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The Management of Infectious Pulmonary Processes in the Emergency Department: Pneumonia

Kasey Dillon, DScPAS, PA-C*, Betsy Garnick, PA-S, Meghan Fortier, PA-S, Belinda Felicia, PA-S, Alison Fulton, PA-S, Courtney Dumont, PA-S, Brooke Dorval, PA-S, Katherine Gardella, PA-S

KEYWORDS

• Pneumonia • Bacterial pneumonia • Community-acquired pneumonia
• COVID-19 pneumonia • Viral pneumonia • Fungal pneumonia

KEY POINTS

- Pneumonia is a common disease process, and emergency medicine providers will be required to accurately diagnosis and manage pneumonia.
- The 3 primary types of pneumonia are bacterial, viral, and fungal.
- Since 2019, SARS-CoV-2 has greatly increased the percentage of patients being seen in emergency departments for symptoms consistent with pneumonia.
- Diagnostic and management guidelines have been established for community-acquired bacterial pneumonia, COVID-19 viral pneumonia, and fungal pneumonia.

INTRODUCTION

In the United States, pneumonia accounts for approximately 2.2% of emergency department visits per year. A significant percentage of those patients can be safely managed at home, not requiring admission.[1] Age, male gender, and the presence of complicating comorbidities increase the likelihood of requiring hospitalization, and therefore, increase the disease burden.[1,2] Bacterial, viral, and fungal pathogens can cause infectious pneumonia. The cause, clinical presentation, and treatment recommendations for each class of pathogens are reviewed. Although nosocomial respiratory infections are prevalent, they will not be discussed in this article. In addition, the revised guidelines established in 2019 for the diagnosis and treatment of community-acquired pneumonia (CAP) recommend that the nosocomial pneumonia classification, also known as health care–associated pneumonia or hospital-acquired pneumonia, be

MCPHS University, 1260 Elm Street, Manchester, NH 03110, USA
* Corresponding author.
E-mail address: Kasey.dillon@mcphs.edu

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abandoned and that recommendations for management be based on severity and epidemiologic data alone.[3]

Community-acquired bacterial pneumonia remains a leading cause of death worldwide with a mortality as high as 24.8 per 10,000 cases in the United States and between 1.5 and 14 cases per 1000 people globally.[2,4] Prevalence varies based on season, population characteristics, and geographical factors. *Streptococcus pneumoniae* and *Haemophilus influenzae* are the leading causes of bacterial pneumonia worldwide. The most common symptoms of cough, fever, and dyspnea are a result of pathogens being transmitted to the lower-respiratory tract via the pharynx. There is, however, significant heterogeneity within the clinical profile of bacterial pneumonia. Evaluation, treatment recommendations, and guidelines have been established and are considered the standard of care for emergency medicine providers.[2,4]

Viral community–acquired pneumonia has an equal prevalence among children and adults with approximately 100 million cases annually in each group.[5] There is consensus that viral pneumonias are underdiagnosed; however, given the availability and sensitivity of molecular diagnostic tests, the gap may be closing. One in 3 CAP are a result of a viral cause, most commonly rhinoviruses, influenza viruses, and coronaviruses.[5] There is risk of bacterial coinfection, making diagnosis and targeted treatment a challenge. In individual circumstances, neuraminidase inhibitors are recommended for influenza-specific pneumonia; however, a clear consensus does not exist for algorithmic management when concerned about bacterial overlap.[5,6] Although sufficient data exist to support the recommended management of SARS-CoV-2 pneumonia, a provider must approach COVID-19 pneumonia with caution given the relative paucity of data and the frequency of iterations in guidelines and suggestions.[6] Given current global epidemiologic trends, this article dedicates the discussion of viral pneumonias primarily to SARS-CoV-2.

Pneumonias secondary to a fungal pathology are rare in immunocompetent individuals but pose life-threatening risk to those with a compromised immune response. Patients with immunodeficiency disorders, such as HIV/AIDS, or patients receiving immunosuppressive therapy are at higher risk for developing fungal respiratory infections. In developed countries, opportunistic pathogens, such as *Candida* or *Cryptococcus*, are increasing in prevalence, as the survival rate of the susceptible population groups increases. Similar to bacterial resistance to antibiotics, there has been an emergence of resistant fungal pathogens to typical treatment, making management of these infections challenging.[7,8] Although not nearly as prevalent as viral or bacterial CAP, it is important that emergency medicine providers consider the possibility of fungal infection in an at-risk patient population so as to ensure early diagnosis and effective treatment.

Community-Acquired Bacterial Pneumonia

Epidemiology

In the United States, CAP accounts for more than 5 million cases of pneumonia per year. Eighty percent of these cases are treated through outpatient management, whereas the remaining 20% of individuals require hospitalization. Incidences of CAP are higher in the male and African American populations. Mortality is greater in women. The incidence rate of CAP increases with the extremes of age, and in the United States, CAP carries a mortality of 7.3%.[3–5]

Cause

CAP is categorized, and treated, based on the cause of “typical” or “atypical” organisms. *S pneumoniae*, *H influenzae*, *Staphylococcus aureus*, and group A streptococci

are 4 of the most common typical organisms causing CAP. Atypical pneumonia can be caused by organisms such as Legionella, *Mycoplasma pneumoniae*, and *Chlamydia pneumoniae*. *S pneumoniae* and *K pneumoniae* are the most common causes of CAP. Methicillin-resistant *Staphylococcus aureus* (MRSA) is the most common cause of health care–associated pneumonia, whereas ventilator-associated pneumonia has a high prevalence of multidrug-resistant bacteria. In recent years, there has been an increase in overall antimicrobial resistance by gram-negative bacteria most commonly found in patients with severe CAP, which substantially increases morbidity, mortality, and health care–associated cost.[4] Bacterial pathogens causing CAP often coexist with viral pathogens, making initial management challenging at best.[3,4]

Clinical presentation

Given the heterogeneity of CAP, the clinical presentation of individuals will vary. The last 10 years, however, have shown substantial expansion of evidence-based data to support the diagnosis and treatment of CAP based on improved and rapid diagnostic testing as well as an increase in understanding of differentiated symptoms based on type of causative agent.[3] The hallmark symptoms of community-acquired bacterial pneumonia include cough, with or without yellow/green sputum production, fever, chills, pleuritic chest pain, and potential confusion in the elderly. Patients may also experience the less-specific symptoms of fatigue, headaches, and feelings of malaise.[9] Progression of bacterial pneumonia can be more rapid than viral or fungal pathogens and, therefore, may produce symptoms representative of systemic involvement, including tachycardia, hypotension, and altered mental status. Atypical pathogens causing CAP are likely to cause extrapulmonary symptoms related to gastrointestinal upset, including nausea, vomiting, or diarrhea.[3,9]

Diagnosis/treatment

Early and accurate diagnosis of CAP is crucial in order to initiate targeted therapy while decreasing unnecessary exposure, and therefore possible resistance or adverse reaction, to antibiotics.[9] Following the physical examination, laboratory diagnostic testing, radiographic imaging, and clinical decision making are crucial components in the diagnosis of CAP.[4,9,10] Clinical decision-making tools are recommended for use in prognosis and to guide the management of patients with pneumonia. They also assist in disposition planning from the emergency department, guiding decision making for individual hospital admission or discharge home. The Pneumonia Severity Index (PSI) is preferential because of the moderate quality of evidence available to support its efficacy over the CURB-65 (confusion, urea level, respiratory rate, blood pressure, and age >65). The PSI demonstrates a higher predictive value as compared with the CURB-65. Clinician judgment must always be integrated into decision making, as predictive tools can oversimplify and do not consistently consider patient variables.[3,9]

In 2019, the Infectious Diseases Society of America (IDSA) and the American Thoracic Society (ATS) established revised guidelines for the diagnosis and treatment of CAP. Criteria are outlined for determining severe CAP based on the following minor and major symptoms and diagnostic findings[3,4,11]:

- Sputum cultures: Recommended only in patients meeting criteria for severe disease, especially if requiring mechanical ventilation. There is lack of evidence to support the use of sputum cultures in outpatient settings.
- Blood cultures: Recommended in patients meeting criteria for severe disease, those being treated empirically for MRSA or *Pseudomonas aeruginosa*, those with a history of MRSA or *P aeruginosa*, or those hospitalized within the past 90 days. These recommendations do have a low quality of evidence, although

blood cultures continue to remain part of most institutional clinical pathways in the diagnosis of CAP. Given the overlap of CAP and sepsis, utilization of blood cultures is appropriate. Data prove that positive blood cultures within 10 hours of admission have shown an increased risk of mortality; however, only 40% of blood cultures drawn at initial presentation are positive.

- Molecular diagnostic testing/polymerase chain reaction testing: Recommended testing for influenza and SARS-CoV-2 based on local transmissibility data and prevalence. Molecular diagnostic tests have an overall 70% to 80% sensitivity rate and 99% to 100% specificity rate, therefore isolating cases of viral or atypical bacterial cause.
- Legionella and pneumococcal urinary antigen testing (UAT): Recommended only in the patient with severe CAP or in cases of high epidemiologic concern/recent travel (Legionella).
- Imaging: Chest computed tomography (CT) is considered the gold standard in detection of both CAP and viral pneumonia; however, cost, accessibility, and radiation continue to be limiting factors. Chest radiograph alone has a sensitivity of 38% to 76%; however, when combined with molecular testing, sensitivity and specificity increase. Ultrasonography has been shown to have sensitivity rates of 80% to 90% in the detection of pneumonia. The IDSA/ATS guidelines no longer recommend routine use of chest radiograph in follow-up after a pneumonia diagnosis.

In all patients where community-acquired bacterial pneumonia is likely, empiric therapy is recommended. Risk assessment should be used to determine if treatment can be conducted in an outpatient or inpatient setting. As stated, the PSI and CURB-65 clinical assessment tools are effective and recommended guidelines used in beginning treatment decisions. The CURB-65 and PSI help estimate mortality risk in CAP based on various risk factors associated with worse outcomes.[9] Treatment decisions vary greatly owing to differences in risk assessment outcomes indicated, comorbidities, and likelihood of MRSA infection. **Tables 1** and **2** outline the recommended outpatient and in-hospital initial treatments for CAP.[3]

Prognosis

Outcomes of treatment largely depend upon age of onset, hospitalization status with treatment, and the presence of comorbidities. The overall mortality for pneumonia may be up to 30% if left untreated. Overall prognosis, however, is tremendous in a healthy patient. Most individuals respond to treatment within 48 to 72 hours of initial management, both in hospital and at home. Respiratory failure, sepsis, organ failure, coagulopathy, and exacerbation of comorbidities are complications to consider as a result of CAP.[9]

Table 1
Empiric treatment of outpatient community-acquired pneumonia

	Recommended Treatment
No comorbidities/risk factors for MRSA or pseudomonas	Amoxicillin OR doxycycline OR macrolide
With comorbidities	Augmentin or cephalosporin AND macrolide or doxycycline OR monotherapy with respiratory fluoroquinolone

Adapted from Ramirez JA, File, TM, Bond S. UpToDate. Overview of community-acquired pneumonia. Sept 7, 2021. Accessed March 1, 2022.

Table 2
Empiric treatment of inpatient community-acquired pneumonia

	Standard	Prior MRSA	Prior Pseudomonas
Nonsevere inpatient	B-Lactam + macrolide[a] OR respiratory fluoroquinolone[b]	Add MRSA coverage[c]	Add pseudo coverage[d]
Severe inpatient	B-Lactam + macrolide[a]		

[a] Ampicillin and sulbactam, cefotaxime, ceftriaxone, ceftaroline, AND azithromycin or clarithromycin.
[b] Levofloxacin or moxifloxacin.
[c] Per 2016 ATS/IDSA guidelines: vancomycin or linezolid.
[d] Per 2016 ATS/IDSA guidelines: piperacillin-tazobactam, cefepime, ceftazidime, imipenem, meropenem, or aztreonam.
Adapted from Ramirez JA, File, TM, Bond S. UpToDate. Overview of community-acquired pneumonia. Sept 7, 2021. Accessed March 1, 2022.

Community-Acquired Viral Pneumonia

Epidemiology

As stated, viral pneumonia is discussed, with reference only to pneumonia caused b the SARS-CoV-2 virus. At the time of publication, there have been more than 470 million confirmed cases of COVID-19 globally with more than 6 million deaths reportedy to the World Health Organization (WHO) and to the Centers for Disease Control and Prevention (CDC).[12] Currently, 10 vaccines have been granted an emergency use listing by the WHO. Worldwide vaccination rates are highest in countries like Canada, Chile, and Australia with countrywide vaccination greater than 90%. Sub-Saharan Africa has the lowest overall population vaccination rates at less than 10%, and China does not report vaccination rates. The United States has an overall nationwide vaccination rate of 70%.[13] Vaccination compliance is determined by factors such as availability, vaccination hesitancy, and political or religious affiliation.

Before the COVID-19 pandemic, common viral causes of pneumonia included influenza A and B, human boca viruses, coronaviruses NL63 and HKU1, and respiratory syncytial virus (commonly in children).[5] Although these viral illnesses remain, SARS-CoV-2 pneumonias have contributed to a majority of viral pneumonias worldwide. Vaccination has been proven to decrease mortality in COVID-19 infections and to decrease hospitalization rates of infected individuals, both with and without comorbidities.[12,14,15] Following the evolution of coronavirus variants, delta and omicron, a third vaccination for COVID-19 has shown a 94% and 82% (respectively) prevention rate of an emergency-department encounter following exposure to the virus. Vaccines have proven to be 94% effective in preventing hospitalization from the delta variant and 90% from the omicron variant.[15]

Clinical presentation

Although data are lacking in long-term effects of COVID-19 as well as efficacy of vaccination over time, there is improved understanding within the medical community regarding presenting symptoms of patients infected by SARS-CoV-2. COVID-19 pneumonia has a virulent pathology and is highly transmissible with the inhalation of virus infecting the alveolar and endothelial cells in the pulmonary tissue.[16] The most common method of transmission for this virus is person to person via respiratory particles. Respiratory secretions can spread when one breathes in close proximity to

another individual (<6 ft) or when eliciting any phonatory behavior (ie, coughing, singing, speaking, and laughing). It is best understood that the airborne transmission of a viable COVID-19 particle can last up to 16 hours before infecting another host, although likelihood of infection is affected by things like viral load and vaccination status.[17,18]

Current data, including contact tracing, support both asymptomatic and symptomatic spread of SARS-CoV-2. This is due to the similar viral loads detected from nasal and throat swabs from each patient population, with a slightly higher predominance of virus detected via nasal swab.[5,19] COVID-19 infectiousness is highest in the early course of the illness, during the 2 days before symptom onset. This viral nucleic acid shedding pattern of SARS-CoV-2 resembles that of influenza and can make it difficult to control transmission.[19] Specific to immunocompetent individuals, an infected patient is less likely to transmit the virus after day 7.[12,20,21]

Within an emergent setting, patients with COVID-19 infection can present with symptoms ranging in severity from mild to severe. Common complaints include fever, cough, dyspnea, myalgia, loss/alterations of gustatory and olfactory senses, gastrointestinal manifestations (most commonly diarrhea), and headaches.[22] Severe illness is more frequent among older individuals and those with multiple comorbidities. Providers may also note delirium and general health decline especially in the older population, who may have previous neurologic impairments.[23] Acute respiratory distress syndrome (ARDS) is a significant complication of COVID-19 pneumonia and has a high mortality.[16]

Current guidelines recommend laboratory and diagnostic testing in the diagnosis of COVID-19 pneumonia. Recommendations are largely consistent with the initial evaluation of CAP with a few exceptions:

- Procalcitonin: Procalcitonin is a biomarker of bacterial infection. It can be useful in determining bacterial coinfection. Data suggest that procalcitonin is an effective diagnostic tool used upon initial presentation as well as for monitoring treatment and guiding management.[24]
- Laboratory inflammatory markers (erythrocyte sedimentation rate and C-reactive protein): These may be increased in patients presenting with COVID-19 pneumonia, however, are nonspecific and do not assist in specific initial management, although they may be better used to monitor progress and outcome.[23]
- Imaging: Chest radiograph is insensitive in accurately detecting early or mild COVID-19 pneumonia. It is, however, cost-effective and time effective. CT imaging of the chest is more sensitive for early detection as well as for monitoring disease progression.[16] It is common to see ground-glass opacities bilaterally with COVID-19 pneumonia on imaging studies.

Treatment

The management of COVID-19 pneumonia is based on the severity of the illness at time of presentation to the emergency department. Minimizing the risk of health care worker and patient exposure must be considered, and measures such as rapid triage and risk stratification should be implemented.[25] Reliable patients who present with any upper-respiratory symptoms, such as rhinorrhea, loss of taste or smell, diarrhea, and fatigue, and who have minimal to no comorbidities, can be managed at home and often should be evaluated through a telemedicine or primary care visit.[25] With signs of lower-respiratory tract pathologic condition, such as dyspnea or cough, and with patients having multiple comorbidities, hospitalization should be considered. Severe illness is defined by an oxygen saturation below 94%, a respiratory rate greater than 30, and the presence of infiltrates on imaging in greater than 50% of lung tissue.[25]

These patients will be monitored, admitted, and likely need supplemental oxygen. Currently, pharmacologic treatments are recommended based on disease severity.[26]

The American Academy College of Emergency Physicians recommends the following specific approach based on severity[26]:

- Mild to moderate signs of COVID-19: These patients may benefit from nonpharmacologic treatment alone. These options include home oxygen therapy, breathing exercises, continual ambulation, adequate sleep, and a consistent healthy diet with adequate hydration.
- Severe signs of COVID-19: Recommendations for oxygen support using a nasal cannula with titration to 6 L, high-flow nasal cannula (HFNC) or high-velocity therapy, noninvasive positive pressure ventilation if HFNC is not available, or a consideration of prone positioning if patient can be monitored closely. Proning of patients is contraindicated in the presence of respiratory distress.
- Endotracheal intubation is considered: If a goal of oxygenation at 92% to 96% cannot be maintained, low-tidal volume, plateau pressures less than 30 cm, higher positive end-expiratory pressure, or if a patient experiences refractory hypoxemia with prone ventilation. Currently, sufficient data do not exist to determine the benefit of extracorporeal membrane oxygenation in the management of severe COVID-19 pneumonia.

Recommendations for pharmacologic management of COVID-19 are not made specific to those patients with or without pneumonia. Recommendations are based on outpatient or inpatient management and therefore on disease severity. Current recommendations as seen in **Tables 3** and **4** and **Fig. 1** are summarized as follows[26,27]:

- Remdesivir is the only antiviral medication approved by the Food and Drug Administration (FDA) for the treatment of COVID-19.
- Ritonavir-boosted nirmatrelvir (Paxlovid) and SARS-CoV-2 monoclonal antibodies have been given an Emergency Use Authorization from the FDA.
- Nonhospitalized patients: All patients with confirmed SARS-CoV-2 who are at risk for progressing to severe disease should receive (in order of preference): paxlovid, sotrovid, remdesivir, and molnupiravir. Systemic corticosteroids are not recommended.
- Hospitalized patients: Remdesivir is recommended in all patients requiring admission for SARS-CoV-2. In addition, dexamethasone is recommended if supplemental oxygen is required. Finally, and dependent on severity of disease and progression, tocilizumab is recommended.
- The National Institutes of Health and CDC update detailed guidelines regularly, including the use of heparin.

Prognosis

The prognosis of COVID-19 pneumonia is variable and ranges widely. Mortality is highest among patients with ARDS. There is no clinical significance in mortalities between COVID-19–related ARDS or non–COVID-19–related ARDS. Data suggest mortalities from 12% to 78% in patients diagnosed with COVID-19 and ARDS. Death from COVID-19 can result from other complications, such as arrhythmias, cardiac arrest, or pulmonary embolism.[28] Rapid symptom progression does not contribute to worsened outcomes. Patient prognosis and outcome are affected by individual comorbidities, patient population and demographics, hospital staffing, and staff experience in treating COVID-19.[28]

Community-Acquired Fungal Pneumonia

Cause/epidemiology

Fungal pneumonia affects 2 different patient populations, neutropenic and nonneutropenic individuals. Risk factors for neutropenic fungal pneumonia include neutropenia greater than 10 days typically following chemotherapy or following a hematopoietic stem cell transplant. Risk factors for nonneutropenic fungal pneumonia include prolonged steroid use, which is further broken down into intermediate risk (<0.3 mg/kg/d prednisone equivalents for >3 weeks) and low risk (<7 days of steroid use). Transplant recipients, and patients with AIDS/HIV infection, chronic obstructive pulmonary disease, diabetes mellitus, liver failure/cirrhosis, renal failure/hemodialysis, severe immunodeficiency (chronic granulomatous disease), and critically ill intensive care unit (ICU) patients are at increased risk for developing fungal pneumonia.[29]

There are several common fungal pathogens leading to pneumonia.[29] Coccidioidomycosis, also known as "valley fever," is endemic to the Southwestern United States (primarily Arizona and California), Mexico, Central America, and South America. The fungal spores of coccidioidomycosis live in soil, which are transmitted via inhalation.[7] *Histoplasma capsulatum* is a dimorphic fungus also transmitted via inhaled spores from soil but is endemic to the Ohio and Mississippi river valleys. Aspergillus species, most commonly *Aspergillus fumigatus*, is a common mold infection found in immunocompromised individuals.[7] Neutropenia is the most common risk factor for invasive aspergillosis.[4,8] *Candida albicans*, *Cryptococcus neoformans*, blastomyces, and *Pneumocystis jiroveci* are additional fungal pathogens found in at-risk patient populations.[2,7]

Clinical presentation

Neutropenic and nonneutropenic individuals with fungal pneumonia will present with varied clinical symptoms. Fever and symptoms consistent with angioinvasion are more prevalent in a neutropenic host. Angioinvasion leads to a higher susceptibility of fungal spread to other organs, most commonly the skin, brain, and eyes. Angioinvasion is not common in a nonneutropenic host. Most nonneutropenic patients are asymptomatic until later stages in the disease.[4,8]

Although variable, patients with fungal pneumonia will typically present with a cough (79%–91%), fever (up to 75%), dyspnea (70%), increased sputum production (up to 65%), or pleuritic chest pain (up to 50%). Generalized symptoms of lightheadedness, malaise, weakness, headache, nausea/vomiting, joint pain, and rash can also be associated with fungal pneumonia but are less common as an initial complaint. The elderly population can present with nonspecific complaints as stated, as well as altered mental status independent of other symptoms. Specifically, coccidioidomycosis can cause fever, cough, headache, rash, muscle aches, and joint pain.[30] *H capsulatum* is commonly asymptomatic but can also mimic mild flulike symptoms, fever, headache, chest pain, dry cough, and night sweats. Inoculum size is a major determinant in the symptomatology of patients.[31] It is important to use appropriate history, physical examination, and laboratory and diagnostic imaging to exclude other disease processes, including bacterial or viral pneumonia.

Diagnosis

Because of the limitations in testing availability within emergency departments, the diagnosis of fungal pneumonia is often limited to the history and physical examination findings that are supported with imaging findings and consistent with patient risk factors[29,32,33]:

- Complete blood Count: Recommended to determine the presence of neutropenia and/or lymphopenia. This allows for a more targeted approach to management.

Table 3
Nonhospitalized patient guidelines for COVID-19[27]

Patient Disposition	Panel's Recommendations
Does not require hospitalization or supplemental oxygen	All patients should be offered symptomatic management (*AIII*) For patients who are at high risk of progressing to severe COVID-19[a] (treatments are listed in order of preference based on efficacy and convenience of use): • Ritonavir-boosted nirmatrelvir (Paxlovid)[b,c] (AIIa) • Sotrovimab[d] (AIIa) • Remdesivir[c,e] (BIIa) • Molnupiravir[c,f] (CIIa) The panel *recommends against* the use of *dexamethasone* or *other systemic corticosteroids* in the absence of another indication (*AIIa*)[g]
Discharged from hospital inpatient setting in stable condition and does not require supplemental oxygen	The panel *recommends against* continuing the use of *remdesivir* (*AIIa*), *dexamethasone*[g] (*AIIa*), or *baricitinib*[g] (*AIIa*) after hospital discharge
Discharged from hospital inpatient setting and requires supplemental oxygen *For those who are stable enough for discharge but who still require oxygen*[h]	There is insufficient evidence to recommend either for or against the continued use of remdesivir or dexamethasone
Discharged from ED despite new or increasing need for supplemental oxygen *When hospital resources are limited, inpatient admission is not possible, and close follow-up is ensured*[i]	The panel recommends using *dexamethasone* 6 mg PO once daily for the duration of supplemental oxygen (dexamethasone use *should not* exceed 10 days) with monitoring of AEs (*BIII*) Because remdesivir is recommended for patients with similar oxygen needs who are hospitalized,[j] clinicians may consider using it in this setting. Given that remdesivir requires intravenous infusions for up to 5 consecutive days, there may be logistical constraints to administering remdesivir in the outpatient setting

Rating of Recommendations: A = strong; B = moderate; C = Optimal.
Rating of Evidence: I = one or more randomized trails without major limitations; IIa = other randomized trails or subgroup analyses of randomized trails; IIb = nonrandomized trials or observational cohort studies; III = expert opinion.

- Blood and sputum cultures: There are limited data to support the benefit of blood and sputum cultures in the emergency department. Both cultures are useful for long-term management of patients and are often obtained upon presentation, especially if the patient is presenting with signs and symptoms of severe disease.
- Serologic testing: Not commonly recommended in the emergent setting. Both acute and convalescent serum titers are necessary and are less likely to be available in this environment. IDSA/ATS guidelines state that serologic testing is only recommended in certain circumstances, such as ICU admission, failure of outpatient antibiotic management, presence of cavitary infiltrates, active alcohol

Table 4
Fungal pneumonia—comparison of 2007 American Thoracic Society/Infectious Diseases Society of America guidelines with 2019 guidelines[3]

Recommendation	2007 ATS/IDSA Guideline	2019 ATS/IDSA Guideline
Sputum culture	Primarily recommended in patients with severe disease	Now recommended in patients with severe disease as well as in all inpatients empirically treated for MRSA or *P aeruginosa*
Blood culture	Primarily recommended in patients with severe disease	Now recommended in patients with severe disease as well as in all inpatients empirically treated for MRSA or *P aeruginosa*
Macrolide monotherapy	Strong recommendation for outpatients	Conditional recommendation for outpatients based on resistance levels
Use of procalcitonin	Not covered	Not recommended to determine need for initial antibacterial therapy
Use of corticosteroids	Not covered	Recommended not to use. May be considered in patients with refractory septic shock
Use of health care-associated pneumonia category	Accepted as introduced in the 2005 ATS/IDSA hospital-acquired and ventilator-associated pneumonia guidelines	Recommend abandoning this categorization. Emphasis on local epidemiology and validated risk factors to determine need for MRSA or *P aeruginosa* coverage. Increased emphasis on deescalation of treatment if cultures are negative
Standard empiric therapy for severe CAP	β-Lactam/macrolide and β-lactam/fluoroquinolone combinations given equal weighting	Both accepted but stronger evidence in favor of β-lactam/macrolide combination
Routine use of follow-up chest imaging	Not addressed	Recommended not to obtain. Patients may be eligible for lung cancer screening, which should be performed as clinically indicated

Patient Disposition	Recommendations for Antiviral or Immunomodulator Therapy		Recommendations for Anticoagulant Therapy
	Clinical Scenario	Recommendation	
Hospitalized for Reasons Other Than COVID-19	Patients with mild to moderate COVID-19 who are at high risk of progressing to severe COVID-19[a]	See Therapeutic Management of Nonhospitalized Adults With COVID-19.	For patients without an indication for therapeutic anticoagulation:
Hospitalized but Does Not Require Oxygen Supplementation	All patients	The Panel **recommends against** the use of **dexamethasone (AIIa)** or **other systemic corticosteroids (AIII)** for the treatment of COVID-19.[b]	
	Patients who are at high risk of progressing to severe COVID-19[a]	**Remdesivir**[c] **(BIII)**	**Prophylactic dose of heparin**, unless contraindicated **(AI)**; **(BIII)** for pregnant patients
Hospitalized and Requires Conventional Oxygen[d]	Patients who require minimal conventional oxygen	**Remdesivir**[e] **(BIIa)**	For nonpregnant patients with D-dimer levels above the ULN who do not have an increased bleeding risk: **Therapeutic dose of heparin**[g] **(CIIa)** For other patients:
	Most patients	Use **dexamethasone plus remdesivir**[e] **(BIIa)**. If remdesivir cannot be obtained, use **dexamethasone (BI)**.	
	Patients who are receiving dexamethasone and who have rapidly increasing oxygen needs and systemic inflammation	Add **PO baricitinib**[f] or **IV tocilizumab**[f] to 1 of the options above **(BIIa)**.	**Prophylactic dose of heparin**, unless contraindicated **(AI)**; **(BIII)** for pregnant patients
Hospitalized and Requires HFNC Oxygen or NIV	Most patients	Promptly start 1 of the following, if not already initiated: **Dexamethasone plus PO baricitinib**[f] **(AI)** **Dexamethasone plus IV tocilizumab**[f] **(BIIa)**	For patients without an indication for therapeutic anticoagulation: **Prophylactic dose of heparin**, unless contraindicated **(AI)**; **(BIII)** for pregnant patients For patients who are started on a therapeutic dose of heparin in a non-ICU setting and then transferred to the ICU, the Panel recommends switching to a **prophylactic dose of heparin**, unless there is another indication for therapeutic anticoagulation **(BIII)**.
		If **baricitinib, tofacitinib, tocilizumab,** or **sarilumab** cannot be obtained: **Dexamethasone**[h] **(AI)** Add **remdesivir** to 1 of the options above in certain patients **(CIIa)**.[i]	
Hospitalized and Requires MV or ECMO	Most patients	Promptly start 1 of the following, if not already initiated: **Dexamethasone plus PO baricitinib**[f] **(BIIa)** **Dexamethasone plus IV tocilizumab**[f] **(BIIa)** If **baricitinib, tofacitinib, tocilizumab**, or **sarilumab** cannot be obtained: **Dexamethasone**[h] **(AI)**	

Fig. 1. Hospitalized patient guidelines for treating COVID-19.[27]

abuse, severe or structural lung disease, positive Legionella UAT, positive pneumococcal UAT, and presence of pleural effusion.

- Imaging: Chest radiograph is an appropriate and recommended initial diagnostic test. Findings may include lobar consolidation, cavitary lesions, or pleural effusions. As with bacterial and viral pneumonia, CT imaging may be required for further diagnostic accuracy. Bedside ultrasound is sensitive and specific in identifying pleural pulmonary lesions.

Treatment

For patients that have not been previously treated for pneumonia, empiric antibiotics are recommended and based on patient's exposure history, risk factors, and severity of disease. Severity of disease and short-term risk assessment can be determined using the CURB-65 and PSI criteria to establish inpatient versus outpatient management. Failure to improve with initial antibiotic management should raise suspicion for fungal infection.[29,32–34]

Treatment of fungal infection is often targeted and based on blood and/or sputum culture results:

- Aspergillosis: Initial therapy with voriconazole is recommended for most patients. The preferred alternative for patients that cannot tolerate the recommended initial therapy is a combination of posaconazole and isavuconazole.[35]
- *P jiroveci*: Initial therapy with trimethoprim/sulfamethoxazole is recommended.[30]
- *H capsulatum*: If less than 4 weeks of an acute lung infection, no treatment is recommended. If greater than 4 weeks of an acute lung infection, a 3-month course of itraconazole is recommended.[31]

Because of the rise in cases of COVID-19, and with the increased need for long-term intubation, there is a concomitant rise in *A fumigatus* infections.[5] Any patient with a recent COVID-19 infection, particularly in the circumstance of a recent history of hospitalization requiring intubation, has a higher risk of developing fungal pneumonia.[3,35] The ATS/IDSA guidelines were revised in 2019 and are accepted as the standard of care (see **Fig. 1**).

DISCUSSION

Pneumonia remains a common condition evaluated and treated in the emergency department. With the emergence of the SARS-CoV-2 virus and COVID-19–associated pneumonia, hospital admission rates for severe pneumonia have increased, leading to increased overall mortality. It is imperative that emergency medicine providers easily identify patients displaying signs and symptoms of both typical and atypical pneumonia and are familiar with the guidelines established for diagnosis and management of pneumonia, including recommended diagnostic testing. Guidelines for the management of bacterial, viral, and fungal pneumonias are created collaboratively by organizations like the IDSA, CDC, and ATS and revised regularly. The prevalence and cause of pneumonia are demographically and seasonally determined; therefore, providers must be aware of guiding treatment based on these factors. Individual patient risk factors must also be considered.

CLINICS CARE POINTS

- *Streptococcus pneumoniae*, *Haemophilus influenzae*, *Staphylococcus aureus*, and group A streptococci are 4 of the most common typical organisms causing community-acquired

bacterial pneumonia. Geographical susceptibility, in addition to current guidelines, must be considered when selecting the appropriate treatment.

- Empiric therapy is recommended in all patients with suspected community-acquired bacterial pneumonia.
- Standard empiric therapy for severe community-acquired bacterial pneumonia includes a B-lactam/macrolide combination.
- Because of the significant overlap in presentation of community-acquired bacterial pneumonia and sepsis, blood cultures are recommended in patients with severe disease or in those at risk for methicillin-resistant *Staphylococcus aureus* and/or pseudomonas.
- Acute respiratory distress syndrome is a significant complication of COVID-19 pneumonia and has a high mortality, making rapid diagnosis critical.
- Remdesivir is recommended in all patients requiring admission for SARS-CoV-2. In addition, dexamethasone is recommended if supplemental oxygen is required.
- Failure to improve with initial antibiotic management should raise suspicion for fungal infection.

DISCLOSURE

These authors declare that they have no conflicts of interest. These authors declare that they have no competing monetary interests or personal relationships that could have influenced the work reported here.

REFERENCES

1. Self WH, Grijalva CG, Zhu YZ, et al. Rates of emergency department visits due to pneumonia in the United States, July 2006-June 2009. Acad Emerg Med 2013; 20(9):957–60.
2. Regunath H, Oba Y. Community-acquired pneumonia. StatPearls. Updated August 18, 2021. Available at: https://www.ncbi.nlm.nih.gov/books/NBK430749/.
3. Metlay JP, Waterer GW, Long AC, et al. 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. Am J Respir Crit Care 2019;200(7).
4. Martin-Loeches I, Torres A. New guidelines for severe community-acquired pneumonia. Curr Opin Pulm Med 2021;27(3):210–5.
5. Ruuskanen O, Lahti E, Jennings LC, et al. Viral pneumonia. Lancet 2011; 377(9773):1264–75.
6. Ng TM, Ong SWX, Loo AYX, et al. Antibiotic therapy in the treatment of COVID-19 pneumonia: who and when? Antibiotics 2022;11(2):184.
7. Arastehfar A, Gabaldon T, Garcia-Rubio R, Jenks JD, Hoenigl M, Salzer HJF, Ilkit M, Lass-Florl C, Perlin DS. Drug-resistant fungi: an emerging challenge threatening our limited antifungal armamentarium. Antib 2020;9(12).
8. Li A, Lu G, Meng G. Pathogenic fungal infection in the lung. Front Immunol 2019; 10(1524).
9. Sattar SA, Sharma S. Bacterial pneumonia. StatPearls. Updated December 28, 2021. Available at: https://www.ncbi.nlm.nih.gov/books/NBK513321/
10. Ramirez JA, File, TM, Bond S. UpToDate. Overview of community-acquired pneumonia. 2021. Available at: https://www.uptodate.com/contents/overview-of-community-acquired-pneumonia-in-adults?search=diagnosis%20of%20community

%20acquired%20pneumonia&source=search_result&selectedTitle=2-~150&usage_type=default&display_rank=2. Accessed March 1, 2022.
11. Karimi E. Comparing sensitivity of ultrasonography and plain chest radiography in detection of pneumonia: a diagnostic value study. Arch Acad Emerg Med 2019;7(1):8.
12. McIntosh K, Hirsch MS, Bloom A. UpToDate. COVID-19: Epidemiology, virology, and prevention. 2022. Available at: https://www.uptodate.com/contents/covid-19-epidemiology-virology-and-prevention?sear ch=COVID%20PNA&topicRef=128323&source=. Accessed March 4, 2022.
13. Vaccination rates, approvals, and trials by country. COVID-19 Vaccine Tracker. 2022. Available at: https://covid19.trackvaccines.org/trials-vaccines-by-country/. Accessed March 18, 2022.
14. 10. CDC. COVID Data Tracker. Updated daily by 8 pm EST. Available at: https://covid.cdc.gov/covid-data-tracker/#vaccine-effectiveness.
15. CDC. Effectiveness of a third dose of MRNA vaccines against COVID-19–associated emergency department and urgent care encounters and hospitalizations among adults during periods of delta and omicron variant predominance — VISION network, 10 states, August 2021–January 2022. Morbidity Mortality Rep 2022;71(4):139–45. Available at: https://www.cdc.gov/mmwr/volumes/71/wr/mm7104e3.htm#:~:text=During%20both%20 Delta%2D%20and%20Omicron,and%2090%25%2C%20respectively.
16. Guarnera A, Podda P, Santini E, Paolantonio P, Laghi A. Differential diagnosis of COVID-19 pneumonia: the current challenge for the radiologist – a pictorial essay. *In.* Img 2021;34.
17. Samet J, Prather K, Benjamin G, et al. Airborne transmission of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2): what we know. Clin Infect Dis 2021;73(10):1924–6. https://doi.org/10.1093/cid/ciab039. Available at: https://escholarship.org/uc/item/1dx8f89w.
18. Ahn JY, An S, Sohn Y, et al. Environmental contamination in the isolation rooms of COVID-19 patients with severe pneumonia requiring mechanical ventilation or high-flow oxygen therapy. J Hosp Infect 2020;106(3). https://doi.org/10.1016/j.jhin.2020.08.014.
19. Zou L, Ruan F, Huang M, et al. SARS-CoV-2 viral load in upper respiratory specimens of infected patients. N Engl J Med 2020;382(12):1177–9. https://doi.org/10.1056/NEJMc2001737.
20. He X, Lau EHY, Wu P, et al. Temporal dynamics in viral shedding and transmissibility of COVID-19. Nat Med 2020;26:672–5.
21. Jones TC, Biele G, Muhlemann B. Estimating infectiousness throughout SARS-CoV-2 infection course. Science 2021;373(655). https://doi.org/10.1126/science.abi5273.
22. Pagliano P, Sellitto C, Conti V, et al. Characteristics of viral pneumonia in the COVID-19 era: an update. Infection 2021;49:607–16.
23. McIntosh, K. COVID-19: Clinical Features. UpToDate. Updated Jan 10, 2022. Available at: https://www.uptodate.com/contents/covid-19-clinical-features. Accessed March 18, 2022.
24. Wonhee S, Simon MS, Choi JJ, et al. Characteristics of procalcitonin in hospitalized COVID-19 patients and clinical outcomes of antibiotic use stratified by procalcitonin levels. Inter Emerg Med 2022;17(5):1405–12.
25. Schalekamp S, Bleeker-Rovers CP, Beenen LFM. Chest CT in the emergency department for diagnosis of COVID-19 pneumonia: Dutch experience. Radiology 2020;298:2.

26. Pantazopoulos I, Tsikrika S, Kolokytha S, et al. Management of COVID-19 patients in the emergency department. J Pers Med 2021;11(10):961.
27. Coronavirus Disease 2019 (COVID-19) Treatment guidelines. National Institutes of Health. 2022. Available at: https://www.covid19treatmentguidelines.nih.gov/. Accessed March 18, 2022.
28. Emergency department Covid-19 management tool. 2022. Available at: https://www.acep.org/globalassets/sites/acep/media/covid-19-main/acep-covid-19-ed-managem ent-tool.pdf. Accessed March 12, 2022.
29. Mertersky Mark. https://www.dynamed.com/condition/community-acquired-pneumonia-in-adults. Accessed 18 March 2022.
30. Center for Disease Control. Pneumocystis pneumonia: fungal diseases. 2021. Available at: https://www.cdc.gov/fungal/diseases/pneumocystis-pneumonia/index.html. Accessed March 6, 2022.
31. Akram SM, Koirala J. Histoplasmosis. StatPearls. Available at: http://www.ncbi.nlm.nih.gov/books/NBK448185/. Accessed March 6, 2022.
32. Patterson TF, Kauffman CA, Hall KK. UpToDate. Available at: https://www.uptodate.com/contents/treatment-and-prevention-of-invasive-aspergillosis?search=aspergillus%20pneumonia&source=search_result&selectedTitle=2~150&usage_type=default&display_rank=2#H5. Accessed March 6, 2022.
33. Woolfrey KGH. Pneumonia in adults: the practical emergency department perspective. Emerg Med Clin North Am 2012;30(2):249–70.
34. Kosmidis C, Denning DW. The clinical spectrum of pulmonary aspergillosis. Thorax 2015;70(3):270–7.
35. Khan AA, Farooq F, Jain SK, et al. Comparative host-pathogen interaction analyses of SARS-CoV2 and aspergillus fumigatus, and pathogenesis of COVID-19-associated aspergillosis. Microb Ecol 2021;(Nov 4):1–9.