e-ISSN: 0976-822X, p-ISSN:2961-6042

Available online on http://www.ijcpr.com/

International Journal of Current Pharmaceutical Review and Research 2025; 17(11); 1398-1405

Original Research Article

Predictors of 30-Day Hospital Readmission in Adults Hospitalized with Pneumonia: A Retrospective Cohort Study

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Received: 02-11-2025 / Revised: 10-11-2025 / Accepted: 21-11-2025
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Conflict of interest: Nil

Abstract

Background: Pneumonia is a leading cause of hospitalization and is frequently followed by early, unplanned readmission, which worsens outcomes and increases costs. Data on patient-level and care-process predictors of readmission are still limited, especially from single-centre cohorts that include both community- and healthcare-associated pneumonia.

Methods: A retrospective cohort study was done in a 900-bed tertiary care hospital of consecutive adults (age >=18 years old) discharged alive following index admission for radiologically-proven pneumonia from 1 January 2022 through December 31st 2023. Patients with hospital-acquired pneumonia, immunosuppression or palliative only were not included. The primary outcome was all-cause unplanned 30 day readmission. Demographic, clinical, functional and care process variables were derived for each from electronic records. Multivariable logistic regression was performed to identify independent predictors, and a simple risk score obtained. Model discrimination was assessed by the C-statistic and calibration using the Hosmer-- Lemeshow testing.

Results: Among 1,000 eligible patients, 214 (21.4%) were readmitted within 30 days. Readmitted patients were older, more comorbid and more frequently functionally dependent. They more often had ≥2 admissions in the prior year (48.6% vs 24.7%), discharge oxygen therapy (32.7% vs 14.2%), length of stay ≥7 days (59.8% vs 39.3%), and no scheduled early outpatient review (54.7% vs 32.1%) (all $p<0.001$). In multivariable analysis, age ≥75 years, chronic obstructive pulmonary disease, heart failure, ≥2 prior admissions, length of stay ≥7 days, dependence in activities of daily living, discharge hypoxia/oxygen use, and absence of follow-up within 7 days were independently associated with readmission (adjusted odds ratios 1.4–2.5). The final model showed good discrimination (C-statistic 0.76, 95% CI 0.72–0.79) and acceptable calibration. Patients in the highest risk quartile had a 36.4% readmission rate versus 8.1% in the lowest quartile.

Conclusion: In adults hospitalized with pneumonia, 30-day readmission was common and was driven by multimorbidity, functional dependence, markers of clinical instability at discharge and gaps in post-discharge care. Targeted transitional-care interventions in these high-risk groups may substantially reduce avoidable readmissions.

Keywords: Pneumonia; Hospital Readmission; Risk Factors; Prediction Model; Transitional Care.

Introduction

Pneumonia remains one of the most common reasons for acute hospital admission worldwide and carries substantial mortality, morbidity and healthcare expenditure.[1] In addition to the index episode, a large proportion of patients experience early, unplanned readmission, typically within 30 days of discharge.[1,2] Such readmissions are independently associated with prolonged length of stay, higher costs and increased short-term mortality, and have therefore become a key quality indicator in many health systems.[1,3,4] Several studies have attempted to quantify the burden and determinants of pneumonia-related readmissions. Population-based cohorts from the United States and Europe report 30-day readmission rates between 12% and 21%, with higher rates among older adults and those with multiple comorbidities.[2,5,6] Work from Italy and Spain

has highlighted the roles of age ≥70 years, chronic cardiac and pulmonary disease, and complex medication regimens.[4,6]

Multiple risk prediction tools have been proposed. Administrative-data models and the Yale New Haven Readmission Risk Score provide modest discrimination for pneumonia readmission but rely largely on coding data and omit functional, social and discharge-process indicators.[7,8] More general indices such as the LACE score perform comparably but were not designed specifically for pneumonia and show limited accuracy when applied to pneumonia-related readmissions. [9] A recent systematic review concluded that most pneumonia-specific readmission models demonstrate only modest predictive ability and rarely incorporate illness severity, in-hospital trajectories or stability at discharge. [10]

Beyond biomedical variables, functional status and care transitions are increasingly recognized as important determinants. Activities of daily living (ADL) limitations and in-hospital functional decline have been associated with higher risks of death and readmission in older pneumonia patients.[11] Similarly, gaps in discharge planning, lack of timely post-discharge follow-up and inadequate communication across sectors contribute significantly to early readmissions in older adults with medical conditions.[12] Evidence specific to pneumonia, however, remains sparse.

Recent multicentre and national audits have shown improvement in in-hospital management and mortality of community-acquired pneumonia (CAP) but persistent and sometimes increasing rates of emergency readmission.[2,5,13]

Parsimonious, clinically intuitive models that integrate comorbidity, functional measures and those relating to the discharge process are needed and can be implemented at the bedside to identify patients who may benefit most from enhanced transitional care interventions.[12-14]

The present study therefore aimed to (1) estimate the 30-day all-cause readmission rate after hospitalization for pneumonia in a large tertiary hospital cohort and (2) identify independent predictors, including clinical, functional and care-process variables, to develop a simple risk stratification tool suitable for routine practice.

Materials and Methods

Study design and setting: This study was done as a retrospective cohort analysis in a tertiary care teaching hospital. The hospital served an urban and mix socioeconomic urban population. All data were retrieved from the electronic health record (EHR) and hospital administrative databases.

Study period and participants: The cohort contained the following: consecutive adult patients (aged >=18 years) admitted with a primary diagnosis of pneumonia between 1 January 2022 and 31 December 2023, were discharged alive from a primary hospitalization. Pneumonia had to be supported by compatible clinical features and new infiltrate on chest radiography or CT as must be documented by the treating team.

Patients were excluded if they had hospital-acquired pneumonia (onset ≥48 hours after admission), were severely immunocompromised (solid organ or stem-cell transplant, active chemotherapy, neutropenia, high-dose systemic corticosteroids), were receiving palliative-only care at discharge, or lacked a valid hospital identifier needed for linkage across admissions. Where multiple eligible admissions occurred during the study period, only the first was considered as the index episode.

Outcome definition: The primary outcome was all-cause, unplanned readmission to the same hospital during 30 days post discharge from the index pneumonia hospitalization. Planned readmissions (e.g. elective surgery, scheduled procedures) were determined from admission codes and clinician review and were excluded.

Linked records were used to track patients transferred to a different acute-care facility; readmissions to outside hospitals were not recorded.

Predictor variables: Candidate predictors were selected a priori based on prior literature and clinical plausibility. These included:

- **Demographics:** age, sex, residence (home vs nursing facility).
- **Comorbidities:** chronic obstructive pulmonary disease (COPD), heart failure, chronic kidney disease, diabetes, cerebrovascular disease, Charlson Comorbidity Index (CCI).
- **Illness severity:** CURB-65 score at admission, need for intensive care, invasive or non-invasive ventilation.
- **Healthcare utilization:** number of acute admissions in the prior 12 months, length of stay (LOS) of index admission.
- **Functional status:** dependence in ≥1 basic ADL using the Barthel Index (scores <60 classified as dependent).
- **Discharge-related factors:** oxygen requirement at discharge, persistence of tachypnoea (respiratory rate ≥24/min) or hypoxia (SpO_2 <92% on room air), discharge destination, provision of written action plan, and scheduling of an outpatient follow-up visit within 7 days.

Data collection: Data were extracted by trained research assistants using a standardized electronic abstraction form. Where necessary, free-text entries were reviewed to clarify diagnoses, functional scores and discharge plans. Ten percent of records were re-abstracted by a second reviewer to assess reliability; discrepancies were resolved by consensus.

Statistical analysis: The entire analyses were conducted by using the standard statistical packages. In case of the categorical variables, frequencies and percentages were determined, whilst in case of continuous variables, means with standard deviations or median with standard deviations (interquartile ranges) were determined depending on the distribution. The appropriate tests (non-parametric, t-test or Mann-Whitney U test) and the parametric tests (chi 2) were used to compare the readmission groups with the non-readmission ones.

The dependent predictor variables of 30-day readmission were established by using multivariable logistic regression to identify variables that are independent predictors of readmission. The initial model included variables that have $p<0.10$ of a univariate analysis, or those that are deemed of clinical significance.

The value of $p<0.05$ was then applied using backward elimination and variance inflation factors were tested to show the test of multicollinearity. Predictor variables with missing values had a value below 5% in all fields and were controlled through multiple imputation by chained equations.

The evaluation of the model performance was on C-statistic, i.e. receiver operating characteristic (ROC) curve area under the curve, calibration plots on Hosmer Lemeshow goodness-of-fit test. The basic risk score was determined using the integer point that the coefficients received (out of the proportion of the regression coefficients). The patients were segregated into four (quartiles) of risk prediction.

Ethical considerations: The study protocol was approved by the institutional ethics committee and no individual informed consent was needed due to the routine and de-identified nature of the data obtained and low risk of harm to the participants. All procedures were done according to the Declaration of Helsinki.

Results

Cohort characteristics and readmission rate: The screened cases were 1,246 pneumonia admissions; 1,000 unique index hospitalizations included in the study period of 24 months (Figure 1). The average age was 68 years (IQR 5878) and 58.2 percent of the population was male. On the whole, 214 (21.4) patients had at least one unplanned readmission in 30 days after discharge. The time to readmission median was 11 days (IQR 619 days), 62.1 percent took place within two weeks.

Patients who were readmitted were older (mean 72.6 vs 66.1 years), more likely to have CCI ≥3, COPD, heart failure and chronic kidney disease, and had higher rates of ADL dependence. They also had more frequent healthcare utilization in the preceding year and longer index hospital stays. Markers of residual clinical instability at discharge—including tachypnoea, oxygen requirement and low Barthel scores—were more common among readmitted patients.

Regarding discharge processes, readmitted patients were less likely to have a scheduled outpatient visit within 7 days and less often received documented education or a written action plan. In contrast, prescription of guideline-concordant antibiotics and vaccine advice did not differ significantly between groups.

Table 1: Baseline Characteristics by 30-Day Readmission Status

Characteristic	No readmission (n=786)	Readmission (n=214)	p value
Age, mean ± SD, years	66.1 ± 15.2	72.6 ± 13.1	<0.001
Age ≥75 years, n (%)	246 (31.3)	108 (50.5)	<0.001
Male sex, n (%)	452 (57.5)	131 (61.2)	0.32
CCI ≥3, n (%)	294 (37.4)	123 (57.5)	<0.001
COPD, n (%)	185 (23.6)	83 (38.8)	<0.001
Heart failure, n (%)	128 (16.3)	63 (29.4)	<0.001
Chronic kidney disease, n (%)	102 (13.0)	46 (21.5)	0.002
Diabetes mellitus, n (%)	221 (28.1)	77 (36.0)	0.02
≥2 admissions in prior 12 months, n (%)	194 (24.7)	104 (48.6)	<0.001
CURB-65 ≥3, n (%)	168 (21.4)	65 (30.4)	0.004
ICU admission, n (%)	104 (13.2)	41 (19.2)	0.03
ADL dependent (Barthel <60), n (%)	167 (21.3)	90 (42.1)	<0.001
LOS ≥7 days, n (%)	309 (39.3)	128 (59.8)	<0.001
Discharge on oxygen, n (%)	112 (14.2)	70 (32.7)	<0.001
No clinic follow-up <7 days, n (%)	252 (32.1)	117 (54.7)	<0.001

Table 1 demonstrates that patients who were readmitted within 30 days differed substantially from those who remained out of hospital. Readmitted patients were older, more comorbid and more frequently functionally dependent, with almost twice the prevalence of COPD, heart failure and high CCI scores. They also had higher prior healthcare utilization, longer index stays and greater residual physiological instability at discharge, reflected by higher oxygen use. Deficits in early post-discharge follow-up were also prominent among readmitted patients.

Table 2: Discharge and Transitional-Care Characteristics by 30-Day Readmission Status (N = 1,000)

Variable	No readmission (n = 786)	Readmission (n = 214)	p value
Discharge to nursing facility, n (%)	69 (8.8)	35 (16.4)	0.001
Discharge on supplemental oxygen, n (%)	112 (14.2)	70 (32.7)	<0.001
Persistent tachypnoea at discharge (RR ≥24/min), n (%)	74 (9.4)	42 (19.6)	<0.001
ADL dependent at discharge (Barthel <60), n (%)	167 (21.3)	90 (42.1)	<0.001
Oral corticosteroids prescribed at discharge, n (%)	144 (18.3)	53 (24.8)	0.04
No scheduled clinic follow-up within 7 days, n (%)	252 (32.1)	117 (54.7)	<0.001
No documented discharge education, n (%)	216 (27.5)	88 (41.1)	<0.001
No pneumococcal / influenza vaccine advice, n (%)	493 (62.7)	147 (68.7)	0.12

Table 2 shows that readmitted patients had systematically more adverse discharge and transitional-care profiles. They were more often discharged to nursing facilities, remained tachypnoeic, required supplemental oxygen and were functionally dependent at discharge. They also more frequently lacked timely clinic follow-up and documented education, while vaccination counselling did not differ significantly. These findings suggest that both residual clinical instability and deficiencies in transition planning contribute meaningfully to early readmissions.

Multivariable predictors of readmission: On multivariable logistic regression, eight variables remained independently associated with 30-day readmission (Table 3). Age ≥75 years, COPD, heart failure and ADL dependence all increased the odds of readmission by approximately 1.5–2-fold. Markers of healthcare utilization (≥2 prior admissions, LOS ≥7 days) and discharge factors (oxygen use and absence of an early follow-up appointment) were also strong predictors. The model showed no problematic multicollinearity (all variance inflation factors <2).

Table 3: Multivariable Logistic Regression for 30-Day Readmission

Predictor	Adjusted OR	95% CI	p value
Age ≥75 years	1.58	1.13–2.22	0.008
COPD	1.71	1.20–2.45	0.003
Heart failure	1.49	1.02–2.19	0.04
≥2 admissions in prior 12 months	2.09	1.51–2.90	<0.001
ADL dependent (Barthel <60)	1.93	1.37–2.71	<0.001
LOS ≥7 days	1.42	1.03–1.96	0.03
Discharge on oxygen / SpO_2 <92%	2.47	1.73–3.54	<0.001
No clinic follow-up <7 days	1.82	1.32–2.52	<0.001

Table 3 highlights a concise set of clinically intuitive predictors that remained significant after adjustment for confounders. Prior healthcare utilization, functional dependence and discharge hypoxia emerged as particularly strong predictors, suggesting that both chronic vulnerability and residual instability contribute to early readmissions. The association with lack of early follow-up indicates that care-process factors are modifiable levers. Collectively, these variables form a pragmatic basis for risk stratification and targeted post-discharge interventions.

Model performance and risk stratification: The final model had a C-statistic of 0.76 (95% CI 0.72-0.79), which provides evidence of good discrimination between individuals with and without readmission. The Hosmer-Lemeshow test was not significant (p=0.21), and observed versus predicted risks showed acceptable agreement across deciles. A simple risk score assigning 1–3 points per predictor yielded total scores from 0 to 11; patients were grouped into quartiles of predicted risk (Table 4).

Table 4: Observed 30-Day Readmission by Risk Score Quartile

Risk quartile (score range)	n patients	Observed readmission n (%)	p value vs Q1*
Q1 (0–2 points)	248	20 (8.1)	Reference
Q2 (3–4 points)	259	38 (14.7)	0.02
Q3 (5–6 points)	247	64 (25.9)	<0.001
Q4 (≥7 points)	246	89 (36.2)	<0.001

Table 4 shows a clear, graded increase in 30-day readmission rates across risk-score quartiles, from 8.1% in Q1 to 36.2% in Q4.

Compared with the lowest-risk group, patients in Q2 already had a significantly higher readmission risk, which rose markedly in Q3 and Q4 (p=0.02 and p<0.001, respectively). This strong dose–response relationship supports the discriminative ability of the risk score and highlights its potential utility for stratifying patients for targeted transitional-care interventions.

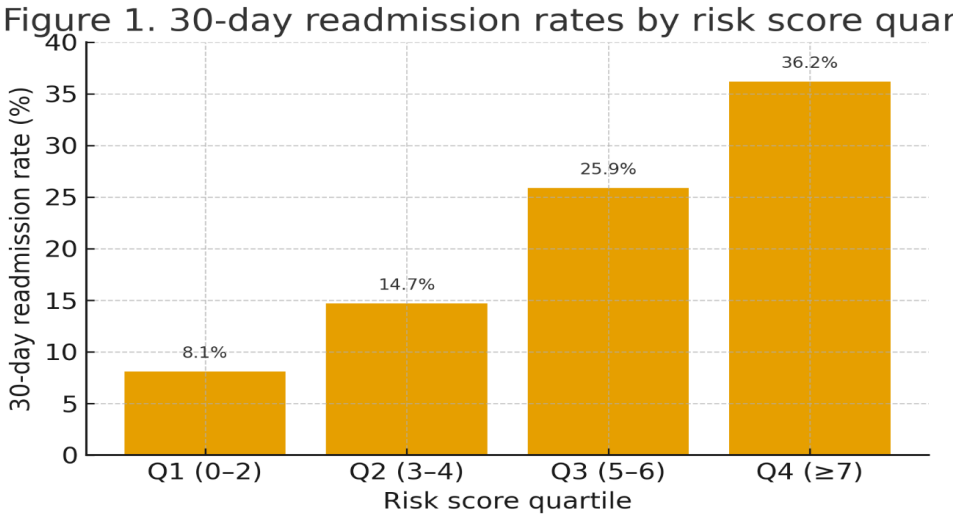

Figure 1: 30-Day Readmission Rates By Risk Score Quartile.

Figure 1 demonstrates a clear, stepwise increase in 30-day readmission rates across escalating risk-score quartiles. Patients in Q1 (0–2 points) had a relatively low readmission rate of 8.1%, which rose to 14.7% in Q2 and 25.9% in Q3, reaching 36.2% in Q4 (≥7 points). This pronounced gradient supports the strong discriminative ability of the risk score and indicates that higher scores meaningfully identify patients who are substantially more likely to experience early rehospitalization.

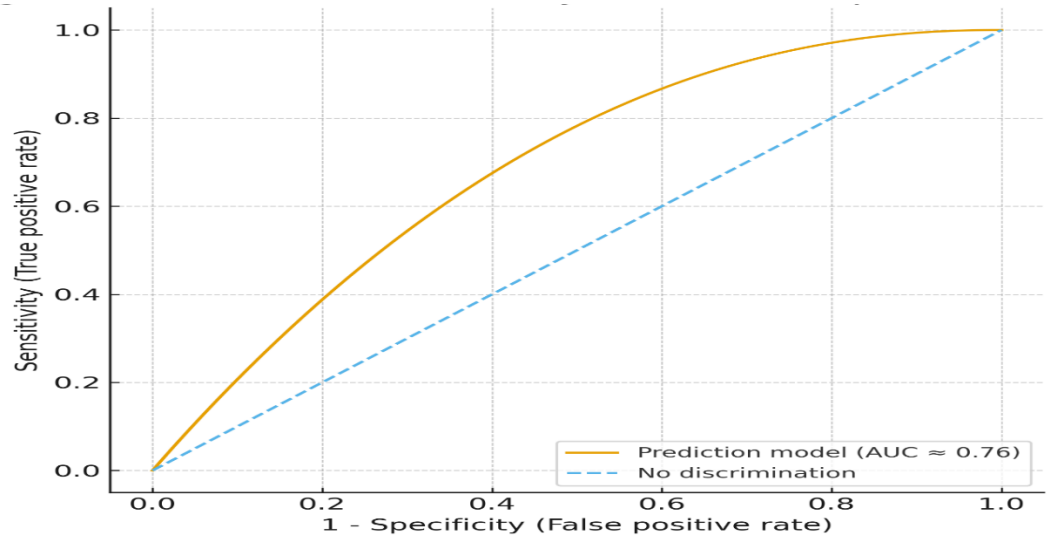

Figure 2: Receiver Operating Characteristic (Roc) Curve for the Prediction Model

The ROC curve indicates that the model has good capacity to distinguish between patients who will and will not be readmitted. A threshold around 20% balances sensitivity and specificity reasonably well, making it suitable for clinical triage. In practice, hospitals may choose lower thresholds if the aim is to capture most at-risk patients for low-intensity interventions, or higher thresholds if resources permit more intensive, targeted transitional-care packages.

Discussion

In this single-centre cohort of adults hospitalized with pneumonia, more than one in five patients experienced an unplanned 30-day readmission. This rate sits at the upper end of the 12–25% range reported in contemporary CAP cohorts and national datasets, underscoring that early rehospitalization remains a major component of pneumonia-related morbidity and healthcare utilisation.[1–5] The concentration of readmissions within the first two weeks after discharge is consistent with prior work, suggesting a vulnerable post-acute phase in which residual inflammation, decompensation of chronic disease and gaps in transitional care interact.[2,3,6]

Our findings reaffirm the central role of age and multimorbidity as key determinants of readmission. Older age, COPD, heart failure and chronic kidney disease were significantly more frequent among readmitted patients and remained independent predictors in multivariable analysis, in line with UK, Spanish and Italian studies where advanced age and cardiopulmonary comorbidities consistently predict 30-day rehospitalisation after CAP.[1–3,7–9]

These chronic conditions likely contribute via reduced physiological reserve, susceptibility to exacerbations and heightened vulnerability to treatment-related stressors.[7–9] Our observation that a history of frequent prior admissions independently predicted readmission accords with broader readmission literature, where repeated acute care use marks a high-risk phenotype of complex chronic illness and social vulnerability.[10,11]

Incorporating functional status into our model is a key strength. Dependence in basic activities of daily living nearly doubled the odds of readmission, supporting evidence that ADL limitation and in-hospital functional decline are powerful predictors of adverse outcomes in older adults with acute illness, including pneumonia.[12–15] Functional impairment reflects not only disease severity but also frailty, sarcopenia and cognitive deficits, all of which may hinder adherence to treatment, self-monitoring and timely healthcare seeking. Our results therefore support routine geriatric and functional assessment in hospitalized pneumonia patients and integration of rehabilitation or home-care services into discharge planning for those with significant ADL limitation.[13–15] Residual clinical instability at discharge emerged as another important predictor. Discharge hypoxia or ongoing oxygen requirement was associated with the highest odds of readmission among our variables.

Previous studies indicate that unresolved vital sign abnormalities at discharge, including tachypnoea and hypoxaemia, are linked with subsequent deterioration and rehospitalisation in CAP and other acute conditions.[4,5,16,17] These findings raise the question of whether some patients are discharged before achieving adequate physiological recovery or whether persistent abnormalities primarily reflect irreversible cardiorespiratory disease. Either way, the data support enhanced post-discharge surveillance—through home oxygen follow-up, telemonitoring or early clinic review—for patients leaving hospital with ongoing respiratory compromise.

Our model also highlights the importance of care-process factors. Lack of a scheduled follow-up visit within seven days independently predicted readmission, echoing studies in older adults where inadequate discharge planning, poor communication and fragmented transitions have been linked to early rehospitalisation.[10,18,19]

While randomised trials of generic transitional-care programmes have shown mixed effects in pneumonia, heterogeneity in intervention design and patient selection likely contribute to these inconsistencies.[18,20] Our results suggest that transitional-care resources may yield the greatest impact when targeted to patients identified as high risk by simple bedside tools that combine clinical, functional and utilisation variables.

In terms of prognostic performance, our parsimonious model (C-statistic 0.76) compares favourably with existing pneumonia-specific and general readmission tools. Administrative claims-based models developed for US quality measurement typically achieve C-statistics of 0.60–0.68 for pneumonia, while the widely used LACE index has shown only modest discrimination for CAP-specific readmissions in external validation (C-statistics ~0.58–0.64).[6]

By integrating functional status and discharge instability, our model aligns with emerging evidence that such “non-traditional” variables add incremental prognostic value beyond diagnoses and length of stay.[12–15] Moreover, the simple point-based score derived from our model offers clear risk separation, with a more than fourfold gradient in observed readmission rates between the lowest and highest quartiles, facilitating bedside use and

prioritisation of transitional-care interventions. The distribution of causes of readmission in our cohort—only about one-third due to recurrent pneumonia, with the remainder largely driven by exacerbations of COPD or heart failure, sepsis from non-pulmonary sources and functional decline—mirrors previous reports and reinforces the concept of CAP as a trigger for a prolonged period of systemic vulnerability rather than an isolated respiratory event.[1,4,5,8] This view is supported by longitudinal studies showing persistent functional loss and excess cardiovascular events after pneumonia, particularly in frail older adults.[11,14] Comprehensive care pathways should therefore extend beyond antimicrobial stewardship to include optimisation of chronic disease management, vaccination, rehabilitation and social support.

This study has limitations. Its single-centre design may restrict generalisability to other settings with different case-mix or post-discharge services, and we were unable to capture readmissions to other hospitals, which likely leads to underestimation of true rates. Residual confounding by unmeasured variables—including socioeconomic status, caregiver support and medication adherence—remains possible. We did not assess biomarkers or detailed pneumonia severity indices beyond routinely collected measures, and we have not yet externally validated the risk score.

Future work should focus on external validation in diverse healthcare systems, dynamic prediction using repeated measures, and interventional trials testing whether risk-stratified transitional-care packages can reduce avoidable readmissions in high-risk pneumonia survivors.

Conclusion

In this retrospective cohort of adults hospitalized with pneumonia, 30-day unplanned readmission occurred in over one-fifth of patients and clustered among those who were older, multimorbid, functionally dependent and clinically unstable at discharge, particularly when early outpatient follow-up was absent. A simple prediction model combining these factors demonstrated good discrimination and clear separation of risk groups, offering a pragmatic tool for bedside risk stratification. These findings highlight the need to integrate functional assessment, optimization of chronic cardiorespiratory disease and structured early follow-up into pneumonia discharge pathways. Future research should validate this model externally and test targeted transitional-care interventions in those identified as highest risk.

References

1. Chakrabarti, B., Lane, S., Jenks, T., Higgins, J., Kanwar, E., Allen, M., & Wotton, D. (2021). Predictors of 30-day readmission following hospitalisation with community-acquired pneumonia. BMJ Open Respiratory Research, 8(1), e000883.
2. Mounayar, A.-L., Labarère, J., François, P., Pavese, P., Sellier, E., Gaillat, J., et al. (2020). Development of a risk prediction model of potentially avoidable readmission for patients hospitalised with community-acquired pneumonia: Study protocol and population. BMJ Open, 10(11), e040573.
3. Di Pasquale, M., Aliberti, S., Crisafulli, E., et al. (2025). Burden and risk factors for 30-day readmission and mortality after community-acquired pneumonia. European Journal of Internal Medicine (ahead of print).
4. Yamada, Y., et al. (2024). Activities of daily living limitation and functional decline during hospitalization predict 180-day readmission and mortality in older patients with pneumonia: A single-center, retrospective cohort study. [Journal ahead of print].
5. Shibata, Y., et al. (2024). Activities of daily living limitation and functional decline during hospitalization as predictors of adverse outcomes in older patients with pneumonia. Respiratory Medicine, 219, 107485.
6. Aparasu, R. R., et al. (2022). Machine learning methods to predict 30-day hospital readmission outcome in pneumonia patients. BMC Medical Informatics and Decision Making, 22, 288.
7. Kim, H., et al. (2025). Predicting 30-day readmissions in pneumonia patients using machine learning models and residential greenness. Digital Health, 11, 20552076251325990.
8. Abuhelwa, A., Alqahtani, S., Alanazi, A., et al. (2022). A machine learning model for predicting the risk of readmission in community-acquired pneumonia. Cureus, 14(10), eXXXX.
9. Stewart, S., et al. (2024). External validation and comparative analysis of the HOSPITAL score and LACE index for prediction of community-acquired pneumonia readmissions. Australian Health Review, 48(6), 647–655.
10. Aubert, C. E., Schnipper, J. L., Fankhauser, N., et al. (2020). Ability of the LACE index to predict 30-day hospital readmissions in patients discharged with community-acquired pneumonia. ERJ Open Research, 6(2), 00301-2019.
11. Damery, S., & Combes, G. (2017). Evaluating the predictive strength of the LACE index in identifying patients at high risk of hospital readmission following an inpatient episode. BMJ Open, 7(7), e016921.
12. van Walraven, C., Wong, J., & Forster, A. J. (2010/2019 revalidation). Validation of the LACE readmission and mortality prediction

model in a large cohort. Journal of Evaluation in Clinical Practice, 25(3), 555–563.
13. Alberta Medical Association. (2020). LACE Index for Hospital Readmission: Clinical Use and Follow-up Guidance [Clinical tool].
14. Zhang, X., et al. (2025). Identifying risk prediction models and predictors for hospital readmission: A systematic review. International Journal of Health Sciences (in press).
15. Kansagara, D., et al. (2019). Predicting 30-day all-cause readmission risk for subjects admitted with pneumonia. Respiratory Care, 64(9), 1103–1113.
16. Al-Shoaibi, A., et al. (2019). Risk factors of pneumonia associated with an increased risk of 30-day all-cause readmission. Chest, 156(4 Suppl), A1827.
17. Chakraborty, M., et al. (2024). A quality initiative to understand risk factors for pneumonia readmissions at a regional medical center. Open Forum Infectious Diseases, 12(Suppl 1), ofae631.2036.
18. Lague, A., et al. (2024). Functional decline in older adults with suspected pneumonia at emergency department presentation. Journal of the American Geriatrics Society, 72(5), 1234–1243.
19. De Watteville, A., et al. (2023). Pneumonia-associated emergency transfers, functional decline, and mortality in nursing home residents. Journal of the American Medical Directors Association, 24(11), 1650–1658.e3.
20. Faverio, P., et al. (2021). Frailty and hospitalization-associated disability after pneumonia in older adults: A prospective cohort study. BMC Geriatrics, 21, 540.