | 0.005 |

Note: Binary logistic regression was performed with antimicrobial treatment failure as the dependent variable. Results are presented as crude and adjusted odds ratios (ORs) with 95% confidence intervals (CIs). Statistical significance was considered at $p < 0.05$.

## DISCUSSION

In the present study, clinical, microbiological and antimicrobial-related predictors of treatment failure have been assessed in 360 hospitalised patients with bacterial infection. However, the overall result of the antimicrobial treatment was failure in 30.00% and success in 70.00%. The most common infections identified were respiratory tract infections (RTIs) (34.44%) and urinary tract infections (UTIs) (27.22%). Sixty eight point 33% patients had positive bacterial cultures, and 45.53% of culture positive patients were multidrug resistant. The results stress the high levels of antibiotic resistance and treatment failures in hospitalised patients. Likewise, Luo et al., (2023) noted issues with inappropriate empirical antimicrobial treatment in hospitalized patients with bacterial infection, highlighting the significance of selecting antibiotics wisely and obtaining microbiological guidance [13].

Compared to non-severe, treatment failure was independently associated with severe infection (adjusted OR = 2.84, 95% CI: 1.62 – 4.98; p less than 0.001), and ICU admission was associated with over 2 times the odds of treatment failure (adjusted OR = 2.15, 95% CI: 1.25 – 3.70; p = 0.006). Also, the treatment failure was significantly higher in patients with comorbidities than in those without any comorbidities (35.20% vs. 18.18%, p = 0.004). The results indicate that there is a potential for sub-optimal clinical response to antimicrobial therapy due to underlying health conditions and increased disease


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severity. A similar result was found by Cheng et al. (2025), who showed that the mortality rate of hospitalized patients with bacterial CAP was significantly related to the number of comorbidities [14].

An interesting result was the relationship of inappropriate empirical antimicrobial therapy with treatment failure. Overall, failure rates for those who received inappropriate empirical treatment versus appropriate treatment were 46.97% versus 20.18% ($p < 0.001$). After adjustment, inappropriate empirical treatment remained the strongest predictor (adjusted OR = 3.12, 95% CI: 1.82–5.35; p less than 0.001). This is in line with Luo et al. (2023) who pointed out the clinical significance of proper empirical antibiotic prescription [13]. In the same manner, Allel et al. (2024) have reported that bloodstream infections were associated with higher mortality due to inappropriate empirical antibiotic treatment [15].

Another important factor affecting the failure of treatment was delayed initiation of effective antimicrobial therapy. Patients who were effectively treated after 24 hours had 44.36% failure rate while those treated within 24 hours had 21.59% failure rate ($p<0.001$). Failure was still significantly related to delayed treatment (adjusted OR = 2.46, 95% CI: 1.45–4.18; p = 0.001). Moreover, there was a significant difference between the mean time to effective therapy between patients whose treatment was successful (14.20 ± 5.40 hours) and patients whose treatment failed (28.60 ± 9.10 hours; p less than 0.001). Similarly, Allel et al. (2024) showed that inadequate empirical antimicrobial treatment was linked with higher mortality, which further highlights the clinical significance of appropriate antimicrobial coverage in a timely manner [15].

Other relationships were important, for multidrug resistance and increases in inflammatory markers. Treatment failure was significantly higher among patients infected with multidrug-resistant organisms (39.29% vs. 25.37%; p = 0.012), with an adjusted OR of 1.75 (95% CI: 1.04–2.94; p = 0.035). The same was true for CRP, which was independently associated with treatment failure (adjusted OR = 2.22, 95% CI: 1.28–3.85; p = 0.005). Patients with treatment failure also had significantly higher mean CRP levels (98.40 ± 28.60 vs. 42.50 ± 15.30 mg/L; p less than 0.001) and leukocyte counts (16.85 ± 4.90 vs. 11.20 ± 3.15 × $10^9$/L; p less than 0.001). In the same way, Serra-Burriel et al. (2020) showed the negative clinical outcomes of multidrug-resistant HAIs [16]. Recently, Yepiz Carrillo et al. (2026) found CRP to be a significant predictor of early treatment failure for patients with community-acquired pneumonia (CAP) who have been hospitalized [17].
In the present study, the hospital stays were also significantly longer in the treatment failure group (11.82 ± 3.84 days) compared to the treatment success group (6.45 ± 2.10 days; p less than 0.001). The lack of adequate antimicrobial response was a serious concern because 7.41% of treatment failures were due to infection-related causes. These results confirm the importance of early identification of high-risk patients, appropriate empirical antibiotic selection, early antibiotic modification when necessary and monitoring of clinical and laboratory parameters. The single centre design and consecutive sampling with inclusion of different types of bacterial infection may restrict generalizability, however. In addition, observational design does not provide evidence of causation. Despite these limitations, the results offer valuable information about what types of clinical predictors of treatment failure are present, and highlight the need for antimicrobial stewardship and individual treatment approaches.

**Strengths and Limitations**
The main advantage of this study was the prospective observational study design that allowed for systematic evaluation of demographic, clinical, microbiological and antimicrobial-associated factors linked to treatment outcomes of hospitalized patients with bacterial infections. Different types of infections, assessment of antimicrobial appropriateness, assessment of treatment timing, and multivariable logistic regression have enabled a comprehensive understanding of potential predictors of treatment failure. In addition, clinical and laboratory parameters were introduced to enhance the treatment outcome assessment. There were a few drawbacks to this study, however. The single centre design might limit the applicability of the results to other health care centers. There could have been some selection bias with consecutive sampling. In addition, the observational design does not allow for causal statements to be made between the predictors identified and treatment failure. Other factors such as differences in infection types, antimicrobial regimens, and clinical management could have also affected treatment results. The study does have some limitations, but it offers important evidence on factors associated with the failure of antimicrobial treatment in the hospital setting.

## CONCLUSION

Failure of antimicrobial treatment is still a significant clinical problem in the treatment of hospitalized patients with bacterial infections. The results show that these factors—infection severity, comorbidities, admission to ICUs, multidrug-resistant infection, inappropriate empirical antimicrobial use, late starting time to the effective antimicrobials, and increased inflammatory markers—are important independent risk factors associated with poor treatment outcome. To improve the effectiveness of treatment, high risk patients should be identified early,


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appropriate antimicrobial treatment promptly started, microbiological investigations performed, and close clinical monitoring undertaken. To reduce treatment failure, avoid complications and enhance clinical outcomes among hospitalized patients, antimicrobial stewardship practices and individual treatment strategies can be strengthened.

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