

To Study the Impact of Stewardship Program on Antibiotic Administration in a Community-acquired Pneumonia: A Before-and-after Interventional Study



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ABSTRACT

Background: Community-acquired pneumonia (CAP) is a common lower respiratory tract infection that leads to millions of hospital admissions annually and contributes to substantial morbidity and mortality worldwide. Effective antimicrobial treatment is crucial for managing CAP. However, due to the high incidence, frequent misdiagnosis of its cause, and associated mortality risks, optimizing antibiotic use is essential. To promote best practices and minimize unnecessary antibiotic exposure in CAP patients, stewardship programs have been implemented. This study aims to evaluate the effect of these stewardship programs on antibiotic prescribing patterns in CAP.

Materials and methods: This prospective interventional study was conducted on patients in the emergency wards of Bowring and Lady Curzon Hospitals from October 23 to October 24. The total sample size is 120; the study population is divided into two phases: phase 1—preintervention—and phase 2—postintervention. The outcome of the study is analyzed.

Results: Of the 120 participants in the study, 60 were preintervention, and 60 were postintervention. Most of the participants in the study are under 60. The majority is male (46.7% and 60%), comprising 65% and 76.6%, respectively. Most patients had CURB-65 scores of 2 or 3. As for stages 1 and 2, the PSI is 2 and 3, respectively. The two most commonly isolated organisms are *Klebsiella pneumoniae* and *Streptococcus pneumoniae*. Following an antimicrobial stewardship (AMS) intervention, 75% of patients in this study adhered to the guidelines and followed de-escalation protocols, a difference that is statistically significant. Additionally, the mean length of hospital stay decreased from 6.1 to 4.9 days.

Conclusion: The implementation of an antibiotic stewardship program resulted in a notable improvement in adherence to clinical guidelines, optimized antibiotic selection, increased de-escalation rates, and a considerable reduction in the overall duration of empirical antibiotic treatment.

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INTRODUCTION

Community-acquired pneumonia (CAP) is a common lower respiratory tract infection that leads to millions of hospital admissions each year, contributing significantly to global morbidity and mortality.¹ While most cases are caused by well-established respiratory pathogens, the accuracy of microbiological confirmation is often limited due to the low sensitivity and specificity of respiratory secretions and challenges in obtaining adequate samples.²

Antimicrobial therapy plays a crucial role in the effective management of CAP.³ However, the high prevalence of cases, frequent misdiagnosis of its etiology, and associated mortality risks contribute to increased antibiotic usage.

Antimicrobial resistance (AMR) among key respiratory pathogens is on the rise worldwide.⁴ According to a recent report from the World Health Organization, antibiotic resistance is responsible for approximately 2,500 deaths annually within the European Union.⁵

To encourage adherence to best practices and minimize unnecessary

antibiotic exposure in CAP patients, antimicrobial stewardship programs have been introduced. This study aims to evaluate the impact of such programs on antibiotic prescribing patterns for CAP prior to their implementation.

AIMS AND OBJECTIVES

To evaluate the influence of the antibiotic stewardship program on antibiotic utilization in CAP.

To assess its effectiveness by analyzing hospital length of stay (LOS), mortality rates, duration of intravenous antibiotic therapy, and overall antibiotic consumption.

MATERIALS AND METHODS

Study Design

Prospective before-and-after interventional study.

Study Setting

Data for the study will be collected from patients in the ward and emergency ward

at Bowring and Lady Curzon Hospitals from October 23 to October 24.

Sample Size

Based on a previous study by Fally et al., the impact of a stewardship program on antibiotic administration in CAP. Considering mortality in the whole cohort of 8.7%, the sample size is as follows:⁶

$$N = 4pq/d^2$$

where p = prevalence, $q = 100 - p$, and d = absolute precision.

$$= 4 \times 8.7 \times 91.3 / (7.5)^2$$

$$= 56$$

So, after rounding, the sample size would be 60 in each group.

Method of Collection of Data

Inclusion Criteria

- Patients who provide written informed consent.
- Patients diagnosed with CAP (defined by the presence of a new infiltrate on chest X-ray and at least one of the following symptoms: cough, sputum production, dyspnea, core body temperature >38.0 °C, and auscultatory findings of rales).
- Age >18 years.

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Exclusion Criteria

- Age <18 years.
- Hospital admission within the past 28 days.
- Active tuberculosis.
- Immunosuppression [corticosteroids (20 mg prednisolone-equivalent/day >14 days), were HIV positive, had received chemotherapy during the last 28 days, had neutropenia].

Procedure

After receiving approval from the institutional ethics committee and obtaining written informed consent, patients admitted to the hospital affiliated with Shri Atal Bihari Vajpayee Medical College and Research Institute will be included in the study.

All patients admitted to the ward and emergency ward with CAP are surveyed,

and demographic, clinical, treatment, and laboratory data are collected.

Phase 1 (Preintervention Phase) 6 Months, 60 Patients

It is to observe the current practice of CAP treatment and antibiotic stewardship in our hospital. Data related to CAP is collected. At the end of 6 months, CAP guideline utilization and antibiotic use, along with length of hospitalization and mortality, are calculated.

Phase 2 (Intervention Phase) 6 Months, 60 Patients

- **Target groups:** Residents, nursing staff, treating faculties.
- **Intervention:** Engaging mass lectures will be conducted on key aspects of CAP management, including severity

assessment, timely initiation of antimicrobial therapy, guideline-based selection of empirical regimens, de-escalation strategies, transition to oral therapy, and appropriate duration of treatment. Additionally, targeted bedside training, one-on-one discussions, educational posters, and monthly feedback sessions will be implemented.

- Compliance with the antibiotic stewardship approach for CAP, along with hospital LOS, mortality rates, and the duration of IV antibiotic therapy, will be assessed and compared before and after the intervention.

Outcome

- **Primary outcome:** An appropriate, correct antibiotic choice, duration, and de-escalation
- **Secondary outcome:** Days of Hospitalization.

Mortality

Statistical tool for analysis: The data were compiled in Microsoft Excel and analyzed using SPSS Statistics version 22. Categorical variables were assessed using the χ^2 test. The Mann-Whitney *U* test was applied to non-normally distributed nominal data, such as hospital LOS and duration of antibiotic therapy. For non-normally distributed ordinal or nominal data on a scale, such as time to antibiotic administration based on the CURB-65 score, the Kruskal-Wallis test was used.

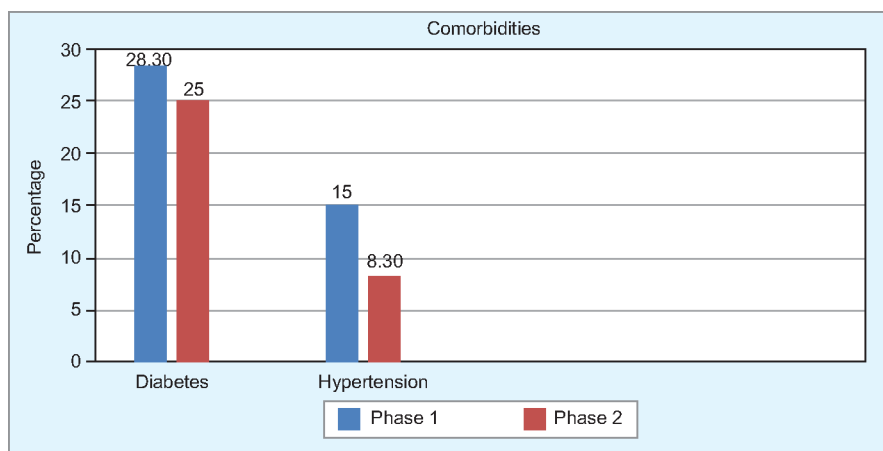


Fig. 1: Comorbidities distribution (In our study population, 28.3% and 25% are diabetics in both the phases)

Table 1: Demographic distribution among the study population

Variables		Preintervention (n = 60) (%)	Postintervention (n = 60) (%)
Gender	Males	28 (46.7)	36 (60)
	Females	32 (53.3)	24 (40)
Age	<60 years	39 (65)	46 (76.6)
	>60 years	21 (35)	14 (23.4)

Among the study population, the majority are less than 60 years (65% and 76.6%), and the majority are male (46.7% and 60%), respectively

Table 2: Severity scoring

Variables		Preintervention (N = 60) (%)	Postintervention (N = 60) (%)
CURB-65	Score 0	6 (10)	0 (0)
	Score 1	16 (26.7)	23 (38.4)
	Score 2	25 (41.7)	31 (51.6)
	Score 3	13 (21.6)	6 (10)
PSI	1	12 (20)	0 (0)
	2	33 (55)	34 (56.6)
	3	14 (23.3)	19 (31.7)
	4	1 (1.7)	7 (11.7)

In our study in phases 1 and 2, the majority of the CURB-65 scores are 2 and 3, and the PSI scores are 2 and 3

DISCUSSION

Antimicrobial resistance is spreading rapidly worldwide, posing an urgent threat to global public health. Antimicrobial stewardship programs (ASP) and institution-specific guidelines for empirical antibiotic therapy play a vital role in preventing the development of antibiotic resistance and improving patient outcomes. CAP is one of the most common acute infections requiring antibiotic treatment, and improper prescribing practices contribute significantly to the overuse and misuse of these critical medications.⁷

In our study population, males constituted the majority, accounting for 46.7% in one group and 60% in the other, and a sizable majority were under 60 (65% and 76.6%) (Table 1). Additionally, 28.3% and 25% of patients were diabetics in both phases of the study (Fig. 1). The data indicate that the majority of patients had a CURB-65 score of 2 or 3 and a Pneumonia Severity Index (PSI) of 2 or 3, suggesting a higher severity of illness (Table 2). The most common organisms are *Streptococcus pneumoniae* and *Klebsiella pneumoniae* (Fig. 2).

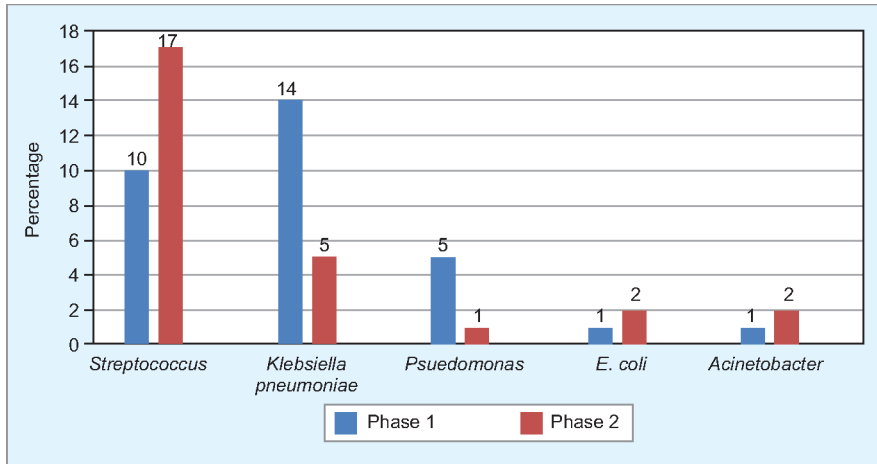


Fig. 2: Antibigram (The most common organisms are *Streptococcus pneumoniae* and *Klebsiella pneumoniae*)

Table 3: Sputum analysis

Variables	N (%)	N (%)
Sputum sent for sputum culture	56 (93.3)	60 (100%)
Mean day of sputum culture sent	Second day	First day
Percentage of normal commensals	37 (61.6)	33 (55%)
Predominant pattern	Bronchopneumonia	20 (33.3%)
	Lobar Pneumonia	36 (60%)
		18 (30%)
		42 (70%)

In this study, in phase (1), 93.3% of sputum samples and in phase (2), 100% of sputum samples were sent for sputum culture. After intervention in phase 2, sputum was sent before starting antibiotics (on the first day). *In vivo*, the culture yield increased by 45%. Most CAP cases were lobar pneumonia (60% and 70%, respectively)

Table 4: Antibiotic utilization

Antibiotic	Phase 1	Phase 2	p-value
Amoxiclav	10 (17%)	21 (35%)	<0.009
Ceftriaxone	25 (42%)	30 (50%)	
Piperacillin tazobactam	23 (39%)	8 (13%)	
Meropenem	1 (2%)	1 (2%)	

In our post-ASP, there is a decrease in utilization of higher antibiotics with a statistically significant p-value <0.001

Table 5: Antibiotic stewardship (Guidelines, de-escalation, and duration of antibiotics)

Variables	Category	Phase 1 N (%)	Phase 2 N (%)	p-value
Guidelines followed	Yes	33 (55%)	45 (75%)	0.01
	No	27 (45%)	15 (25%)	0.01
De-escalation	Done	20 (33.3%)	45 (75%)	0.05
	Not done	40 (66.7%)	15 (25%)	0.05
Average duration of antibiotics	-	6.35 days	4.4 days	0.06
Mean duration of stay	-	6.11	4.93	<0.01

In this study, following the intervention about antibiotic stewardship, there is 75% to guidelines, and de-escalation is followed in 75% of patients, which is statistically significant (p < 0.05). The average duration of antibiotics after phase 2 is around 5 days. Mean duration of hospitalization is also reduced from 6.1 to 4.9 days, which is statistically significant with p < 0.01

Our intervention involved sending sputum cultures on the second day of admission preintervention, while postintervention cultures were collected on the first day before antibiotic administration. This strategic change led to a remarkable 45% increase in

culture yields. Furthermore, the predominant form of CAP observed in the study was lobar pneumonia, affecting 60% and 70% of patients, respectively (Table 3).⁸ In our post-ASP, there is a decrease in utilization of higher antibiotics with a significant statistical p-value <0.001 (Table 4).

This study unambiguously demonstrates that during the preintervention period, nonadherence to antibiotic guidelines was alarmingly high, with a rate of 55% for CAP. However, the implementation of the ASP, which incorporated a written local guideline and restricted antibiotic usage, led to a substantial improvement in adherence for agent selection, increasing from 55% to 75%. Fesus et al. corroborated this trend, revealing that 41.7% of antibiotic use in the pulmonology department was nonadherent to guidelines.⁹ Notably, the frequent and unnecessary combination of beta-lactams with metronidazole, comprising 8.7% of prescriptions, contributed to prolonged LOS. In stark contrast, during the ASP phase, adherence to agent selection guidelines surged from 58.3% to an impressive 93.3%.

Our findings conclusively show that implementing the ASP led to a significant reduction in the total duration of antibiotic therapy, from a median of 7 days to 5 days, which directly correlated with a marked decrease in empirical antibiotic use. Fesus et al. reported a comparable success, highlighting a 16.0% reduction in the total duration of antibiotic therapy, with the median decreasing from 8 days to 6 days, along with a decline in direct empirical antibiotic use. Similarly, a study by Avdic et al. supported these findings, showing a reduction in antibiotic usage from a median of 10 days to 7 days (p < 0.001) after the implementation of the ASP intervention.¹⁰

Moreover, in our analysis, the increase in antibiotic de-escalation from preintervention to postintervention was substantial, rising from 33.3% to 75%, with a statistically significant p-value < 0.05. Waagsbo et al. also recognized the pressing need for improved antibiotic de-escalation strategies in their research conducted at a teaching university hospital in Norway, revealing a notable increase in de-escalation from 28.3% to 64.8%.¹¹

Finally, the length of hospitalization decreased significantly from 6.1 days to 4.9 days after the ASP was implemented (p < 0.05). Fesus et al. reported comparable results, revealing a striking 13.5% decrease in mean LOS (from 8.85 ± 6.10, with a median of 8 days, to 7.09 ± 5.84, with a median of 6 days) (Table 5). These findings unequivocally support the effectiveness of ASP in improving antibiotic prescribing practices and patient outcomes.⁹

STUDY LIMITATIONS

- Conducted at a single center.
- Limited sample size.

CONCLUSION

The implementation of the antibiotic stewardship program resulted in notable improvements in adherence to clinical guidelines, appropriate antibiotic use, and increased de-escalation. Additionally, it led to a significant reduction in the overall duration of empirical antibiotic therapy. The ASP was also associated with a considerable decrease in hospital LOS. Our findings suggest that the ASP may be instrumental in optimizing antibiotic treatment for CAP.

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