Chapter 85
Approach to Pneumonia in the ICU

85.1 Introduction

Pneumonia remains a leading cause of morbidity and mortality among critically ill patients in the ICU. Early detection and appropriate therapeutic interventions are essential to optimize patient outcomes. Employing structured diagnostic criteria—such as those recommended by the Centers for Disease Control and Prevention (CDC) for ventilator-associated pneumonia (VAP) and other ICU-related pulmonary infections—helps clinicians differentiate VAP from other respiratory conditions and ensures consistency in clinical assessment and management strategies [1–3] [Ref: Algorithm 85.1].

The approach to pneumonia in the ICU involves:

- Differentiating infectious from noninfectious causes of respiratory symptoms.
- Categorizing the pneumonia type (community-acquired vs. nosocomial).
- Tailoring management based on clinical context and multidrug-resistant (MDR) pathogens risk.
- Implementing prevention strategies to reduce incidence.

85.2 Initial Assessment: Suspicion of Pneumonia

Patients presenting with fever, cough, dyspnea, purulent respiratory secretions, or a new infiltrate on chest imaging should prompt suspicion of pneumonia. However, these symptoms are nonspecific and may overlap with noninfectious conditions. Utilizing standardized surveillance criteria aids in accurate diagnosis. Early identification of the cause is crucial to avoid unnecessary antibiotics and promptly initiate appropriate therapy [4–6].

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85.3 Rule Out Non-Infectious Causes

- Noninfectious conditions like atelectasis, acute respiratory distress syndrome (ARDS), pulmonary embolism, or pulmonary edema can mimic pneumonia. Identifying these is critical as their treatment differs significantly.
- Approach: Use clinical judgment alongside diagnostic tools such as chest imaging, D-dimer tests, echocardiography, and biomarkers like procalcitonin to differentiate infectious and noninfectious causes. Advanced imaging techniques like lung ultrasound provide rapid bedside evaluation. A negative infectious workup should lead to reconsidering these diagnoses.

85.4 Timing of Symptoms

Community-Acquired pneumonia (CAP) vs. Nosocomial/Healthcare-Associated Pneumonia (HCAP)

- <48 h After Admission: Pneumonia developing within 48 h is classified as community-acquired pneumonia (CAP), typically caused by pathogens acquired outside the healthcare setting [7, 8].
- >48 h After Admission: Pneumonia occurring after 48 h is considered nosocomial. This includes hospital-acquired pneumonia (HAP) and ventilator-associated pneumonia (VAP), which are more likely to involve MDR pathogens.

85.5 Diagnostic Workup

For all suspected pneumonia cases in the ICU, a thorough diagnostic evaluation is necessary:

Gram stain and culture of respiratory secretions, along with blood cultures, should be obtained before starting antibiotics in select high-risk cases. These include patients with severe CAP, those receiving empirical therapy for *Pseudomonas aeruginosa* or Methicillin-Resistant Staphylococcus Aureus (MRSA) individuals with prior infections due to these organisms, and patients who have received parenteral antibiotics within the past 90 days [9].

Severe community-acquired pneumonia is identified by clinical indicators reflecting significant physiological compromise. A diagnosis is made when one high-risk feature or three or more moderate-risk features are observed.

High-Risk Features (Major Criteria):

- Presence of septic shock that mandates vasopressor administration.
- Acute respiratory failure requiring initiation of mechanical ventilation.

Moderate-Risk Features (Minor Criteria):

- Rapid breathing with respiratory rate > 30/min.
- Oxygenation impairment with a PaO_2/FiO_2 ratio below 250.
- Imaging showing infiltrates across multiple lobes.
- Changes in mental status, such as confusion or disorientation.
- Elevated urea levels (BUN >20 mg/dL), indicating renal involvement.
- Low white cell count (<4000 cells/mm^3), suggesting immune suppression.
- Reduced platelet count (<100,000/mm^3), reflecting hematologic dysfunction.
- Core body temperature below 36.8 °C, indicating hypothermia.
- Low blood pressure necessitating fluid resuscitation.

This scoring framework assists in identifying patients who may require intensive care admission and aggressive intervention.

- Blood Cultures: Essential to identify bacteremia or sepsis. Obtain two sets.
- Sputum Culture: For non-intubated patients to identify the causative organism.
- Endotracheal Aspirates: For intubated patients, noninvasive methods like endotracheal aspirates (colony forming unit 10^5 is considered significant) are recommended over invasive procedures like bronchoalveolar lavage (BAL—10^4 colony-forming unit is significant) unless clinically justified. This aligns with recent recommendations favoring less invasive diagnostics for suspected HAP/VAP. Protected specimen brush is another method for obtaining culture (10^3 colony-forming unit is significant).
- Chest Imaging: Chest X-rays are first-line; CT scans may assess complications like empyema, abscesses, or ARDS.
- Advanced Imaging: Lung ultrasound is valuable for rapid bedside differentiation between infectious and noninfectious causes.
- Biomarkers: Procalcitonin aids in distinguishing bacterial infections from other inflammatory causes.
- Urinary Antigen Tests: Useful for detecting *Legionella* and *Pneumococcus* in severe CAP.
- Viral PCR: Consider if a viral etiology (e.g., influenza, SARS-CoV-2) is suspected based on clinical or epidemiological factors.

A sterile culture of respiratory secretions in the absence of a new antibiotic in the past 72 h generally rules out bacterial pneumonia, but viral or *Legionella* infection can be possible.

HCAP: is suspected if the patient has a radiographic infiltrate that is new or progressive, along with new onset of fever, purulent sputum, leukocytosis, and decline in oxygenation. The findings without chest infiltrates on radiography should be considered as tracheobronchitis.

85.6 Risk Assessment for Multidrug-Resistant (MDR) Pathogens

- Risk Factors: Prior antibiotic use (usually in the last 90 days), prolonged hospitalization (5 days or more), recent healthcare exposure (hospitalization for 2 days or more in the preceding 90 days), immunosuppression, severe comorbidities, or local epidemiology indicating a high prevalence of MDR organisms, chronic dialysis within 30 days.

85.7 Management

Community-Acquired Pneumonia

Severe CAP Without MRSA or *Pseudomonas* Risk.

For patients with severe CAP who do not have risk factors for MRSA or *Pseudomonas aeruginosa*, empiric therapy should consist of a β-lactam in combination with a macrolide. Suitable β-lactams include:

- Ampicillin-sulbactam (1.5–3 g IV every 6 h).
- Cefotaxime (1–2 g IV every 8 h).
- Ceftriaxone (1–2 g IV once daily).

Macrolide options include:

- Azithromycin (500 mg once daily).
- Clarithromycin (500 mg twice daily).

If macrolides are contraindicated, levofloxacin (750 mg daily) or moxifloxacin (400 mg daily) may be considered as alternatives. However, to preserve fluoroquinolones for use in drug-resistant tuberculosis, they are typically avoided in our setting. In such cases, doxycycline (100 mg twice daily) is a suitable option.

Empirical MRSA Coverage.

When MRSA is suspected, initiate one of the following:

- Vancomycin: 15 mg/kg IV every 12 h, with dosing adjusted by therapeutic drug monitoring.
- Linezolid: 600 mg IV or oral every 12 h.

Empirical *Pseudomonas* Coverage.

In patients at risk for *Pseudomonas aeruginosa*, select one of these agents:

- Piperacillin-tazobactam: 4.5 g every 6 h.
- Cefepime: 2 g every 8 h.
- Ceftazidime: 2 g every 8 h.
- Aztreonam: 2 g every 8 h.
- Meropenem: 1 g every 8 h.
- Imipenem: 500 mg every 6 h.

De-escalation to pathogen-directed therapy is recommended as soon as microbiological results become available to reduce unnecessary broad-spectrum exposure.

Additional Considerations

- Corticosteroids are reserved for patients with ongoing septic shock and are not part of routine management.
- Oseltamivir may be added if influenza is suspected based on clinical signs or seasonal trends.
- Antibiotic therapy duration should be guided by clinical recovery and should not be less than 5 days.

Healthcare-Associated Pneumonia

In HCAP, the likelihood of multidrug-resistant pathogens is higher, particularly in those with healthcare exposure or other risk factors. Initial treatment should offer broad-spectrum coverage tailored to the local antibiogram and commonly includes agents effective against:

- *Pseudomonas aeruginosa.*
- *Klebsiella pneumoniae.*
- *Acinetobacter* species.
- Methicillin-resistant *Staphylococcus aureus* (MRSA).

Appropriate empirical agents may involve:

- Carbapenems.
- Polymyxins.
- Ceftazidime-avibactam.
- Vancomycin.
- Additional agents as guided by culture results and institutional resistance data.

85.7.1 Day 3 Reassessment of Antibiotics

- Evaluate Clinical Improvement: Reduction in leukocyte count, temperature normalization, and improved oxygenation indicate a positive response.
- De-escalation: Tailor antibiotics based on culture results.
- If No Improvement:
- Escalate Antibiotics: Consider broader-spectrum agents if the patient deteriorates.
- Reassess Diagnosis: Investigate complications like empyema, abscess, or alternative diagnoses.
- Additional Diagnostics: Repeat cultures, imaging, or consider bronchoscopy to identify resistant or atypical pathogens.

Duration 5–7 days

85.7.2 Continuation of Therapy

If the patient shows improvement with a reduction in leukocyte count by $\geq 2 \times 10^9$/L and clinical stabilization, continue the current antibiotic regimen for the recommended duration.

85.7.3 Escalation of Care

Patients failing to improve despite appropriate antibiotics require thorough reassessment:

- Repeat Cultures and Imaging: Identify persistent or new pathogens.
- Evaluate Alternative Diagnoses: Consider fungal or viral infections, or noninfectious causes like malignancy.

85.7.4 Special Populations

- Immunocompromised Patients: May present atypically and are at higher risk for opportunistic infections. Empirical therapy should cover a broader range of pathogens, including fungi and viruses.
- Patients with Severe Comorbidities: Conditions like chronic lung disease or renal failure may require adjusted dosing or alternative therapies.

85.7.5 Outcomes and Metrics

Track outcomes to evaluate the effectiveness of implemented strategies:

- Mortality Rates: Monitor pneumonia-associated mortality in the ICU.
- Duration of Ventilation: Assess the length of mechanical ventilation required.
- ICU Length of Stay: Evaluate pneumonia's impact on ICU resources.
- Incidence of VAP/HAP: Regular surveillance aids in quality improvement.
- Antibiotic Usage Patterns: Monitoring supports antibiotic stewardship efforts.

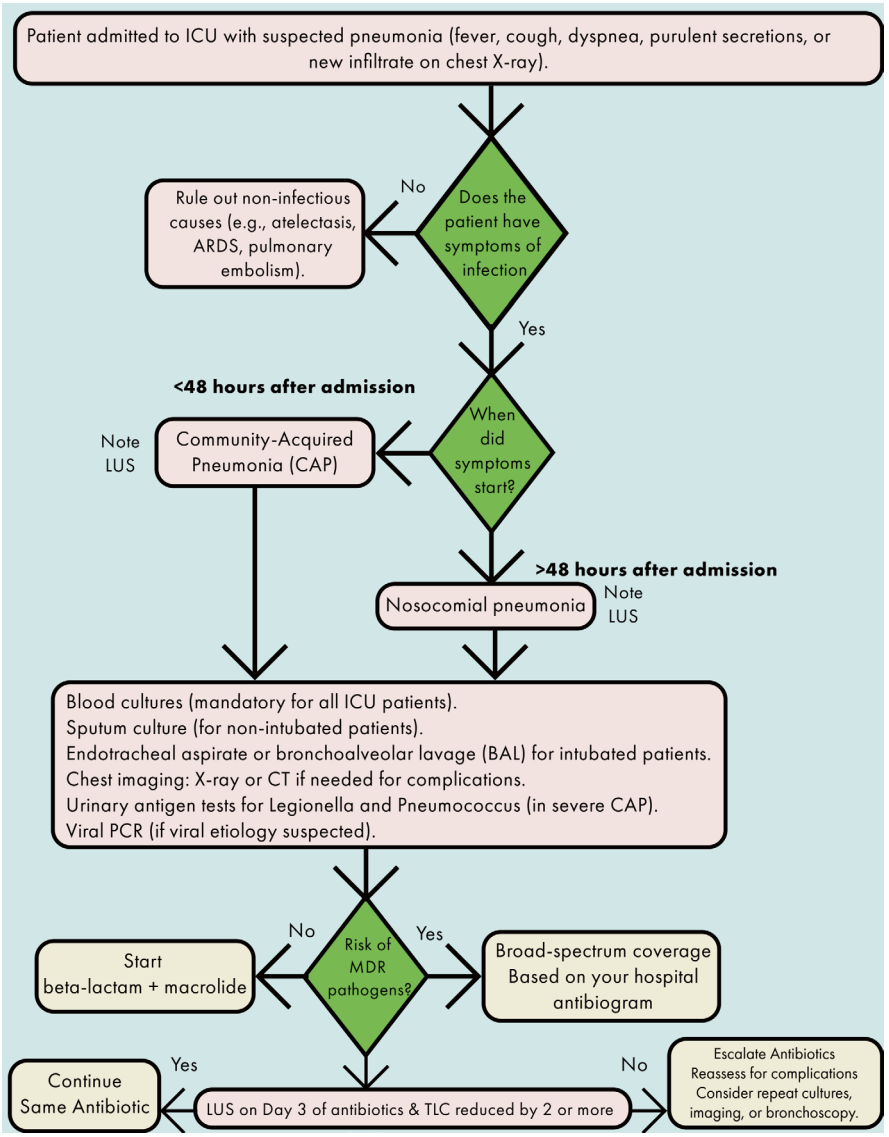
85.8 Conclusion

A systematic and standardized approach to pneumonia in the ICU enhances patient care by ensuring accurate diagnosis, appropriate management, and effective prevention strategies. Key components include:

- Differentiating infectious from noninfectious causes early using clinical assessment, biomarkers, and imaging.
- Classifying pneumonia into CAP or nosocomial based on symptom timing and applying CDC-defined surveillance criteria.
- Assessing MDR pathogen risk using structured frameworks and tailoring empirical therapy accordingly, guided by local antibiograms.
- Implementing antibiotic stewardship principles, including de-escalation based on microbiological data and clinical response.
- Employing prevention strategies and strict infection control protocols to reduce pneumonia incidence.
- Evaluating treatment response using standardized criteria and adjusting management as needed.
- Considering special populations who may require different management approaches.
- Tracking outcomes and metrics to continuously improve care quality and patient outcomes.

By integrating these practices, healthcare providers can reduce morbidity, mortality, and the risk of antibiotic resistance associated with pneumonia in critically ill patients.

Algorithm 85.1: Approach to pneumonia in the ICU



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