Volume 6, No. 7 July, 2025
p ISSN 2723-6927-e ISSN 2723-4339

Community-Acquired Pneumonia (CAP) in HIV Patients

Muzaijadah Retno Arimbi
Universitas Wijaya Kusuma Surabaya, Indonesia
Email: retno_arimbi@yahoo.com

Abstract
CAP continues to be a significant infectious disease among individuals living with HIV, even in the era of ART. HIV-positive individuals are at heightened risk for CAP due to altered immune function and exposure to a broader range of potential pathogens compared to the general population. This study aimed to examine the clinical characteristics, causative agents, and outcomes of CAP in HIV-infected patients to inform more accurate and evidence-based management practices. A descriptive qualitative approach was employed, with data obtained from various documented sources relevant to the topic. The analysis process followed the three-step model by Miles and Huberman, which includes data reduction, data display, and conclusion drawing. The findings reveal that HIV-infected patients with pneumonia often present with typical acute symptoms and can be appropriately evaluated using the PSI. Diagnostic and therapeutic procedures were consistent with those used for non-HIV patients, involving chest X-rays, sputum or BAL sampling, and blood tests prior to the initiation of empirical antibiotic therapy. Key strategies such as consistent use of ART, smoking cessation, and vaccination (particularly against pneumococcus and influenza) were found to be critical in both the treatment and prevention of CAP among HIV-positive individuals. Nevertheless, further research is necessary to refine prevention strategies and determine the most effective approaches for long-term disease management in this vulnerable population.
Keywords: ART, HIV, Pneumonia Severity Index, community-acquired pneumonia, vaccination

INTRODUCTION

CAP is defined as an acute infection of the lungs, specifically involving the alveoli, in individuals who have not had recent contact with healthcare facilities (Krajewska et al., 2020). CAP represents a serious and common complication among people living with HIV. The risk of developing pneumonia is significantly higher in individuals with lower CD4 cell counts. According to research by Lee et al., bacterial pneumonia is the most prevalent respiratory complication in HIV-infected individuals whose CD4 counts fall below 200 cells/μL (Brown et al., 2014).

Cillóniz et al. (2018) note that individuals living with HIV or those who are immunocompromised are at a markedly elevated risk of contracting bacterial pneumonia. Nuttal (2019) emphasizes that, among HIV-infected infants and young children, community-acquired pneumonia is a leading contributor to both morbidity and mortality. In 2015, there were an estimated 1.4 million global cases of clinical pneumonia attributed to HIV infection. Moreover, data from 2010 indicate that pneumonia was responsible for the deaths of around 88,000 children with HIV, with 93% of these deaths occurring among African children under the age of five (Mengesha et al., 2022). Research conducted by Mane et al. (2018) and Cillóniz et al. (2018) reveals that BCAP occurs at a rate approximately 25 times higher in people living with HIV compared to their HIV-negative counterparts.

According to Nuttal (2019), the frequent presence of multiple pathogens in a single case of infection complicates the determination of the exact etiology of pneumonia. In the context

of HIV-positive patients undergoing antiretroviral therapy, Streptococcus pneumoniae remains the most commonly detected pathogen and shows a greater tendency to cause bacteremia than in HIV-negative individuals (Cillóniz et al., 2018). Brown et al. (2014) highlight several contributing factors that heighten pneumonia risk in this population, such as diminished CD4+ T-cell counts, high levels of circulating HIV, tobacco consumption, intravenous drug use, and pre-existing kidney conditions.

As noted by Schleenvoight et al. (2017), both the incidence and fatality rates of CAP increase with age, underscoring the importance of accurate diagnostic methods and effective treatment strategies, particularly for HIV-positive individuals affected by CAP. Shoar et al. (2020) stress that current medical protocols advocate for the rapid initiation of empirical antibiotic therapy immediately after diagnosis to enhance patient outcomes. According to Mane et al. (2018), the initial choice of empirical treatment is generally informed by the pathogens most commonly found in this specific population. Among immunocompromised patients, vulnerability to various infections may differ significantly, depending on the level and nature of immune dysfunction whether due to the disease itself or as a result of medical treatment.

To reduce the risk of CAP in individuals living with HIV, several preventive measures have been proposed, including immunization, the use of prophylactic antimicrobials, vigilant tracking of drug-resistant strains, and heightened recognition of the contribution of viral infections and tuberculosis to CAP development (Nuttal, 2019). Brown et al. (2014) recommend pneumococcal vaccination and smoking cessation as key interventions to minimize the likelihood of CAP occurrence in this vulnerable population.

Scheenvoigt et al. (2024) reported that while pneumococcal and influenza vaccination coverage was greater among PLWH who developed CAP compared to non-HIV controls, Streptococcus pneumoniae continued to be the most frequently identified pathogen in both cohorts. This was followed by Haemophilus influenzae and Staphylococcus aureus, although distinguishing true infection from colonization by S. aureus can be clinically challenging. Despite a lower overall incidence than in previous studies, the six-month mortality rate remained elevated in PLWH relative to the control group. Interestingly, classical opportunistic pathogens linked with HIV, such as Pneumocystis jirovecii, were rarely detected.

In a study involving 82,822 individuals diagnosed with community-acquired pneumonia (CAP), Bai et al. (2025) found that 1.8% (1,518 patients) were living with HIV. Compared to the non-HIV group, HIV-positive patients were generally younger, more likely to be male, and had fewer existing health conditions. The in-hospital mortality rate was 4.4% among those with HIV and 8.5% among those without, showing no statistically significant association between HIV status and risk of death (adjusted subdistribution hazard ratio [aSHR] 1.02; $p = 0.8440$). However, individuals classified as having AIDS were found to have a substantially higher risk of mortality three times greater than non-HIV patients (aSHR 3.04; $p = 0.0002$). Classifications of HIV and AIDS were determined using ICD-10-CA diagnostic codes and patients' ART history. The study's primary outcome was in-hospital mortality, while secondary outcomes included 30-day hospital readmission after discharge.

Investigating CA in individuals with HIV remains crucial, particularly in the context of evolving clinical patterns, microbial etiology, and treatment responses in the ART era an area that remains underrepresented in current literature. Despite the continued high incidence of CAP among people living with HIV (PLWH), there is a notable gap in up-to-date data detailing

microbial profiles and clinical trajectories, especially when distinguishing between those with and without a diagnosis of AIDS. This study, therefore, seeks to comprehensively characterize the clinical features, pathogens involved, severity of illness, and patient outcomes associated with CAP in HIV-infected populations, with the goal of informing more targeted empirical therapies and enhancing prevention efforts for this vulnerable group.

This study presents several significant contributions. Clinically, a clearer understanding of the manifestations, causative organisms, and outcomes of CAP in individuals with HIV enables more accurate and evidence-informed treatment decisions, ultimately enhancing patient care. From a public health perspective, reinforcing preventive measures such as immunization, smoking cessation, and consistent adherence to ART may effectively reduce both the incidence and fatality rates of CAP in this population. In terms of policy, the findings can serve as a foundation for revising and strengthening clinical guidelines, contributing to more uniform management strategies and improved healthcare quality for HIV-positive patients. Moreover, by addressing the current lack of updated data on CAP in the ART era, this research deepens our understanding of evolving microbial trends and treatment outcomes, helping to bridge a critical gap in contemporary medical knowledge.

RESEARCH METHODS

This study adopts a qualitative descriptive design, which aims to generate a detailed and contextual understanding of a particular phenomenon through the analysis of collected data (Stanley, 2023). Data for this research are gathered using documentation techniques, involving the examination of various sources relevant to the topic. These may include official documents, archival records, photographs, video materials, personal correspondence, meeting transcripts, newspaper articles, or personal journals (Hensen et al., 2021). This method was chosen to enable a comprehensive exploration and nuanced description of CAP among individuals living with HIV.

The data analysis in this study is guided by the three core phases of qualitative analysis described by Miles and Huberman: data condensation, data display, and conclusion drawing or verification (Muthmainnah et al., 2025). In the first phase, data condensation refers to the process of organizing, selecting, and focusing key information from the collected documents. The next stage involves presenting the data in a structured descriptive format, which enables clearer observation of emerging themes and patterns. Finally, the conclusion-drawing phase entails interpreting the refined data to generate insights and verify the core findings derived from the analysis.

RESULT AND DISCUSSION

Pneumonia, an acute inflammation of the lung tissue caused by a range of infectious agents, continues to be a significant cause of morbidity and mortality among people living with HIV (Tilahun et al., 2023). As one of the most common respiratory infections, effective management relies heavily on appropriate antibiotic selection and awareness of prevailing antimicrobial resistance trends within the local setting (Grief et al., 2018). Among its forms, CAP remains a major factor contributing to hospitalizations and death, thereby exerting considerable pressure on healthcare resources (Regunant & Oba, 2024). CAP typically arises in

individuals without recent exposure to healthcare facilities and presents with a broad spectrum of clinical severity from mild respiratory illness in otherwise healthy patients to critical conditions such as multilobar or necrotizing pneumonia, often complicated by septic shock (Krajewska et al., 2020).

The landscape of HIV-related pulmonary disease is complex and influenced by multiple elements, including regional pathogen prevalence such as tuberculosis and the accessibility of healthcare interventions like ART and antimicrobial prophylaxis (Figueiredo-Mello et al., 2017). For individuals living with HIV, the incidence of CAP is reported to be at least four times greater than in those without HIV infection (Zifodya et al., 2020). Furthermore, CAP in this population is associated with an increased risk of long-term mortality. Nonetheless, overall mortality rates for CAP in HIV-positive patients typically range between 6% and 15%. Importantly, individuals whose HIV is well-managed through ART tend to experience mortality rates from CAP that are similar to those observed in HIV-negative populations (Rider et al., 2018).

Etiology and Risk Factors of CAP in HIV Patients

Streptococcus pneumoniae continues to be the predominant causative agent of CAP, accounting for approximately 50% of all confirmed cases. In addition to this primary pathogen, respiratory viruses particularly influenza A and atypical bacteria such as Mycoplasma pneumoniae and Chlamydophila pneumoniae are also frequently identified. While encountered less commonly, organisms like Haemophilus influenzae, Staphylococcus aureus, Moraxella catarrhalis, and Legionella pneumophila remain significant contributors to the overall etiological spectrum of CAP and warrant clinical attention due to their potential severity (Brown, 2012). A range of factors heightens the risk of CAP in adults, including being over the age of 65, having chronic respiratory illnesses, living with HIV, engaging in tobacco use or excessive alcohol consumption, poor oral hygiene, and comorbid conditions such as chronic heart failure, cerebrovascular disorders (including dementia), as well as chronic liver or renal disease (Regunath et al., 2017). For individuals with HIV, the introduction and expansion of ART have been pivotal in lowering the rates of both opportunistic and bacterial infections, in both resource-rich and resource-limited settings (Lamas et al., 2017). Recent evidence suggests that in HIV-positive patients, the most isolated bacteria include Klebsiella pneumoniae (27.0%), Staphylococcus aureus (20.8%), Streptococcus pneumoniae (18.8%), and Escherichia coli (8.3%) (Tilahun et al., 2023). The elevated susceptibility of people living with HIV to bacterial causes of CAP is largely attributed to persistent immune dysfunction and chronic immune activation (Cillóniz et al., 2018).

Pathophysiology of CAP in HIV Patients

Pneumonia is an infection of the alveoli that arises when the innate immune system fails to eliminate pathogens from the lower respiratory tract. This leads to a local inflammatory response, where cytokines and other mediators contribute to damage in the lung parenchyma and initiate systemic inflammation, causing symptoms such as fever, chills, and fatigue. CAP can affect individuals of all ages and health statuses, though certain pathogens tend to be more prevalent in specific patient subgroups. Risk increases with any condition that impairs mucociliary clearance or suppresses the cough reflex, such as smoking. Additionally, disorders

that lead to aspiration like cerebrovascular accidents, esophageal abnormalities, or neuromuscular diseases further heighten susceptibility. In older adults and those experiencing dehydration, the presentation of pneumonia can be atypical, making diagnosis more challenging. Moreover, the presence of cardiovascular or structural lung disease may delay recognition and treatment (Rider & Frazee, 2018).

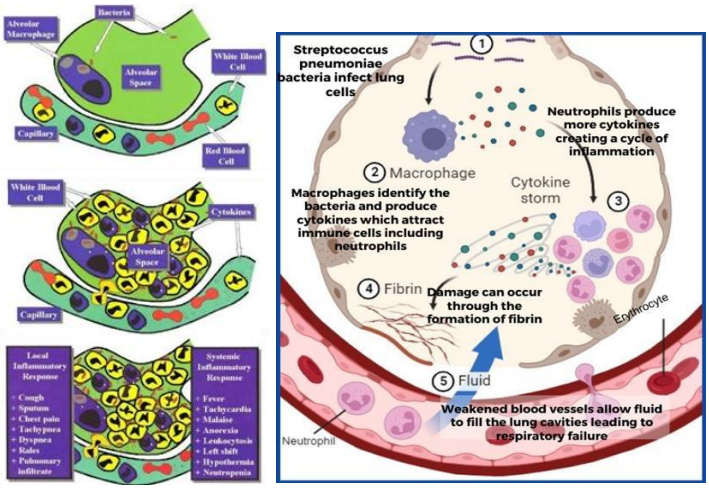

Figure 1. Pathophysiology of CAP
Source: Adapted from Rider & Frazee (2018)

Viral infections constitute an important contributor to respiratory disease in people living with HIV, though comprehensive data regarding their precise clinical impact remain limited. A prospective investigation in Montreal involving 50 HIV-positive individuals presenting with fever and respiratory complaints found that viral pathogens were implicated in 64% of cases. As noted by Brown et al., most participants 90% were on ART, had a median CD4+ T cell count of 325 cells/μL, and exhibited a median HIV viral load below 50 copies/mL. Influenza viruses emerged as the predominant etiology, with 22 of the 34 viral infections attributed to either influenza A or B. Other identified respiratory viruses included human metapneumovirus (types A and B), RSV, parainfluenza viruses (types 2 and 3), and various strains of coronavirus. While these pathogens are also commonly encountered in the general population, the extent to which HIV infection influences their prevalence or clinical severity remains unclear. Notably, RSV has been specifically associated with severe CAP in HIV-infected individuals (Brown & Lipman, 2014).

Clinical Manifestations of CAP in HIV Patients

Common clinical manifestations of pneumonia include fever, chills, productive cough with purulent sputum, shortness of breath, pleuritic chest discomfort, and unintended weight loss. However, in individuals with compromised immunity or chronic alcohol use, these typical symptoms may not be apparent. Instead, the disease may present with vague or systemic complaints such as fatigue, lethargy, gastrointestinal upset, altered mental status, or upper abdominal discomfort. Some clinical signs may provide insight into the probable etiology—for example, the combination of diarrhea, headache, and confusion linked to low sodium levels could indicate Legionella infection. Meanwhile, features like otitis media, Stevens-Johnson

syndrome, or anemia with accompanying jaundice (suggestive of hemolysis) may raise suspicion for Mycoplasma pneumoniae. Additionally, pneumonia can exacerbate underlying chronic illnesses, such as congestive heart failure, potentially masking early symptoms and contributing to delays in diagnosis and treatment (Rider & Frazee, 2018).

Diagnosis of CAP in HIV Patients

Individuals living with HIV who develop pneumonia frequently exhibit a typical acute illness profile, characterized by symptoms such as fever, pleuritic chest pain, dyspnea, and reduced blood oxygen levels. In this population, established clinical tools for evaluating illness severity have shown to be effective, with the PSI being the most thoroughly researched and validated for predicting outcomes. A recent study conducted in California has further confirmed the value of PSI in assessing disease severity and mortality risk among HIV-infected patients with pneumonia (Brown & Lipman, 2014).

All participants received a comprehensive clinical assessment that included a structured medical history obtained through a standardized questionnaire and a physical examination performed by the attending physician. Routine diagnostic procedures encompassed chest radiography, collection of induced sputum or BAL, and procurement of blood samples for microbiological evaluation. Importantly, all diagnostic sampling was conducted prior to the initiation of empirical antibiotic therapy to ensure accurate pathogen identification (Mane et al., 2018). Although current pneumonia guidelines in the United States and Europe do not provide specific recommendations for managing CAP in HIV-infected individuals, treatment should generally follow the same clinical principles used for HIV-negative patients. Those with high CURB-65 or PSI scores are considered at increased risk of mortality and should, when possible, receive care in intensive or critical care settings. The spectrum of bacterial pathogens in HIV-infected individuals is largely similar to that of the general population, with Streptococcus pneumoniae being the most consistently reported causative agent. Other commonly isolated bacterial pathogens include Haemophilus influenzae, Klebsiella pneumoniae, Staphylococcus aureus, Moraxella catarrhalis, and Pseudomonas aeruginosa. Atypical organisms such as Legionella pneumophila, Mycoplasma species, and Chlamydia pneumoniae account for fewer than 5% of cases, and their precise prevalence among individuals with HIV remains underexplored. Clinicians must also consider opportunistic pathogens like Pneumocystis jirovecii and Cryptococcus neoformans, which can clinically mimic acute bacterial pneumonia and should be included in the differential diagnosis for immunocompromised patients. Moreover, individuals living with HIV face a markedly higher risk of infection with Mycobacterium tuberculosis, a pathogen that can closely resemble typical bacterial pneumonia in both symptomatology and radiologic appearance (Brown & Lipman, 2014).

Table 1. 2007 Infectious Diseases Society of America/American Thoracic Society Criteria for defining CAP.[19]

Validated definitions include one major criterion or three or more minor criteria
Minor criteria: • Breathing speed ≥ 30 breaths/minute • PaO2/FiO2 ratio ≤ 250 • Multilobar infiltrate • Confusion/disorientation

- Uremia (blood urea nitrogen level ≥ 20 mg/dl)
- Leukopenia* (white blood cell count < 4,000 cells/μl)
- Thrombocytopenia (platelet count < 100,000/μl)
- Hypothermia (core temperature < 36°C)
- Hypotension requires aggressive fluid resuscitation

Major criteria:

- Septic shock with the need for a vasopressor
- Respiratory failure requires mechanical ventilation

Source: Metlay et al. (2019)

Management of CAP in HIV Patients

The treatment of CAP in both HIV-infected and non-HIV-infected patients generally follows the same principles, as it is primarily guided by the bacterial pathogens responsible for the infection. However, empirical antibiotic choices may vary between populations due to differences in local antimicrobial resistance patterns. For example, in 2011, penicillin resistance levels in Streptococcus pneumoniae across Europe ranged widely from less than 1% to as high as 61%. Some evidence indicates that antibiotic resistance among respiratory pathogens may be higher in individuals with HIV. This increased resistance could be linked to the widespread use of cotrimoxazole for prophylaxis against Pneumocystis pneumonia or to differences in the bacterial serotypes that tend to infect HIV-positive individuals (Brown & Lipman, 2014).

In most cases of CAP, clinical symptoms begin to improve within 72 hours of initiating treatment, although radiographic recovery typically occurs more slowly. It is recommended that the patient's condition be reassessed at the 72-hour mark to evaluate response to therapy. For patients who exhibit a slower recovery but show no worsening of clinical signs, it is generally appropriate to continue the current treatment regimen without making immediate changes (Cao et al., 2018).

Figueiredo-Mello et al. (2018) evaluated the effectiveness of ceftriaxone in combination with a macrolide versus ceftriaxone monotherapy in hospitalized patients with HIV/AIDS diagnosed with CAP. The study concluded that the addition of a macrolide did not result in superior clinical outcomes compared to ceftriaxone alone in this specific patient group.

Complications and Prognosis of CAP in HIV Patients

Although mortality rates for CAP differ among studies, they typically range between 10% and 15%. Emerging evidence indicates that CD4 cell count is not a dependable predictor of mortality risk and should not be solely relied upon to inform treatment strategies or decisions regarding ICU admission. As the demographic landscape of the HIV-positive population evolves particularly with the growing proportion of older individuals clinical outcomes may likewise undergo significant changes. For instance, data from hospital claims databases in the United States indicate that older HIV-infected individuals experience higher mortality rates from pneumonia and influenza compared to their HIV-negative counterparts (Brown & Lipman, 2014).

Prevention

1. Smoking Cessation

Individuals living with HIV remain disproportionately exposed to secondhand smoke, a factor that significantly heightens their vulnerability to pneumonia. Evidence consistently indicates that smoking is associated with a higher incidence of pneumonia when compared to non-smoking populations, and that quitting smoking can markedly lower this risk. A recent systematic review by De et al. reported that current smokers face a significantly increased likelihood of developing bacterial pneumonia, with a hazard ratio of 1.73 (95% CI: 1.44–2.06). Notably, this elevated risk diminishes after smoking cessation. For instance, a prospective study in France demonstrated that former smokers had a substantially reduced risk of pneumonia, with a hazard ratio of 0.48 relative to current smokers. While the efficacy of pharmacological aids for smoking cessation has been well established in the general (HIV-negative) population, there is a notable scarcity of high-quality research assessing their specific effectiveness among people living with HIV.

2. Pneumococcal Immunization (preventive entry)

Vaccination against pneumococcus and influenza, alongside ART, is strongly recommended to lower the incidence of CAP in people living with HIV. Studies affirm the protective benefits of these vaccines, particularly in older adults and individuals considered at high risk. Two primary pneumococcal vaccines are utilized: the 23-valent PPV-23 and the PCV. While PPV-23 exhibits reduced immunogenicity in individuals with low CD4+ T cell levels, PCV elicits a stronger immune response in people living with HIV, owing to its T cell–dependent mechanism. Furthermore, widespread administration of the PCV-7 vaccine in children has contributed to indirect protection for HIV-infected adults through herd immunity. The British HIV Association recommends PPV-23 vaccination for patients with CD4 counts above 200 cells/μL, although it may still be given to those with lower counts despite diminished effectiveness. Conversely, the Infectious Diseases Society of America advises a sequential vaccination strategy starting with PCV-13 followed by PPV-23, ideally when the patient's CD4 count is above 200 cells/μL and on ART (Brown & Lipman, 2014).

3. Influenza immunization

Both U.S. and U.K. clinical guidelines advocate for annual influenza vaccination in individuals living with HIV. Evidence from Beck et al. supports the vaccine's effectiveness in reducing the occurrence of influenza among this population, with studies showing it is generally safe and well tolerated. This recommendation is particularly relevant given the high prevalence of respiratory comorbidities—such as COPD in HIV-positive individuals, which heightens their vulnerability to complications from influenza. Emerging research also indicates that immune responses to influenza vaccination may be improved in this group by administering a high-dose version of the trivalent vaccine, which contains four times the standard antigen amount. Although this approach has proven both immunogenic and safe, it remains unclear whether the enhanced antibody response leads to superior clinical protection or is cost-effective over time (Brown & Lipman, 2014).

CONCLUSION

The results show that individuals with HIV who develop pneumonia commonly exhibit classic acute symptoms such as fever, pleuritic chest pain, shortness of breath, and hypoxemia. Pneumonia severity assessment tools, especially the PSI, which has been extensively validated, prove effective in evaluating disease severity and mortality risk within this group. All

participants in the study completed a structured questionnaire and underwent comprehensive physical examinations by the attending physicians. Diagnostic evaluations involved chest radiography, sputum collection via induction or bronchoalveolar lavage (BAL), and blood sampling for microbiological analyses, all conducted before starting empirical antibiotic treatment. The clinical management approaches and outcomes for HIV-positive patients with pneumonia were found to be comparable to those observed in HIV-negative patients. Essential components of care include ART, achieving plasma viral suppression, smoking cessation, and vaccination against pneumococcus and influenza. Notably, smoking cessation stands out as a particularly important preventive measure; however, further research is necessary to identify the most effective prevention strategies specifically suited to the needs of people living with HIV/AIDS (PLWHA).

REFERENSI

Bai, A. D., Srivastava, S., Martinez Cajas, J. L., Razak, F., & Verma, A. A. (2025). Community-acquired pneumonia in people with HIV during the current era of effective antiretroviral therapy: A multicenter retrospective cohort study. *Clinical Infectious Diseases, 80*(2), 397–403. https://doi.org/10.1093/cid/ciae393

Brown, J. S. (2012). Community-acquired pneumonia. *Clinical Medicine, 12*(6), 538. https://doi.org/10.7861/clinmedicine.12-6-538

Brown, J., & Lipman, M. (2014). Community-acquired pneumonia in HIV-infected individuals. *Current Infectious Disease Reports, 16*(3). https://doi.org/10.1007/s11908-014-0396-7

Cao, B., Huang, Y., She, D. Y., Cheng, Q. J., Fan, H., Tian, X. L., & Zhan, Q. Y. (2018). Diagnosis and treatment of community-acquired pneumonia in adults: 2016 clinical practice guidelines by the Chinese Thoracic Society, Chinese Medical Association. *Clinical Respiratory Journal, 12*(4), 1320–1330. https://doi.org/10.1111/crj.12674

Cillóniz, C., García-Vidal, C., Moreno, A., Miro, J. M., & Torres, A. (2018). Community-acquired bacterial pneumonia in adult HIV-infected patients. *Expert Review of Anti-infective Therapy, 16*(7), 579–588. https://doi.org/10.1080/14787210.2018.1496330

Cillóniz, C., Ielpo, A., & Torres, A. (2018). Treating HIV-positive/non-AIDS patients for community-acquired pneumonia with ART. *Current Infectious Disease Reports, 20*(11), 46. https://doi.org/10.1007/s11908-018-0651-9

Figueiredo-Mello, C., Naucler, P., Negra, M. D., & Levin, A. S. (2017). Prospective etiological investigation of community-acquired pulmonary infections in hospitalized people living with HIV. *Medicine (United States), 96*(4), e5948. https://doi.org/10.1097/MD.0000000000005948

Figueiredo-Mello, C., Naucler, P., Negra, M. D., & Levin, A. S. (2018). Ceftriaxone versus ceftriaxone plus a macrolide for community-acquired pneumonia in hospitalized patients with HIV/AIDS: A randomized controlled trial. *Clinical Microbiology and Infection, 24*(2), 146–151. https://doi.org/10.1016/j.cmi.2017.06.021

Grief, S. N., & Loza, J. K. (2018). Guidelines for the evaluation and treatment of pneumonia. *Primary Care: Clinics in Office Practice, 45*(3), 485–503. https://doi.org/10.1016/j.pop.2018.04.001

Hensen, B., Mackworth-Young, C. R. S., Simwinga, M., Abdelmagid, N., Banda, J., Mavodza, C., Doyle, A. M., Bonell, C., & Weiss, H. A. (2021). Remote data collection for public health research in a COVID-19 era: Ethical implications, challenges and opportunities. *Health Policy and Planning, 36*(3), 360–368. https://doi.org/10.1093/heapol/czaa158

Krajewska, M., Kruczkowska, A., Kusztal, M. A., & Królicka, A. L. (2020). Hyponatremia in infectious diseases—A literature review. *International Journal of Environmental Research and Public Health, 17*(15), 1–16. https://doi.org/10.3390/ijerph17155325

Lamas, C. C., Coelho, L. E., Grinsztejn, B. J., & Veloso, V. G. (2017). Community-acquired lower respiratory tract infections in HIV-infected patients on antiretroviral therapy: Predictors in a contemporary cohort study. *Infection, 45*(6), 801–809. https://doi.org/10.1007/s15010-017-1062-2

Mane, A., Gujar, P., Gaikwad, S., Bembalkar, S., Gaikwad, S., Dhamgaye, T., & Kagal, A. (2018). Aetiological spectrum of severe community-acquired pneumonia in HIV-positive patients from Pune, India. *Indian Journal of Medical Research, 147*(2), 202–206. https://doi.org/10.4103/ijmr.IJMR_1531_16

Mengesha, T., Embiale, T., Azmeraw, M., Kerebeh, G., Mulatu, S., Meseret, F., & Gedefaw, L. (2022). Incidence of pneumonia and predictors among human immunodeficiency virus-infected children at public health institutions in the northwest part of Ethiopia: Multicenter retrospective follow-up study. *Pediatric Health, Medicine and Therapy, 13*, 13–25. https://doi.org/10.2147/PHMT.S348300

Metlay, J. P., Waterer, G. W., Long, A. C., Anzueto, A., Brozek, J., Crothers, K., . . . Infectious Diseases Society of America. (2019). Diagnosis and treatment of adults with community-acquired pneumonia: An official clinical practice guideline of the American Thoracic Society and Infectious Diseases Society of America. *American Journal of Respiratory and Critical Care Medicine, 200*(7), e45–e67. https://doi.org/10.1164/rccm.201908-1581ST

Muthmainna, A., Siroj, R. A., & Hartatiana. (2025). Mastering the art of qualitative data analysis and interpretation: Key steps and procedures. *FiHeSu International Journal of Education and Development Research (FIJEES), 2*(1). https://ejournal.fihesu.com/index.php/FIJEES/article/view/12

Nuttall, J. J. C. (2019). Current antimicrobial management of community-acquired pneumonia in HIV-infected children. *Expert Opinion on Pharmacotherapy, 20*(5), 595–608. https://doi.org/10.1080/14656566.2019.1576352

Ramirez, J. A., Musher, D. M., Evans, S. E., Dela Cruz, C., Crothers, K. A., Hage, C. A., . . . Infectious Diseases Society of America. (2020). Treatment of community-acquired pneumonia in immunocompromised adults: A consensus statement regarding initial strategies. *Chest, 158*(5), 1896–1911. https://doi.org/10.1016/j.chest.2020.05.603

Regunath, H., & Oba, Y. (2024). Community-acquired pneumonia. In *StatPearls*. StatPearls Publishing. https://www.ncbi.nlm.nih.gov/books/NBK441924/

Rider, A. C., & Frazee, B. W. (2018). Community-acquired pneumonia. *Emergency Medicine Clinics of North America, 36*(4), 665–683. https://doi.org/10.1016/j.emc.2018.07.001

Schleenvoigt, B. T., Ankert, J., Barten-Neiner, G., Pletz, M. W., Rohde, G., & the CAPNETZ Study Group. (2024). Pathogen spectrum of community-acquired pneumonia in people

living with HIV (PLWH) in the German CAPNETZ cohort. *Infection, 52*, 129–137. https://doi.org/10.1007/s15010-023-02070-3

Schleenvoigt, B. T., Rupp, J., Rohde, G., Rockstroh, J. K., Fätkenheuer, G., & Pletz, M. W. (2017). Strategies for the treatment of community-acquired pneumonia in HIV-positive patients. *Pulmonology, 71*(4), 207–214. https://doi.org/10.1055/s-0042-123974

Shoar, S., & Musher, D. M. (2020). Etiology of community-acquired pneumonia in adults: A systematic review. *Pneumonia, 12*(1). https://doi.org/10.1186/s41479-020-00065-5

Stanley, M. (2023). Qualitative descriptive: A very good place to start. In M. Stanley (Ed.), *Qualitative research methodologies for occupational science and occupational therapy* (2nd ed., p. 16). Routledge. https://doi.org/10.4324/9781003456216

Tilahun, M., Gebretsadik, D., Seid, A., Gedefie, A., Belete, M. A., Tesfaye, M., & Getu, M. (2023). Bacteriology of community-acquired pneumonia, antimicrobial susceptibility pattern and associated risk factors among HIV patients, Northeast Ethiopia: Cross-sectional study. *SAGE Open Medicine, 11*, 1–10. https://doi.org/10.1177/20503121231158480

Zifodya, J. S., Duncan, M. S., So-Armah, K. A., Attia, E. F., Akgün, K. M., Rodriguez-Barradas, M. C., & Justice, A. C. (2020). Community-acquired pneumonia and risk of cardiovascular events in people living with HIV. *Journal of the American Heart Association, 9*(23), e017531. https://doi.org/10.1161/JAHA.120.017531