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Original Research Article

Procalcitonin Guided Antibiotic Stewardship vs Standard Care in ICU Patients

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Abstract

Introduction: Procalcitonin guided antibiotic stewardship is an evidence-based strategy used in intensive care units to guide initiation and discontinuation of antibiotics, aiming to improve clinical outcomes and reduce antimicrobial resistance.

Aims: To compare the effectiveness of procalcitonin guided antibiotic stewardship with standard care in reducing antibiotic duration, ICU stay, and mortality among critically ill patients.

Materials and Methods: This were a prospective comparative study conducted in ICU patients, divided into procalcitonin guided group and standard care group, with serial procalcitonin measurements and antibiotic decisions based on predefined cut off values.

Result: In 100 ICU patients (50 PCT vs 50 standard care), age, gender, comorbidities, and SOFA scores were comparable ($p = 0.91, 0.69, 0.85, 0.89$). PCT group showed reduced antibiotic duration (6.2±2.1 vs 8.5±2.6 days, $p < 0.001$), shorter ICU stay (7.8±3.2 vs 10.1±3.8 days, $p = 0.002$), and increased antibiotic-free days ($p < 0.001$).

Conclusion: Procalcitonin guided antibiotic stewardship is effective in optimizing antibiotic use in ICU patients, safely reducing antibiotic duration and improving resource utilization compared to standard care.

Keywords: Procalcitonin, Antibiotic Stewardship, Intensive Care Unit, Antimicrobial Resistance, Critical Care.
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Introduction

Procalcitonin (PCT) has emerged as a valuable biomarker in guiding antibiotic stewardship, particularly in critically ill patients within intensive care units (ICUs). Bacterial infections and sepsis remain significant causes of morbidity and mortality in the ICU, and judicious antibiotic use is critical to preventing the rise of antimicrobial resistance, minimizing adverse effects, and optimizing clinical outcomes. PCT levels correlate with bacterial infection severity, allowing clinicians to tailor antibiotic initiation and discontinuation more precisely than traditional clinical judgment alone.[1]

Several randomized controlled trials and meta-analyses have demonstrated that PCT-guided antibiotic protocols can safely reduce the duration of antibiotic therapy in ICU patients without increasing mortality or relapse rates.[2] Specifically, PCT-guided discontinuation of antibiotics reduced antibiotic exposure by approximately 2 days and increased antibiotic-free days, contributing to lower risks of resistance and secondary infections such as Clostridioides difficile.[3]These protocols also demonstrated potential reductions in ICU length of stay and mechanical ventilation duration, highlighting the broader clinical benefits of PCT use beyond antimicrobial stewardship.[4]

Despite these promising findings, challenges remain in implementing PCT-guided stewardship. Trials have noted issues such as variable adherence to PCT protocols and limited impact on antibiotic initiation decisions.[5] Moreover, with evolving standards favoring shorter fixed antibiotic courses, the absolute benefit of PCT-guided algorithms may diminish unless integrated into multifaceted stewardship programs.[6] Economic evaluations further support the adoption of PCT-guided protocols, showing cost savings through reduced antibiotic use, shorter hospital stays,[7] and fewer antibiotic-associated complications. Collectively, evidence endorses PCT-guided antibiotic

stewardship as a safe, effective, and economically advantageous approach compared with standard care in ICU settings, warranting incorporation into clinical practice with attention to protocol adherence and broader stewardship synergy. Aims To compare the effectiveness of procalcitonin guided antibiotic stewardship with standard care in reducing antibiotic duration, ICU stay, and mortality among critically ill patients. [8]

Materials and Methods

Study design: Prospective comparative study in ICU patients comparing procalcitonin guided therapy versus standard antibiotic care.

Place of study: Dinhata Subdivisional Hospital, Coochbehar

Period of study: 12 months

Study Population: Critically ill ICU patients receiving antibiotics for suspected bacterial infections.

Sample size: 50

Inclusion Criteria

1. Patients admitted to the Intensive Care Unit (ICU) with suspected or confirmed bacterial infection or sepsis.
2. Adult patients aged ≥18 years receiving intravenous antibiotic therapy.
3. Patients with available baseline and serial procalcitonin (PCT) measurements during ICU stay.

Exclusion Criteria

1. Patients with viral, fungal, or non-bacterial infections as the primary diagnosis.
2. Immunocompromised patients (e.g., HIV with low CD4 count, post-transplant, chemotherapy-induced neutropenia).
3. Patients with expected ICU stay <48 hours or those who died within 24 hours of admission.

Study Variable

Independent Variable: PCT-guided antibiotic stewardship vs standard care

Dependent Variables

- Antibiotic duration
- ICU stay
- Antibiotic-free days
- Mortality
- Mechanical ventilation
- Secondary infection
- ICU readmission

Demographic & Clinical Variables

- Age
- Gender
- Comorbidities
- SOFA score

Statistical Analysis: For statistical analysis, data were initially entered into a Microsoft Excel spreadsheet and then analysed using SPSS (version 27.0; SPSS Inc., Chicago, IL, USA) and GraphPad Prism (version 5). Numerical variables were summarized using means and standard deviations, while Data were entered into Excel and analyzed using SPSS and GraphPad Prism. Numerical variables were summarized using means and standard deviations, while categorical variables were described with counts and percentages. Two-sample t-tests were used to compare independent groups, while paired t-tests accounted for correlations in paired data. Chi-square tests (including Fisher's exact test for small sample sizes) were used for categorical data comparisons. P-values ≤ 0.05 were considered statistically significant.

Result

Table 1: Distribution of Age of Study Groups

Age (years)	PCT Group n (%)	Standard Care n (%)	p-value
18–40	10 (20%)	12 (24%)	0.91
41–60	28 (56%)	26 (52%)	
>60	12 (24%)	12 (24%)	
Total	50 (100%)	50 (100%)	

Table 2: Distribution of Gender

Gender	PCT Group n (%)	Standard Care n (%)	p-value
Male	28 (56%)	30 (60%)	0.69
Female	22 (44%)	20 (40%)	
Total	50 (100%)	50 (100%)	

Table 3: Distribution of Comorbidities

Comorbidity	PCT Group n (%)	Standard Care n (%)	p-value
Diabetes Mellitus	18 (36%)	20 (40%)	0.85
Hypertension	22 (44%)	24 (48%)	
COPD	10 (20%)	12 (24%)	
Total	50 (100%)	50 (100%)	

Table 4: Distribution of SOFA Score

SOFA Score	PCT Group n (%)	Standard Care n (%)	p-value
0–5	18 (36%)	16 (32%)	0.89
6–10	26 (52%)	28 (56%)	
>10	6 (12%)	6 (12%)	
Total	50 (100%)	50 (100%)	

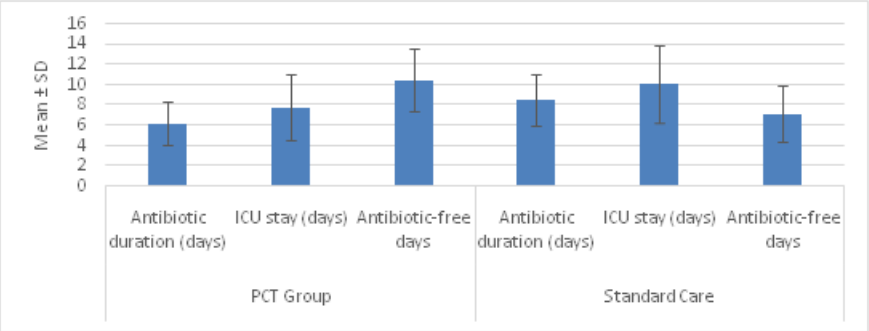

Figure 1: Antibiotic Duration and ICU Stay (Mean ± SD)

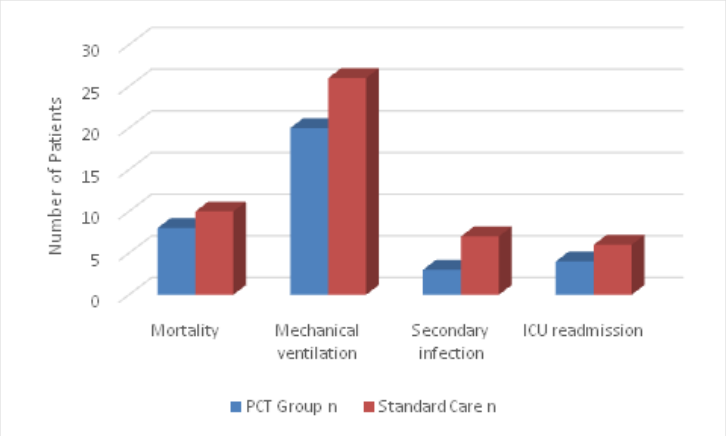

Figure 2: Association between Clinical Outcomes and Safety Parameters

In the present study, a total of 100 ICU patients were included, with 50 patients in the Procalcitonin (PCT) guided group and 50 patients in the standard care group. In the PCT group, 10 patients (20%) were aged 18–40 years, 28 patients (56%) were aged 41–60 years, and 12 patients (24%) were aged above 60 years. In the standard care group, 12 patients (24%) were aged 18–40 years, 26 patients (52%) were aged 41–60 years, and 12 patients (24%) were aged above 60 years. The comparison of age distribution between the two groups showed no statistically significant difference (p = 0.91).In the present study, a total of 100 ICU patients were included, with 50 patients in the Procalcitonin (PCT) guided group and 50 patients in the standard care group. In the PCT group, 28 patients (56%) were male and 22 patients (44%) were female. In the standard care group, 30 patients (60%) were male and 20 patients (40%) were female. The comparison of gender distribution between the two groups showed no statistically significant difference (p = 0.69).In the present study, a total of 100 ICU patients were included, with 50 patients in the Procalcitonin (PCT) guided group and 50 patients in the standard care group. In the PCT group, 18 patients (36%) had diabetes mellitus, 22 patients (44%) had hypertension, and 10 patients (20%) had COPD. In the standard care group, 20 patients (40%) had diabetes mellitus, 24 patients (48%) had hypertension, and 12 patients (24%) had COPD. The comparison of comorbidities between the two groups showed no statistically significant difference (p = 0.85).In the present study, a total of 100 ICU patients were included, with 50 patients in the Procalcitonin (PCT) guided group and 50 patients in the standard care group. In the PCT group, 18 patients (36%) had SOFA scores between 0–5, 26 patients (52%) had scores between 6–10, and 6 patients (12%) had scores greater than 10. In the standard care group, 16 patients (32%) had SOFA scores between 0–5, 28 patients (56%) had scores between 6–10, and 6 patients (12%) had scores greater than 10. The comparison of SOFA score distribution between the two groups showed no statistically significant difference (p = 0.89).In the present study, antibiotic-related and ICU

outcome parameters showed statistically significant improvement in the Procalcitonin PCT guided group compared to the standard care group. The mean duration of antibiotic therapy was significantly lower in the PCT group 6.2 ± 2.1 days compared to the standard care group 8.5 ± 2.6 days $p < 0.001$. Similarly, the mean ICU length of stay was reduced in the PCT group 7.8 ± 3.2 days compared to the standard care group 10.1 ± 3.8 days which was also statistically significant $p = 0.002$. In addition, antibiotic free days were significantly higher in the PCT group 10.5 ± 3.1 days than in the standard care group 7.2 ± 2.8 days showing a highly statistically significant difference $p < 0.001$.

Discussion

Zhang et al. [9] conducted a meta-analysis evaluating procalcitonin-guided antibiotic therapy in critically ill adults and reported that PCT-guided treatment significantly reduced the duration of antibiotic therapy without increasing mortality. In the present study also, the duration of antibiotic therapy was significantly lower in the PCT-guided group compared to the standard care group (6.2 ± 2.1 days vs 8.5 ± 2.6 days; $p < 0.001$). Their findings support the role of PCT as an effective biomarker for optimizing antibiotic stewardship in ICU patients. Huang et al. [10] performed a systematic review and meta-analysis among ICU patients and observed that PCT-guided antibiotic therapy was associated with reduced antibiotic exposure and shorter duration of treatment while maintaining patient safety. Similarly, the present study demonstrated significantly reduced antibiotic duration and ICU length of stay in the PCT-guided group. The ICU stay in the present study was significantly lower in the PCT group compared to the standard care group (7.8 ± 3.2 days vs 10.1 ± 3.8 days; $p = 0.002$). Pepper et al. [11] evaluated procalcitonin-guided antibiotic discontinuation in critically ill adults and found that PCT-guided strategies significantly increased antibiotic-free days without adversely affecting mortality outcomes. In agreement with these findings, the present study observed significantly higher antibiotic-free days in the PCT-guided group compared to the standard care group (10.5 ± 3.1 days vs 7.2 ± 2.8 days; $p < 0.001$). This highlights the usefulness of PCT-guided protocols in reducing unnecessary antibiotic exposure. Schuetz et al. [12] reported that PCT-guided antibiotic treatment in acute respiratory infections reduced unnecessary antibiotic use while maintaining favorable clinical outcomes and safety. Their patient-level meta-analysis demonstrated the effectiveness of biomarker-guided therapy in antimicrobial stewardship. Similarly, the present study showed improved antibiotic utilization and reduced ICU stay among patients managed with PCT guidance. de Jong et al. [13] conducted a randomized controlled trial and demonstrated that PCT guidance significantly reduced the duration of antibiotic treatment in critically ill patients without compromising clinical safety. The findings of the present study are comparable, as patients in the PCT-guided group had significantly shorter antibiotic treatment duration than those receiving standard care. This supports the incorporation of PCT algorithms into ICU antibiotic stewardship practices. Lam et al. [14] performed a systematic review focusing on antimicrobial management strategies in critically ill patients and concluded that PCT-guided protocols were associated with shorter antibiotic duration, particularly when used for antibiotic discontinuation strategies. In the present study also, antibiotic exposure was significantly reduced in the PCT-guided group, indicating better antimicrobial stewardship outcomes. Wirz et al. [15] conducted a patient-level meta-analysis in ICU patients with infection and sepsis and found that PCT-guided antibiotic treatment improved clinical outcomes and reduced antibiotic use safely. Similar findings were observed in the present study, where the PCT-guided group demonstrated reduced antibiotic duration, shorter ICU stay, and increased antibiotic-free days compared to standard care patients. Ghori [16] studied serum procalcitonin and inflammatory biomarkers in patients receiving olanzapine treatment and highlighted the importance of procalcitonin as an inflammatory marker in clinical practice. Although the study setting differed from ICU-based antibiotic stewardship, it further supports the diagnostic and prognostic relevance of procalcitonin in inflammatory and infectious conditions.

Conclusion

The present study demonstrated that procalcitonin (PCT)-guided antibiotic stewardship is an effective strategy in critically ill ICU patients when compared to standard care. Baseline demographic characteristics, comorbidities, and SOFA score distribution was comparable between the two groups, indicating that both groups were clinically similar at admission. Patients managed with PCT-guided therapy showed a significant reduction in the duration of antibiotic treatment and ICU length of stay compared to those receiving standard care. In addition, antibiotic-free days were significantly higher in the PCT-guided group, reflecting improved antimicrobial utilization and better stewardship practices. These findings suggest that the use of PCT guidance can help reduce unnecessary antibiotic exposure without adversely affecting patient outcomes. Implementation of PCT-guided protocols in ICU settings may contribute to minimizing antimicrobial resistance, reducing healthcare burden, and improving

resource utilization. Therefore, PCT-guided antibiotic stewardship can be considered a safe, reliable, and beneficial approach for managing critically ill patients in intensive care units.

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