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Adjunctive corticosteroid therapy and clinical recovery in hospitalized community-acquired pneumonia patients: a retrospective comparative study

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Abstract: Dysregulated inflammation in community-acquired pneumonia (CAP) has prompted investigation of corticosteroids as adjunctive therapy; however, their clinical utility remains contested, particularly in non-severe presentations and resource-limited settings. This study aims to evaluate the effect of adjunctive corticosteroid therapy on length of hospital stay and key clinical parameters in adult CAP patients at a secondary referral hospital in Bandar Lampung, Indonesia. This retrospective comparative study analyzed medical records of 59 eligible CAP patients admitted during 2023. Patients were categorized into steroid (n = 39) and non-steroid (n = 20) groups. Time to clinical improvement in temperature, cough, dyspnea, and respiratory rate, as well as length of hospital stay, were compared using chi-square and Fisher's exact tests. Steroid-treated patients had significantly longer hospital stays (28.2% vs. 5.0% with stays ≥5 days; p = 0.044), slower dyspnea resolution (p = 0.022), and delayed respiratory rate normalization (p = 0.042). No significant differences were observed for temperature (p = 0.653) or cough resolution (p = 0.679). Adjunctive corticosteroid therapy was not associated with clinical benefit in this cohort and was associated with prolonged hospitalization. Severity-based patient selection and standardized protocols are essential before routine corticosteroid use can be recommended in similar settings.

Keywords: adjunctive therapy, community-acquired pneumonia, corticosteroids, hospitalization, respiratory outcomes

Introduction

Community-acquired pneumonia (CAP) remains a leading cause of morbidity and mortality worldwide, imposing a substantial burden on healthcare systems particularly in low- and middle-income countries [1,2]. CAP is defined as an acute lower respiratory tract infection acquired outside healthcare settings, caused by a diverse range of pathogens including bacteria, viruses, and fungi that infect the lung parenchyma [1]. In Indonesia, the magnitude of this burden is considerable; the Indonesian Health Profile 2020 recorded 309,838 pneumonia cases nationally, with a case fatality rate of 7.6% and a population prevalence of 2% based on clinician-diagnosed cases [3]. These figures underscore the continued need for evidence-based therapeutic strategies to reduce disease severity and prevent adverse outcomes, particularly in hospital settings.

The pathophysiology of CAP involves a complex interplay between pathogen virulence and host immune responses. While an adequate inflammatory response is essential for pathogen clearance, dysregulated or excessive inflammation can precipitate acute lung injury, respiratory failure, and systemic complications [4]. This inflammatory cascade is characterized by marked elevation of pro-inflammatory cytokines—including tumor necrosis factor-alpha (TNF-α), interleukin-6 (IL-6), and interleukin-8 (IL-8)—that contribute to tissue damage and clinical deterioration independent of microbial burden [4,5]. Standard CAP management is therefore primarily antimicrobial; however, antibiotic therapy alone does not directly attenuate the inflammatory component driving disease progression in severe cases [6].

Corticosteroids have been investigated as adjunctive therapy for CAP based on their potent immunomodulatory properties. By suppressing pro-inflammatory transcription factors and inhibiting cytokine expression, corticosteroids theoretically attenuate excessive pulmonary inflammation, potentially accelerating clinical recovery and reducing complications [5,7]. The 2019 joint clinical practice guidelines of the American Thoracic Society and Infectious Diseases Society of America (ATS/IDSA) acknowledge a conditional role for corticosteroids in CAP management,

specifically in patients with severe CAP refractory to initial therapy or those presenting with septic shock [6]. Supporting this, several randomized controlled trials and meta-analyses have demonstrated reductions in time to clinical stability and early clinical failure rates with adjunctive steroid use in severe CAP [7,8]. Nevertheless, steroid use carries meaningful risks—including hyperglycemia, immunosuppression, gastrointestinal complications, and delayed infection clearance—and the net clinical benefit remains highly dependent on patient selection, disease severity, timing, and dosing regimen [7,8].

Evidence on corticosteroid efficacy in CAP is therefore heterogeneous, and findings from high-income settings may not translate directly to resource-limited contexts where pneumonia severity distribution, pathogen profiles, and prescribing practices differ substantially [2,8,9]. In Indonesia, published data on the clinical impact of adjunctive steroid therapy in hospitalized CAP patients remain limited, and no study to date has examined this question in the Bandar Lampung hospital setting using real-world prescribing data. Local practice patterns, including the use of diverse steroid agents and regimens without standardized protocols, further highlight the need for context-specific evidence to guide clinical decision-making.

This study aimed to evaluate the effect of adjunctive corticosteroid therapy on length of hospital stay and key clinical parameters—including dyspnea resolution, respiratory rate normalization, fever, and cough—in adult CAP patients hospitalized at a secondary referral hospital in Bandar Lampung, Indonesia, during 2023. By comparing outcomes between patients who received steroids alongside standard therapy and those who received standard therapy alone, this study sought to generate real-world evidence to inform steroid prescribing practices and support the development of standardized treatment protocols in the local clinical setting.

Methods

Study design and setting

This retrospective observational study was conducted at a secondary referral hospital in Bandar Lampung, Indonesia. Medical records of all adult patients diagnosed with CAP during the 2023 calendar year were systematically reviewed. A comparative design was employed to evaluate clinical outcomes between patients who received corticosteroids as adjunctive therapy alongside standard treatment and those who received standard treatment alone. Ethical approval was obtained from the institutional review board prior to data collection, and patient confidentiality was maintained throughout by anonymizing all extracted records.

Study population and sample selection

The source population comprised all medical records of adult patients with a documented physician diagnosis of CAP admitted to the study hospital during 2023 (N = 69). Sample size was estimated using a two-proportion z-test formula, based on an anticipated difference in the proportion of patients achieving clinical improvement between groups, with a two-sided significance level of $\alpha = 0.05$ and power of 80%, yielding a minimum required sample of 59 patients [10]. Final sample selection followed consecutive sampling, whereby all eligible records identified sequentially from the medical record registry were included until the required sample size was reached.

Inclusion criteria were: (1) documented physician diagnosis of CAP; (2) age ≥ 18 years; and (3) receipt of corticosteroids via any route (oral, inhalation, or parenteral) as adjunctive therapy, or receipt of standard treatment without corticosteroids.

Exclusion criteria were: (1) pregnancy or lactation; (2) length of hospitalization < 2 days or > 3 months; (3) comorbid liver cirrhosis or chronic renal disease; (4) death during hospitalization; and (5) incomplete or damaged medical records.

Of 69 records reviewed, 59 met the eligibility criteria and were included in the final analysis. Patients were allocated to two groups: the steroid group (n = 39, 66.1%), who received corticosteroids in addition to standard therapy, and the non-steroid group (n = 20, 33.9%), who received standard therapy alone.

Data collection

Data were extracted from electronic and paper-based medical records by two trained personnel independently, with discrepancies resolved by consensus. The following variables were systematically recorded for each patient: demographic characteristics (age, sex), comorbidities, type and route of corticosteroid administration, concomitant medications, clinical signs (fever, cough, dyspnea), respiratory rate (RR, breaths per minute), and length of hospital stay (days). Data quality was verified through double-checking of all extracted entries against original source records.

Table 1. Demographic and clinical characteristics of CAP patients stratified by treatment group.

Characteristic	Steroid group n (%) = 39 (66.1%)	Non-steroid group n (%) = 20 (33.9%)
Sex		
Male	21 (53.8%)	8 (40.0%)
Female	18 (46.2%)	12 (60.0%)
Age		
17-25 years	3 (7.7%)	0 (0%)
26-35 years	2 (5.1%)	1 (5.0%)
36-45 years	4 (10.3%)	2 (10.0%)
46-55 years	6 (15.4%)	4 (20.0%)
56-65 years	14 (35.9%)	3 (15.0%)
>65 years	10 (25.6%)	10 (50.0%)
Comorbidities		
Bronchitis	2 (6.1%)	1 (5.6%)
Tuberculosis	2 (6.1%)	0 (0.0%)
COPD	2 (6.1%)	0 (0.0%)
Prolonged fever	1 (3.0%)	0 (0.0%)

Data are presented as n (%). COPD, chronic obstructive pulmonary disease.

Study variables

The independent variable was corticosteroid administration as adjunctive therapy, categorized dichotomously as steroid group versus non-steroid group.

The dependent variables were: (1) length of hospital stay (days), and (2) time to clinical improvement for each of four parameters—body temperature normalization, cough resolution, dyspnea resolution, and respiratory rate normalization. Clinical improvement for each parameter was defined as the duration from hospital admission to resolution of the symptom or normalization of the vital sign as documented in the medical record, dichotomized as < 5 days (rapid improvement) versus ≥ 5 days (prolonged improvement). This threshold was selected based on the definition of clinical stability in CAP management literature, wherein most patients receiving appropriate therapy are expected to achieve clinical stability within the first four to five days of treatment [6,11].

Operational definitions

CAP was defined based on documented physician diagnosis supported by clinical presentation (fever, cough, dyspnea, or tachypnea) consistent with an acute lower respiratory tract infection acquired outside the hospital setting, in the absence of an alternative diagnosis. Length of hospital stay was calculated from the date of admission to the date of discharge. Respiratory rate normalization was defined as a sustained RR of ≤ 20 breaths per minute. Fever resolution was defined as a sustained body temperature of < 37.5°C. Dyspnea and cough resolution were defined as the absence of these symptoms as documented by the attending physician in the medical record.

Statistical analysis

Data were analyzed using SPSS version 25.0 (IBM Corp., Armonk, NY, USA). Categorical variables are presented as frequencies and percentages. Associations between corticosteroid administration and categorical outcomes were examined using the chi-square test; Fisher's exact test was applied where expected cell counts were < 5 [12]. Statistical significance was set at $p < 0.05$ (two-tailed) with a 95% confidence interval. Due to the observational nature of this study, the possibility of residual confounding, particularly confounding by indication, cannot be excluded, and findings should be interpreted accordingly.

Results

Baseline characteristics

A total of 59 patients with CAP met the eligibility criteria and were included in the analysis, comprising 39 patients (66.1%) in the steroid group and 20 patients

Table 2. Corticosteroid regimens prescribed in the steroid group (n = 39).

Steroid regimen	n	% of total sample
Budesonide	14	23.7%
Methylprednisolone	4	6.8%
Methylprednisolone + Budesonide	4	6.8%
Methylprednisolone + Fluticasone	3	5.1%
Methylprednisolone + Budesonide + Fluticasone + Triamcinolone	3	5.1%
Methylprednisolone + Budesonide + Triamcinolone	2	3.4%
Methylprednisolone + Fluticasone + Triamcinolone	2	3.4%
Methylprednisolone + Budesonide + Fluticasone	2	3.4%
Dexamethasone	1	1.7%
Triamcinolone	1	1.7%
Fluticasone + Budesonide	1	1.7%
Fluticasone	1	1.7%
Fluticasone + Budesonide + Dexamethasone	1	1.7%
Total	39	

Data are presented as n and percentage of the total sample (N = 59).

(33.9%) in the non-steroid group. The two groups were broadly comparable in terms of sex distribution and the prevalence of comorbidities, though notable differences were observed in age distribution. Overall, the sample showed a slight female predominance (50.8%), while the majority of patients were aged above 55 years in both groups. In the steroid group, patients in the 56–65 year age bracket were most frequent (35.9%), whereas in the non-steroid group, patients aged above 65 years predominated (50.0%). Comorbidities were documented in only a small subset of patients; bronchitis, tuberculosis, and COPD were each present in two patients (6.1%) in the steroid group, while only one patient (5.6%) in the non-steroid group had a documented comorbidity (bronchitis). The steroid group appeared to carry a modestly higher comorbidity burden, which should be considered when interpreting outcome differences between groups (Table 1).

Table 3. Concomitant non-corticosteroid therapy profile in CAP patients (N = 59).

Therapy class	n	%
Antibiotics	56	94.9%
Mucolytics	49	83.1%
Proton pump inhibitors	37	62.7%
Bronchodilators	37	62.7%
Multivitamins	34	57.6%
Analgesics	34	57.6%
Diuretics	30	50.8%
Antihypertensives	22	37.3%
NSAIDS	18	30.5%
Antiemetics	17	28.8%

Data are presented as n (%). NSAIDs, non-steroidal anti-inflammatory drugs. Values represent prescriptions across both groups combined.

Corticosteroid regimens and concomitant therapy

Among the 39 patients in the steroid group, budesonide monotherapy was the most frequently prescribed regimen (n = 14, 35.9%), administered primarily via nebulization, followed by methylprednisolone monotherapy and the combination of methylprednisolone plus budesonide (n = 4 each, 10.3% each). A wide variety of other single-agent and combination regimens were employed, reflecting the absence of a standardized steroid protocol at the study site (Table 2). Regarding concomitant non-steroid medications, antibiotics were prescribed to 56 patients (94.9%) and mucolytics to 49 patients (83.1%), consistent with standard CAP management. Full details of the concomitant therapy profile are presented in Table 3.

Clinical outcomes

Temperature and cough

No statistically significant differences were observed between the steroid and non-steroid groups in the time to temperature normalization ($p = 0.653$) or cough resolution ($p = 0.679$). In both parameters, the

Table 4. Time to clinical improvement for temperature, cough, dyspnea, and respiratory rate in CAP patients stratified by treatment group.

Clinical parameter	Time to improvement	Steroid group n (%) = 39 (66.1%)	Non-steroid group n (%) = 20 (33.9%)	p-value*
Temperature normalization	<5 days	35 (89.7%)	19 (95.0%)	0.653
	≥5 days	4 (10.3%)	1 (5.0%)	
Cough resoution	<5 days	35 (89.7%)	17 (85.0%)	0.679
	≥5 days	4 (10.3%)	3 (15.0%)	
Dyspnea resolution	<5 days	30 (76.9%)	20 (100%)	0.022
	≥5 days	9 (23.1%)	0 (0.0%)	
Respiratory rate	<5 days	31 (79.5%)	20 (100.0%)	0.042
	≥5 days	8 (20.5%)	0 (0.0%)	

Data are presented as n (%). *Chi-square test; Fisher's exact test applied where expected cell count < 5. Statistical significance set at $p < 0.05$.

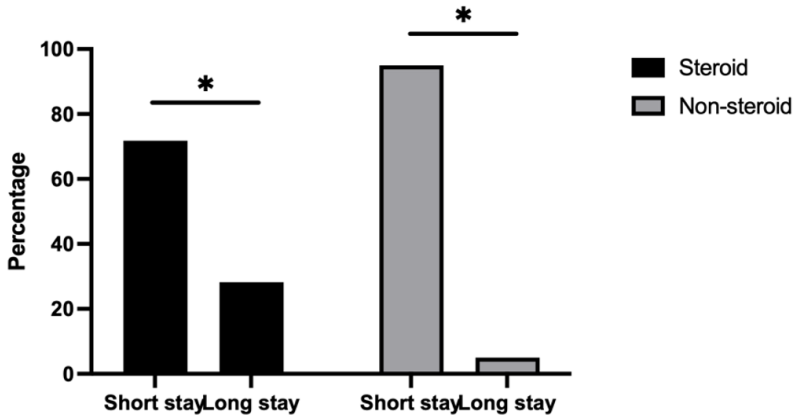

Figure 1. Comparison of length of hospital stay between steroid and non-steroid treatment groups in hospitalized community-acquired pneumonia patients (N = 59). Bar chart displaying the percentage of patients within each group categorized as short stay (< 5 days) versus long stay (≥ 5 days). The steroid group showed a significantly higher proportion of prolonged hospitalizations compared to the non-steroid group (28.2% vs. 5.0%; *p = 0.044, chi-square test).

proportion of patients achieving rapid improvement (< 5 days) was numerically higher in the non-steroid group, though the differences did not reach statistical significance (Table 4).

Dyspnea and respiratory rate

Statistically significant between-group differences were found for both dyspnea resolution (p = 0.022) and respiratory rate normalization (p = 0.042). Contrary to the expected benefit of steroid therapy, outcomes were less favorable in the steroid group: 23.1% of steroid-treated patients required ≥ 5 days for dyspnea resolution and 20.5% for respiratory rate normalization, compared to none (0%) in the non-steroid group, where all patients achieved improvement within five days for both parameters (Table 4). These findings suggest that corticosteroid administration was not associated with accelerated resolution of respiratory symptoms in this cohort.

Length of hospital stay

A statistically significant difference in length of hospital stay was observed between groups (p = 0.044). Among steroid-treated patients, 28.2% had a prolonged stay of ≥ 5 days, compared to only 5.0% in the non-steroid group (Figure 1). The majority of patients in both groups achieved a shorter stay (< 5 days); however, the steroid group demonstrated a notably higher proportion of prolonged hospitalizations. These findings indicate that adjunctive corticosteroid therapy was associated

with longer hospital stays in this patient population, a relationship that may reflect confounding by indication whereby clinicians preferentially prescribed steroids to patients with greater disease severity.

Discussion

This retrospective study evaluated the clinical impact of adjunctive corticosteroid therapy in hospitalized CAP patients at a secondary referral hospital in Bandar Lampung, Indonesia. The principal finding was that corticosteroid use was associated with significantly prolonged hospital stay ($p = 0.044$), delayed dyspnea resolution ($p = 0.022$), and slower respiratory rate normalization ($p = 0.042$), with no significant differences observed for temperature or cough resolution. Before these findings can be interpreted as evidence of steroid-related harm, however, a critical methodological caveat must be acknowledged: this is an observational study susceptible to confounding by indication. Clinicians in real-world practice tend to prescribe steroids preferentially to patients with greater disease severity or clinical complexity [12,13], and without validated pneumonia severity scoring—such as CURB-65 or the Pneumonia Severity Index—it is not possible to determine whether the poorer outcomes in the steroid group reflect the effect of the drug itself or the underlying severity of illness in those who received it.

The broader evidence base on adjunctive corticosteroids in CAP is heterogeneous, and the present findings should be contextualized accordingly. The landmark CAPE COD trial, a multicenter double-blind RCT, demonstrated that hydrocortisone 200 mg/day administered within 24 hours of ICU admission for severe CAP significantly reduced 28-day mortality compared to placebo (6.2% vs. 11.9%; hazard ratio 0.59; 95% CI 0.40–0.86) [14]. Conversely, the ESCAPe trial [3], which used methylprednisolone 40 mg/day for seven days in critically ill CAP patients, found no significant reduction in 60-day mortality. A 2024 meta-analysis of 15 RCTs encompassing 3,252 patients confirmed that the mortality benefit of corticosteroids in CAP is largely restricted to hydrocortisone therapy in severe CAP, with younger patients deriving greater benefit [15]. These findings collectively underscore that corticosteroid efficacy in CAP is highly agent-specific, severity-dependent, and sensitive to timing of administration—none of which were controlled in the present study.

The heterogeneity of steroid regimens observed in this cohort—spanning 13 distinct single-agent and combination regimens across oral, parenteral, and inhaled routes—is a particularly important consideration. The predominance of inhaled budesonide (35.9% of the steroid group), while clinically rational for its local anti-inflammatory effect on the airways, is not the agent or route supported by the highest-quality RCT evidence for systemic CAP. Evidence from major trials supporting steroid benefit has consistently used systemic agents, primarily hydrocortisone or methylprednisolone, at defined doses and durations [14,15]. The absence of a standardized protocol in this study likely introduced substantial pharmacological heterogeneity that could dilute or obscure any potential treatment effect, and may partly explain why steroid-treated patients did not demonstrate improved respiratory outcomes. This heterogeneity in prescribing practice is consistent with findings reported by Meiliana and Lestari (2023) in a similar local context, who likewise noted variable steroid use without standardized protocols in severe CAP management [9].

The lack of clinical benefit observed for temperature and cough resolution is consistent with previous literature. Ardyati et al. (2017), studying adjunctive steroids in pediatric pneumonia, similarly found no significant effect on fever duration or cough resolution [16]. It should be noted, however, that extrapolating from pediatric data to the adult population studied here requires caution, as the pathophysiological response to infection and the pharmacodynamics of steroids differ substantially between age groups. In adults, the proposed antipyretic mechanism of corticosteroids—via inhibition of interleukin-1 production and suppression of prostaglandin synthesis—may be insufficient to produce measurable acceleration in fever resolution when inflammation is not of the dysregulated severity required to benefit from immunomodulation [6]. The absence of microbiological data in this study further limits mechanistic interpretation, as the pathogens involved may substantially influence inflammatory response magnitude and therefore steroid responsiveness.

This study has several important limitations. The retrospective design precludes causal inference, and the absence of pneumonia severity scoring represents the most significant methodological constraint, as it prevents adjustment for the primary confounder—baseline disease severity—in a study comparing a treatment that is itself severity-driven. The sample size, while formally calculated, may have been insufficient to detect smaller but clinically meaningful effect sizes, and the diverse steroid regimens preclude drawing conclusions about

any specific agent or dosing approach. The operational dichotomization of clinical outcomes at five days, while supported by the literature on time to clinical stability in CAP [11], may not capture the full clinical trajectory of patients. Furthermore, the absence of data on inflammatory biomarkers (C-reactive protein, procalcitonin), microbiological confirmation, and long-term outcomes limits the depth of interpretation. As a single-center study from a secondary referral hospital, generalizability to other settings—including tertiary centers, primary care hospitals, or other regions of Indonesia—is limited and should not be assumed.

Conclusion

This retrospective study found that adjunctive corticosteroid therapy was not associated with clinical benefit in hospitalized CAP patients at a secondary referral hospital in Bandar Lampung, and was instead associated with longer hospital stays and delayed resolution of dyspnea and respiratory rate. These findings, however, must be interpreted cautiously in light of substantial methodological limitations—particularly the absence of pneumonia severity stratification and the marked heterogeneity of steroid regimens employed—which preclude any causal conclusion. The results underscore that steroid benefit in CAP is highly context-dependent, driven by disease severity, agent selection, timing of initiation, and route of administration. These findings reinforce the need for severity-based patient selection using validated scoring tools, standardized institutional treatment protocols, and prospective randomized evaluation before adjunctive corticosteroids can be routinely recommended for CAP management in similar clinical settings in Indonesia.

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Author contributions

Conceptualization, IR; Methodology and investigation, IR and MLM; Data curation, MLM and MAK; Formal analysis and writing—original draft, IR; Writing—review and editing, IR, MLM, and MAK; Supervision, IR.

Declaration of interest

The authors declare no competing interests.

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