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Original Article

Predictors of Prolonged Hospital Stay in Patients with Community-Acquired Pneumonia: A Retrospective Cohort Study

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Abstract-

Background: Community-acquired pneumonia (CAP) remains one of the leading causes of hospitalization and healthcare expenditure worldwide. Length of hospital stay (LOS) is a key determinant of cost and resource utilization, yet the factors driving prolonged admission in CAP are heterogeneous across populations. ***Objective***: To identify clinical, laboratory, and demographic predictors of prolonged hospital stay (defined as LOS greater than the cohort median) among adult patients admitted with CAP. ***Methods***: A retrospective cohort study was conducted on adult patients admitted with a confirmed diagnosis of CAP over a 12-month period. Demographic data, comorbidities, vital signs, laboratory parameters, CURB-65 score, and treatment-related variables were extracted from medical records. Patients were dichotomized into normal-stay and prolonged-stay groups based on the median LOS. Univariate and multivariate logistic regression analyses were performed to identify independent predictors of prolonged LOS. ***Results***: Of 220 patients included, the median LOS was 8 days (interquartile range 5–12). Age ≥65 years, CURB-65 score ≥3, multilobar involvement, hypoalbuminemia (<3.0 g/dL), elevated blood urea nitrogen, need for supplemental oxygen ≥35% FiO_2, ICU transfer, and presence of pleural effusion were significantly associated with prolonged stay on univariate analysis ($p<0.05$). On multivariate analysis, CURB-65 score ≥3 (adjusted odds ratio [aOR] 3.42, 95% CI 1.78–6.58), hypoalbuminemia (aOR 2.95, 95% CI 1.52–5.73), multilobar pneumonia (aOR 2.61, 95% CI 1.34–5.08), and ICU transfer (aOR 4.87, 95% CI 2.05–11.58) remained independent predictors of prolonged LOS. ***Conclusion***: Disease severity at presentation (high CURB-65 score), hypoalbuminemia, multilobar radiographic involvement, and ICU transfer independently predict prolonged hospitalization in patients with CAP. Early identification of these factors may support risk-stratified care pathways and more efficient bed utilization.

Keywords: Community-acquired pneumonia; Length of stay; Hospitalization; CURB-65; Risk factors; Prognosis.

INTRODUCTION

Community-acquired pneumonia (CAP) is an acute infection of the lung parenchyma acquired outside the hospital setting and remains one of the most common infectious causes of hospitalization and mortality worldwide. It continues to impose a substantial burden in terms of morbidity, healthcare utilization, and economic cost, particularly among older adults and those with underlying comorbid conditions[1]. Despite advances in antimicrobial therapy, diagnostic imaging, and severity-assessment tools, CAP continues to account for a disproportionate share of medical admissions and intensive care unit (ICU) utilization across both high-income and resource-limited settings.

Length of hospital stay (LOS) is widely used as a surrogate marker of disease severity, quality of care, and resource consumption. Prolonged LOS is associated with increased direct medical costs, greater exposure to hospital-acquired complications such as nosocomial infection and venous thromboembolism, and downstream strain on bed availability and staffing[2,3]. From a health-systems perspective, the ability to predict which patients with CAP are likely to require extended hospitalization at the time of admission carries direct implications for resource planning, discharge counselling, and the design of risk-stratified care pathways.

Several validated severity-assessment tools, including the Pneumonia Severity Index (PSI) and the CURB-65 score (confusion, blood urea nitrogen, respiratory rate, blood pressure, and age ≥65 years), were originally developed to predict short-term mortality but have subsequently been shown to correlate with LOS as well[4,5]. Higher CURB-65 class has consistently been linked to longer average hospital stay across multiple cohorts, with patients in the highest-risk strata remaining hospitalized several days longer than those with low-risk scores[5,6]. More recently, the expanded CURB-65

score, incorporating additional variables such as lactate dehydrogenase, serum albumin, and platelet count, has been proposed as a more granular tool for risk stratification, again demonstrating a graded relationship with both mortality and LOS[7].

Beyond composite severity scores, individual clinical and laboratory variables have independently been associated with prolonged hospitalization in CAP. A large Japanese administrative-data study of nearly 33,000 patients identified advanced age, poor functional status (low Barthel index), high inspired-oxygen requirement, and impaired consciousness as significant predictors of prolonged LOS, with a reported median stay of 11 days[8]. A Swiss multicenter study similarly reported that older age, tachypnea, nursing-home residence, chronic pulmonary disease, diabetes mellitus, multilobar involvement, and higher PSI class were independently associated with longer admission at baseline, while hypoalbuminemia, ICU transfer, and CAP-associated complications such as empyema emerged as additional predictors once follow-up data were considered[9,10].

Complications arising during the hospital course appear to be particularly important drivers of extended stay. Development of complicated parapneumonic effusion or empyema requiring tube thoracostomy has been shown to markedly prolong admission, with mean stays approaching 18 days in affected patients[11], and a more recent retrospective analysis identified respiratory failure, pressure ulcers, elevated blood urea nitrogen, modification of antibiotic therapy, and prolonged antibiotic duration as independent predictors of longer LOS, with a non-linear relationship demonstrated between antibiotic duration and LOS beyond approximately one week of treatment[12].

Although the determinants of LOS in CAP have been studied extensively in East Asian, European, and pediatric African populations, data characterizing this relationship in other settings, and the relative contribution of severity scores versus individual laboratory and radiographic markers, remain comparatively limited. Given the substantial heterogeneity in case mix, antimicrobial stewardship practices, and discharge criteria across institutions, locally derived predictors of prolonged LOS are needed to inform context-specific clinical pathways.

The present study was therefore designed to identify the demographic, clinical, laboratory, and treatment-related predictors of prolonged hospital stay among adult patients admitted with CAP, with the aim of generating a practical, bedside-applicable risk profile that can be used at the time of admission to flag patients likely to require extended inpatient care.

MATERIALS AND METHODS

Study Design and Setting

This was a retrospective, observational cohort study conducted in the Department of General Medicine/Pulmonology of a tertiary care teaching hospital. Medical records of all adult patients admitted with a discharge diagnosis of community-acquired pneumonia over a 12-month period were reviewed. The study was approved by the Institutional Ethics Committee, and the requirement for individual informed consent was waived given the retrospective, de-identified nature of data collection.

Study Population

Adult patients aged 18 years and above who were admitted with a clinical and radiological diagnosis of CAP, defined as the presence of a new infiltrate on chest radiograph together with at least one of fever, cough, purulent sputum, pleuritic chest pain, or dyspnea, acquired outside the hospital or within 48 hours of admission, were eligible for inclusion.

Exclusion criteria comprised: hospital-acquired or ventilator-associated pneumonia; pneumonia in the setting of severe immunosuppression (active malignancy on chemotherapy, HIV with CD4 count <200 cells/μL, long-term immunosuppressive or biologic therapy); active pulmonary tuberculosis; aspiration pneumonia with a clear witnessed aspiration event; incomplete medical records; and patients who left against medical advice or were transferred to another facility before clinical resolution, since LOS in these patients could not be reliably attributed to the natural course of CAP.

Data Collection

Data were abstracted from electronic and physical medical records using a structured proforma by two independent reviewers, with discrepancies resolved by consensus. Variables collected included: (i) demographic data – age, sex, smoking status, residence (community-dwelling versus nursing-home/assisted living); (ii) comorbidities – diabetes mellitus, chronic obstructive pulmonary disease, congestive heart failure, chronic kidney disease, chronic liver disease, and malignancy; (iii) clinical findings at admission – respiratory rate, systolic and diastolic blood pressure, heart rate, temperature, oxygen saturation, and mental status; (iv) laboratory parameters within 24 hours of admission – total leukocyte count, hemoglobin, serum albumin, blood urea nitrogen, serum creatinine, serum sodium, C-reactive protein, and arterial blood gas parameters where available; (v) radiological findings – unilobar versus multilobar infiltrates and presence of pleural effusion; (vi) severity scores – CURB-65, calculated retrospectively from admission parameters; and (vii) treatment

and course variables – initial antibiotic regimen, need for antibiotic escalation or modification, requirement and fraction of supplemental oxygen, need for invasive or non-invasive ventilation, and transfer to the ICU.

Outcome Definition

The primary outcome was length of hospital stay, defined as the number of days from the date of admission to the date of discharge, transfer, or in-hospital death. Because LOS distributions in pneumonia cohorts are typically right-skewed, patients were dichotomized into a "normal-stay" group and a "prolonged-stay" group using the cohort median LOS as the cut-off, consistent with the approach used in comparable studies of LOS in CAP.

Statistical Analysis

Data were analyzed using standard statistical software. Continuous variables were expressed as mean ± standard deviation or median (interquartile range) as appropriate, and compared between groups using the independent-samples t-test or Mann-Whitney U test. Categorical variables were expressed as frequencies and percentages and compared using the chi-square test or Fisher's exact test. Variables found to be significant on univariate analysis ($p<0.10$) were entered into a multivariate binary logistic regression model to identify independent predictors of prolonged LOS, with results expressed as adjusted odds ratios (aOR) and 95% confidence intervals (CI). A two-tailed p-value of <0.05 was considered statistically significant throughout.

RESULTS

A total of 220 patients met the inclusion criteria during the study period. The median length of hospital stay for the cohort was 8 days (interquartile range 5–12 days); patients with LOS greater than 8 days (n=104) were classified as the prolonged-stay group, and those with LOS of 8 days or fewer (n=116) as the normal-stay group.

Table 1. *Baseline demographic and clinical characteristics of patients with community-acquired pneumonia, stratified by length of hospital stay*

Variable	Normal stay (n=116)	Prolonged stay (n=104)	p-value
Age ≥65 years, n (%)	38 (32.8)	61 (58.7)	<0.001
Male sex, n (%)	65 (56.0)	59 (56.7)	0.91
Current smoker, n (%)	28 (24.1)	33 (31.7)	0.21
Nursing-home residence, n (%)	9 (7.8)	21 (20.2)	0.007
Diabetes mellitus, n (%)	26 (22.4)	37 (35.6)	0.03
COPD, n (%)	19 (16.4)	29 (27.9)	0.04
Congestive heart failure, n (%)	11 (9.5)	22 (21.2)	0.02
Chronic kidney disease, n (%)	8 (6.9)	18 (17.3)	0.02
Respiratory rate ≥30/min, n (%)	21 (18.1)	47 (45.2)	<0.001
SBP <90 mmHg, n (%)	9 (7.8)	24 (23.1)	0.001
Multilobar infiltrate, n (%)	24 (20.7)	52 (50.0)	<0.001
Pleural effusion, n (%)	14 (12.1)	33 (31.7)	<0.001
CURB-65 score ≥3, n (%)	16 (13.8)	48 (46.2)	<0.001

COPD = chronic obstructive pulmonary disease; SBP = systolic blood pressure. Chi-square/Fisher's exact test used for categorical comparisons.

Patients in the prolonged-stay group were significantly older and were more likely to reside in nursing-home or assisted-living facilities. The burden of comorbid disease – including diabetes mellitus, COPD, congestive heart failure, and chronic kidney disease – was significantly higher in the prolonged-stay group. Markers of clinical severity at presentation, including tachypnea, hypotension, multilobar radiographic involvement, presence of pleural effusion, and a CURB-65 score of 3 or higher, were all significantly more frequent among patients with prolonged hospitalization (Table 1).

Table 2. *Laboratory parameters and treatment-course variables stratified by length of hospital stay*

Variable	Normal stay (n=116)	Prolonged stay (n=104)	p-value
Serum albumin <3.0 g/dL, n (%)	17 (14.7)	44 (42.3)	<0.001
Blood urea nitrogen >20 mg/dL, n (%)	22 (19.0)	51 (49.0)	<0.001
C-reactive protein >100 mg/L, n (%)	31 (26.7)	55 (52.9)	<0.001
Hemoglobin <10 g/dL, n (%)	12 (10.3)	26 (25.0)	0.005
Hyponatremia (Na <135 mEq/L), n (%)	18 (15.5)	34 (32.7)	0.003
FiO_2 requirement ≥35%, n (%)	20 (17.2)	46 (44.2)	<0.001
Antibiotic regimen modified, n (%)	14 (12.1)	39 (37.5)	<0.001
ICU transfer, n (%)	6 (5.2)	29 (27.9)	<0.001
Mechanical ventilation, n (%)	3 (2.6)	15 (14.4)	0.001
Mean antibiotic duration, days (±SD)	6.1 (±1.8)	10.4 (±3.2)	<0.001

ICU = intensive care unit; FiO_2 = fraction of inspired oxygen; SD = standard deviation.

Laboratory derangements reflecting disease severity – hypoalbuminemia, elevated blood urea nitrogen, marked elevation of C-reactive protein, anemia, and hyponatremia – were all significantly more common in the prolonged-stay group. Treatment-course variables, including a higher requirement for supplemental oxygen, modification of the initial antibiotic regimen, ICU transfer, need for mechanical ventilation, and longer mean antibiotic duration, were likewise significantly associated with prolonged hospitalization (Table 2).

Table 3. *Multivariate logistic regression analysis of independent predictors of prolonged hospital stay*

Predictor	Adjusted OR	95% CI	p-value
Age ≥65 years	1.86	0.96–3.62	0.07
CURB-65 score ≥3	3.42	1.78–6.58	<0.001
Serum albumin <3.0 g/dL	2.95	1.52–5.73	0.001
Multilobar infiltrate	2.61	1.34–5.08	0.005
Pleural effusion	1.94	0.97–3.88	0.06
Blood urea nitrogen >20 mg/dL	1.78	0.91–3.49	0.09
ICU transfer	4.87	2.05–11.58	<0.001
Antibiotic regimen modified	2.22	1.05–4.69	0.04

OR = odds ratio; CI = confidence interval. Model adjusted for all variables significant at p<0.10 on univariate analysis. Hosmer-Lemeshow goodness-of-fit p=0.62; model AUC = 0.81 (95% CI 0.75–0.87).

On multivariate logistic regression, four variables emerged as independent predictors of prolonged hospital stay after adjustment for confounders: CURB-65 score ≥3 (aOR 3.42, 95% CI 1.78–6.58, p<0.001), serum albumin <3.0 g/dL (aOR 2.95, 95% CI 1.52–5.73, p=0.001), multilobar radiographic involvement (aOR 2.61, 95% CI 1.34–5.08, p=0.005), and transfer to the ICU during the hospital course (aOR 4.87, 95% CI 2.05–11.58, p<0.001). Modification of the initial antibiotic regimen also remained independently associated with prolonged stay (aOR 2.22, 95% CI 1.05–4.69, p=0.04). Age ≥65 years, pleural effusion, and elevated blood urea nitrogen showed a trend toward significance but did not reach statistical significance after multivariate adjustment (Table 3). The overall model demonstrated good discriminative ability, with an area under the receiver operating characteristic curve of 0.81 (95% CI 0.75–0.87) and adequate calibration on the Hosmer-Lemeshow goodness-of-fit test (p=0.62).

DISCUSSION

In this retrospective cohort of 220 adults hospitalized with community-acquired pneumonia, the median length of stay was 8 days, and four variables – CURB-65 score ≥3, hypoalbuminemia, multilobar radiographic involvement, and ICU transfer – emerged as independent predictors of prolonged hospitalization on multivariate analysis. These findings are broadly consistent with, and extend, the existing literature on determinants of LOS in CAP.

The strong association between CURB-65 score and prolonged stay observed in this study mirrors findings from multiple prior cohorts. CURB-65 was originally validated as a mortality-prediction tool, but several studies have since demonstrated a graded relationship between CURB-65 class and LOS, with patients in higher-risk classes experiencing markedly longer average admissions than those in the lowest-risk strata[5,6]. A comparative study of CURB-65 and the quick Sequential Organ Failure Assessment (qSOFA) score similarly found both tools to be predictive of hospital stay duration, with CURB-65 providing better discrimination for LOS specifically, while qSOFA performed somewhat better for ICU admission[13]. The retained predictive value of CURB-65 ≥3 in our multivariate model, independent of individual laboratory markers, supports the continued use of this simple bedside score not only for mortality risk stratification but also for anticipating resource utilization at the point of admission.

Hypoalbuminemia emerged as one of the strongest independent predictors of prolonged LOS in our cohort, consistent with the Swiss multicenter study by Kaplan et al.-type analyses in which low albumin level was identified as an independent risk factor for extended hospital stay when follow-up data were incorporated into the prediction model[9,10]. Low serum albumin in the setting of acute infection reflects a combination of pre-existing nutritional depletion, the acute-phase inflammatory response, and capillary leak, and has repeatedly been linked to adverse outcomes across a range of acute infectious illnesses. Its persistence as an independent predictor even after adjustment for CURB-65 suggests that albumin captures physiological reserve and inflammatory burden not fully reflected in standard severity scores, and supports its consideration as an adjunctive marker in admission risk assessment.

Multilobar involvement on chest radiography was likewise an independent predictor of prolonged stay in our cohort, in agreement with earlier work identifying multilobar disease as an independent correlate of longer admission alongside older age, tachypnea, and higher PSI class[9]. Multilobar pneumonia reflects a greater burden of infected lung parenchyma and is associated with slower radiographic and clinical resolution, more frequent treatment failure, and a higher likelihood of complications such as parapneumonic effusion, which in turn independently prolongs hospitalization, as has been demonstrated in patients with complicated parapneumonic effusion requiring tube thoracostomy, among whom mean LOS approached 18 days[11].

ICU transfer carried the strongest association with prolonged LOS in our multivariate model, a finding that aligns closely with previous work identifying ICU transfer as an independent predictor of extended stay once in-hospital course is taken into account[9,10]. This is an expected finding given that ICU-level care is typically reserved for patients with respiratory failure, hemodynamic instability, or multiorgan dysfunction, all of which require a longer period of stabilization, weaning, and step-down care before safe discharge. A recent retrospective analysis using restricted cubic spline modelling similarly identified respiratory failure as one of the principal drivers of prolonged LOS, together with elevated blood urea nitrogen and the need for modification of antibiotic therapy[12], a finding mirrored in our data, where antibiotic regimen modification remained independently predictive of prolonged stay even after adjustment for severity score and ICU transfer. This likely reflects both true treatment failure, requiring escalation or broadening of antimicrobial coverage, and the downstream consequence of a more complicated clinical course rather than a primary causal driver of LOS.

Interestingly, age ≥65 years and elevated blood urea nitrogen, both established predictors in larger cohorts[8,9], showed only a trend toward significance in our multivariate model. This is most plausibly explained by collinearity with CURB-65, since both age and renal function are embedded within the CURB-65 score itself, such that their independent contribution may be attenuated once the composite score is included in the same model. This observation is consistent with the broader literature suggesting that individual CURB-65 components carry differential weight when examined separately versus as part of the aggregate score[7].

From a clinical standpoint, these findings suggest that a simple bedside assessment combining CURB-65 score, serum albumin, and chest radiograph findings at the time of admission could meaningfully flag patients likely to require an extended hospital course, allowing for earlier engagement of multidisciplinary care, nutritional support, and discharge planning. Such early identification has been proposed as a strategy to optimize bed turnover and reduce the systemic burden associated with prolonged CAP admissions[2,8].

This study has several limitations. First, its retrospective, single-center design limits generalizability and introduces the possibility of unmeasured confounding and information bias inherent to chart-based data abstraction. Second, the

dichotomization of LOS at the cohort median, while methodologically consistent with prior studies, is somewhat arbitrary and may not capture the full non-linear relationship between predictor variables and LOS that has been demonstrated using more flexible modelling approaches[12]. Third, social and discharge-related factors such as caregiver availability, post-discharge placement, and socioeconomic status, which have previously been shown to independently contribute to LOS[3], were not systematically captured in this analysis. Future prospective, multicenter studies incorporating both clinical severity and psychosocial determinants of discharge readiness are warranted to build more comprehensive and externally validated prediction models for LOS in CAP.

CONCLUSION

In this cohort of adults hospitalized with community-acquired pneumonia, disease severity at presentation as reflected by a CURB-65 score of 3 or higher, hypoalbuminemia, multilobar radiographic involvement, and subsequent ICU transfer were identified as independent predictors of prolonged hospital stay. Modification of the initial antibiotic regimen during admission was also independently associated with extended LOS. These readily available clinical, laboratory, and radiological parameters can be assessed at or shortly after admission and may help clinicians identify, at an early stage, patients who are likely to require a longer hospital course. Incorporation of these predictors into routine admission assessment may support more proactive multidisciplinary care planning, earlier nutritional and respiratory support, and more efficient allocation of inpatient resources. Larger, prospective, multicenter studies are needed to validate these findings and to develop a externally generalizable risk-stratification tool for LOS in CAP.

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