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Approach to community-acquired pneumonia in high-risk patient groups in the emergency department

Maşide Arı

Department of Pulmonology, Ankara Atatürk Sanatorium Training and Research Hospital, University of Health Sciences, Ankara, Turkiye

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Corresponding Author: Maşide Arı, masidetuten@icloud.com

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ABSTRACT

Pneumonia remains one of the leading causes of morbidity and mortality worldwide, with a particularly severe clinical course observed in high-risk patient groups. Elderly individuals, immunocompromised patients, and pregnant women are especially vulnerable to adverse outcomes because of increased susceptibility to infection, atypical clinical presentations, diagnostic challenges, and a greater risk of complications. In these populations, delayed recognition and treatment may substantially worsen prognosis. Current evidence also highlights the importance of individualized diagnostic evaluation, timely microbiological assessment, and appropriate antimicrobial therapy tailored to patient-specific risk factors. Given that emergency physicians are frequently responsible for the initial assessment and stabilization of these patients, early recognition, accurate risk stratification, and timely disposition decisions are essential to optimize clinical outcomes. This narrative review summarizes current evidence regarding the clinical characteristics, diagnostic evaluation, and management of pneumonia in high-risk patient populations, with particular emphasis on emergency department assessment, risk stratification, early therapeutic decision-making, and disposition planning.

Keywords: Geriatrics, pregnancy, immunosuppression, point-of-care ultrasound, pneumonia, opportunistic infections

INTRODUCTION

Pneumonia represents a significant cause of morbidity and mortality worldwide.[1] The disease tends to be more severe and is associated with worse clinical outcomes in high-risk groups, such as the elderly, immunocompromised individuals, and pregnant women.[2] In these populations, alterations in immune response, coexisting comorbidities, and atypical clinical presentations may lead to delayed diagnosis and complicate the management process. Therefore, early recognition of pneumonia and timely initiation of appropriate treatment are of critical importance in improving prognosis. Moreover, in these patient groups where standard diagnostic and therapeutic approaches may not always prove sufficient, an individualized and multidisciplinary management strategy should be adopted. This review discusses the clinical characteristics, diagnostic approaches, and current treatment principles of pneumonia in high-risk patient groups, with an emphasis on emergency department management considerations.

PNEUMONIA IN OLDER ADULTS

In older adults, immunosenescence, multiple comorbidities, malnutrition, and a decline in functional capacity significantly increase the risk of developing pneumonia.[3-5] Additionally, conditions such as dementia, cerebrovascular diseases, and dysphagia predispose this population to aspiration pneumonia.[6] It is clinically important to distinguish between aspiration pneumonia and standard community-acquired pneumonia in elderly patients, as their pathophysiology, microbiology, and empiric antibiotic strategies differ substantially. Aspiration pneumonia typically involves the aspiration of oropharyngeal secretions or gastric contents in patients with impaired protective airway reflexes, and most commonly affects dependent lung segments (right lower lobe, posterior segments). While anaerobic organisms historically were considered predominant, contemporary evidence suggests that aerobic gram-negative bacteria and polymicrobial infections are more common in institutionalized and hospitalized elderly patients. Routine anaerobic coverage is not universally recommended in the emergency department for aspiration events unless there is clinical evidence of lung abscess, empyema, or a prolonged aspiration episode with putrid sputum; in such cases, adding anaerobic coverage (e.g., with amoxicillin-clavulanate, piperacillin-tazobactam, or clindamycin in combination with a beta-lactam) should be considered in accordance with current ATS/IDSA guidance.[7] In elderly patients, infection often presents not with classic symptoms such as fever, cough, and sputum production, but rather with nonspecific manifestations including confusion, falls, loss of appetite, or functional decline.[8] Therefore, maintaining a high index of clinical suspicion is essential for timely diagnosis.

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Streptococcus pneumoniae (S. pneumoniae) remains the most common causative pathogen of community-acquired pneumonia in older adults. However, *Haemophilus influenzae (H. influenzae)*, *Moraxella catarrhalis*, gram-negative bacteria, and respiratory viruses also represent important etiological agents in this population.[9,10] The need for empiric antimicrobial therapy targeting resistant pathogens should be determined based on individual risk factors—such as prior isolation of methicillin-resistant *Staphylococcus aureus* (MRSA) or *Pseudomonas aeruginosa (P. aeruginosa)*, recent hospitalization, and recent intravenous antibiotic exposure—rather than residence in a long-term care facility alone.

A detailed medical history, thorough physical examination, and appropriate imaging studies constitute the cornerstone of the diagnostic approach. Although chest radiography remains the first-line imaging modality, lung ultrasonography may be used for diagnostic purposes in centers with adequate expertise and can serve as an alternative to chest radiography in selected patients. In the emergency department setting, a systematic review and meta-analysis of 17 prospective studies including 5,108 patients demonstrated that point-of-care lung ultrasound (LUS) achieved a pooled diagnostic sensitivity of 92% and specificity of 93% for community-acquired pneumonia, substantially outperforming standard chest radiography while avoiding ionizing radiation and enabling rapid bedside assessment.[11] LUS findings such as consolidation with dynamic air bronchograms, focal B-line patterns, and associated pleural effusion can support or refute the diagnosis of pneumonia at the bedside, facilitating faster clinical decision-making in the emergency department.[12] In cases where the diagnosis remains uncertain, chest computed tomography (CT) may provide additional diagnostic value.[13] Laboratory evaluation should include a complete blood count, biochemical tests, inflammatory markers, and microbiological investigations when clinically indicated. Procalcitonin levels should not be used as the sole criterion for initiating or discontinuing antibiotic therapy; rather, they should be interpreted as an adjunctive biomarker within the context of the overall clinical assessment.[14] In patients with suspected aspiration pneumonia, evaluation of swallowing function, assessment of protective airway reflexes, and, when indicated, advanced diagnostic studies such as videofluoroscopic swallowing examination are recommended.[15]

Treatment should be tailored according to disease severity and individual patient risk factors. For mild to moderate community-acquired pneumonia, beta-lactam–based regimens or, in appropriately selected patients, respiratory fluoroquinolones may be considered.[16] In severe cases, risk factors for MRSA and *P. aeruginosa* should be carefully assessed, and appropriate broad-spectrum antimicrobial therapy should be initiated when indicated.[17] In patients who achieve clinical stability, a treatment duration of approximately 3–5 days is generally considered sufficient.[18] In older adults, special consideration should be given to renal function, potential drug–drug interactions, and treatment-related adverse effects when selecting and monitoring antimicrobial therapy.[19]

From an emergency department perspective, the evaluation of older adults presenting with suspected community-acquired pneumonia requires a comprehensive approach because atypical clinical presentations, frailty, and multiple comorbidities frequently complicate early recognition and may mask disease severity. Initial assessment should extend beyond the identification of classic infectious symptoms and include careful evaluation of mental status, baseline functional capacity, respiratory rate, oxygen saturation, hemodynamic stability, and the presence of sepsis or acute organ dysfunction. Diagnostic investigations should be guided by the initial clinical assessment. While chest radiography remains the first-line imaging modality, point-of-care LUS may facilitate rapid bedside diagnosis, and chest CT should be reserved for patients with persistent clinical suspicion despite inconclusive initial imaging or when alternative diagnoses are being considered. Appropriate laboratory investigations and microbiological specimens should be obtained whenever feasible before the initiation of antimicrobial therapy, particularly in patients with severe disease or risk factors for multidrug-resistant pathogens. Although validated severity assessment tools such as CURB-65 and the Pneumonia Severity Index provide valuable support for risk stratification, they may underestimate disease severity in older adults because they do not adequately capture frailty, functional impairment, or atypical presentations; therefore, they should always be interpreted in conjunction with clinical judgment. Continuous reassessment during the emergency department stay is essential, as clinical deterioration may occur despite initially subtle findings. Prompt initiation of appropriate empiric antimicrobial therapy, timely correction of hypoxemia with supplemental oxygen, and close monitoring for respiratory and hemodynamic deterioration constitute the cornerstones of emergency department management. Decisions regarding hospital admission should integrate not only severity scores but also frailty, comorbidities, cognitive impairment, functional decline, the ability to maintain adequate oral intake and medication adherence, caregiver support, and the availability of appropriate outpatient follow-up.

Vaccination against pneumococcal disease, influenza, and COVID-19 plays a pivotal role in the prevention of pneumonia among older adults.[20-22] To reduce the risk of aspiration, assessment of swallowing function, implementation of appropriate nutritional strategies, and maintenance of good oral hygiene are recommended.[23] Given that older individuals recovering from pneumonia may experience functional decline, cognitive deterioration, and reduced quality of life, post-treatment rehabilitation and supportive care should also be considered integral components of comprehensive patient management.[24]

COMMUNITY-ACQUIRED PNEUMONIA IN IMMUNOCOMPROMISED PATIENTS

Conditions associated with impaired immune function include solid organ transplantation, hematologic malignancies, the use of immunosuppressive therapies, and primary or secondary immunodeficiency disorders. In these individuals, pneumonia occurs more frequently, follows a more severe clinical course, and presents unique diagnostic and therapeutic challenges due to the involvement of opportunistic pathogens.[25,26] The risk of pneumonia and the spectrum of potential causative organisms vary considerably according to the type and severity of immunosuppression.[27]

In immunocompromised patients, pneumonia may frequently present with atypical clinical manifestations. Classic symptoms such as fever, cough, and sputum production may be subtle or even absent.[28] Therefore, maintaining a high index of suspicion and initiating diagnostic evaluation promptly are essential. Although chest radiography remains the first-line imaging modality, chest CT substantially improves diagnostic sensitivity, particularly in the early stages of disease or when chest radiographic findings are inconclusive.[29] Analysis of bronchoalveolar lavage specimens using culture-based, antigen-detection, and polymerase chain reaction-based methods plays a critical role in pathogen identification.[30,31] While *S. pneumoniae*, *H. influenzae*, and atypical bacteria remain common causative pathogens in this population, opportunistic infections must also be considered in the presence of immunosuppression. Important pathogens include *Pneumocystis jirovecii (P. jirovecii)*, *Aspergillus spp.*, cytomegalovirus, other herpesviruses, *Mycobacterium tuberculosis*, and nontuberculous mycobacteria.[32-36] The spectrum of causative agents varies depending on the type and duration of the patient's underlying immunodeficiency, and the immunosuppressive treatments used.[27]

Because delays in treatment may lead to serious adverse outcomes, empiric antimicrobial therapy should be initiated without delay. When selecting an appropriate treatment regimen, clinicians should consider the patient's immune status, likely pathogens, local antimicrobial resistance patterns, and previous microbiological findings.[29] The need for expanded antimicrobial coverage targeting resistant pathogens such as MRSA and *P. aeruginosa* should be evaluated only in patients with relevant individual risk factors.[37] Whenever feasible, appropriate clinical specimens should be obtained before the initiation of antimicrobial therapy, and molecular diagnostic techniques should be utilized to facilitate pathogen identification and enable timely transition to targeted therapy.[38]

Vaccination is one of the basic approaches to protection. Pneumococcal and influenza vaccines are recommended, and COVID-19 and RSV vaccines should also be considered as part of protective strategies in appropriate patient groups.[39] However, in some immunodeficiency conditions, additional protective measures may be necessary as the vaccine response may be insufficient. In patients at high risk for *P. jirovecii*, trimethoprim-sulfamethoxazole prophylaxis is the standard protective approach.[40]

From an emergency department perspective, immunocompromised patients presenting with suspected community-acquired pneumonia require an expedited and systematic evaluation because rapid clinical deterioration and opportunistic infections are common. Initial assessment should include careful evaluation of respiratory status, hemodynamic stability, the severity and type of the underlying immunodeficiency, recent immunosuppressive therapies, and previous microbiological findings, as these factors directly influence both the differential diagnosis and the initial management strategy. Diagnostic investigations should be individualized according to the patient's immune status. While chest radiography is generally obtained as the initial imaging modality, early chest CT should be considered in patients with persistent clinical suspicion despite inconclusive initial imaging or in those at high risk for opportunistic pulmonary infections. Appropriate microbiological specimens, including blood cultures and respiratory samples when indicated, should be obtained as early as possible without delaying treatment. Continuous clinical reassessment throughout the emergency department stay is essential to detect early respiratory or hemodynamic deterioration requiring escalation of care. Empiric antimicrobial therapy should be initiated promptly after appropriate specimens have been collected whenever feasible. Because validated severity scores have limited applicability in immunocompromised populations, decisions regarding hospital admission and intensive care unit referral should rely primarily on clinical judgment, the degree of immunosuppression, and the patient's overall clinical stability. Early consultation with infectious diseases specialists, together with hematology, oncology, or transplant teams when appropriate, may facilitate timely diagnostic evaluation and optimization of subsequent targeted antimicrobial therapy.

BACTERIAL PNEUMONIA IN INDIVIDUALS LIVING WITH HUMAN IMMUNODEFICIENCY VIRUS (HIV) INFECTION

The widespread use of antiretroviral therapy has led to a substantial reduction in the incidence of opportunistic infections and bacterial pneumonia among people living with Human Immunodeficiency Virus (HIV). Nevertheless, bacterial pneumonia remains an important cause of morbidity and mortality, particularly in individuals with advanced immunosuppression.[41] Effective ART, sustained viral suppression, and recovery of $CD4^+$ T-lymphocyte counts are among the most important factors associated with a reduced risk of pneumonia.[42] Therefore, maintaining clinical vigilance for infectious complications and implementing appropriate preventive strategies remain essential components of care for individuals living with HIV. Although ART significantly decreases the incidence of bacterial pneumonia, the risk persists, particularly among patients with low $CD4^+$ T-cell counts.[43] A $CD4^+$ T-cell count below 200 cells/μL markedly increases the risk of pneumonia, whereas counts below 50 cells/μL are associated with a higher frequency of infections caused by opportunistic and drug-resistant pathogens.[44] In addition, cigarette smoking, intravenous substance use, chronic lung diseases such as chronic obstructive pulmonary disease and bronchiectasis, malnutrition, neutropenia, and corticosteroid therapy are important risk factors that facilitate the development of infection.[45-47]

In individuals living with HIV, the etiological spectrum of bacterial pneumonia largely resembles that observed in the general population. *S. pneumoniae* remains the most frequently isolated pathogen, followed by *H. influenzae*.[48] However, in the setting of advanced immunosuppression, *P. aeruginosa* and other gram-negative bacteria are encountered more frequently. Recent studies have demonstrated that among patients receiving effective ART and achieving adequate immunological control, the distribution of causative pathogens increasingly resembles that of the general population. Nevertheless, invasive pneumococcal disease continues to represent a significant source of morbidity and mortality in people living with HIV.[49,50] Clinically,

bacterial pneumonia most commonly presents with classic symptoms such as fever, cough, sputum production, and dyspnea. However, clinical manifestations may be attenuated in patients with advanced immunosuppression, potentially leading to delays in diagnosis. Imaging findings most frequently include lobar or segmental consolidation, although multifocal infiltrates and diffuse pulmonary opacities may also be observed. Chest CT provides valuable additional information for characterizing pulmonary infiltrates and establishing the differential diagnosis.[51]

When pulmonary infiltrates are identified in individuals living with HIV, the differential diagnosis should remain broad. *P. jirovecii* pneumonia, tuberculosis, fungal infections, and viral pneumonias represent important alternative diagnoses that should be carefully considered. An acute onset of symptoms, the presence of purulent sputum, and the identification of focal or lobar consolidation on imaging are generally regarded as findings that support a bacterial etiology. During the diagnostic evaluation, the patient's $CD4^+$ T-cell count, HIV viral load, and ART status should be systematically assessed, as these factors have important implications for both the differential diagnosis and subsequent management.

From an emergency department perspective, the initial management of individuals living with HIV and suspected bacterial pneumonia should be guided not only by the severity of the acute illness but also by the patient's level of immune dysfunction. Because opportunistic pulmonary infections may mimic bacterial pneumonia, emergency physicians should maintain a broad differential diagnosis, particularly in patients with advanced HIV disease or uncertain antiretroviral treatment status. Empiric antimicrobial therapy should not be delayed while the diagnostic evaluation is ongoing, and early consultation with infectious diseases specialists should be considered in patients with severe disease or suspected opportunistic infections. Decisions regarding hospital admission should take into account the patient's overall clinical status, immune function, ability to ensure close outpatient follow-up, and the risk of rapid clinical deterioration.

COMMUNITY-ACQUIRED PNEUMONIA DURING PREGNANCY

Pneumonia during pregnancy is an important clinical condition associated with significant maternal and fetal morbidity and mortality. Pregnancy-specific physiological changes—including elevation of the diaphragm, reduction in functional residual capacity, increased oxygen demand, and modulation of the immune system—reduce tolerance to hypoxemia and may contribute to a more severe course of respiratory infections. Viral pneumonias, particularly those caused by influenza, varicella, and SARS-CoV-2, are known to present with greater severity during pregnancy. Furthermore, the effects of maternal infection and hypoxemia on the fetoplacental circulation may increase the risk of adverse obstetric outcomes, including preterm delivery and low birth weight.[52]

Pneumonia typically presents with classic respiratory symptoms, including fever, cough, dyspnea, and pleuritic chest pain. However, physiological changes of pregnancy, such as tachycardia and mild dyspnea, may overlap with manifestations of infection and complicate the diagnostic process. Therefore, findings such as tachypnea (>20 breaths/min) and oxygen saturation levels below 95% should be regarded as important warning signs suggestive of pneumonia. Imaging studies play a pivotal role in the diagnostic evaluation. Chest radiography is considered a safe first-line imaging modality during pregnancy, as fetal radiation exposure remains extremely low (<0.01 mGy) when appropriate abdominal shielding is used.[53] Lung ultrasonography is being increasingly utilized in pregnant patients because it does not involve ionizing radiation, can be performed at the bedside, and is highly effective in detecting peripheral consolidations and pleural effusions. In centers with appropriate expertise, it can provide substantial diagnostic value as part of the evaluation of suspected pneumonia.[54]

In the treatment of community-acquired pneumonia during pregnancy, antibiotic selection should be guided by disease severity, the presence of comorbidities, local resistance patterns, and the fetal safety profile of the antimicrobial agents. Current guidelines emphasize that antibiotic therapy should not be delayed in pregnant patients and that maintenance of adequate maternal oxygenation is a primary therapeutic objective. For mild disease managed in the outpatient setting, a combination of amoxicillin or amoxicillin–clavulanate with azithromycin has been recommended;[55] however, it must be emphasized that macrolide monotherapy is no longer recommended as a first-line strategy in settings where macrolide resistance among *S. pneumoniae* exceeds 25%, in accordance with the 2019 ATS/IDSA guidelines.[7] Azithromycin should therefore be used as a combination partner rather than monotherapy in pregnant patients with CAP, and local resistance patterns should guide empiric choices. In patients with penicillin allergy, third-generation oral cephalosporins may be used with caution; however, clinicians should note that cefpodoxime and cefditoren have limited safety data in pregnancy and should be used only when no safer alternatives exist, with close attention to local resistance profiles. In more severe penicillin allergy, a combination of clindamycin and azithromycin may be chosen. Respiratory fluoroquinolones—while effective against resistant pathogens—should generally be avoided during pregnancy due to concerns regarding fetal cartilage toxicity, as highlighted in ACOG guidance on maternal respiratory infections.[56] Tetracyclines (especially doxycycline) and clarithromycin should similarly be avoided. In cases requiring inpatient treatment, intravenous ceftriaxone or cefotaxime in combination with azithromycin is recommended.[57]

In pregnant patients with pneumonia, the decision to hospitalize should be based on a comprehensive assessment of both infection severity and maternal–fetal risks. Although pregnant individuals who can maintain adequate oral intake, have no significant comorbidities, and can be closely monitored may be managed in the outpatient setting, hospitalization should be considered in the presence of hypoxemia, rapid clinical deterioration, inability to tolerate oral intake, significant comorbid conditions, or the need for assessment of fetal well-being. Because maternal hypoxemia can directly affect fetal oxygenation, the hospitalization

threshold for pregnant women should be kept lower than in the general population.[52]

Emergency physicians play a central role in the initial evaluation and stabilization of pregnant patients with pneumonia. In the emergency department, rapid assessment of oxygen saturation, respiratory rate, and fetal heart rate should be prioritized upon presentation. Because standard severity scoring tools such as CURB-65 are not validated in pregnancy and may underestimate severity, clinical parameters—including SpO_2 below 95%, respiratory rate above 30 breaths/min, and systolic blood pressure below 90 mmHg—should guide immediate triage and disposition decisions. Early obstetric consultation should be obtained in the emergency department for all pregnant patients with pneumonia requiring hospitalization. Point-of-care LUS can be performed rapidly at the bedside to assess consolidation and pleural effusion without radiation exposure, complementing the initial diagnostic evaluation. In patients with moderate-to-severe disease, empiric antibiotic therapy should be initiated within one hour, while the obstetric team should be engaged early to coordinate fetal assessment and subsequent inpatient management.

During hospitalization, supplemental oxygen therapy should be continued until clinical stability is achieved, with maternal oxygen saturation maintained above 95% and arterial oxygen tension (PaO_2) above 70 mmHg. Antibiotic treatment and supportive therapies should be started without delay, and fetal assessment should be planned according to gestational age and clinical condition. Patients with severe clinical conditions, those requiring mechanical ventilation, or those needing advanced supportive treatment should be monitored in the intensive care unit.[55] In centers with dedicated obstetric intensive care facilities, close collaboration between obstetric and intensive care teams should be ensured, and a multidisciplinary approach should be adopted.[58] Such an approach contributes to the prevention of maternal and fetal complications and may improve overall perinatal outcomes.

Seasonal influenza and COVID-19 vaccination play a central role in the prevention of pneumonia during pregnancy.[59] Vaccination has been shown to reduce the risk of severe infection, pneumonia, hospitalization, and intensive care unit admission among pregnant individuals. Consequently, current clinical guidelines consider vaccination one of the fundamental preventive strategies recommended throughout pregnancy.

CONCLUSION

Pneumonia in older adults, immunocompromised individuals, and pregnant patients continues to pose substantial diagnostic and therapeutic challenges because of atypical clinical presentations, altered host responses, and heterogeneous etiological pathogens. Improving outcomes in these vulnerable populations requires an individualized approach that extends beyond appropriate antimicrobial therapy to include timely recognition, comprehensive diagnostic evaluation, accurate risk stratification, multidisciplinary collaboration, and well-informed disposition planning. As emergency physicians are frequently responsible for the initial evaluation and stabilization of these patients, incorporating evidence-based emergency department management principles into routine clinical practice has the potential to facilitate earlier diagnosis, optimize therapeutic decision-making, and improve both short- and long-term clinical outcomes. Although considerable advances have been achieved in diagnostic imaging, molecular microbiological techniques, and antimicrobial therapies, important knowledge gaps remain regarding emergency department–specific risk stratification, standardized diagnostic pathways, and individualized management strategies for high-risk patient populations. Future prospective studies evaluating emergency department workflows, the integration of point-of-care diagnostic modalities, and tailored treatment algorithms are warranted to strengthen the evidence base and support the development of updated clinical guidelines for these vulnerable patient groups.

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