นิพนธ์ต้นฉบับ

ปัจจัยเสี่ยงต่ออัตราการเสียชีวิตจากโรคปอดอักเสบในโรงพยาบาลปฐมภูมิ: กรณีศึกษาโรงพยาบาลพัฒนานิคม จังหวัดลพบุรี ประเทศไทย

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บทคัดย่อ

ความเป็นมา: โรคปอดบวมเป็นสาเหตุหลักของการเข้ารับการรักษาในโรงพยาบาลและการเสียชีวิต โดยเฉพาะอย่างยิ่งในผู้สูงอายุและผู้ที่มีโรคประจำตัว รายงานล่าสุดระบุว่าโรงพยาบาลพัฒนานิคมมีแนวโน้มอัตราการเสียชีวิตจากโรคปอดบวมสูงขึ้น การศึกษานี้จึงมุ่งเน้นการหาปัจจัยเสี่ยงที่เกี่ยวข้องกับการเสียชีวิต เพื่อปิดช่องและลดการเสียชีวิตในโรงพยาบาลปฐมภูมิทั่วประเทศ

วัตถุประสงค์: เพื่อประเมินปัจจัยที่เกี่ยวข้องกับการเสียชีวิตของผู้ป่วยโรคปอดบวมที่เข้ารับการรักษาในโรงพยาบาลพัฒนานิคม

วิธีการศึกษา: การศึกษาย้อนหลังในกลุ่มผู้ป่วยโรคปอดบวม 2,384 ราย ที่รักษาในโรงพยาบาลพัฒนานิคม ช่วงปี พ.ศ. 2562-2567 ใช้การวิเคราะห์ Competing Risk Regression

ผลลัพธ์: อัตราการเสียชีวิตโดยรวมอยู่ที่ 0.9 ต่อ 100 คน-วัน มีผู้เสียชีวิต 186 ราย การเข้ารับการรักษาในวันสุดสัปดาห์ (95% CI: 1.03-2.15, p = 0.036), ผู้ที่คะแนนชาร์ลสัน≥ (95% CI: 1.81-3.94, p < 0.001), ค่า Shock Index Age ที่สูง(95% CI: 1.13-2.62, p = 0.011) อัตราการหายใจที่มากกว่า 30 ครั้งต่อนาที (95% CI: 1.46-2.98, p < 0.001) และ ผู้ป่วยที่ได้รับการกู้ชีพ (95% CI: 21.39-53.19, p < 0.001) เพิ่มความเสี่ยงการเสียชีวิต ในขณะที่ความดันโลหิตสูงมีลดความเสี่ยงการตาย (95% CI: 0.37-0.91, p = 0.019)

ข้อสรุป: ผู้ได้รับการกู้ชีพ, มีคะแนนโรคร่วมสูง และผู้ป่วยที่ได้เข้ารับการรักษาในวันสุดสัปดาห์เป็นปัจจัยที่ส่งผลต่ออัตราการเสียชีวิต แสดงให้เห็นถึงความจำเป็นในการตัดสินใจส่งต่อผู้ป่วยตามความเสี่ยง การนำ Shock Index Age มาใช้ อาจช่วยปรับปรุงการส่งต่อให้เหมาะสม

คำสำคัญ: *● ปอดบวม ● อัตราการเสียชีวิต*

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Original article

Risk Factors for Pneumonia Mortality in Primary Healthcare Centers A Study in Phatthana Nikhom District, Lopburi Province, Thailand

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Abstract

Background: Pneumonia remains a significant public health concern and is one of the leading causes of hospital admissions and mortality, particularly among the elderly and individuals with underlying health conditions. Recent reports indicate a rising trend in pneumonia-related mortality at Phatthana Nikhom Hospital. This study aims to identify risk factors associated with pneumonia-related deaths in a primary care setting.

Objective: This study aims to evaluate the risk factors associated with pneumonia mortality in patients admitted to Phatthana Nikhom Hospital, Lopburi Province, Thailand

Methods: A retrospective cohort study was conducted on 2,384 pneumonia patients admitted to Phatthana Nikhom Hospital, between 2019 and 2024. Multivariable competing risk regression analysis was used to evaluate demographic, clinical, and physiological risk factors associated with in-hospital mortality and referrals to higher-level care.

Result: The overall incidence of mortality was 0.9 per 100 person-days, with 186 deaths recorded. Weekend admission was associated with increased mortality risk (95% CI: 1.03-2.15, p = 0.036). Patients with a Charlson Comorbidity Index (CCI) ≥3 had significantly higher mortality risk (95% CI: 1.81-3.94, p < 0.001). Elevated Shock Index Age (SIA ≥82) (95% CI: 1.13-2.62, p = 0.011) and respiratory rate ≥30 were also significant factors.

Conclusions: Late referrals to higher-level center care, particularly among those with physiological deterioration, may contribute to increased pneumonia mortality. The high mortality rate among patients requiring CPR, a high CCI, and the weekend admission effect underscores the need for early risk-based referral decisions to prevent critical deterioration. Implementing standardized triage protocols using Shock Index Age (SIA) could help improve timely referrals and reduce pneumonia mortality rates.

Keywords*: ● *Pneumonal* ● *Mortality

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Introduction

Pneumonia is a major cause of morbidity and mortality worldwide[1], particularly among vulnerable populations such as the elderly and individuals with chronic conditions[2–5] Despite advancements in healthcare and antibiotic therapy, pneumonia remains a significant public health challenge due to its potential complications and multi-organ dysfunction[6].

In Thailand, pneumonia is one of the leading causes of hospitalization and death, especially among older adults. Data from the Thai Ministry of Public Health indicate that the incidence of pneumonia-related hospital admissions has steadily increased over the past five years, with seasonal surges during colder months[7] While tertiary and secondary hospitals have access to intensive care units (ICU) and specialized care, primary healthcare hospitals face considerable limitations in terms of diagnostic tools, critical care capabilities, and early risk stratification systems.

Phatthana Nikhom Hospital, a primary care hospital in Lopburi Province, has reported consistently high pneumonia mortality rates, and in 2023, pneumonia became the leading cause of inpatient deaths at this facility. This trend highlights critical gaps in early identification, timely referral, and effective treatment strategies at the primary care level.

Several international studies have identified demographic, clinical, and healthcare-related risk factors influencing pneumonia outcomes[5,8] However, limited research has been conducted in Thailand's primary care settings, where resource constraints and delayed decision or interventions may significantly impact survival rates[9] This study aims to address this gap by evaluating the risk factors associated with pneumonia mortality in a primary healthcare setting. By identifying key predictors of mortality, this research seeks to improve early risk assessment, optimize clinical decision-making, and enhance patient outcomes at the primary care level.

Methods

Study Design: A descriptive, retrospective cohort study analyzing retrospective hospital data from Phatthana Nikhom Hospital, Lopburi Province, Thailand, between 2019 and 2024.

Study Population: The study included patients aged ≥ 20 years who were diagnosed with pneumonia and admitted for inpatient care. Exclusion criteria were patients with an incomplete medical record and cases misclassified as pneumonia without radiologic confirmation.

Data Collection: Patient data were retrieved from electronic medical records (EMR), using ICD-10 codes for pneumonia diagnosis. Variables collected included: demographics, comorbid conditions, and clinical indicators (vital signs).

Statistical Analysis: Descriptive statistics summarized demographic and clinical characteristics. Pearson's Chi-square test and Fisher's exact test were used for categorical variables. Univariate and multivariate survival time competing risk regression analysis in the Fine and Gray model was used to identify independent risk factors for mortality. A p-value < 0.05 was considered statistically significant.

Results

Characteristics of the Patients

A total of 2,384 patients were included. Of these, 206 patients (8.64%) experienced in-hospital mortality, while 210 patients (8.81%) were referred to higher healthcare facilities. The demographic and clinical characteristics of the study population are presented in Table 1. The mean age was 63.8 years, and 1,281 were male (53.74%). The mean length of hospital stay was 6.65 ± 4.87 days. A considerable proportion of admissions occurred on weekdays, accounting for 1,903 patients or 79.82% of the study population. Among the study population, 1,088 (45.64%) patients reported a history of smoking, and 925 (38.80%) reported alcohol consumption. The underlying diseases of the population were hypertension (947, 39.72%), dyslipidemia (683, 28.65%), diabetes mellitus (525, 22.02%), chronic obstructive pulmonary disease (COPD) (368, 15.44%), cancer (140, 5.87%), and asthma (72, 3.02%). The mean Shock Index Age (SIA) was 52.97.

Table 1 : Demongraphic data general characteristic

	n(%)
Gender (n = 2,384)	
Male	1,281 (53.74)
Female	1,103 (46.26)
Age (years old) (n = 2,065)	
Mean ± SD	63.8 ± 18
Median(Min-Max)	66 (20-102)
Age group (years old) (n = 2,065)	
< 65	976 (47.26)
≥ 65	1,089 (52.74)
Status (n = 2,382)	
Single	294 (12.34)
Married	1,730 (72.63)
Widow	274 (11.50)
Divorced	58 (2.44)
Monk	26 (1.09)
Lenght of hospital stay (day) (n = 2,384)	
Mean ± SD	6.65 (4.87)
Median(Min-Max)	5 (0-31)
Admitted day (n= 2,384)	
Weekend	481 (20.18)
Weekday	1,903 (79.82)
Smoking status (n = 2,384)	
Yes	1,088(45.64)
No	1,296 (54.36)
Alcohol drinking (n = 2,384)	
Yes	925 (38.80)
No	1,459 (61.20)
Outcomes (n = 2,384)	
Dead	206 (8.64)
Refer	210 (8.81)
Discharge (alive)	1,968 (82.55)
Underlying disease (n=2,384)	
Diabetes Mellitus	525 (22.02)
Hypertesion	947 (39.72)
Dyslipidemia	683 (28.65)
COPD	368 (15.44)
Asthma	72 (3.02)
Cancer	140 (5.87)
Shock Index Age (SIA) (n=1,632)	
Mean ± SD	52.97± 24
Median(Min-Max)	(8.8 166.9412)

The Charlson Comorbidity Index

The Charlson Comorbidity Index (CCI) of the study population was detailed in Table 2. Of these, 1,023 (42.91%) of patients had a score ≥3, indicating a substantial burden of comorbid conditions. The most prevalent comorbidity contributing to the CCI score was diabetes without chronic complications (525, 22.02%), followed by chronic pulmonary disease (368, 15.44%), and renal disease (192, 8.22%). Other notable comorbidities included congestive heart failure (149, 6.17%), cerebrovascular disease (84, 3.52%), and malignancy (50, 2.10%). Metastatic solid tumors were reported in 93 (3.90%) of patients. HIV infection without AIDS was in 18 (0.76%) of cases, while 36 (1.51%) had AIDS.

Table 2 : Charlson Comorbidity Index

	n(%)
Myocardial infarction	14 (0.59)
Congestive heart failure	147 (6.17)
Peripheral vascular disease	3 (0.13)
Cerebrovascular disease	84 (3.52)
Hemiplegia or paraplegia	40 (1.68)
Dementia	13 (0.55)
Chronic pulmonary disease	368 (15.44)
Rheumatic disease	7 (0.29)
Peptic ulcer disease	0 (0)
Mild liver disease	32 (1.34)
Diabetes without chronic complication	525 (22.02)
Diabetes with chronic complications	2 (0.08)
Renal disease	196 (8.22)
Liver disease	4 (0.17)
HIV infection, no AIDS	18 (0.76)
AIDS	36 (1.51)
Metastatic solid tumor	93 (3.90)
Any malignancy	50 (2.10)
Charlson Comorbidity Index	
score <3	1,361 (57.09)
score ≥3	1,023 (42.91)

Mortality Analysis

The survival time competing risk regression analysis was presented in Tables 3 and 4, where the Fine and Gray model was applied in the framework. Overall, the incidence of mortality was 0.9 per 100 person-days, with 186 deaths recorded as shown in Table 3. Univariate survival time competing risk regression analysis was first applied to find mortality factors. Weekend admission (SHR = 1.55, 95% CI: 1.12-2.13, p = 0.008), hypertension (SHR = 0.62, 95% CI: 0.45-0.84, p = 0.002),

CCI ≥3 (SHR = 1.19, 95% CI: 1.14-1.23, p < 0.001), SIA≥82 (SHR = 2.42, 95% CI: 1.67-3.52, p < 0.001), Respiratory rate ≥30 (SHR = 0.98, 95% CI: 0.97-0.99, p < 0.001), and CPR (SHR = 10.19, 95% CI: 2.93-35.48, p < 0.001) were identified. Then the final model in multivariate analysis was analyzed by significant factors from the univariate analysis. weekend admission remained as significant predictor of mortality (SHR = 1.49, 95% CI: 1.03-2.15, p = 0.036) as well as the CCI ≥3 (SHR = 2.67, 95% CI: 1.81-3.94, p < 0.001), SIA ≥82 (SHR = 1.72, 95% CI: 1.13-2.62, p = 0.011), RR ≥30 (SHR = 2.11, 95% CI: 1.46-2.98, p < 0.001), and CPR (SHR = 33.73, 95% CI: 21.39-53.19, p < 0.001). Interestingly, hypertension demonstrates a protective effect (SHR = 0.58, 95% CI: 0.37-0.91, p = 0.019) in this model.

Table 3 : Mortality survival time competing regression analysis

				Univariable analysis			Multivariable analysis		
	Events	Person-days	Incidence (100Person-Days)	Subdistribution Hazard Ratio (SHR)	95% CI	P-value	Subdistribution Hazard Ratio	95% CI	P-value
Overall mortality	186	15,858	0.9						
Gender									
Male	115	670	17.2			1 (Reference)			
Female	91	551	16.5	0.92	0.69-1.23	0.583	1.29	0.91-1.81	0.15
Weekend admission	59	2,861	2.1	1.55	1.12-2.13	0.008*	1.49	1.03-2.15	0.036*
Underyling disease									
Dyslipidemia	48	4,071	1.2	0.71	0.51-1.00	0.053	0.73	0.45-1.18	0.201
Hypertension	61	5,807	1.1	0.62	0.45-0.84	0.002*	0.58	0.37-0.91	0.019*
Charlson comorbidity index (CCI)									
CCI < 3	58	910	6.4			1 (Reference)			
CCI ≥ 3	148	311	47.6	1.19	1.14-1.23	<0.001*	2.67	1.81-3.94	<0.001*
Shock Index Age (SIA)									
SIA < 82	130	7,910	1.6			1 (Reference)			
SIA ≥ 82	40	1,004	4	2.42	1.67-3.52	<0.001*	1.72	1.13-2.62	0.011*
Respiratory rate (RR)									
RR < 30	122	8,442	1.4			1 (Reference)			
RR ≥ 30	75	2,275	3.3	0.98	0.97-0.99	<0.001*	2.11	1.46-2.98	<0.001*
Cardiopulmonary resuscitation (CPR)	3	11	27.3	10.19	2.93-35.48	<0.001*	33.73	21.39-53.19	<0.001*

A comparison of mortality versus referral in the same multivariate analysis model was shown in Table 4. The outcomes revealed that there were 2 factors associated with both mortality and referral. The first factor was CCI ≥3 (multivariate analysis of mortality SHR = 2.67, 95% CI: 1.81-3.94, p < 0.001 and referral SHR = 2.00, 95% CI: 1.37-2.93, p < 0.001). The last was CPR (multivariate analysis of mortality SHR = 33.73, 95% CI: 21.39-53.19, p < 0.001 and referral SHR = ∞,95% CI: ∞-∞, p < 0.001). Other variables that were significant in the mortality model did not demonstrate statistical significance in the referral model, suggesting differing mechanisms or thresholds for clinical deterioration versus referral decisions.

Table 4 : Mortality vs refer Multivariate survival time competing regression analysis

	Multivariable analysis (Death)			Multivariable analysis (Refer)		
	Subdistribution Hazard Ratio	95% CI	P-value	Subdistribution Hazard Ratio	95% CI	P-value
Gender						
Male	1 (Reference)			1 (Reference)		
Female	1.29	0.91-1.81	0.150	0.75	0.51-1.09	0.127
Weekend admission	1.49	1.03-2.15	0.036*	0.78	0.50-1.22	0.283
Underling disease						
Dyslipidemia	0.73	0.45-1.18	0.201	0.81	0.51-1.29	0.366
Hypertension	0.58	0.37-0.91	0.019*	1.11	0.73-1.71	0.62
Charlson comorbidity index (CCI)						
CCI<3	1 (Reference)			1 (Reference)		
CCI>=3	2.67	1.81-3.94	<0.001*	2.00	1.37-2.93	<0.001*
Shock Index Age (SIA)						
SIA <82	1 (Reference)			1 (Reference)		
SIA>=82	1.72	1.13-2.62	0.011*	1.25	0.78-2.00	0.359
Respiratory rate (RR)						
RR < 30	1 (Reference)			1 (Reference)		
RR >= 30	2.11	1.46-2.98	<0.001*	0.97	0.64-1.46	0.888
Cardiopulmonary resuscitation	33.73	21.39-53.19	<0.001*	∞	∞-∞	<0.001*

Discussion

This study analyzed risk factors associated with pneumonia mortality in a primary health-care setting, focusing on patient demographics, clinical indicators, and comorbidities. Our findings align with recent literature emphasizing that advanced age, multiple chronic conditions, and acute physiological derangements are key drivers of poor pneumonia outcomes[2,5,10]

Impact of Gender on Referral and Mortality

Female patients in our cohort exhibited a higher (though not statistically significant) mortality risk and were less likely to be referred for intensive care. While our data did not reach significance, the trend is in contrast with other studies[11,12] in which male gender was associated with worse outcomes. This finding may reflect that male patients with severe conditions may be referred to a higher hospital care level more than female patients and resulting in a non-significant gender difference in this study. However, our findings may propose crucial improvements to stop the trend in the hospital so that female patients might benefit from more vigilant assessment and early intervention to avoid missed opportunities for timely ICU referral or higher hospital care level.

Role of Hypertension as a Protective Factor

Interestingly, hypertension emerged as a protective factor in our analysis, associated with lower mortality risk. Patients with hypertension had better survival, which aligns with some emerging research in the COVID era[13–15] One explanation is that hypertensive patients are often on long-term medical therapy and regular monitoring, which may improve their overall health stability. Common antihypertensive medications such as ACE inhibitors (ACEIs) and angiotensin II receptor blockers (ARBs) have been hypothesized to confer protective effects in pneumonia by modulating the renin-angiotensin system and reducing acute lung injury[16] However, this finding needs to be further investigated.

Charlson Comorbidity Index (CCI) and Mortality

A higher Charlson Comorbidity Index was a strong predictor of mortality in our study, consistent with prior findings in pneumonia populations. Patients with CCI ≥3 had a markedly increased mortality risk and were also more likely to be referred to a higher level of care[17–19]

Referral Patterns and Mortality Risk

The decision to refer pneumonia patients to a higher-level hospital was significantly associated with comorbidity burden in our study, but notably, it did not aligned with some acute physiological markers of severity. Importantly, Shock Index Age (SIA) and tachypnea (RR ≥30) were strong predictors of mortality in our cohort, yet did not significantly increase the likelihood of referral. This disconnect suggests a possible delay or gap in escalation of care for patients who were deteriorating hemodynamically[20,21]

Weekend Admission and Mortality Risk

Patients admitted on weekends had higher mortality risk (SHR = 1.49, 95% CI = 1.03-2.15, p = 0.036), reinforcing the "weekend effect" observed in multiple healthcare systems. This aligns with previous research[22] indicating that variations in staffing and resource availability might contribute to worse weekend outcomes. However, weekend admission did not significantly influence referral rates, suggesting that patients were not necessarily transferred more or less frequently based on admission timing. Improving weekend staffing, access to specialized care, and early escalation protocols may help mitigate excess mortality.

CPR Requirement in Pneumonia Patients

Patients requiring cardiopulmonary resuscitation (CPR) had the highest mortality risk (SHR = 33.73, 95% CI = 21.39-53.19, p < 0.001), consistent with prior studies[23] demonstrating that patients who require CPR for pneumonia-related complications rarely survive. The study emphasized that patients with pneumonia requiring CPR often have underlying multi-organ failure and severe respiratory distress, leading to high post-resuscitation mortality.

Shock Index Age and Mortality Risk

Shock Index Age (SIA) is an emerging predictor of mortality in pneumonia patients as it incorporates both physiological response to infection and age-related vulnerability[24] Studies indicate that a higher SIA score is associated with increased mortality[25,26] A retrospective study found that incorporating SIA into routine triage assessments improved early detection of high-risk patients and facilitated timely ICU admission, thereby reducing overall mortality[24] Implementing SIA as part of routine triage could enhance early identification of high-risk pneumonia patients requiring urgent intervention[26]

Late ICU Admission and Mortality Risk

Late ICU admission in patients with CAP has been associated with significantly increased mortality rates16. Delays in recognizing deteriorating clinical conditions and transferring patients to intensive care may lead to worsened outcomes, as patients who receive late ICU admission often require more aggressive interventions, such as mechanical ventilation and vasopressor support.[21]

Limitation

The use of hospital databases may result in missing or incomplete data, as some patient records might not have been fully documented.

There is a risk of misclassification bias, as coding practices might vary among physicians and institutions.

The COVID-19 pandemic might have influenced pneumonia management strategies during certain periods, introducing variability in patient outcomes. Clinical practices and treatment guidelines may have changed over time, potentially affecting the results.

Conclusion

This study highlights critical demographic, clinical, and physiological factors influencing pneumonia mortality and referral likelihood. While some factors, such as high comorbidities (CCI ≥ 3), severe physiological instability (SIA ≥ 82, RR ≥ 30), and CPR requirement, were associated with both increased mortality and higher referral rates, other factors showed discrepancies between death and referral outcomes.

Female patients had a slightly higher but non-significant mortality risk (SHR = 1.29, 95% CI = 0.91-1.81, p = 0.15) and were less likely to be referred (SHR = 0.75, 95% CI = 0.50-1.22, p = 0.127). Future studies should investigate whether clinician bias, symptom perception differences, or delayed recognition of severity in female patients contribute to this trend.

Patients admitted on weekends had higher mortality risk (SHR = 1.49, 95% CI = 1.03-2.15, p = 0.036), reinforcing the “weekend effect” observed in multiple healthcare systems. However, weekend admission did not significantly influence referral rates, suggesting that patients were not necessarily transferred more or less frequently based on admission timing. Improving weekend staffing, access to specialized care, and early escalation protocols may help mitigate excess mortality.

Late referrals emerged as a significant concern, with many patients being transferred only after experiencing critical deterioration, leading to a higher need for CPR and poor survival outcomes. These findings emphasize the importance of early recognition and timely transfer of high-risk pneumonia patients before they reach an irreversible clinical state.

Recommendations

To address the identified challenges, it is imperative to establish structured triage protocols in primary healthcare facilities to facilitate the early identification of high-risk pneumonia patients. The use of validated risk stratification tools, such as CURB-65, the Quick Sequential Organ Failure Assessment (qSOFA) score, and the National Early Warning Score 2 (NEWS-2), should be integrated into routine clinical practice to guide referral decisions. Additionally, parameters such as the Shock Index Age (SIA) and respiratory rate should be considered preemptive indicators for transfer rather than late-stage markers of deterioration.

Optimizing referral criteria is also essential to prevent unnecessary delays in transferring patients to secondary and tertiary care facilities. Standardized referral guidelines should prioritize the early transfer of patients with a high comorbidity burden, persistent hypoxia despite supplemental oxygen, or worsening hemodynamic instability. A proactive referral approach should replace the current reliance on transferring patients only after they have reached a critical state requiring CPR, given the poor survival outcomes associated with late-stage interventions. Establishing real-time consultation mechanisms with specialists at referral centers can further support primary care physicians in making timely decisions regarding patient transfers.

Enhancing weekend care resources is also essential to mitigate the increased mortality risk associated with weekend admissions. Strengthening healthcare workforce availability and ensuring access to on-call specialists could help improve pneumonia management during non-business hours. Additionally, telemedicine consultations with specialists should be expanded to support real-time decision-making for critically ill patients during weekends and off-hours.

Finally, further research is needed to investigate the protective role of hypertension in pneumonia mortality. Studies exploring the impact of antihypertensive medications, particularly ACE inhibitors and ARBs, on pneumonia outcomes could provide valuable insights into potential therapeutic benefits. Understanding whether hypertensive patients benefit from specific immunomodulatory mechanisms that reduce pneumonia-related complications could inform future treatment strategies.

By implementing these recommendations, healthcare systems can improve pneumonia triage, enhance timely referral processes, and ultimately reduce mortality rates in primary care settings. Strengthening referral pathways, addressing disparities in patient care, and prioritizing early intervention strategies will be essential in optimizing pneumonia outcomes and ensuring that high-risk patients receive appropriate treatment before their condition becomes life-threatening.

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