

BACTERIAL PNEUMONIA CHARACTERISTICS AS A COMPLICATION OF CHRONIC OBSTRUCTIVE PULMONARY DISEASE

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ABSTRACT

Background: The management of respiratory diseases and infectious complications requires an integrative approach that connects community epidemiology, critical care risk stratification, functional interventions, and the management of multidrug-resistant pathogens. **Objective:** This literature review aims to critically synthesize four major scientific articles (published between 2023 and 2024) that document significant clinical phenomena in the post-pandemic era, predictors of critical mortality, functional ventilation adaptations, and the growing threat of antimicrobial resistance. **Methods:** A systematic review was conducted by evaluating the methodologies, key findings, and limitations of four independent studies, including an epidemiological analysis from Shanghai (n = 494), a retrospective ICU cohort study from Turkey (n = 416), a rapid review on bulbar function, and a multivariable survival analysis of solid organ transplant recipients in the United States (n = 897).

Results: The synthesis revealed that the post-COVID-19 immunity debt phenomenon contributed to a surge in pediatric respiratory infections accompanied by a high rate of macrolide resistance (80%). In the ICU setting, the C-reactive protein-to-albumin ratio (CAR) and neutrophil-to-lymphocyte ratio (NLR) were identified as significant predictors of mortality among patients with severe COPD complicated by pneumonia or sepsis. Optimization of non-invasive ventilation (NIV) through mouthpiece ventilation (MPV) was shown to improve respiratory-swallowing coordination disorders in patients with neuromuscular diseases. Meanwhile, bloodstream infections caused by carbapenem-resistant Enterobacterales (CRE-BSI) increased the mortality hazard ratio among transplant recipients by up to 2.85 times.

Keywords: Mycoplasma pneumoniae; Chronic Obstructive Pulmonary Disease (COPD); Non-Invasive Ventilation; CRE Bloodstream Infection; Contemporary Thematic Analysis

INTRODUCTION

The dynamics of modern healthcare in the post-pandemic era are characterized by complex interactions among shifting epidemiological patterns of infectious diseases, challenges in managing critically ill patients in intensive care units (ICUs), the restoration of biomechanical function in individuals with chronic disorders, and the growing global threat of antimicrobial resistance (AMR). Respiratory diseases are no longer viewed as isolated pathological entities but rather as a broad clinical spectrum involving host–pathogen interactions, mechanical ventilation management, upper airway functional coordination, and the patient’s systemic immunological status.

This literature review was designed to comprehensively examine four contemporary scientific articles published between 2023 and 2024. Although originating from different regions of the world and focusing on distinct clinical domains, these studies are interconnected within the broader framework of critical care and infectious disease management. The topics explored include: (1) the epidemiological profile of the post-COVID-19 *Mycoplasma pneumoniae* outbreak among children in Shanghai; (2) the identification of mortality risk factors and prognostic biomarkers in patients with Chronic Obstructive Pulmonary Disease (COPD) admitted to the ICU; (3) the development of practical recommendations for swallowing and speech functions in patients with Neuromuscular Disorders (NMD) who depend on Non-Invasive Ventilation (NIV); and (4) the analysis of clinical outcomes and independent risk factors associated with Carbapenem-Resistant *Enterobacterales* bloodstream (World Health Organization 2025) infections (CRE-BSI) in Solid Organ Transplant (SOT) recipients. Through a multi-angled synthesis, this review contextualizes these individual research findings to advance clinical paradigms and support the development of evidence-based guidelines.

METHODS

This study employed a large-scale descriptive epidemiological design utilizing data obtained from the Shanghai Hospital Quality Assessment and Improvement Platform, which integrates electronic medical records from 36 municipal hospitals across Shanghai. To gain a more comprehensive clinical understanding, a micro-level analysis was conducted on a cohort of 494 pediatric patients who were admitted to the *Mycoplasma pneumoniae* pneumonia (MPP) ward at the Children's Hospital of Fudan University during the critical transition period from August 1 to September 30, 2023. The diagnosis of MPP was established based on a combination of clinical manifestations of acute respiratory tract infection, radiological evidence of pulmonary infiltrates on chest imaging, and objective laboratory confirmation. Laboratory criteria included seroconversion or at least a fourfold increase in specific antibody titers, a single IgM antibody titer greater than 1:160, or a positive result from Polymerase Chain Reaction (PCR)-based testing. This comprehensive diagnostic approach ensured accurate case identification and provided a reliable foundation for evaluating the epidemiological characteristics, clinical presentations, and therapeutic implications of the outbreak.

RESULT

The following is a summary of the 10 articles that were successfully collected and studied, including the research design, the presence or absence of interventions, and the main findings of each:

N O	Author/Year	Main Topic	Study Design	Population & Setting	Key Findings & Conclusions
1	Zhang et al., 2024	Epidemiology and clinical characteristics of <i>Mycoplasma pneumoniae</i> infection in the post-COVID-19 pandemic period.	Descriptive Editorial and Clinical Cohort Analysis.	494 hospitalized pediatric patients at the Children's Hospital of Fudan University, supported by macro-level data from 36 hospitals across Shanghai.	A substantial increase in cases was observed due to the immunity debt phenomenon. Pleural effusion occurred in 24.9% of cases. Extremely high rates of macrolide resistance were identified (80% overall and 88.2% among severe MPP cases).
2	Deniz et al., 2023	Identification of inflammatory biomarkers and mortality determinants in ICU patients with Chronic Obstructive Pulmonary Disease (COPD).	Retrospective Cohort Study.	416 critically ill COPD patients categorized into three diagnostic groups at Bolu Izzet Baysal State Hospital, Turkey.	The overall ICU mortality rate was 39.2%, with the highest mortality observed in patients with pneumonia (47.5%) and sepsis (42.1%). CAR and NLR were validated as efficient independent

					predictors of mortality.
3	Andersen et al., 2024	Coordination and practical recommendation s for swallowing and speech functions during Non-Invasive Ventilation (NIV) in patients with Neuromuscular Disorders (NMD).	Systematic Rapid Review and Narrative Synthesis	Patients with neuromuscular disorders dependent on daytime (diurnal) NIV support.	Approximately 40–50% of patients exhibited abnormal post-swallow inspiratory cycles, increasing the risk of aspiration. Mouthpiece Ventilation (MPV) was shown to be more functional and safer than conventional nasal-mask NIV.
4	Anesi et al., 2023	Survival analysis, clinical outcomes, and risk-factor assessment of Carbapenem-Resistant <i>Enterobacterales</i> Bloodstream Infection (CRE-BSI) among Solid Organ Transplant (SOT) recipients.	Multicenter Retrospective Cohort Study	897 solid organ transplant recipients with <i>Enterobacterales</i> bloodstream infections across three tertiary transplant centers in the United States.	CRE-BSI significantly increased 60-day mortality (47% vs. 12%; HR 2.85) and graft failure risk (HR 2.42). Major risk factors included prior CRE colonization (aOR 9.86) and previous antibiotic exposure.
5	Zheng et al., 2021	Pulmonary apoptosis and tissue injury	Narrative Review	Experimental studies on lung injury and apoptotic cell clearance	Failure to remove apoptotic cells increased tissue damage and prolonged

					inflammation. Effective clearance mechanisms are necessary to prevent lung injury progression.
6	Zheng et al., 2021	Therapeutic enhancement of efferocytosis	Narrative Review	Experimental models of lung injury and repair	Enhanced efferocytosis promoted tissue healing and reduced inflammatory burden. Targeting efferocytosis may provide innovative therapeutic opportunities for respiratory diseases.
7	Zheng et al., 2021	Specialized Pro-Resolving Mediators (SPMs) in respiratory inflammation	Narrative Review	Experimental and translational studies on inflammatory resolution	SPMs facilitated inflammation resolution and tissue recovery. They represent a potential novel therapeutic strategy for inflammatory lung diseases.
8	Zheng et al., 2021	Efferocytosis dysfunction in COPD	Narrative Review	Studies involving COPD pathophysiology and chronic inflammation	Reduced efferocytosis contributed to persistent inflammation and disease progression in

					COPD. Restoration of efferocytosis may improve clinical outcomes.
	Zheng et al., 2021	Role of alveolar macrophages in lung inflammation	Narrative review	Studies involving alveolar macrophages and pulmonary immune responses	Alveolar macrophages are responsible for clearing apoptotic cells and maintaining pulmonary homeostasis. Their activity is crucial for inflammation resolution.
10	Zheng et al., 2021	Efferocytosis dysfunction in COPD	Narrative Review	Studies involving COPD pathophysiology and chronic inflammation	Reduced efferocytosis contributed to persistent inflammation and disease progression in COPD. Restoration of efferocytosis may improve clinical outcomes.

DISCUSSION

1. Impact of the COVID-19 Pandemic on Community Respiratory Infection Patterns

The study conducted by Zhang et al. (2024) provides strong empirical evidence regarding the indirect consequences of large-scale public health interventions on the ecology of respiratory pathogens. The implementation of lockdowns, mandatory mask use, and strict social distancing measures in China from 2020 to late 2022 not only suppressed SARS-CoV-2 transmission but also interrupted the natural circulation of endemic respiratory pathogens such as *Mycoplasma pneumoniae*, respiratory syncytial virus (RSV), and influenza. Consequently, reduced exposure to these pathogens created an immunological gap, giving rise to the phenomenon known as **immunity debt** among the pediatric population.

Following the lifting of restrictions, an accumulation of susceptible individuals lacking prior immunological memory resulted in an exponential surge of infections, accompanied by more severe clinical manifestations and atypical seasonal patterns. This thematic analysis highlights the need for global health authorities to prepare adaptive healthcare systems capable of responding to secondary waves of accumulated post-pandemic respiratory infections.

2. Clinical Rationale and Validation of Inflammatory Biomarkers in Critically Ill Patients

A common theme connecting the studies by Deniz et al. (2023) and Zhang et al. (2024) is the optimization of inexpensive and rapidly obtainable blood-based biomarkers for patient risk stratification. In patients with chronic obstructive pulmonary disease (COPD) admitted to intensive care units (ICUs), localized inflammation within the pulmonary parenchyma frequently progresses to systemic inflammatory responses, particularly when complicated by sepsis.

Deniz et al. demonstrated that the C-Reactive Protein-to-Albumin Ratio (CAR) and Neutrophil-to-Lymphocyte Ratio (NLR) possess high predictive accuracy for mortality. Biologically, elevated CRP levels or neutrophil counts reflect the intensity of the innate immune response to infection, whereas decreased albumin levels or lymphocyte counts indicate malnutrition, immunosuppression, and systemic capillary leakage. Similarly, Zhang et al. identified elevated lactate dehydrogenase (LDH) and D-dimer levels as significant predictors of progression from uncomplicated pneumonia to severe *Mycoplasma pneumoniae* pneumonia (SMPP). The integration of these inflammatory biomarkers into clinical triage algorithms offers a practical solution, particularly for secondary healthcare facilities with limited access to advanced imaging modalities and molecular diagnostic testing. (Kemenkeu RI 2026)

3. Antimicrobial Resistance Crisis: A Cross-Continental and Cross-Population Threat

Antimicrobial resistance (AMR) emerged as the most critical and alarming theme identified in this literature analysis, manifesting across different pathogen spectra and geographic regions. In Asia, Zhang et al. documented macrolide resistance rates of 80–88% among pediatric *Mycoplasma pneumoniae* isolates in Shanghai, largely attributable to point mutations in the 23S ribosomal RNA gene resulting from years of excessive macrolide prescribing, particularly azithromycin, within the community. Meanwhile, in the United States,

Anesi et al. reported the devastating impact of carbapenem-resistant Enterobacterales (CRE) infections among highly vulnerable solid-organ transplant recipients, with mortality rates approaching 50%. Notably, mediation analyses performed by Anesi et al. revealed that mortality was not solely attributable to delays in administering effective antimicrobial therapy but also to the intrinsic virulence and biological burden associated with resistant strains. Collectively, these studies conclusively demonstrate that AMR is no longer a future threat but a present clinical reality that independently eliminates first-line therapeutic options and substantially increases patient mortality risk. (DENİZ, ÖZÇELİK, and OZGUN 2023)

4 Restructuring the Paradigm of Non-Invasive Ventilation (NIV) Management

Non-invasive ventilation (NIV) was examined from two complementary perspectives by Deniz et al. (2023) in the context of acute ICU care and Andersen et al. (2024) in the context of long-term functional respiratory management. Deniz et al. reinforced the role of non-invasive mechanical ventilation (NIMV) as the gold-standard initial intervention for acute COPD exacerbations, effectively reducing the need for endotracheal intubation and consequently lowering mortality rates. However, Andersen et al. highlighted an often-overlooked daytime clinical challenge: functional laryngeal dyssynchrony. (Zhang et al. 2024)

Continuous positive airway pressure alters normal swallowing mechanics and may induce hazardous inspiratory efforts immediately after swallowing in approximately 40–50% of patients with neuromuscular disorders (NMDs). Over time, this mechanism contributes to silent microaspiration and recurrent pneumonia. The innovative solution proposed through the implementation of Mouthpiece Ventilation (MPV) underscores the necessity of redesigning ventilation circuits to better align with patients' daily physiological activities, thereby maintaining an optimal balance between adequate ventilatory support and quality-of-life preservation, including speech and oral intake. (Faraby and Saputro 2022)

5. Multidimensional Vulnerability Patterns in Clinical Subpopulations

Cross-study synthesis identified distinct vulnerability patterns influenced by both intrinsic host factors, such as age and comorbidities, and extrinsic factors, including previous medical interventions. In the pediatric population examined by Zhang et al., children under five years of age represented the new epicenter of vulnerability. Among elderly patients with COPD in the study by Deniz et al., the presence of a single comorbidity, particularly diabetes mellitus, significantly amplified mortality risk by impairing cellular immune function and reducing the body's ability to eliminate respiratory pathogens. In transplant recipients studied by Anesi et al., the type of transplanted organ, especially liver and lung grafts, as well as prior exposure to cephalosporins or carbapenems within the previous six months, were the strongest predictors of CRE colonization. This thematic analysis emphasizes that clinical management cannot rely on a one-size-fits-all approach; rather, early identification of high-risk subpopulations must precede therapeutic decision-making to minimize adverse clinical outcomes and treatment failure. (Kim et al. 2022)

Cross-Thematic Synthesis

The synthesis of the five themes reveals that respiratory diseases should no longer be viewed as isolated clinical conditions but rather as components of a dynamic and

interconnected healthcare ecosystem influenced by epidemiological, immunological, microbiological, technological, and patient-related factors. Across all studies, a common pattern emerges in which changes occurring at one level of the healthcare system subsequently influence outcomes at other levels.(Anesi et al. 2023)

First, the post-COVID-19 disruption of respiratory pathogen circulation has altered global epidemiological patterns, resulting in increased susceptibility among vulnerable populations. The phenomenon of immunity debt identified by Zhang et al. (2024) demonstrates how public health interventions, while effective in controlling viral transmission, inadvertently reshaped population immunity and contributed to the resurgence of respiratory infections. This epidemiological shift has consequently increased the burden on healthcare systems and intensified the need for effective risk stratification strategies.(Non-invasif 2026) Second, the growing reliance on inflammatory biomarkers such as CAR, NLR, LDH, and D-dimer reflects a broader movement toward precision-based respiratory care. Both pediatric pneumonia and critically ill COPD populations demonstrated the clinical value of early identification of disease severity through accessible laboratory parameters. These biomarkers serve as a critical bridge between epidemiological risk and individualized clinical management, enabling healthcare professionals to identify patients at risk of deterioration before severe complications occur.(Tiala 2023) Third, antimicrobial resistance emerged as a major challenge that intersects with all aspects of respiratory care.

The increasing prevalence of macrolide-resistant *Mycoplasma pneumoniae* and carbapenem-resistant *Enterobacterales* highlights how therapeutic effectiveness is progressively compromised worldwide. The studies collectively suggest that the consequences of AMR extend beyond treatment failure, contributing directly to increased morbidity, mortality, prolonged hospitalization, and healthcare costs. This finding underscores the urgent need for antimicrobial stewardship programs integrated across both community and hospital settings.Fourth, advances in non-invasive ventilation strategies illustrate the importance of balancing technological effectiveness with patient-centered care. While NIV remains essential for preventing invasive mechanical (Li Jing et al. 2021)ventilation and reducing mortality, Andersen et al. (2024) demonstrated that long-term respiratory support must also consider physiological functions such as swallowing, communication, and quality of life. This reflects a broader paradigm shift from survival-focused treatment toward comprehensive functional outcomes in respiratory medicine. Finally, the identification of high-risk clinical subpopulations—including young children, elderly patients with comorbidities, and immunocompromised transplant recipients—serves as a unifying theme across all studies. Regardless of the specific disease process, vulnerability consistently emerged as the strongest determinant of adverse outcomes. Therefore, effective respiratory care requires an integrated approach combining epidemiological surveillance, early biomarker-guided assessment, antimicrobial stewardship, optimized ventilatory support, and targeted interventions for high-risk populations.(Zheng, Taka, and Heit 2021) Overall, the evidence suggests that future respiratory healthcare systems must adopt a multidisciplinary and adaptive framework capable of responding simultaneously to emerging infectious threats, evolving resistance patterns, technological innovations, and the complex needs of vulnerable patient populations.

CONCLUSIONS

This literature review successfully synthesized the available evidence on respiratory diseases and critical care management, providing a comprehensive and multidimensional

understanding of the evolving challenges in respiratory healthcare during the post-pandemic era.(Sinaga2020)

From the epidemiological dimension: (1) the COVID-19 pandemic and subsequent public health interventions significantly altered the circulation patterns of respiratory pathogens, resulting in the phenomenon of immunity debt and an increased burden of respiratory infections among susceptible populations, particularly children (Zhang et al., 2024); (2) the resurgence of respiratory infections following the relaxation of pandemic restrictions demonstrated the dynamic interaction between population immunity and pathogen transmission; and (3) changing infection patterns highlighted the importance of adaptive surveillance systems capable of responding to emerging respiratory threats (Zhang et al., 2024).

From the clinical and diagnostic dimension: (1) inflammatory biomarkers such as the C-Reactive Protein-to-Albumin Ratio (CAR), Neutrophil-to-Lymphocyte Ratio (NLR), lactate dehydrogenase (LDH), and D-dimer demonstrated significant prognostic value for predicting disease severity and mortality in patients with respiratory illnesses (Deniz et al., 2023; Zhang et al., 2024); (2) these biomarkers provide cost-effective and accessible tools for early risk stratification, particularly in resource-limited healthcare settings; and (3) biomarker-guided assessment may facilitate timely clinical interventions and improve patient outcomes (Deniz et al., 2023).

From the antimicrobial stewardship dimension: (1) antimicrobial resistance has emerged as a critical global challenge affecting both community-acquired and healthcare-associated respiratory infections; (2) high rates of macrolide-resistant *Mycoplasma pneumoniae* among pediatric patients and carbapenem-resistant Enterobacterales (CRE) among transplant recipients significantly limit therapeutic options and increase mortality risk (Zhang et al., 2024; Anesi et al., 2024); and (3) the findings emphasize the urgent need for rational antibiotic use and strengthened antimicrobial stewardship programs across healthcare systems (Anesi et al., 2024).

From the respiratory support and critical care dimension: (1) non-invasive mechanical ventilation (NIMV) remains an effective first-line intervention for acute respiratory failure and COPD exacerbations, reducing the need for invasive ventilation and improving survival outcomes (Deniz et al., 2023); (2) long-term ventilation management should address not only respiratory function but also swallowing safety, communication ability, and overall quality of life; and (3) innovative approaches such as Mouthpiece Ventilation (MPV) offer promising alternatives for optimizing long-term respiratory support in patients with neuromuscular disorders (Andersen et al., 2024).

From the patient vulnerability dimension: (1) children under five years of age, elderly individuals with chronic comorbidities, and immunocompromised transplant recipients consistently demonstrated the highest risk of severe disease and adverse clinical outcomes (Zhang et al., 2024; Deniz et al., 2023; Anesi et al., 2024); (2) age, underlying diseases, and previous antibiotic exposure were identified as important determinants of disease progression and mortality; and (3) early identification and targeted management of high-risk populations remain essential components of effective respiratory healthcare.(Song et al. 2023)

Future research should prioritize longitudinal studies investigating the long-term effects of post-pandemic immunity debt on respiratory disease epidemiology and healthcare utilization. Further multicenter clinical studies are needed to validate the diagnostic and prognostic utility of inflammatory biomarkers across diverse respiratory conditions and healthcare settings. Additional research should also focus on developing innovative strategies to combat antimicrobial resistance, particularly among vulnerable patient populations and emerging resistant pathogens.(Li Jing et al. 2021) Moreover, randomized controlled trials evaluating

patient-centered ventilation strategies, including Mouthpiece Ventilation and other advanced non-invasive respiratory support modalities, are warranted to assess their long-term effectiveness, safety, and impact on quality of life. Future investigations should also explore integrated approaches that combine epidemiological surveillance, biomarker-guided assessment, antimicrobial stewardship, and personalized respiratory care to improve clinical outcomes and strengthen healthcare system preparedness for future respiratory health challenges.(Solehati et al. 2024)

APPRECIATE

The authors wish to express gratitude to all researchers and authors of the primary articles reviewed in this study, whose scientific contributions formed the foundation of this literature review.

REFERENCES

- Anesi, Judith A., Ebbing Lautenbach, Kerri A. Thom, Pranita D. Tamma, Emily A. Blumberg, Kevin Alby, Warren B. Bilker, et al. 2023. "Clinical Outcomes and Risk Factors for Carbapenem-Resistant Enterobacterales Bloodstream Infection in Solid Organ Transplant Recipients." *Transplantation* 107(1): 254–63. doi:10.1097/TP.0000000000004265.
- DENİZ, Mustafa, Zerrin ÖZÇELİK, and Pinar OZGUN. 2023. "Factors Affecting Mortality and Patient Outcome in Patients with COPD Followed in the Intensive Care Unit." *Konuralp Tıp Dergisi* 15(3): 395–402. doi:10.18521/ktd.1330530.
- Faraby, Lus Prastyan, and Sutiyo Dani Saputro. 2022. "Program Studi Keperawatan Program Diploma Tiga Fakultas Ilmu Kesehatan Universitas Kusuma Husada Surakarta 2022 Mahasiswa Prodi Keperawatan Program Diploma Tiga Fakultas Ilmu Kesehatan Universitas Kusuma Husada Surakarta 2)." *Universitas Kusuma Husada Surakarta 2).*
- Kemenkeu RI. 2026. "No Title." *Nucl. Phys.* 13(1): 104–16.
- Kim, Bo Guen, Minwoong Kang, Ji Hyun Lim, Jin Lee, Danbee Kang, Minjung Kim, Jinhee Kim, et al. 2022. "Comprehensive Risk Assessment for Hospital-Acquired Pneumonia: Sociodemographic, Clinical, and Hospital Environmental Factors Associated with the Incidence of Hospital-Acquired Pneumonia." *BMC Pulmonary Medicine* 22(1): 1–11. doi:10.1186/s12890-021-01816-9.
- Li Jing, Wang Meiqin, Peng Lingling, Zhang Hongiuan, He Huiling, and Zhao Yanhua. 2021. "Effect of Care Bundle 45 Degree Lateral." *American Journal Translational Research* 13(3): 1757–63.
- Non-invasif, D A N Ventilasi. 2026. "LITERATURE REVIEW: PENYAKIT RESPIRATORI ,." : 1–11.
- Sinaga, Siti Nurmawan. 2020. "Pengaruh Pengetahuan Tentang Tuberkulosis (Tb) Terhadap Tingkat Kecemasan Pada Pasien Tb Paru Di Rumah Sakit Tria Dipa Jakarta Tahun 2019." *eecellent widwifery journal*.
- Solehati, Tetti Indriani., Jamlaay., and Dinar Ruth. 2024. "Jurnal Keperawatan Jurnal Keperawatan." *Jurnal Keperawatan* 17(1): 153–64.
- Song, Zhe, Guangyuan Jia, Guangzhi Luo, Chengen Han, Baoqing Zhang, and Xiao Wang. 2023. "Global Research Trends of Mycoplasma Pneumoniae Pneumonia in Children: A Bibliometric Analysis." *Frontiers in Pediatrics* 11(November): 1–16. doi:10.3389/fped.2023.1306234.
- Tiala, aulia insani latif & nur hijrah. 2023. *Tuberculosis Tinjauan Medis, Asuhan Keperawatan E-Health*. ed. Amran Hapsan.

World Health Organization. 2025. *Global Tuberculosis Report 2025*.

Zhang, Xiao Bo, Wen He, Yong Hao Gui, Quan Lu, Yong Yin, Jian Hua Zhang, Xiao Yan Dong, et al. 2024. "Current Mycoplasma Pneumoniae Epidemic among Children in Shanghai: Unusual Pneumonia Caused by Usual Pathogen." *World Journal of Pediatrics* 20(1): 5–10. doi:10.1007/s12519-023-00793-9.

Zheng, David Jiao, Maria Abou Taka, and Bryan Heit. 2021. "Role of Apoptotic Cell Clearance in Pneumonia and Inflammatory Lung Disease." *Pathogens* 10(2): 1–32. doi:10.3390/pathogens10020134.

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