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Original Article

De-escalation of Antibiotics in Respiratory Tract Infection based upon Age, Gender and Culture Report

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ABSTRACT

Background: Antibiotic de-escalation is a critical antimicrobial stewardship practice that ensures targeted, safer therapy. However, the influence of patient-specific factors such as age, gender, and microbiological cultures on de-escalation in Respiratory Tract Infections (RTIs) remains underexplored in real-world settings. **Objectives:** To assess the impact of age, gender, and culture positivity on antibiotic de-escalation timing in patients admitted with respiratory tract infections. **Materials and Methods:** A retrospective observational study was conducted in the medical wards of a tertiary care hospital in Kerala between January and December 2023. Medical records of 571 patients diagnosed with RTIs and on empirical antibiotic therapy for more than 48 hr were reviewed. Patients were stratified based on age (<60 or ≥60 years), gender, and culture results. Time to antibiotic de-escalation was assessed and compared across these variables. **Results:** Among 571 patients, 351 (61.5%) were aged <60 years and 220 (38.5%) were aged ≥60 years. The median time to de-escalation in the elderly group was 8 days, compared to 5 days in younger patients ($p<0.05$). Gender showed no statistically significant difference in de-escalation timing. Out of 571 patients, only 134 (23.5%) had positive cultures. However, culture positivity did not significantly alter de-escalation timelines. **Conclusion:** Age is a key factor influencing delayed antibiotic de-escalation in respiratory infections, whereas gender and culture positivity had limited impact. These findings highlight the need for tailored de-escalation protocols, especially in elderly patients.

Keywords: Antibiotic De-escalation, Respiratory Tract Infections, Age, Gender, Culture Sensitivity, Antimicrobial Stewardship.

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INTRODUCTION

Respiratory Tract Infections (RTIs) are a major public health burden, particularly in low- and middle-income countries, where they represent one of the most frequent causes for antibiotic use in both outpatient and inpatient settings (World Health Organization (WHO), 2023). In India, RTIs contribute significantly to hospital admissions, leading to widespread empirical use of broad-spectrum antibiotics (Kotwani *et al.*, 2014). This empirical therapy is often initiated without culture guidance, potentially leading to prolonged or inappropriate antibiotic exposure (Lakbar *et al.*, 2020).

In response to rising concerns about Antimicrobial Resistance (AMR), the WHO and national agencies have emphasized the importance of Antimicrobial Stewardship Programs (ASPs), of which De-Escalation (ADE) is a core component (Lakbar *et al.*, 2020). ADE refers to the strategic narrowing or discontinuation of empirical antibiotic therapy once clinical improvement or culture results support such a change (De Waele *et al.*, 2020). This process helps minimize unnecessary exposure to broad-spectrum agents, reduces cost, lowers toxicity, and helps control AMR spread (De Waele *et al.*, 2020).

Despite its clinical significance, the implementation of ADE is often suboptimal in routine hospital practice. Studies show that real-time factors such as age, sex, and microbiological culture results may influence the clinician's willingness or timing to de-escalate (Lakbar *et al.*, 2020). For instance, elderly patients may experience longer durations of antibiotic therapy due to delayed clinical response, higher severity of illness, or prescriber hesitation (Al-Zakwani *et al.*, 2018). In contrast, while sex-related physiological differences in drug metabolism have been reported, their practical influence on de-escalation decisions remains unclear (Soldin and Mattison, 2009).

Another key determinant is culture sensitivity. In ideal settings, culture results should guide definitive therapy. However, challenges such as low yield, late reporting, or lack of action on results may diminish their real-world impact on ADE (Gonçalves-Pereira

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and Póvoa, 2011). As a result, even when cultures are available, physicians may continue empirical regimens based on clinical response rather than laboratory data (Micek *et al.*, 2004).

In this context, our study aimed to evaluate the influence of age, gender, and culture reports on the timing of antibiotic de-escalation among patients admitted with respiratory tract infections in a tertiary care ward-based setting in South India.

Inappropriate and prolonged use of broad spectrum antibiotics for respiratory tract infection remains a major concern, especially in Indian hospitals. Although de-escalation is encouraged in antimicrobial stewardship, limited data exist on how factors like age, gender, and culture results influence de-escalation decisions in real- world setting. Generating such local evidence is essential to guide targeted interventions and promote responsible antibiotic use.

MATERIALS AND METHODS

Study Design

A retrospective cohort study was conducted.

Study Site

The study was carried out in the Department of General Medicine at Believers Church Medical College Hospital (BCMCH), Thiruvalla, Kerala, India. The topic of investigation was "De-escalation of Antibiotics in Respiratory Tract Infections in the Ward."

Study Duration

The study was conducted over a period of six months, from November 2023 to April 2024.

Sampling Method

A purposive sampling technique was used.

Sample Size

A total of 571 patients who fulfilled the inclusion criteria were enrolled. All eligible patients were included without sampling calculation.

Study Approval

The study was approved by the Institutional Review Board (IRB) of Believers Church Medical College Hospital, Thiruvalla.

Inclusion Criteria

- Patients aged 18 years and above,
- Patients admitted to medical wards with a diagnosis of respiratory tract infection.

Exclusion Criteria

- Patients admitted to the Intensive Care Unit (ICU),
- Pregnant women.

Source of Data

Patient data were extracted from the Hospital Information System (HIS) and Laboratory Information System (LIS). Culture and sensitivity reports were retrieved from the microbiology lab registry.

Study Procedure

Eligible patient records were reviewed retrospectively. Data were collected using structured Google Forms and transferred to Microsoft Excel for analysis.

Statistical Analysis

Kaplan-Meier (KM) curves were used to estimate the median time to de-escalation, stratified by age, gender, and culture results. Statistical analysis was performed using appropriate tests, with $p<0.05$ considered significant.

RESULTS

The study aimed to evaluate the time taken for the de-escalation of antibiotics in respiratory tract infections. This is a retrospective cohort study conducted at Believers Church Medical College Hospital, Thiruvalla. Our study population includes 571 patients who were admitted to the respiratory ward of BCMCH.

AGE GROUP

Table 1 and Figure 1 show how respiratory tract infections were distributed across different age groups. The study was conducted on 571 patients who had been diagnosed with respiratory tract infections. The study observed that the disease most frequently occurs in the older age group of 70-79 (about 163 people, accounting for 28.6%), followed by the age group of 60-69 (151 people accounting for 26.4%), the age group of >=80 (1104 people accounting for 18.2%), the age group of 50-59 (58 people accounting for 10.2%), the age group of 40-49 (34 people accounting for 6.0%), the age group of 30-39 (333 people accounting for 5.8%), and the age group of <30 (28 people accounting for 4.9%).

Figure 2 shows the Kaplan-Meier survival curve. In particular, it looks at the connection between age and how long it takes to de-escalate antibiotic use. The likelihood of continuing to use antibiotics is shown by the Y-axis, which has a range of 0.0 to 1.0. The follow-up period (in days), which varies from 0 to 24 days, is represented by the X-axis. Two age groups are compared: "60 years and older" (represented by the green step-line) and "<60" (represented by the blue step-line). Red plus signs stand for suppressed data points, which are incomplete or lack precise

timing information. The median times for both age groups are shown by a dashed horizontal line with the name "Median" intersecting both step lines. The two age groups' antibiotic de-escalation timings appear to differ significantly, based on the *p*-values.

Interpretation of the graph

The green line, which represents people 60 years of age and older, indicates a greater likelihood of continuing to use antibiotics over time. The blue line, which represents people under 60, shows a decreased likelihood of continuing to use antibiotics. The statistical tests verify that there is a statistically significant difference. The group aged 60 and above (represented by the green line) shows an approximate day of de-escalation around day 20. The group aged below 60 (represented by the blue line) shows an approximate day of de-escalation around day 12.

Clinical Implications

Older patients (60 and older) may require longer antibiotic treatment before de-escalation. Out of 571 patients, 351 (61.5%) were aged <60 years, and 220 (38.5%) were ≥60 years. Elderly patients had a median de-escalation time of 8 days compared to 5 days in younger adults ($p<0.05$).

GENDER GROUP

From the study population of 571 people, the data, as presented in Table 2 and Figure 3, show that there are 310 males (54.29%) and 261 females (45.71%) affected with respiratory tract infection.

The graph in Figure 4 indicates the Kaplan Meier Survival Curve of Time to De-escalate by sex, which shows that female patients take more time to de-escalate than male patients. Both male and female patients initially start with a high probability of continued antibiotic use (near 1.0) at the beginning of follow-up. As time progresses, the probability decreases for both groups. The blue line (representing male patients) shows a steeper decline, suggesting that male patients tend to de-escalate antibiotic use more quickly. The green line (representing female patients) has a more gradual decline, indicating that female patients continue antibiotic use for a longer duration. Although the statistical tests do not reach conventional significance levels, there is still a trend suggesting that females may take more time to de-escalate than the male patient.

Clinical Implications

Gender-wise, 310 (54.29%) were male, and 261 (45.71%) were female. There was no statistically significant difference in de-escalation timing between males and females.

CULTURE REPORTS

As shown in Figure 5 and Table 3, out of 571 patients, 134 had a positive culture report and 437 had a negative culture report.

The graph in Figure 6 shows the Kaplan-Meier Survival Curve that illustrates the time to de-escalation based on culture reports. It compares the probability of continued antibiotic use over time for patients with positive and negative culture reports. The green line represents patients with negative culture reports, while the blue line represents patients with positive culture reports. Both lines decrease over time, indicating a reduction in the probability of continued antibiotic use as days pass. The chart also includes markers labelled as "Censored," which indicate data points where information is incomplete or uncertain.

Interpretation of the graph

The vertical axis (Y-axis) represents the probability of continuing antibiotic treatment and its values range from 0 (no probability) to 1 (100% probability). The horizontal axis (X-axis) shows the duration of follow-up in days and it ranges from 0 to 24 days. Both groups (i.e., positive and negative) initially start with a high probability of continued antibiotic use (near 1.0) at the beginning of follow-up. As time progresses, the probability decreases for both the negative (green line) and positive (blue line) culture report groups. The statistical tests do not reach conventional significance level; therefore, it is not considered as statistically significant.

Clinical implications- Culture positivity was observed in 134 patients (23.5%), while 437 (76.5%) had negative or no culture growth. Culture positivity did not significantly influence de-escalation timing.

Table 1: Distribution of age group.

Sl. No.	Age group	Frequency	Percentage
1	<30	28	4.9%
2	30-39	33	5.8%
3	40-49	34	6.0%
4	50-59	58	10.2%
5	60-69	151	26.4%
6	70-79	163	28.6%
7	>=80	104	18.2%
8	TOTAL	571	100%

Table 2: Distribution of Participants by Gender

Sl. No.	Sex	Frequency	Percentage
1	Male	310	54.29%
2	Female	261	45.71%
	Total	571	100%

Table 3: Distribution of culture reports.

Sl. No.	Culture	Frequency	Percentage
1	Positive	134	23.5%
2	Negative	437	76.5%
	Total	571	100%

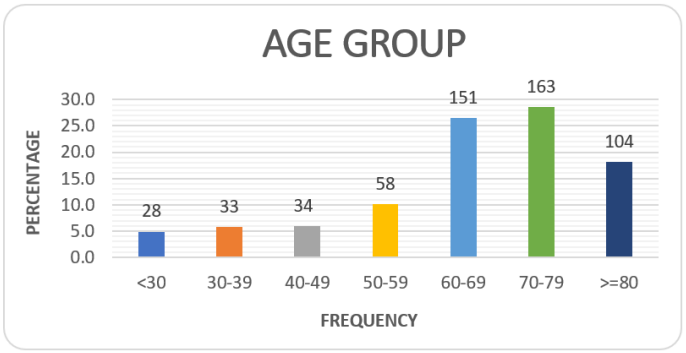

Figure 1: Distribution of age group.

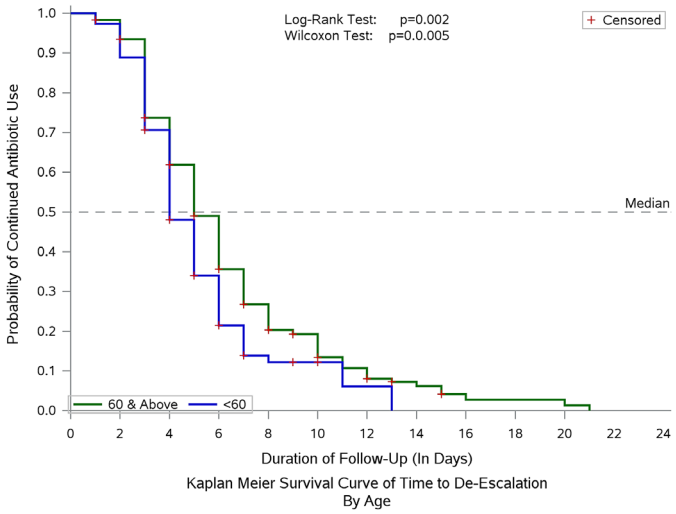

Figure 2: Distribution of KM- survival curve of time to de-escalation by age.

DISCUSSION

Our study found that age significantly influenced the timing of antibiotic de-escalation. Patients aged ≥60 years experienced a median delay of 8 days, compared to 5 days in patients below 60 years. This finding aligns with literature suggesting that clinicians often hesitate to de-escalate antibiotics in elderly patients due to comorbidities, immunosenescence, and atypical presentations, which make clinical assessment of improvement more complex (Falcone *et al.*, 2016). Elderly patients may also be subject to more frequent diagnostic uncertainty, further delaying step-down decisions (Murray *et al.*, 2015).

From an antimicrobial stewardship standpoint, this represents a critical area for intervention. Prolonged empirical therapy in older adults may increase risks such as *clostridioides difficile* infection, nephrotoxicity, and resistance emergence, particularly when narrow-spectrum options are underutilized (Tamma *et al.*, 2017). Decision support tools, early infectious disease consultations, and use of biomarkers like procalcitonin may help guide safer and earlier de-escalation in this vulnerable group (Schuetz *et al.*, 2017).

Regarding gender, our study found no significant difference in the timing of de-escalation between males and females. While sex-based pharmacokinetic variations and immune responses have been reported, these do not appear to significantly alter real-world antibiotic decisions in ward-based settings (soldin and mattison, 2009). This suggests that clinical response and disease severity remain the dominant factors in guiding de-escalation, regardless of patient sex.

In terms of culture results, only 23.5% of patients in our cohort had positive cultures, and this did not significantly alter de-escalation timing. Although microbiological confirmation is an ideal basis for narrowing therapy, the low positivity rate, delayed turnaround time, and clinician reliance on empirical improvement may limit its real-time utility (kollef, 2001). This aligns with prior studies, which observed that de-escalation is often driven by clinical stability rather than culture sensitivity, especially when pathogen identification is delayed or deemed unreliable (Micek *et al.*, 2004).

These observations emphasize the need for more proactive diagnostic stewardship. Encouraging timely culture collection before antibiotic initiation, investing in rapid diagnostics, and improving microbiology-clinician communication may enhance the integration of laboratory data into de-escalation decisions (Gonçalves-pereira and Póvoa, 2011). Moreover, standardizing ade checklists or implementing electronic alerts

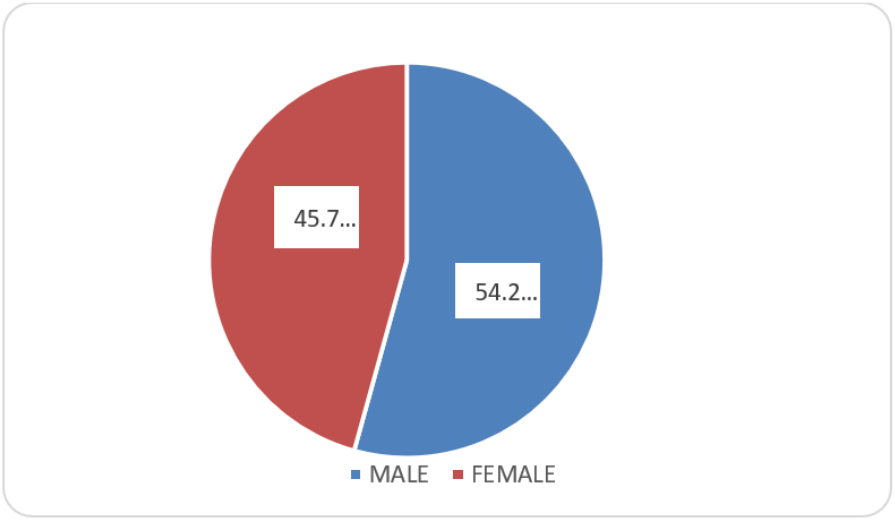

Figure 3: Distribution of gender.

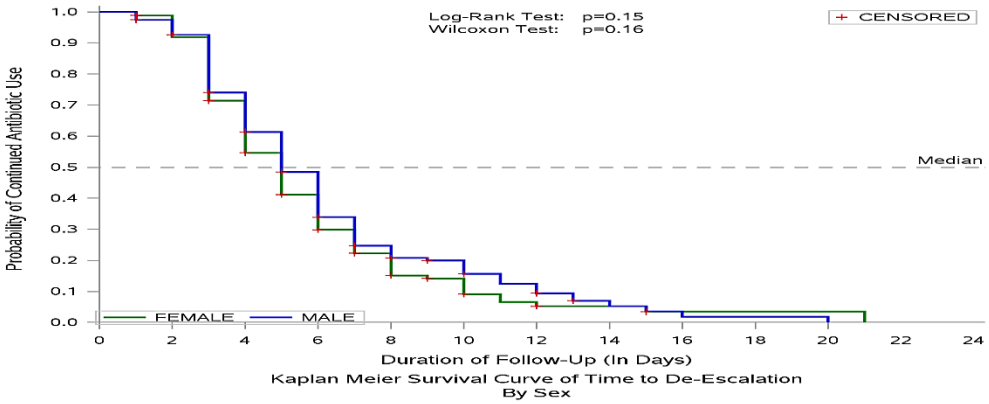

Figure 4: Distribution of KM- survival curve of time to de-escalation by gender. Kaplan-Meier survival analysis was used to estimate time to de-escalation.

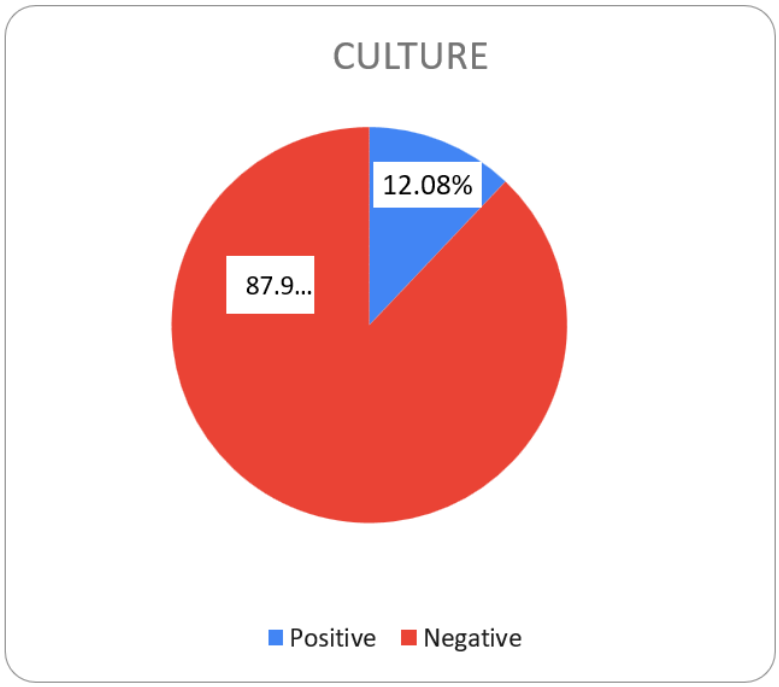

Figure 5: Distribution of culture reports.

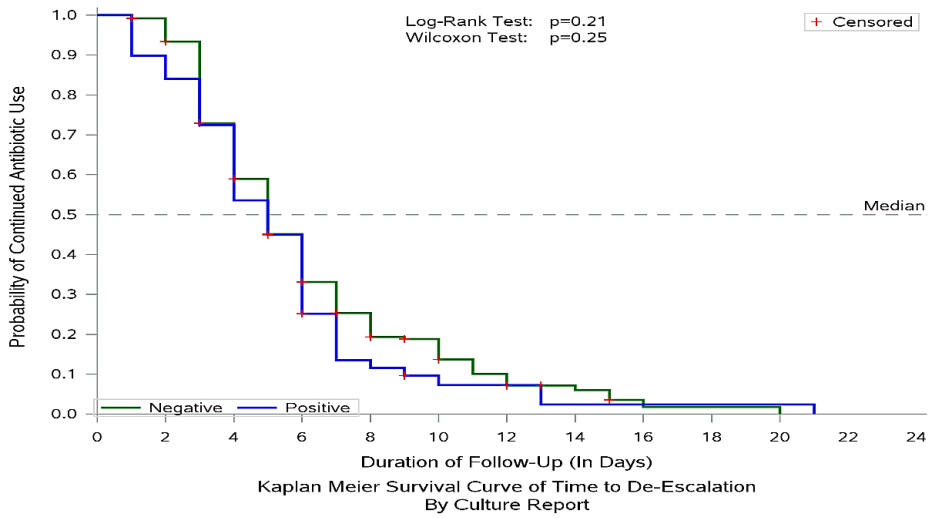

Figure 6: Distribution of KM- survival curve of time to de- escalation by culture reports.

may help overcome inertia and promote more evidence-based de-escalation practices (Weiss *et al.*, 2019).

Overall, our findings highlight that age remains the most influential factor in delaying de-escalation, and targeted stewardship strategies should focus on overcoming barriers to timely narrowing of therapy in elderly patients.

CONCLUSION

This study highlights that age is a significant determinant in the timing of antibiotic de-escalation among patients hospitalized with respiratory tract infections. Patients aged 60 years and above experienced a notable delay in de-escalation compared to younger adults, emphasizing the need for increased clinical vigilance and tailored antimicrobial stewardship in geriatric care.

In contrast, gender showed no observable influence on de-escalation practices, suggesting that antibiotic decisions were based on objective clinical parameters rather than sex-based differences. Additionally, although culture positivity was present in nearly one-fourth of patients, it did not lead to earlier de-escalation, indicating limited real-world impact of microbiological confirmation on antibiotic step-down decisions.

These findings underscore the necessity of strengthening age-specific stewardship strategies and enhancing the utility of culture reports in clinical practice. Promoting early review of antibiotic therapy, especially in elderly patients, and improving diagnostic efficiency could support more consistent and timely de-escalation in hospital settings.

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ABBREVIATIONS

ADE: Antibiotic De-escalation; **AMR:** Antimicrobial Resistance; **ASP:** Antimicrobial Stewardship Program; **RTI:** Respiratory Tract Infection; **ICU:** Intensive Care Unit; **HIS:** Hospital Information System; **LIS:** Laboratory Information System; **KM:** Kaplan-Meier.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

SUMMARY

This retrospective observational study investigated how age, gender, and microbiological culture results affect the timing of antibiotic de-escalation among patients admitted with respiratory tract. Data on 571 patients were analyzed. Older patients (≥60 years) experienced a median longer time to de-escalation compared to younger patients, but neither gender nor culture positivity was linked to the duration of de-escalation. The findings emphasize the need for age-targeted antimicrobial stewardship programs and improved integration of diagnostic findings into clinical practice.

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