Community-Acquired Bacterial Pneumonia

Updated: May 27, 2026
Reviewed: May 27, 2026

Epidemiology

Community-acquired bacterial pneumonia is among the most common infections that affect people with HIV and is a leading cause of hospitalization for people with HIV worldwide.[1] Bacterial pneumonia occurs at any CD4 T lymphocyte (CD4) cell count and frequently can be the first manifestation of underlying HIV infection. Although viral infections (e.g., influenza, COVID-19, respiratory syncytial virus [RSV]) are a cause of community-acquired pneumonia (CAP), they are outside the scope of these guidelines, which also do not consider hospital-acquired or ventilator-associated pneumonia.

The incidence of bacterial CAP in people with HIV has decreased progressively with the advent of effective antiretroviral therapy (ART).[2-8] The incidence declined from 22.7 episodes per 100 person-years in 1993 (pre-ART) to 9.1 episodes per 100 person-years[6] in 1997, soon after its introduction, with continued declines in developed countries since then.[4,9] Despite ART, bacterial pneumonia remains more common in people with HIV than in those without HIV.[9,10]

Recurrent bacterial pneumonia, defined as two or more episodes within a 1-year period, is an AIDS-defining condition. Although expected to have also declined, the incidence of recurrent bacterial pneumonia in people receiving ART is hard to evaluate because surveillance data are not collected as systematically as for other opportunistic infections (OIs) and because in most clinical settings it is difficult to distinguish viral from bacterial pneumonias.[11]

Risk Factors

Immune defects associated with HIV infection increase the risk of bacterial pneumonia and include decreased CD4 count,[12] with especially higher risk when <100 cells/mm^3; quantitative and qualitative B-cell abnormalities that result in impaired pathogen-specific antibody production[13]; abnormalities in neutrophil function or numbers[14]; and abnormalities in alveolar macrophage function.[15,16] Regardless of CD4 count, lack of continuous effective ART increases the risk for pneumonia.[4]

Additional risk factors in people with HIV include those also found in people without HIV, such as older age, tobacco use, alcohol use, injection drug use, opioid use (particularly at higher doses and with opioids that have immunosuppressive properties) and chronic viral hepatitis.[3,10,17,18,19] Chronic obstructive pulmonary disease (COPD), malignancy, renal insufficiency, and congestive heart failure are also recognized risk factors for pneumonia, particularly in the population of older adults with HIV.[20] Obesity, an emerging health problem in people with HIV and the general population, can also increase risk for CAP.[4]

Microbiology

In people with HIV, *Streptococcus pneumoniae* is the most commonly identified bacterial cause of CAP (not considering mycobacterial infections); *Haemophilus* and *Moraxella* species are also frequently identified,[21-23] while *Staphylococcus aureus* has been a common pathogen in some series.[24,25]

Pseudomonas aeruginosa was a frequently identified etiologic agent in studies from the pre-ART or early effective ART era but is less frequently seen in the setting of effective ART.[26] Atypical bacterial pathogens, such as *Legionella pneumophila*, *Mycoplasma pneumoniae*, and *Chlamydia pneumoniae*, have been reported as infrequent causes of CAP in people with HIV.[27,28] However, when more extensive testing has been performed, such as serology to detect immunoglobulin M antibodies (IgM) or polymerase chain reaction (PCR) of respiratory secretions, additional infections due to *Mycoplasma* and *Chlamydia sp.* have been detected.[29]

Additional microbial etiologies of CAP that should be considered in people with HIV include *Mycobacterium tuberculosis, Pneumocystis jirovecii*, and other OIs (e.g., histoplasmosis, coccidioidomycosis) depending on the geographic region and local prevalence of respiratory pathogens, as well as the patient's risk factors. Respiratory viruses, including influenza, RSV, metapneumovirus, and SARS-CoV-2, are also common causes of CAP in people with HIV. The likelihood of hospitalization and mortality may be increased among people with HIV for these viral infections, especially among those with more advanced immunosuppression.[30-35]

Certain bacterial pathogens, such as *S. aureus* and *P. aeruginosa*, warrant further discussion. In general, risk factors for those pathogens are similar in people with HIV and without HIV. For *S. aureus*, the risk factors include recent viral infection (particularly influenza), a history of injection drug use, receipt of antibiotics prior to hospital admission, comorbid illnesses, and recent health care contact.[36] For *P. aeruginosa* infection, the risk factors include prior contact with the health care system, neutropenia, pre-existing lung disease, and current or recent use of corticosteroids.[26,37,38]

Clinical Manifestations

The clinical manifestations of bacterial pneumonia in people with HIV, particularly in those with higher CD4 counts and HIV viral suppression, are similar to those in people without HIV.[39]

Notable similarities and/or differences in people with HIV include the following:

- **Clinical and radiographic presentation:** Patients with greater immunosuppression can present with more advanced disease and complicating features.[40] The white blood cell count is usually elevated, either in absolute numbers or relative to baseline count. Neutrophilia and/or left shift may be present. CAP from *C. pneumoniae, M. pneumoniae*, and *Legionella* sp. presents similarly and may be more common in people with HIV who have advanced immunosuppression.[23,29,41] Assessment of clinical features and the use of severity scoring systems for pneumonia such as the Pneumonia Severity Index (PSI) for CAP and the CURB-65 Score for Pneumonia Severity and their application to patients with HIV are discussed in the Treating Disease section.
- **Bacteremia:** The incidence of bacteremia accompanying pneumonia is greater in people with HIV, especially when infection is due to *S. pneumonia*.[42] The introduction of ART and pneumococcal conjugate vaccines have decreased but not eliminated the incidence of pneumococcal bacteremia.[43-47] Risk factors for bacteremia include lack of ART and low CD4 count (particularly <100 cells/mm^3), as well as alcohol use disorder, current smoking, and certain comorbidities, particularly liver disease.[44]
- **Mortality:** Although some studies suggest that people with HIV experience greater mortality from bacterial pneumonia,[26,48,49] others do not.[39,50-52] Independent predictors of increased mortality include CD4 count <100 cells/mm^3, radiographic progression of disease, and presence of shock.[53] In patients receiving effective ART who have well-controlled HIV viremia and high

CD4 counts (>350 cells/mm^3), the clinical course and outcome of pneumonia appear to be similar to those in patients without HIV.[39]

- **Long-term outcome:** Hospitalization of people with HIV for pneumonia has been associated with increased mortality for up to 1 year,[54] a phenomenon also observed in people without HIV.
- **Cardiovascular and pulmonary complications:** Like people without HIV, people with HIV may experience an increased incidence of cardiovascular events during or after hospitalization for CAP, irrespective of any cardiovascular risk factors or CAP severity.[55] In people with HIV, pneumonia has been associated with impaired lung function and increased risk of subsequent lung cancer.[56-58]

Microbiologic Diagnosis

The American Thoracic Society (ATS) and the Infectious Diseases Society of America (IDSA) guidelines for microbiological testing for CAP generally apply to people with HIV who have well-controlled disease. The ATS/IDSA guidelines were not developed to apply to people with significant immunocompromise, such as people with HIV who have low CD4 counts.[59] The differential diagnosis of pneumonia in people with advanced HIV is broad, and evaluation to establish a microbiologic diagnosis should be pursued. Importantly, due to its public health implications, tuberculosis should always be considered in differential diagnoses for people with HIV who have pneumonia (see the *Mycobacterium tuberculosis* Infection and Disease chapter).

A microbiological diagnosis allows clinicians to target treatment to the specific pathogen and minimizes exposure to unnecessary antimicrobials. Evaluation of the upper respiratory tract for SARS-CoV-2 and influenza should be strongly considered, as well as testing for other respiratory viruses when resources are available, based on the local epidemiology, especially among hospitalized patients. The following recommendations for microbiological testing apply to suspected bacterial CAP; additional testing may be indicated when evaluating for other infectious or noninfectious etiologies:

- In patients with HIV and CAP who do not meet criteria for hospitalization and can be treated as outpatients, routine diagnostic tests to identify a bacterial etiology are optional, especially if the microbiological studies cannot be performed promptly.
- For patients with HIV hospitalized for CAP, diagnostic testing is recommended, including Gram stain and culture of expectorated sputum. Sputum should be obtained only if a good-quality specimen can be collected and quality performance measures for its collection, transport, and processing can be met. Sputum cultures in people with HIV have yielded a bacterial etiology in up to 30% to 40% of good-quality specimens.[49,60] Correlation with Gram stain can help in the interpretation of sputum culture data.
- For intubated patients, an endotracheal aspirate sample should be obtained promptly after intubation. Specimens should ideally be obtained before initiation of antibiotics, or as soon as possible thereafter because the likelihood of bacterial growth decreases substantially after 12 to 18 hours of antibiotic therapy.
- Blood cultures prior to antibiotic administration are recommended for hospitalized patients because people with HIV and pneumonia are more likely to be bacteremic than those without HIV. Results can also address concerns for drug-resistant pathogens and inform de-escalation of therapy when appropriate.[61]

- Urinary antigen testing for *S. pneumoniae* and *L. pneumophila* is recommended in all hospitalized patients with HIV, regardless of the severity of infection. Urinary antigen tests for *S. pneumoniae* have performed similarly in people with and without HIV in a small study.[62] *Legionella* testing should also be done in people with outpatient or inpatient CAP when indicated by epidemiological factors, such as association with a *Legionella* outbreak or recent travel.
- In adults with severe CAP, lower respiratory tract secretions should be tested for *Legionella* species by culture on selective media or by *Legionella* nucleic acid amplification testing (depending on the availability of each testing modality). Direct fluorescent antibody staining is a less preferred option.
- When available, rapid methicillin-resistant *Staphylococcus aureus* (MRSA) nasal testing should be performed, particularly in patients with severe pneumonia and risk factors for MRSA or patients residing in settings or communities with a high prevalence of MRSA, because results can inform empiric antibiotic therapy.[63]
- Bronchoscopy with bronchoalveolar lavage should be considered for patients with severe disease, especially if the differential diagnosis includes *P. jirovecii* (see the *Pneumocystis* Pneumonia chapter for further information) and/or other OIs.
- Diagnostic thoracentesis with pleural fluid sent for microbiological studies should be performed in all patients with pleural effusion if concern exists for accompanying empyema. In addition, clinicians should be vigilant for evidence of extrapulmonary/extrathoracic complications of infection and obtain the appropriate clinical samples for evaluation.
- Further diagnostic testing is indicated whenever epidemiologic, clinical, or radiographic clues prompt suspicion of specific pathogens that could alter standard empirical management. The role of molecular diagnostic testing of lower respiratory tract samples for viruses and bacteria in CAP is evolving, and its diagnostic performance in people with HIV needs further study. A small study from Uganda suggests the use of a pneumonia multiplex PCR panel might improve diagnostic yield and the identification of antimicrobial-resistant pathogens.[64]
- Procalcitonin (PCT) testing has been proposed as a tool to discriminate between bacterial and viral respiratory infections. This test has variable sensitivity for bacterial pneumonia,[59] and specific PCT thresholds have not been established or validated for HIV-associated bacterial pneumonia. Clinicians might choose to use it as an additional tool in their assessment along with other clinical and laboratory parameters and consider an elevated PCT as a possible indicator for a bacterial process.

Preventing Exposure

No effective means exist to completely prevent exposure to bacterial and viral pathogens that can cause CAP. General precautions to maintain health, such as adhering to hand hygiene and cough etiquette and refraining from close contact with individuals who have respiratory infections, should be emphasized.

Preventing Disease

The most important intervention to prevent CAP is prompt initiation of effective ART. Pneumococcal vaccination can prevent pneumococcal CAP, and vaccination against influenza, RSV, and COVID-19 can prevent bacterial CAP as a complication of these viral lung infections. These

vaccines can be administered during the same visit when indicated. Vaccination of household members against influenza, RSV, and COVID-19 might offer additional protection for members with HIV and might be particularly considered in households in which the person with HIV has advanced immunosuppression and/or comorbidities that increase the risk for severe CAP. See the Immunization chapter for a summary of these and other recommended vaccinations, as well as evidence summaries.

Antibiotics **should not** be prescribed solely to prevent bacterial respiratory infection **(AIII).** Although daily administration of TMP-SMX for *Pneumocystis* pneumonia (PCP) prophylaxis has reduced the frequency of bacterial respiratory infections in multiple studies,[12,65,66] the safety and effectiveness of daily antibiotic prophylaxis solely to prevent CAP has not been demonstrated and may promote antimicrobial resistance.

Treating Disease

Recommendations for Treating Community-Acquired Bacterial Pneumonia

General Approach to Treating Community-Acquired Bacterial Pneumonia in People With HIV

- Consider not initiating antibiotics in people with HIV who are stable enough to be treated as outpatients and have well-controlled HIV and no other significant comorbidities (BIII).
- Consider initiating empiric antibiotics to cover bacterial pathogens in CAP in people with HIV who are able to be treated as outpatients if they have significant immunocompromise (CD4 count <200 cells/mm^3, noncontrolled viremia) or other comorbidities that place them at risk for progression of disease (BIII).
- Initiate empiric antibiotics to cover bacterial pathogens in non-severe CAP in people with HIV who are hospitalized (AIII).
- Initiate empiric antibiotics to cover bacterial pathogens in severe CAP in people with HIV who are hospitalized (AIII).

Empiric Antimicrobial Therapy for Treating Community-Acquired Bacterial Pneumonia

Note: Empiric antimicrobial therapy should be initiated promptly for patients presenting with clinical and radiographic evidence consistent with bacterial pneumonia. The recommendations listed below are suggested empiric therapy. The regimen should be modified as needed once microbiologic and antimicrobial susceptibility testing results are available. Providers should also consider the risk of opportunistic lung infections, such as PCP or TB, which could affect the selection of empiric therapy.

Empiric Outpatient Therapy for Patients With Non-severe CAP (Oral)

Preferred Therapy

- A PO beta-lactam + a PO macrolide (azithromycin or clarithromycin[a]) (AI)
  - *Preferred PO beta-lactams*: high-dose amoxicillin or amoxicillin/clavulanate
  - *Alternative PO beta-lactams:* cefpodoxime or cefuroxime

or

- A PO respiratory fluoroquinolone (levofloxacin or moxifloxacin)[b] (AI) [recommended for penicillin-allergic patients (AI)]

Alternative Therapy (If a Macrolide or a Fluoroquinolone Cannot Be Used)

- A PO beta-lactam + PO doxycycline (BIII)

Empiric Therapy for Hospitalized Patients With Non-severe CAP

Preferred Therapy

- An IV beta-lactam + a PO or IV macrolide (azithromycin or clarithromycin[a]) (AI)
  - *Preferred IV beta-lactams:* ceftriaxone, cefotaxime, or ampicillin-sulbactam

or

- A PO or IV respiratory fluoroquinolone (levofloxacin[c] or moxifloxacin)[b] (AI) [recommended for penicillin-allergic patients (AI)]

Alternative Therapy

- An IV beta-lactam (as above) + PO or IV doxycycline (BIII) in patients with contraindication to a macrolide or a fluoroquinolone.

Note: Corticosteroids are not recommended for people with HIV who have non-severe CAP (BII).

Empiric Therapy for Patients With Severe CAP

Note: Prompt therapy with combination antibiotic therapy active against the range of potential pathogens is needed (AI).

Preferred Therapy

- An IV beta-lactam + IV macrolide (azithromycin or clarithromycin)[a] (AI) *or*
- An IV beta-lactam + an IV respiratory fluoroquinolone (levofloxacin[c] or moxifloxacin)[b] (AI)
  - *Preferred IV beta-lactams*: ceftriaxone, cefotaxime, or ampicillin-sulbactam

Alternative Therapy for Penicillin-Allergic Patients

- Aztreonam IV + an IV respiratory fluoroquinolone (levofloxacin[c] or moxifloxacin)[b] (BIII)

Adjunctive Therapy

- Systemic corticosteroids should be considered for patients with severe CAP, especially those who have well-controlled HIV and have increased C-reactive protein (BII).

Empiric Therapy for Patients With Severe CAP at Risk of *Pseudomonas* Pneumonia

Preferred Therapy

- An IV antipneumococcal, antipseudomonal beta-lactam + an IV antipseudomonal fluoroquinolone (ciprofloxacin or levofloxacin[c]) (AI)
  - *Preferred IV beta-lactams*: piperacillin-tazobactam, cefepime, imipenem, or meropenem

Alternative Therapy

- An IV antipneumococcal, antipseudomonal beta-lactam (as above) + IV azithromycin (BII) *or*
- An IV antipneumococcal, antipseudomonal beta-lactam (as above) + an IV antipneumococcal fluoroquinolone (moxifloxacin or levofloxacin[c]) (BII)

For Penicillin-Allergic Patients

- Replace beta-lactam with IV aztreonam + an IV antipneumococcal, antipseudomonal fluoroquinolone (levofloxacin[c]) (BII).

Empiric Therapy for Patients With Severe CAP at Risk of MRSA Pneumonia

- A nasal swab for MRSA can help inform whether a need exists for initial empiric coverage for MRSA (see text for discussion).

Preferred Therapy

- Vancomycin IV or linezolid (IV or PO) should be added to the antibiotic regimen (AII). Therapy should be de-escalated if cultures for MRSA are negative (BIII).
- Although not routinely recommended, for patients with severe necrotizing pneumonia, clindamycin plus vancomycin or the use of linezolid alone can be used to minimize bacterial toxin production (CII).

Duration of Therapy

- At least 5 days for most patients following assessment of clinical stability[d] (AII)
- At least 7 days for patients with MRSA or *Pseudomonas* pneumonia (AII)
- Patients should achieve clinical stability before discontinuation of therapy (AII).
- Longer duration may be needed in those who are likely to take longer to achieve clinical stability, such as those with advanced HIV and CD4 count <100 cells/mm^3.
- Longer duration of antibiotics (e.g., 7 to 14 days) may be necessary for patients who have severe CAP.
- Duration of antibiotics for those with extrapulmonary complications (e.g., empyema, meningitis, endocarditis, other deep-seated infection) would be determined by the condition being treated.

Switch From IV to PO Therapy

- A switch to oral therapy should be considered for patients who have improved clinically, can swallow and tolerate oral medications, and have intact gastrointestinal function (BIII).

Other Considerations

- Empiric monotherapy with a macrolide is not routinely recommended because of increasing pneumococcal resistance (up to 30% for erythromycin) (BIII). Patients receiving a macrolide for MAC prophylaxis may have macrolide-resistant *S. pneumoniae* due to chronic exposure (BIII).
- Fluoroquinolones should be used with caution in patients in whom TB is suspected but who are not being treated with concurrent standard four-drug TB therapy (BIII).
- Once the pathogen has been identified by reliable microbiologic methods, antibiotic therapy should be modified to target the pathogen (BIII).
- If drug-resistant pathogens have not been identified by reliable microbiologic methods, antibiotic therapy can be de-escalated to cover routine causes of CAP (BIII).
- Antibiotic chemoprophylaxis for CAP is generally not recommended because of the potential for development of drug-resistant microorganisms and drug toxicities (AI).

Pregnancy Considerations

- During pregnancy, azithromycin is recommended when a macrolide is indicated (BIII).
- When indicated, quinolones can be used during pregnancy for serious respiratory infections only when a safe alternative is not available (CIII).

[a] Consider drug interaction potential when selecting macrolide therapy. Azithromycin, in general, has less risk for drug–drug interactions than clarithromycin.

[b] Respiratory fluoroquinolones, such as levofloxacin or moxifloxacin, are also active against *Mycobacterium tuberculosis*. In patients with undiagnosed TB, fluoroquinolones may alter response to therapy, delay TB diagnosis, and increase the risk of drug resistance. Fluoroquinolones should be used with caution in patients with suspected active TB disease who are not receiving a standard four-drug TB regimen.

[c] High-dose levofloxacin (750 mg) is recommended for treating serious pneumonia.

[d] Clinical stability is defined as resolution of vital signs abnormalities (temperature, heart rate, respiratory rate, arterial oxygen saturation or partial pressure, and systolic blood pressure), and normal mentation.

Key: ART = antiretroviral therapy; CAP = community-acquired pneumonia; CD4 = CD4 T lymphocyte cell; CRP = C-reactive protein; IM = intramuscular; IV = intravenous; MAC = *Mycobacterium avium* complex; MRSA = methicillin-resistant *Staphylococcus aureus*; PCP = *Pneumocystis* pneumonia; PO = oral; TB = tuberculosis

General Approach to Treatment

The basic principles of antibiotic treatment of CAP are the same for patients with and without HIV.[59] As discussed in the Diagnosis section, diagnostic specimens for culture should be collected before antibiotic therapy is initiated and no later than 12 to 18 hours after. However, empiric antibiotic therapy should be administered promptly when indicated, without waiting for the results of diagnostic testing. Empiric therapy should consider local epidemiology and resistance patterns; exposure history; results of rapid testing for MRSA nares carriage, if done; and individual patient risk factors, including severity of immunocompromise (recent CD4 count, HIV viral load) and use of ART. For patients with CAP for whom a viral etiology is identified, the decision to treat with antibiotics needs to be individualized considering all factors.

Recommendations for empiric antibiotic therapy of CAP were updated. ATS[67] and IDSA[68] both recommend providers not prescribe empiric antibiotics for outpatients without comorbidities diagnosed with CAP if the patient tests positive for a respiratory virus. For outpatients with comorbidities and for hospitalized patients with non-severe CAP, ATS recommends initiating empiric antimicrobials because of concerns for bacterial coinfection that can be difficult to exclude at presentation. In contrast, IDSA recommends clinicians not treat these patients empirically, but rather "exercise individualized, dynamic decision-making" that considers the severity of illness as well as clinical features for and against a bacterial etiology. Both ATS and IDSA strongly endorse empiric treatment of hospitalized patients with severe CAP.[68] Of note, no studies have specifically addressed withholding antibiotics in people with HIV who have clinical and imaging evidence of CAP if they test positive for a respiratory virus.

For patients with HIV and CAP we recommend the following approach:

- Consider not initiating antibiotics in people with HIV who are stable enough to be treated as outpatients and have well-controlled HIV and no other significant comorbidities **(BIII).**
- Consider initiating empiric antibiotics to cover bacterial pathogens in CAP in people with HIV who are able to be treated as outpatients if they have significant immunocompromise (CD4 count <200 cells/mm^3, noncontrolled viremia) or other comorbidities that place them at risk for progression of disease **(BIII).**
- Initiate empiric antibiotics to cover bacterial pathogens in non-severe CAP in people with HIV who are hospitalized **(AIII).**
- Initiate empiric antibiotics to cover bacterial pathogens in severe CAP in people with HIV who are hospitalized **(AIII).**

In people with HIV, providers must also consider the risk of opportunistic lung infections, such as PCP, that would influence selection of empiric treatment. In settings where the prevalence of tuberculosis (TB) is high, initiation of empiric therapy for both bacterial pneumonia and TB might be appropriate for patients in whom both diagnoses are strong considerations and while diagnostic evaluation is in process. Because respiratory fluoroquinolones are also active against *M. tuberculosis,*

they should be used with caution in patients with suspected TB who are not being treated with concurrent standard four-drug TB therapy **(BIII).** Patients with TB who are treated with fluoroquinolones in the absence of standard four-drug TB therapy may have an initial but misleading therapeutic response (which could delay diagnosis of TB and initiation of appropriate multidrug TB therapy) and increase the risk of drug-resistant TB and TB transmission.

Assessing Severity of Disease and Treatment Location

Whether patients should be treated on an outpatient basis or admitted to the hospital depends on several factors. Severity of illness is generally the key driver. Other determinants include the ability to take oral medications and adhere to the treatment plan, whether there is a support system at home, the distance to the hospital, and the patient's comorbidities, among others.

Severity indices commonly used—the PSI for CAP and the CURB-65 Score for Pneumonia Severity—appear valid for predicting mortality in people with HIV who have CAP and can be used as guides for deciding admission vs. outpatient management in these patients.[53,69,70] The IDSA/ATS severity criteria provide a physiologic severity score that assists in determining level of care.[59] However, no prospective randomized clinical trials have assessed the performance of these indices in people with HIV. One study suggested that the decision on disposition be dictated by considering the PSI score and CD4 count together.[69] Mortality was increased in patients with higher PSI risk class; however, even in those without an increased mortality risk by PSI, a CD4 count <200 cells/mm^3 was associated with an increased risk of death.[69] This finding led to the suggestion to hospitalize CAP patients with CD4 counts <200 cells/mm^3 and to use the PSI to help guide decision-making in those with higher CD4 counts.[71] Other studies have found the PSI was predictive of outcomes independent of CD4 count.[72]

In general, we recommend that validated clinical prediction scores such as the PSI be used in people with HIV in conjunction with clinical judgement to guide treatment location for CAP, as is done for people without known HIV. Low-risk patients for whom there are no concerns regarding adherence or other complicating factors can be treated as outpatients. Patients with severe CAP, suggested by a PSI risk class of III or IV, a CURB-65 score ≥3, or the presence of ≥3 of the IDSA/ATS minor severity criteria for CAP[59] require admission, and those presenting with shock or respiratory failure, as per the IDSA/ATS major severity criteria, require a higher level of care, typically intensive care unit (ICU) admission.

CAP Treatment by Setting and Severity of Disease

Treatment recommendations for CAP in people with HIV are generally consistent with the ATS/IDSA guidelines for people without HIV.[59,67] Clinical trials evaluating different antibiotic regimens for treating CAP in populations with HIV are lacking; similarly, no evidence supports that treatment response to antibiotics differs by HIV status.

Outpatient CAP Treatment

People with HIV treated as outpatients should receive an oral beta-lactam plus a macrolide **(AI)** or a single-drug regimen of respiratory fluoroquinolone **(AI).** Preferred beta-lactams are high-dose amoxicillin or amoxicillin-clavulanate; alternatives are cefpodoxime or cefuroxime. Preferred macrolide is azithromycin. Preferred respiratory fluoroquinolones are moxifloxacin or levofloxacin, which should be used as an alternative to a beta-lactam in patients allergic to penicillin **(AI).** If a

patient has contraindications to a macrolide or a fluoroquinolone, then doxycycline should be given as an alternative **(BIII)** in addition to a beta-lactam.

Empirical monotherapy with a macrolide for outpatient CAP **is not routinely recommended** in people with HIV due to concerns for pneumococcal macrolide resistance, which has been reported to be as high as 30% for erythromycin **(BIII).**[73] Local drug resistance patterns, if available, can help inform treatment decisions**.** Patients already receiving a macrolide, such as for *Mycobacterium avium* complex prophylaxis, may have macrolide-resistant *S. pneumoniae* due to chronic exposure **(BIII).**

Non-severe CAP Inpatient Treatment

People with HIV treated as inpatients should receive a combination of intravenous (IV) beta-lactam plus a macrolide **(AI)** or monotherapy with a respiratory fluoroquinolone **(AI).** Monotherapy with a macrolide **is not recommended** for inpatients as per the reasons stated for outpatient treatment. The utility of dual beta-lactam plus a macrolide therapy has been explored in observational studies and a limited number of prospective clinical trials in patients without HIV and CAP.[74,75] A 2014 meta-analysis that included 4 prospective studies and 12 retrospective cohort studies (n = 42,942) showed that compared to beta-lactam monotherapy, beta-lactam and macrolide dual therapy was associated with significantly reduced mortality in the total population, as well as in subgroups analyzed by site of care (ward vs. ICU), in patients with mild-moderate and severe pneumonia, and in patients with pneumococcal pneumonia.[76] A recent prospective randomized controlled trial (RCT) comparing beta-lactam monotherapy to a beta-lactam/macrolide combination regimen for CAP in hospitalized patients without known HIV showed a significant benefit of the dual therapy in terms of clinical response and a trend to reduced mortality and readmission rate.[77]

Only one study has compared a cephalosporin (ceftriaxone) monotherapy to dual therapy with a cephalosporin (ceftriaxone) plus macrolide for CAP in people with HIV.[29] The investigators found no difference in either in-hospital or 14-day mortality between the groups, but most patients had low severity of disease: 7% had a CURB-65 score >2, and 17% had a PSI risk class >III.[78] Given the heterogeneity and limitations of recent studies and the scarcity of data in people with HIV, the recommendation for patients with HIV who are hospitalized with non-severe CAP remains the same as in people without HIV, namely, administer either dual therapy with beta-lactam/macrolide combination or monotherapy with a respiratory fluoroquinolone **(AI).**

Preferred beta-lactams are ceftriaxone, cefotaxime, or ampicillin-sulbactam. Preferred macrolides are azithromycin and clarithromycin. Preferred respiratory fluoroquinolones are moxifloxacin or levofloxacin (at higher dose of 750 mg/day). If a patient has contraindications to a macrolide or a fluoroquinolone, then doxycycline plus a beta-lactam should be given as an alternative **(BIII).** IV penicillin is an acceptable option for treatment of pneumococcal disease in patients with HIV once susceptibility has been confirmed and there are no suspected additional bacterial pathogens **(BIII).**[79] If a patient is allergic to penicillin, then monotherapy with moxifloxacin or levofloxacin (at a higher dose of 750 mg/day) should be used **(AI).** As noted, fluoroquinolone monotherapy should be used with caution in patients in whom TB is suspected but who are not being treated with concurrent standard four-drug TB therapy.

Severe CAP Treatment

Treatment of severe CAP in people with HIV is generally the same as that for people without HIV. Prompt therapy with combination antibiotic therapy active against the range of potential pathogens is

needed **(AI).** Treatment should consist of an IV beta-lactam plus either an IV macrolide (azithromycin or clarithromycin) **(AI)** or an IV respiratory fluoroquinolone (levofloxacin at the higher dose of 750 mg/day or moxifloxacin) **(AI).**[77] Preferred beta-lactams are ceftriaxone, cefotaxime, or ampicillin-sulbactam. In patients who are allergic to penicillin, aztreonam plus a respiratory fluoroquinolone (levofloxacin at the higher dose of 750 mg/day or moxifloxacin) should be used **(BIII).**

CAP caused by *P. aeruginosa* and *S. aureus* (including community-acquired MRSA) requires special considerations. In the 2019 ATS/IDSA CAP guidelines, empiric therapy for *P. aeruginosa* or MRSA is recommended in those with severe CAP who have had these organisms previously isolated from sputum cultures, or for those with high risk for these pathogens, even in the absence of prior culture isolation, with de-escalation if these organisms are not isolated from current episode cultures.[59]

Corticosteroids

The 2025 ATS guidelines[67] recommend against the use of systemic corticosteroids in non-severe CAP (strong recommendation, low quality of evidence) while suggesting they be used in cases of severe CAP (conditional recommendation, low quality of evidence). No data specific to corticosteroids for bacterial CAP (from non-opportunistic causes) are available in people with HIV, with the exception of a recent pragmatic, open-label trial of individuals hospitalized with mostly non-severe CAP in Kenya that included people with HIV, as discussed below.[80]

The 2025 ATS guidelines provided a conditional recommendation for the use of corticosteroids in people without HIV who have severe CAP; studies suggest that corticosteroids may reduce mortality, particularly in those with markers of increased inflammation, although conflicting data and knowledge gaps persist. In people without HIV, the CAPE COD RCT using hydrocortisone at 200 mg daily for 4 to 7 days followed by a taper, for a total of 8 to 14 days, as adjunctive therapy for severe CAP significantly decreased 28-day mortality.[81,82] Another RCT found that corticosteroids were of benefit for a composite outcome of mortality and pneumonia progression among patients with severe CAP and evidence of inflammation, defined as a C-reactive protein (CRP) >150 mg/L.[83,84] In contrast, the RE-MAP CAP trial of corticosteroid for CAP in ICU patients terminated the fixed-dose hydrocortisone arm for severe CAP early, finding no benefit. The arms of the study investigating dexamethasone and shock-dependent hydrocortisone are ongoing. A recent meta-analysis of eight RCTs with 3,224 patients showed a significant reduction in overall mortality from adjuvant corticosteroid therapy in all patients hospitalized for CAP; however, the treatment effect varied significantly among subgroups, and only patients with high baseline CRP levels (>204 mg/L) had a survival benefit.[85]

In the 2025 ATS guidelines, corticosteroids were not recommended for non-severe CAP because they were not associated with a significant mortality benefit and posed a risk of harm, primarily hyperglycemia[86] in persons without HIV. However, in a pragmatic, open-label trial from Kenya[80] that was not included in these guidelines, 344 of the enrolled 2,180 participants were people with HIV (15% of the cohort). Overall, there was a significantly lower risk of death among those randomized to adjunctive steroid therapy (hazard ratio, 0.84; 95% confidence interval, 0.73–0.97; $P = 0.02$) and results were similar in those with and without HIV. Most of the patients included in this study had non-severe CAP. For those with HIV, no additional information was provided (e.g., CD4 count, receipt of ART, etiology of pneumonia). Notably, despite most participants having non-severe CAP, the mortality rate was substantially higher at 24% compared with 9% in the CAPE COD trial[83] Hence, results of this study may not be applicable to other settings.

Based on guidelines for populations without immunosuppression, systemic corticosteroids **are not recommended** for people with HIV who have non-severe CAP **(BII).** The results from the study from Kenya cannot be extrapolated to settings in the United States at this time. No data are available regarding the benefits from corticosteroids specifically for HIV patients who have severe CAP. However, based on the ATS guidelines, providers should consider administering corticosteroids to people with HIV who have severe CAP, especially to those who have well-controlled HIV and have increased CRP **(BII).** Providers must ensure that no contraindications to steroids exist and must be vigilant to adverse events. The optimal regimen—including dose, duration, and formulation of corticosteroid—remains uncertain. Importantly, effects of corticosteroids appear variable according to geographic region, as well as etiology of pneumonia. In CAP due to a virus, corticosteroids may increase mortality in influenza pneumonia[87] but decrease mortality in patients with COVID-19 who require higher levels of respiratory support.[88]

Empiric *Pseudomonas aeruginosa* Treatment

For severe CAP, if risk factors for *Pseudomonas* infection are present (e.g., CD4 count $\leq$50 cells/mm^3, underlying neutropenia, pre-existing lung disease, use of corticosteroids, severe malnutrition, hospitalization within the past 90 days, residence in a health care facility or nursing home, chronic hemodialysis), an antipneumococcal, antipseudomonal beta-lactam plus either ciprofloxacin (400 mg every 8 hours) or levofloxacin (750 mg/day) should be used **(AI).** Preferred beta-lactams are piperacillin-tazobactam, cefepime, imipenem, or meropenem. Alternative therapeutic agents are an antipneumococcal, antipseudomonal beta-lactam plus azithromycin **(BII)** or an antipneumococcal, antipseudomonal beta-lactam plus an antipneumococcal fluoroquinolone **(BII).** In patients who are allergic to penicillin, aztreonam is recommended in place of the beta-lactam to be combined with an IV antipneumococcal, antipseudomonal quinolone (levofloxacin) **(BII).** De-escalation of antipseudomonal coverage should be considered when an alternative microbiology is confirmed and/or if the clinical course does not suggest *P. aeruginosa* infection.

Empiric *Staphylococcus aureus* Treatment

In patients with severe CAP, a nasal swab for MRSA can help inform whether initial empiric coverage should include anti-MRSA antimicrobials. In studies of patients without HIV, negative test results have a high negative predictive value for pneumonia due to MRSA. If the nasal swab is negative for MRSA, and no other risk factors or features suggestive of MRSA pneumonia are present, empiric coverage for MRSA is likely not necessary **(BII).**[63]

If risk factors for *S. aureus* infection are present in patients with severe CAP, including recent viral infection (particularly influenza), history of injection drug use; severe, bilateral, necrotizing pneumonia; recent antibiotic use; or recent contact with the health care system, vancomycin or linezolid should be added to the antibiotic regimen **(AII).** Empiric coverage for MRSA should also be added if a rapid nasal swab is positive for MRSA, although the positive predictive value for pneumonia is only moderate, and therapy should be de-escalated if cultures are negative **(BIII).** Although not routinely recommended, the addition of clindamycin to vancomycin or the use of linezolid alone is recommended by many experts to minimize bacterial toxin production in cases where severe necrotizing pneumonia is present **(CII).**

Although ceftaroline has activity against MRSA and data suggest it can be effective for MRSA pneumonia, it was approved by the U.S. Food and Drug Administration for treatment of bacterial CAP based on studies that did not include any MRSA isolates.[89] Ceftaroline has not been specifically

studied in people with HIV with bacterial pneumonia. Daptomycin **should not** be used to treat pneumonia because it is not active in the lung **(AI).**

Pathogen-Directed Therapy

When the etiology of pneumonia has been identified using reliable microbiological methods, antimicrobial therapy should be modified and directed at the identified pathogen **(BIII).**

Monitoring Response to Therapy and Duration of Therapy

Duration of therapy for CAP should be at least 5 days for those who have achieved clinical stability assessed by validated measures **(AII).** The clinical response to appropriate antimicrobial therapy for CAP is generally similar in patients with and without HIV.[39,52] Clinical improvement typically is observed within 48 to 72 hours after initiation of appropriate antimicrobial therapy, and most patients achieve clinical stability (defined as resolution of vital signs abnormalities [temperature, heart rate, respiratory rate, arterial oxygen saturation or partial pressure, and systolic blood pressure]), and normal mentation within 5 days; hence, a 5-day course of antimicrobials is appropriate for most patients. The 2025 ATS guidelines suggest a shorter course of 3 to 5 days may be considered when certain criteria are met, including the ability to closely monitor the patient and the patient's preferences. For patients with CAP due to suspected or proven MRSA or *P. aeruginosa,* duration of treatment should be at least 7 days **(AII).** A switch to oral therapy should be considered in patients with CAP on IV antibiotic therapy who have improved clinically, can swallow and tolerate oral medications, and have intact gastrointestinal function **(BIII).**

HIV may impact the time to clinical stability in CAP. A review of patients with CAP found that advanced HIV infection and CD4 count <100 cells/mm^3 were predictors for longer time to clinical stability (i.e., >7 days) and that patients who received ART tended to become clinically stable sooner and had better outcomes.[71,90] A longer duration of antibiotic therapy (e.g., 7–14 days) might be necessary in patients who have severe CAP, which typically requires a longer time to achieve clinical stability. As in patients without HIV, radiographic improvement of pneumonia usually lags behind clinical improvement.

For patients with extrapulmonary foci of infection associated with the pneumonia event, such as meningitis, endocarditis, empyema, or other serious deep-seated infections, the total duration of antibiotics will be determined by the infectious syndrome or complication.

Special Considerations Regarding Antiretroviral Therapy Initiation

In patients with bacterial pneumonia not receiving effective ART, ART should be promptly initiated (or reinitiated or optimized to be effective) within 2 weeks of initiating therapy for pneumonia and whenever feasible prior to discharge for those that required admission **(AI).**

Immune Reconstitution Inflammatory Syndrome

Immune reconstitution inflammatory syndrome (IRIS) in people with HIV and bacterial CAP has only been described in case reports and in the context of pneumonia due to *Rhodococcus equi*.[91,92] The lack of data suggests IRIS is not a clinically relevant concern for patients with CAP, and this diagnosis **should not** by itself impact ART management decisions and/or delay initiation/reinitiation of effective ART.[2,93]

Managing Treatment Failure

Patients who do not respond to appropriate antimicrobial therapy should undergo further evaluation to search for complications secondary to pneumonia (e.g., emphysema, abscess formation, metastatic infection), other infectious processes, the presence of a drug-resistant pathogen, and/or noninfectious causes of pulmonary dysfunction (e.g., pulmonary embolus, COPD).

Preventing Recurrence

The most important intervention to prevent bacterial pneumonia (first episode or recurrence) is initiation and adherence to effective ART **(AI),** which is beneficial even among people not receiving ART who have a high CD4 count.[4] People with HIV who have recovered from CAP should receive pneumococcal **(AI)** and influenza vaccines **(AI)** if they have not already received them (see the Immunization chapter). Antibiotic chemoprophylaxis **is not recommended** to prevent recurrences of bacterial respiratory infections because of the potential for development of drug-resistant microorganisms and drug toxicity **(AI).** Smoking cessation reduces the risk of bacterial pneumonia by approximately 27%,[94] and people who have had CAP and who smoke tobacco should be encouraged to quit and be provided with the appropriate smoking cessation tools and referrals whenever possible **(AI).** Likewise, people with substance use disorders should be referred for appropriate counseling and services **(AI).**

Special Considerations During Pregnancy

The diagnosis of bacterial respiratory tract infections during pregnancy is the same as in other people with HIV, with appropriate shielding of the abdomen during radiographic procedures. During pregnancy, bacterial respiratory tract infections should be managed the same as in other people with HIV, with certain exceptions. Among macrolides, clarithromycin **is not recommended** because of an increased risk of birth defects seen in some animal studies. Two studies, each involving at least 100 women with first-trimester exposure to clarithromycin, did not document a clear increase in or specific pattern of birth defects, although an increased risk of spontaneous abortion was noted in one study.[95,96] Azithromycin did not produce birth defects in animal studies, but experience with human use in the first trimester is limited. A recent nationwide study from France supports its safety profile in humans.[80] Azithromycin is recommended when a macrolide is indicated in pregnancy **(BIII).** Arthropathy has been noted in immature animals with *in utero* exposure to quinolones. Studies evaluating quinolone use in pregnant women did not find an increased risk of birth defects or fetal musculoskeletal abnormalities.[97,98] When indicated, quinolones can be used in pregnancy for serious respiratory infections only when a safer alternative is not available **(CIII).**[99]

Doxycycline **is not recommended** for use during pregnancy because of increased hepatotoxicity and staining of fetal teeth and bones. Beta-lactam antibiotics have not been associated with teratogenicity or increased toxicity in pregnancy. Clindamycin use in pregnancy has not been associated with an increased risk of birth defects or adverse outcomes.[100] Aminoglycosides can be used as needed. A theoretical risk of fetal renal or eighth nerve damage exists with aminoglycoside exposure during pregnancy, but this finding has not been documented in humans, except with streptomycin (10% risk) and kanamycin (2% risk). Animal reproductive toxicity studies in rats and rabbits were negative for vancomycin, but data on first-trimester exposure in humans are limited.[101] A study of neonates after *in utero* exposure did not find evidence of renal or ototoxicity.[102] Experience with linezolid in human pregnancy has been limited, but it was not teratogenic in mice, rats, or rabbits.

Pneumonia during pregnancy is associated with increased rates of preterm labor and delivery. Pregnant women with pneumonia after 20 weeks' gestation should be monitored for evidence of contractions **(BII). Because of the increased risk of complications of CAP during pregnancy, preventive interventions are of the most importance, including vaccinations.** For recommendations related to immunization, refer to the Influenza Vaccine section and the Pneumococcal Vaccine section of the Immunization chapter.

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