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Pneumonia in the Emergency Department

Joseph F. Plouffe, MD^{a,*}, Daniel R. Martin, MD^b

^a5205 Canterbury Drive, Sarasota, FL 34243, USA

^bDepartment of Emergency Medicine, The Ohio State University Medical Center,
410 West 10th Avenue, Columbus, OH 43210, USA

Pneumonia is an important cause of morbidity and mortality in adults, with more than 5 million cases occurring annually in United States. Guidelines for the diagnosis and treatment of community-acquired pneumonia (CAP) have evolved since initial meetings in Halifax, Nova Scotia in 1991 [1]. Recent consensus guidelines for CAP have been published by a committee consisting of members from the Infectious Diseases Society of America (IDSA), American Thoracic Society (ATS), and Centers for Disease Control and Prevention (CDC) and are referred to as the 2007 CAP guidelines [2]. Guidelines for health care-associated pneumonia (HCAP) reflecting broader etiologies, including resistant gram-negative bacilli and *Staphylococcus aureus*, have been published by the ATS and IDSA [3]. This article draws extensively from these guidelines and their cited references. Our references emphasize more recent publications. The reader is referred to published guidelines for in-depth discussions and older references.

Common bacterial etiologies of CAP (Fig. 1) include *Streptococcus pneumoniae*, *Mycoplasma pneumoniae*, *Chlamydia pneumoniae*, *Haemophilus influenzae*, *Legionella pneumophila*, anaerobes associated with aspiration, *S aureus*, and gram-negative bacilli. Viral causes of CAP include influenza, parainfluenza, respiratory syncytial virus, metapneumonia virus, Hanta virus, coronavirus, varicella, and rubeola. *S pneumoniae* is the most commonly diagnosed etiology of CAP among patients treated in the hospital. *M pneumoniae*, *C pneumoniae*, and viruses are more common in patients treated at home. *S pneumoniae* is more common than *M pneumoniae* and *C pneumoniae* among patients who have moderate disease. *S pneumoniae*

* Corresponding author.

E-mail address: jsplouf@aol.com (J.F. Plouffe).

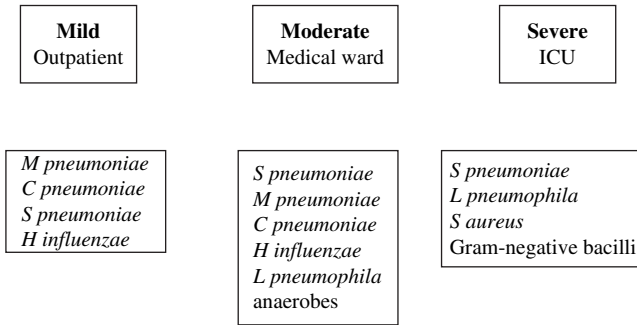


Fig. 1. Bacterial etiologies of CAP. ICU, intensive care unit.

and *L pneumophila* are more common in patients who have severe disease and are treated in the intensive care unit (ICU).

More recently, *S pneumoniae* has become more resistant to penicillin and the macrolides. A small proportion of cases are also resistant to fluoroquinolones. Recent antimicrobial use (within 3 months) is associated with resistance to the same class of antibiotics [4]. The 2007 guidelines emphasize the importance of recent prior antibiotic therapy and prescribing a different class of antimicrobial therapy. There is also evidence that resistance to penicillin and cephalosporins may be decreasing or stabilizing, whereas the resistance to erythromycin is increasing. Doern and colleagues [5], using data from 44 US centers, demonstrated a stable rate of penicillin resistance of 34.2%, with 15.7% intermediate resistance and 18.5% high resistance. Macrolide resistance had increased, although most was efflux pump mediated and considered to be low-level resistance. Nevertheless, the mean macrolide resistance of pneumococci was 27.2% in a recent meta-analysis [6]. Despite this relatively high rate, it is widely believed that this is likely attributable to the efflux pump mechanism, which is more a laboratory phenomenon, because significant failure rates with the newer macrolides have not been reported. Fluoroquinolone resistance was less than 1%. The most active β -lactam was ceftriaxone, with a resistance rate of 6.9%. Although prior antibiotic use of macrolides, penicillins, cephalosporins, and sulfonamides increased the likelihood of future pneumococcal antibiotic resistance to all these agents, this was not the case for fluoroquinolones, wherein pneumococci resistant to other antibiotics remained susceptible to fluoroquinolones [7]. The fluoroquinolone clinical failures that have been reported mainly have been with ciprofloxacin and levofloxacin. Ciprofloxacin is not considered an antipneumococcal fluoroquinolone, and levofloxacin failures occurred mainly at lower dose ranges [8]. The 2007 CAP guidelines caution that inappropriate overuse of fluoroquinolones (ie, acute bronchitis) hastens the development of resistance.

More recent data suggest that empiric coverage in all levels of CAP severity should include atypical organisms, such as *M pneumoniae*, *C pneumoniae*, and *L pneumophila*, although some reports [9,10] that analyzed several studies by

meta-analysis or review of published studies reported no difference in outcomes in hospitalized patients treated with atypical coverage versus β -lactams. These studies used antibiotics that included mainly monotherapy (macrolides or quinolones) in the treatment regimens for atypical organisms rather than a treatment regimen that included β -lactams in addition to atypical coverage, however. A recent report from Arnold and colleagues [11] evaluated the effects of treating CAP in four different worldwide regions with a β -lactam alone versus therapy, including atypical coverage, and reported significant benefits in time to clinical stability, decreased length of stay, decreased total mortality, and decreased CAP-related mortality when atypicals were treated.

One unanticipated result of previous guidelines was with pay-for-performance measure PN-5b, which recommended that antibiotics for patients who have CAP be administered within 4 hours of emergency department (ED) triage. Patients with respiratory symptoms who did not have pneumonia were inappropriately receiving antibiotics. In fact, one study [12] reported that 28.5% of patients with an admission diagnosis of CAP received antibiotics for CAP without radiographic abnormalities and this represented an increase from previous data (20.6%). In this study, the final diagnosis of CAP decreased to 58.9%. Data were publicly available. Local media compared hospitals regarding their success in treating CAP quickly.

Pines and colleagues [13] performed a survey of 90 academic ED directors or chairpersons, which revealed that 69% did not believe receiving antibiotics within the 4-hour time window would improve patient care. Most EDs instituted policies to improve timing of antibiotic therapy for patients suspected of having pneumonia, 46 (51%) automated chest radiograph (CXR) ordering at triage, 37 (41%) prioritized patients suspected of having pneumonia, and 33 (37%) administered antibiotics before obtaining CXR results. Despite these efforts, the increasing volumes in US EDs and resulting overcrowding made achieving 4-hour quality standards much less likely [14,15]. Another source of barriers to administer appropriate antibiotics rapidly is the atypical presentation of many patients who have CAP. One study found that altered mental status, absence of fever, absence of hypoxia, and elderly age were significant predictors of antibiotic delays, but it was not clear that such delays contributed to mortality [16]. Pines and colleagues [17] found that less severe illness and nonclassic presentation were associated with antibiotic delays. In another study, Metersky and colleagues [18] found that 22% of their cohort of admitted Medicare patients who had CAP presented in a manner that was atypical enough to cause delays in antibiotic administration. Fee and Weber [19] found that many of the "outliers" who were given their antibiotics after 4 hours did not have a diagnosis of ED CAP and many did not have an abnormal chest radiograph.

The two articles most often quoted regarding the benefit of early antibiotic therapy were by Meehan and colleagues [20] and Houck and colleagues [21], and as has been pointed out by others, these studies have numerous

limitations [22]. For example, the sample used was taken from the National Pneumonia Project from the Centers for Medicare and Medicaid Services (CMS) and included patients 65 years of age and older but excluded many patients who have immune-compromising conditions. Moreover, although it is assumed that these patients were treated in both studies by emergency medicine physicians in an ED before hospital admission, these details are never described anywhere in either paper; in fact, the term *emergency department* is not even used in the publications. Several recent editorials and opinion papers [23,24] have criticized this 4-hour time recommendation. The CMS is in the process of changing the 4-hour window (PN-5b) to a 6-hour window (PN-5c) for reporting purposes. The 2007 CAP guidelines have changed the focus from an absolute time frame to recommending that patients receive the initial antibiotic dose during their time in the ED before being admitted to the hospital. Hospitals were also urged to monitor for inappropriate antimicrobial treatment of patients who do not have CAP [2].

Patients come to the ED based on the severity of their symptoms. The ED physician faces a series of critical decisions. Initially, one must decide if the patient has pneumonia and, if so, where and how the patient should be treated. National guidelines suggest that local pneumonia protocols be established at each hospital. Patients treated at hospitals that follow CAP guidelines have been shown to have improved outcomes. Use of local protocols should facilitate improved patient care and documentation for reimbursement. Pham and colleagues [25] reported data on ED treatment of acute myocardial infarction (AMI) and pneumonia from the National Hospital Ambulatory Medical Care Survey involving 544 EDs from 1998 through 2004. Recommended antibiotics were administered to 69% of patients who had pneumonia, and pulse oximetry was measured in 46% of patients who had pneumonia. There were more than 2.7 million opportunities to improve care and 22,000 excess deaths per year associated with current treatment of AMI and pneumonia. These data suggest that we can continue to improve. ED physicians can be valuable team members in the development of local pneumonia protocols.

Local hospital pneumonia protocols

Each hospital should have its own protocol that reflects the local environment, resources, and patient population. Some of the factors to be considered in developing or redefining a local pneumonia protocol are listed here. Obviously, some cost is going to be expended. Hospital administrators need to be convinced that the pneumonia protocol is valuable. Certainly, adverse publicity can be avoided with good adherence. Local pneumonia protocols could be cost-saving, because fewer health care dollars would be spent by identifying patients who have mild disease and could be treated at home. Information from 2007 guidelines on site of care should provide important criteria [26,27]. The cost differential is hundreds of dollars for outpatient treatment

compared with thousands of dollars for an admission. Adherence to protocols also has resulted in shorter hospitalization stays with cost savings.

Factors to be included in local guidelines

Define local epidemiologic factors that may influence care

Proportion of antimicrobial resistance in *S pneumoniae*

Presence of outbreaks in community: influenza, methicillin-resistant *Staphylococcus aureus* (MRSA)

Type of patient population

Isolation procedures in the ED

Notification of local health authorities

Triage

Identify patients with respiratory symptoms

Rapid identification of patients with vital sign abnormalities

Define patients who should have pulse oximetry

Facilitate obtaining CXR and appropriate laboratory studies

Historical information (checklist may be a useful aid for documentation and completeness, especially to identify unusual circumstances)

Differential diagnosis

Factors that may influence the site and type of initial care

Immunization status: documentation

Physical examination

Mental status, vital signs, and oxygenation status are critical in profiling disease severity (**Box 1**)

Findings important in the differential diagnosis (**Box 2**)

Radiology: CXR and other imaging studies

Laboratory studies: results should be available promptly. It is important to note that most patients who have CAP come to ED outside of office hours. Adequate staffing can facilitate timely and appropriate treatment of patients.

Classification of pneumonia type (CAP versus HCAP)

Box 1. CURB65

Confusion: recent disorientation to person, place, or time

Uremia: blood urea nitrogen greater than 20 mg/dL (17 mmol/L)

Respiratory rate: 30 breaths per minute or greater

Blood pressure: systolic <90 mm Hg, or diastolic 60 mm Hg or less

Age 65 years or older

If the patient was transported to the ED by emergency medical technicians (EMTs), initial vital signs obtained by EMTs should be used to profile the patient.

One point for each abnormal variable (0–5 points) should be assigned.

Box 2. Nonpneumonic illnesses masquerading as pneumonia

Acute bronchitis: clear CXR

Chronic obstructive pulmonary disease (COPD) with exacerbation: change in dyspnea, sputum volume, or purulence

Asthma: prior episodes, wheezing

Pleuritis: pleuritic chest pain

Myocardial infarction: coronary artery disease, risk factors

Congestive heart failure (CHF): prior myocardial infarction, orthopnea, peripheral edema

Pulmonary emboli: leg pain, venous thrombosis, prior emboli, malignancy, recent prolonged plane or car travel

Lung cancer: weight loss, hemoptysis, smoker

Ruptured esophagus: protracted vomiting, severe chest pain

Profile CAP severity and site of care

Prescribe initial empiric therapy

Adequate follow-up for patients sent home

ED physicians and hospital administrators can address several of these issues and incorporate potential solutions in local pneumonia protocols (ie, provide oral antimicrobial therapy, set up ED holding area for initial observation, make follow-up telephone calls, arrange for ED follow-up visit for patients without a primary care physician).

Regardless of whether all these factors can be implemented into a local protocol for treatment of patients who have CAP, collection of subsequent quality improvement (QI) data is key to determine the successful adherence to these protocols.

Monitored data

National performance indicators

1. Initial antimicrobial therapy is consistent with 2007 CAP guidelines.
2. Initial antimicrobial therapy for hospitalized patients should be given in the ED.
3. Mortality data should be stratified by site of care in the hospital.
4. Is immunization for influenza or pneumococci recommended for the patient? Is the patient's immunization status up to date?

Additional data that may assist hospitals in improving care and documenting protocol success

Admitted or discharged?

Adequacy of follow-up for those treated at home?
Admitted to the ward or intensive care unit (ICU) and mortality rate for each?
Blood cultures in ICU admissions?
Documentation of antismoking advice?
Number of patients admitted to the ward and then transferred to the ICU (mortality)?
Length of stay?
Readmission rate?
Time back to work or prepneumonia activity?
Costs?

Protocol adherence

It seems logical that once a local protocol is put together, physicians should abide by the recommendations. Recent data from Australia showed minimal compliance with national recommendations, however [28]. Documentation of the pneumonia severity index (PSI) was only 5%. Concordance with antibiotic recommendations was less than 20%. Educational efforts are a critical part of protocol implementation and should be underway to improve acceptance and compliance. These efforts must include a defined educational campaign and a mechanism for auditing and providing feedback to ED physicians and ED QI committees.

Decisions to be made in the emergency department

1. Does the patient have pneumonia? (Fig. 2)
2. CAP versus HCAP? (Fig. 3)
3. How severe is the pneumonia, and where should the patient be treated? (Fig. 4)
4. What studies should be obtained in the ED?
5. Determine empiric antimicrobial therapy (Figs. 5–7)
6. Do unusual circumstances exist?
7. What are the new areas of diagnosis and treatment in the ED?

Available data to assist with decisions

National guidelines
Local guidelines
History and physical examination
Radiologic studies
Laboratory studies
Microbiologic studies
Consultation for unusual circumstances

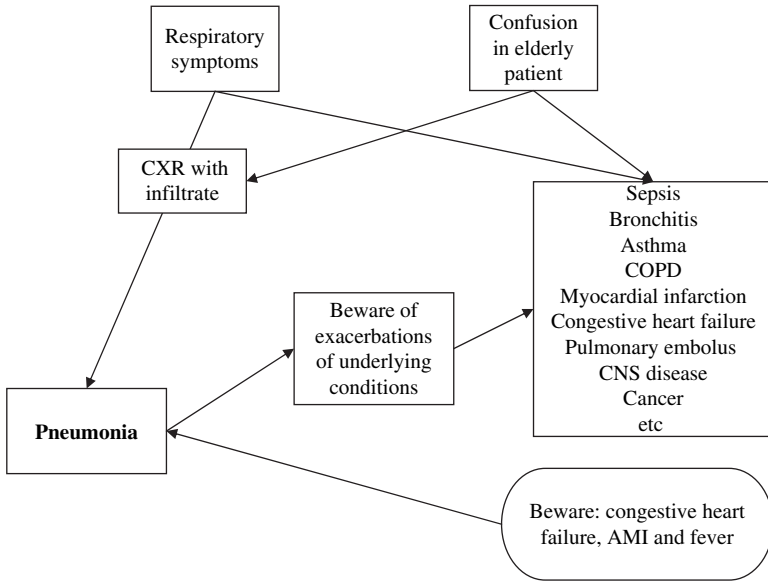


Fig. 2. Does patient have pneumonia, an alternative diagnosis, or perhaps both? CNS, central nervous system.

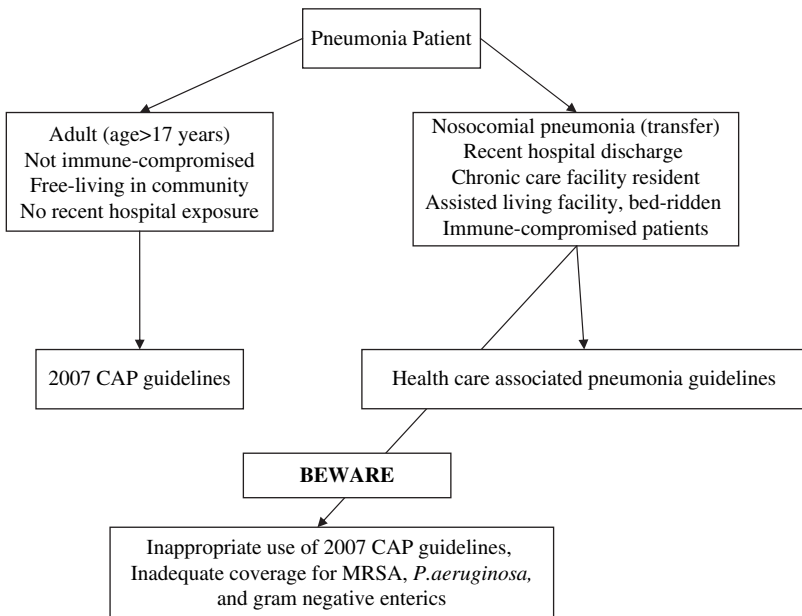


Fig. 3. Does patient have CAP as defined by the 2007 guidelines or not?

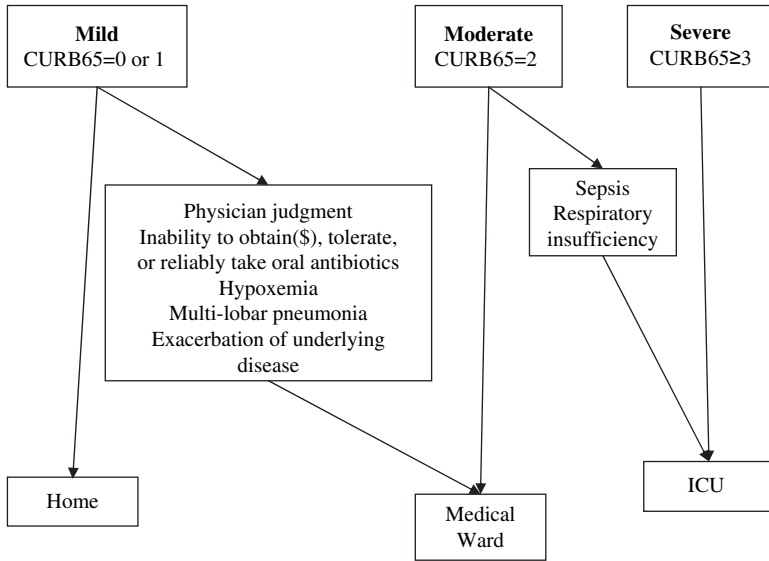


Fig. 4. Profile of disease severity.

Does the patient have pneumonia?

The patient who has pneumonia usually presents to ED with the recent onset of some respiratory symptoms that may include fever, acute cough (with or without sputum production), dyspnea, tachypnea, or chest pain.

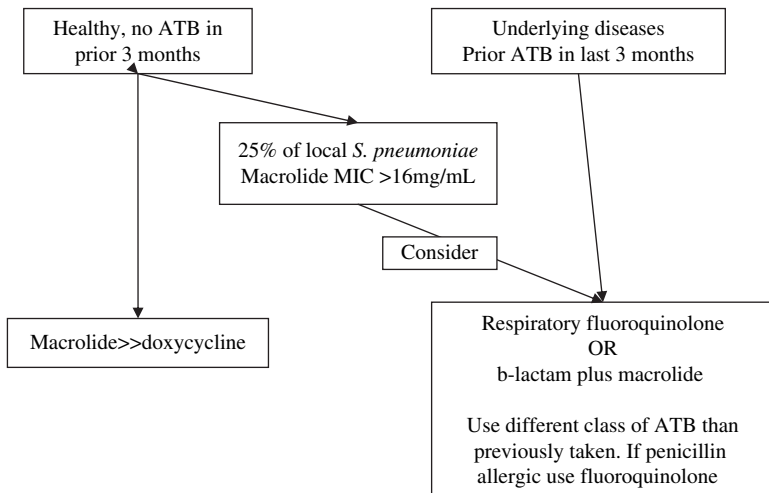


Fig. 5. Therapy for a patient who has CAP to be treated as an outpatient. ATB, antibiotics; MIC, minimum inhibitory concentration.

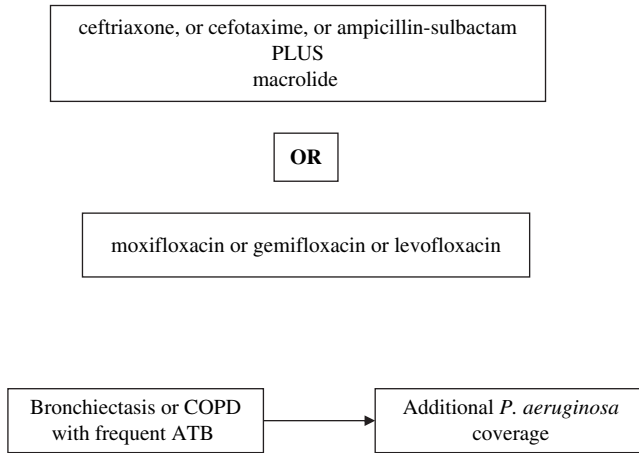


Fig. 6. Empiric therapy for patients who have CAP on the general ward. ATB, antibiotics.

Unfortunately, most patients do not have all the classic symptoms. In elderly patients, the presenting symptoms may not even point directly to the respiratory system (ie, decreased mentation, nonspecific aches and pains).

Symptoms may be associated with severe vital sign abnormalities. Immediate action may be required, including treatment of sepsis and respiratory failure.

As many as 30% of patients may have been pretreated with antimicrobial agents (personal physician, prior ED visit, or self-prescribed). Symptoms may not have resolved, or had a chance to resolve, or may have progressed. Infrequently, side effects from the antimicrobial agents bring the patient to the ED.

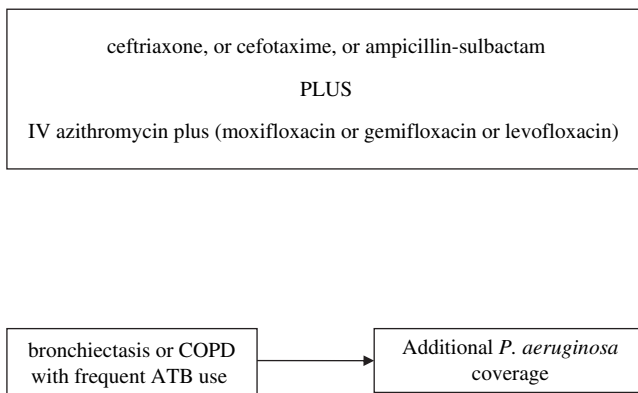


Fig. 7. Empiric therapy for patients in the ICU who have CAP. ATB, antibiotics.

The presenting respiratory symptoms may be caused by a nonpneumonic illness. The ED physician should identify the patient with a realistic possibility of pneumonia and differentiate patients presenting with other illnesses and similar symptoms (see Fig. 2). Information obtained from the history and physical examination should be helpful in making alternative diagnoses more or less likely. The presence of underlying diseases and medication history may be useful in defining the type of pneumonia and profiling its severity. Metlay and colleagues [29] reported that the absence of any vital sign abnormality or any abnormalities on chest auscultation can substantially reduce the likelihood of CAP. Several studies, including an emergency medicine evidenced-based review [30], make the point that there is no one historical finding or physical examination finding or combination of findings that can accurately rule in or rule out the diagnosis of pneumonia. Nevertheless, it is still recommended by these authors that history and physical examination findings can help to contribute to the diagnosis of pneumonia; thus, the concept of performing a complete history and physical examination findings continue to be an integral part of evaluating these patients. Moreover, pertinent history and examination findings can help the emergency physician to determine if certain organisms are more likely causative agents and whether antimicrobial resistance is likely.

The indications for a CXR in suspected CAP have been widely debated. An early report by Heckerling and colleagues [31] determined that certain findings, such as fever, tachycardia, decreased breath sounds, and absence of asthma were predictors of finding CAP on CXR. Subsequent studies suggest that no one symptom, sign or examination finding is statistically powerful enough to rule in or rule out the diagnosis of pneumonia on CXR. The absence of any vital sign abnormality, coupled with a normal examination, may nearly excluded the diagnosis, with only a 5% miss rate, as reported recently by O'Brien and colleagues [32]. Despite the lack of predictors to rule in the diagnosis, several vital sign abnormalities (hypoxia, fever, tachycardia, or tachypnea) make the diagnosis of pneumonia more likely [33]. Most consensus recommendations state that a CXR should be obtained in patients older than the age of 40 years and in patients with abnormal vital signs or physical examination findings or the presence of significant comorbidities.

CXR demonstrating an acute infiltrate is part of the definition of CAP in the 2007 guidelines. Unfortunately, the CXR rarely suggests a specific etiology. Multilobar infiltrates and cavity infiltrates are associated with poor outcomes. The presence of a pleural effusion may suggest empyema. The presence of hyperinflated airways or flattened diaphragms may suggest COPD, with the need for arterial blood gases and more cautious assessment. In patients with fever and a CXR interpreted as congestive heart failure (CHF), coexisting pneumonia should be considered.

Another limitation of the CXR is that despite the fact that it is considered the "gold standard" by many, it also has several limitations and does not have 100% sensitivity or 100% specificity. In one study, one third of admitted

patients were found to have a normal CXR on admission, and these patients had similar rates of positive blood and sputum cultures [34]. Although the CXR is still considered the standard of care for diagnosing CAP, high-resolution CT scanning may be more sensitive. In a frequently cited study [35], chest radiography missed 31% of cases of possible pneumonia (8 of 26 cases) that were subsequently diagnosed on high-resolution CT. Diagnosis by CT is being made even more commonly, given the increasing numbers of CT scans done to rule out common causes of chest pain, such as CT pulmonary embolus studies to rule out pulmonary embolus and CT aneurysm studies to rule out aortic dissection. The precise role of CT scanning to rule in or rule out CAP remains to be determined, however, and studies connecting the CT diagnosis with some microbiologic diagnoses are still lacking.

Is the pneumonia community-acquired pneumonia or health care-associated pneumonia?

Most patients who have pneumonia and are seen in the ED have CAP, and the approach to these patients can be as recommended in 2007 CAP guidelines (see Fig. 3). Previously, many ED studies of pneumonia lumped all pneumonia cases together. The ED physician must be alert to the occasional patient who has pneumonia who has HCAP or reasons cited here that exclude them from the 2007 CAP guidelines.

Children aged 17 years or younger are not covered by the recent CAP guidelines.

Patients exposed to an environment that has been altered by selective pressure of antimicrobial agents, such as those recently hospitalized (within 3 months), those residing in chronic care facilities, and those nonambulatory residents of nursing homes or assisted living facilities, should be considered to have HCAP. These patients have an expanded spectrum of etiologic agents that would be better addressed using the HCAP guidelines [3] with broader spectrum therapy. Appropriate consultation in this small group of patients is suggested. Ambulatory residents of assisted living facilities would be expected to have etiologies similar to those patients who have CAP.

Patients whose immune systems are compromised may have pneumonia caused by typical community organisms. A wide variety of unusual organisms may cause the pneumonia, however. The 2007 CAP guidelines exclude transplant recipients, lymphatic malignancies, neutropenic patients, patients receiving chemotherapy or high-dose steroids for at least a month, and HIV-infected patients with CD4 counts less than 350 cells/mm³ [2]. Appropriate consultation should assist in prescribing initial therapy in these patients because they generally require broader spectrum coverage.

There are minimal data on the proportions of patients presenting to the ED with pneumonia who have CAP versus HCAP. It has been the authors' experience that most patients presenting to ED with pneumonia have CAP. A recent study [36] from Barnes Hospital in St. Louis of 639 patients admitted

between 2001 and 2003 who had culture-positive pneumonia reported twice as many HCAP admissions as CAP admissions. *S aureus* (MRSA and methicillin-sensitive *Staphylococcus aureus* [MSSA]), *S pneumoniae*, *P aeruginosa*, and *H influenzae* were the most common pathogens identified overall. Patients who had HCAP frequently received inadequate empiric therapy (28.3%) and had a higher mortality rate (24.6%) than did patients who had CAP (inappropriate therapy of 13.0%, mortality rate of 9.1%). This series of patients is a different population from usually seen in EDs because it includes direct admissions from those caring for immune-compromised patients in a large medical center. The study also only addresses culture-positive patients. The data presented emphasize the importance in obtaining thorough historical information to distinguish accurately between patients who have CAP and HCAP, however.

Many of the patients admitted who have CAP are older and have associated chronic diseases. The stress of hypoxemia and or sepsis may worsen many of these conditions. Musher and colleagues [37] reported on 170 patients who had pneumococcal pneumonia, of whom 33 (19.4%) had concomitant severe acute cardiac conditions; CHF (new or worsening), arrhythmias, or AMI. Mortality was significantly higher in patients who had associated acute cardiac events. Lichtman and colleagues [38] reviewed 3904 cases of AMI and found 267 (6.8%) patients who also had an acute, severe, noncardiac condition in the initial 24 hours. Pneumonia was the most common coexisting illness. The adjusted mortality rate was fivefold greater for patients who had AMI and an additional acute severe illness. ED physicians must be vigilant for patients who have more than one acute disease.

How severe is the pneumonia, and where should the patient be treated?

Previous recommendations for deciding on the site and type of care were based, in part, on the PSI [26]. The PSI was made up of 20 variables and was somewhat cumbersome to use in many EDs. The 2007 guidelines favor the CURB65 (see Box 1) designed by the British Thoracic Society [27]. Only 5 variables are required: newly developed confusion (C), uremia (U), increased respiratory rate (R), decreased blood pressure (B) and age older than 65 years. Niederman [39] suggested that the two instruments should be complementary, because each has its limitations. Although the PSI has been used to determine which patients have a low mortality risk, it can occasionally underestimate CAP severity, especially in younger patients who do not have comorbid illnesses. In one study comparing both instruments in patients in the ED [40], both successfully predicted which patients had a low risk for mortality. The CURB65 had a better gradation of severe disease, however, with those patients having scores from 2 to 5 having a progressively greater mortality rate compared with the PSI, which has only two categories of severe illness (IV and V). Interestingly, both tools were designed to predict mortality and not to determine the optimal site of care. Renaud and colleagues [41] found that the routine use of the PSI increased the percentage of patients in PSI classes I and II

who were treated as outpatients (42.8%) compared with an ED in which the PSI was not routinely used (23.9%). The increased outpatient treatment was not associated with any compromise in patient safety. The accompanying editorial by Marrie [42] emphasized the need for prospective trials of patients discharged from the ED and managed on an ambulatory basis.

The most common recommendations have been that patients with a PSI class of I or II or a CURB65 score of 0 or 1 generally be considered “low risk” and may be considered for outpatient treatment (see Fig. 4). Patients who have mild pneumonia have low mortality rates (0.7%–2.1%) and prefer to be treated at home. Physician judgment can and should override site of care suggestion from low PSI or CURB65 scores in certain circumstances (see Fig. 4) [43,44]. Does the patient appear sicker than a “mild pneumonia”? Perhaps an underlying disease, such as CHF, coronary artery disease, diabetes, or COPD, has been exacerbated. Perhaps the patient is hypoxemic and requires oxygen supplementation even though the respiratory rate is less than 30 breaths per minute. Perhaps the pneumonia is more severe but has not yet been associated with systemic dysfunction (ie, multilobar infiltrates, cavitary disease). The patient must be able to fill a potentially expensive prescription in a timely fashion and tolerate and reliably take the antimicrobial therapy. Is there adequate supervision available for the patient over the subsequent 24 to 48 hours, and can adequate medical follow-up be arranged?

ED physicians and hospital administrators can address several of these issues and incorporate potential solutions in local pneumonia protocols (ie, provide oral antimicrobial therapy or the initial doses until a prescription can be filled, set up an ED holding area for initial observation, make follow-up telephone calls, arrange for ED follow-up visit for patients without a primary care physician). The cost of treating a patient who has pneumonia at home is hundreds of dollars versus thousands of dollars for treating patients in the hospital. Innovative partnerships with nursing home physicians may prevent hospitalizations for some patients better treated at the nursing home or for patients who have indicated a preference not to be hospitalized [45].

Patients who have mild pneumonia (CURB65 = 0 or 1) with confounding problems, as listed previously, may require admission to the general medical ward.

Most patients (90%) admitted to the hospital have moderate disease (CURB65 = 2) and are admitted to the general medical ward. The mortality rate for this group is 9.2%. There is an increased mortality rate among patients initially admitted to medical ward and then later transferred to the ICU. The reason for more intensive care is usually progressive respiratory failure. It has been difficult to predict this heterogeneous population that develops clinical deterioration after admission [46]. The 2007 guidelines suggest cautious assessment of patients who have hypothermia, multilobar infiltrates, leukopenia, and thrombocytopenia. Recent data suggest that

patients who have COPD and CAP have higher mortality rates and more frequently require mechanical ventilation [47,48].

Approximately 10% of admitted patients go directly to the ICU, with 80% of these patients requiring ventilatory support [46]. Patients in septic shock or with respiratory insufficiency are admitted directly to the ICU. Patients who have severe disease (CURB65 = 3, 4, or 5) usually are admitted to the ICU. Mortality is high in this population. Recent data from Spain [49] in patients who had CAP and were admitted to the ICU reported that a delay in the ED of longer than 1 hour in obtaining pulse oximetry resulted in a delay in initial antibiotic therapy. An ED delay in obtaining pulse oximetry of longer than 3 hours was associated independently with a twofold increase in mortality.

What studies should be obtained in the emergency department?

With regard to laboratory data, pulse oximetry should be part of the initial vital signs evaluation in all patients with a possible diagnosis of pneumonia.

For the patient who has mild disease who is to be treated at home, minimal or no additional laboratory data are needed.

In the sicker patient who is to be admitted, laboratory studies should include blood urea nitrogen (BUN; CURB65), complete blood cell count (CBC), differential, platelet count, and basic admission tests. In patients who have COPD, pulse oximetry is suboptimal. Arterial blood gases are necessary to define the carbon dioxide content. Urine antigen assays should be obtained for *Legionella* and pneumococci in sicker patients. These assays can be performed in 15 minutes, and results should be available to ED physicians in the same time frame as CBC results. In general the more severe the pneumonia, the more aggressive the diagnostic studies should be.

With regard to blood cultures, there has been debate about the cost-effectiveness of blood and sputum cultures in patients who have CAP [50]. Certainly, the low mortality rate in patients treated at home does not justify a search for an etiologic agent. The criticism of routinely obtaining blood cultures is that studies show that they rarely change therapy. A recent emergency medicine study reported that blood cultures altered therapy in only 3.6% of patients and that most of these were changes to narrow therapy, with only 1.0% of patients having their antibiotics broadened [51]. The accompanying editorial by Moran and Abrahamian [52] rationalized that blood cultures still make sense for patients in the ICU because they are more likely to be bacteremic and they are more at risk should empiric therapy be inappropriate. The editorial by Walls and Resnick [23] in the same issue criticized the JCAHO and CMS for adopting the original policy to require blood cultures for all admitted patients who have CAP, because the weight of evidence clearly does not support this. The 2007 guidelines recommend obtaining blood and respiratory cultures in all patients admitted to

the ICU. They also suggest obtaining blood cultures in a subset of patients admitted to the ward who have comorbid conditions associated with potentially higher bacteremic rates. Blood cultures should be obtained before empiric antimicrobial therapy. If patients were pretreated with antibiotics, blood cultures still should be obtained in appropriate patients, because resistant organisms may be present. In patients who have bacteremia, antimicrobial susceptibility can guide continued therapy and the appropriate switch to oral agents.

The value of microbiologic examination of sputum has always been debated. There is no value in examining saliva. If the patient is producing purulent sputum, however, important data can be obtained. MRSA is becoming a common pathogen in skin infections among community residents. Unfortunately, it is likely that as MRSA colonizes more community residents, it is going to become a more common cause of CAP. MRSA pneumonia has already been seen in children who have influenza. A Gram stain of an appropriate sputum specimen can be diagnostic for pneumonia caused by *S aureus*.

A sputum Gram stain and culture can be helpful in the patient with COPD who also has CAP. These patients have frequently been exposed to multiple courses of antibiotics and might have resistant pathogens. Recent data suggest that patients who have COPD and CAP are sicker and have a higher mortality rate than patients who do not have COPD [47,48].

Determining empiric antimicrobial therapy

Prior exposure to antibiotics or to an antibiotic-pressured environment can assist in deciding whether empiric therapy need cover antibiotic resistant *S pneumoniae*. Did the patient take any antibiotics in past 3 months? What kind of antibiotics? Has there been a recent hospitalization, prolonged exposure to medical outpatient clinics, or exposure to day care or preschool (direct or indirectly)? Many patients claim allergies to various antimicrobial agents. It is important to define the patient's definition of allergic symptoms (eg, anaphylaxis, hives, rash, upset stomach, diarrhea). In patients who state that they are allergic to penicillin, it is important to ask if they have been treated with cephalosporin antibiotics without allergic symptoms.

Recognition of epidemiologic clues may assist the ED physician in ordering empiric therapy, appropriate isolation procedures, and consultations. The epidemiologic information may be specific to the individual patient, such as exposure to the health care system, recent hospitalization, or residence in a chronic or extended care facility. The patient may have had a known exposure to a sick individual who had tuberculosis, chicken pox, or measles. A history of alcohol abuse, drug abuse, or neurologic disorders may suggest an increased likelihood of aspiration pneumonia.

Travel history should be documented in all patients (variance from local pneumonia protocol). The patient may have visited other communities with higher rates of resistant pneumococci. The patient may have been to

a foreign country with an outbreak of viral hemorrhagic fever, severe acute respiratory syndrome (SARS), or avian influenza. A recent cruise, whirlpool spa exposure, or travel away from home in the past 2 weeks may be associated with Legionnaire's disease.

If animal or bird exposure has occurred, consider the following associations:

Rabbit hunting: tularemia

Psittacine birds: psittacosis

Cattle, pregnant cats: Q fever

Cave exploring, bat exposure: histoplasmosis

Similarly, the type of employment should be documented (ie, day care, preschool, chronic care, extended care facility, laboratory worker, pet store employee). Importantly, is the patient in residence at a chronic care or an assisted living facility (ambulatory)?

Physical examination may suggest particular diagnoses or important coexisting illnesses, including mental status changes, such as a recent change in the ability to recognize persons, place, and time, and patients who have neurologic disorders and those with drug or alcohol abuse may have an increased incidence of aspiration pneumonia. Intravenous drug abuse may be associated with undiagnosed HIV infection.

Presence of nuchal rigidity: meningitis may be also present.

Red, swollen, tender joint: septic arthritis may be present.

Rash: varicella, rubeola, hemorrhagic fever, or stigmata of intravenous drug or alcohol abuse may be present.

The lung examination and auscultatory findings may indicate consolidation; dullness to percussion; or diminished breath sounds, which may also suggest pleural effusion (may suggest obtaining a lateral decubitus film). Signs of COPD are useful in categorization of the patient and suggest the need for measurement of arterial blood gases.

Cardiac examination may reveal pericarditis or signs of CHF. Abdominal examination may assist in the diagnosis of findings consistent with cirrhosis, such as ascites, small liver, or jaundice. Extremity examination may reveal swelling, calf tenderness, needle tracts, or diminished pulses.

Fig. 5 summarizes outpatient empiric treatment recommendations that are designed to treat atypical pathogens, *S pneumoniae*, and *H influenzae*. For uncomplicated CAP, a newer macrolide or less optimally doxycycline is usually recommended. If there are problems with local macrolide resistance for *S pneumoniae* or recent use of antibiotics, a respiratory fluoroquinolone or combination oral therapy is recommended. Although not well studied, it seems logical that patients who have mild CAP and are to be treated at home should receive their first dose of oral antibiotics in the ED unless the prescription can be filled immediately.

With regard to macrolides, azithromycin and clarithromycin are better tolerated than erythromycin. Azithromycin has better activity against *H influenzae*. Doxycycline as a macrolide alternative is a less expensive, although there are few data in comparison trials.

With regard to respiratory fluoroquinolones, moxifloxacin, gemifloxacin, and levofloxacin have good activity against atypical pathogens, *S pneumoniae*, and *H influenzae*.

With regard to oral β -lactams to be used with macrolides for outpatient therapy, high-dose amoxicillin, 1 g, administered three times daily or amoxicillin-sulbactam, 2 g, administered twice daily is preferred in the 2007 guidelines because of their activity against *S pneumoniae*. Less preferred alternatives include cefpodoxime, cefuroxime, or parenteral ceftriaxone.

In patients admitted to the general medical ward with moderate pneumonia, parenteral antimicrobial therapy is generally recommended (see Fig. 6). Empiric therapy is designed to cover *S pneumoniae*, *H influenzae*, and the atypical pathogens, including *Legionella* spp. The two major choices would be combination therapy with a β -lactam and a macrolide or monotherapy with a fluoroquinolone. Both of these regimens are suboptimal for pneumonia caused by MRSA, some gram-negative enterics, and *P aeruginosa*. Care must be taken to search for clues for unusual circumstances that would make these organisms more likely possible etiologic agents. For patients who have bronchiectasis or COPD with frequent antibiotic courses, obtain consultation for additional *P aeruginosa* coverage.

The β -lactams (parenteral) recommended for inpatients include ceftriaxone, cefotaxime, and ampicillin-sulbactam because of their activity against *S pneumoniae*.

Patients admitted to the ICU who have severe pneumonia should receive the broadest empiric therapy (see Fig. 7) because they are in imminent danger of respiratory failure and death. All patients should receive combination therapy with a β -lactam plus intravenous azithromycin or intravenous fluoroquinolone. As with patients admitted to the general medical ward, if the patient has bronchiectasis or COPD associated with frequent antibiotic therapy, additional *P aeruginosa* therapy should be added.

Do unusual circumstances exist?

Historical information associated with travel, an unusual living environment, unusual exposures, or work or leisure activities should prompt additional questions and perhaps consultation. Local pneumonia protocols need to be updated if organisms, such as MRSA, become a community problem.

Penicillin allergy may be claimed by 20% to 30% of patients who have pneumonia. Carefully define what the patient means by penicillin allergy. Has the patient taken cephalosporins without difficulty? If not a type 1 hypersensitivity, cephalosporins may be used for inpatients. For outpatients, if macrolides are not an option, use a respiratory fluoroquinolone. Similarly,

for patients admitted to a medical ward in which macrolides are not an option, use fluoroquinolones rather than combination therapy. In patients admitted to the ICU, the 2007 guidelines recommend using a respiratory fluoroquinolone and aztreonam. Local pneumonia guidelines need to address this issue, because many pharmacies may not stock aztreonam. Appropriate consultation may be helpful in these patients.

If an outbreak of influenza is occurring in the community, patients suspected of having influenza should be placed on respiratory isolation in the ED. If the results of rapid antigen testing for influenza are positive, antiviral therapy should be prescribed. The most common cause of bacterial pneumonia in patients who have influenza is *S pneumoniae*. Other organisms to consider include *S aureus* (MSSA or MRSA), *H influenzae*, and *Neisseria meningitidis* (with concomitant meningitis). A Gram stain and culture of purulent sputum may assist with the diagnosis of staphylococcal pneumonia. Blood cultures should be obtained in these patients.

What are the new areas of diagnosis and treatment in the emergency department?

Rapid diagnosis of pathogens to aid in the choice of initial antibiotics

Unfortunately, most of the antimicrobial therapy in the ED is empiric, because we have few rapid diagnostic assays to identify etiologic agents. Rapid assays for detection of *S pneumoniae* antigens in urine, *L pneumophila* serogroup 1 antigens in urine, and throat swabs for influenza A and B antigens are available. Pneumococcal urinary antigen detection is highly specific in the adult population with pneumococcal pneumonia [53,54]. Rarely, recent (within days) administration of a pneumococcal vaccine may be associated with a false-positive result on a pneumococcal urinary antigen assay [55]. A negative pneumococcal urinary antigen result does not exclude bacteremic pneumococcal pneumonia.

A positive *Legionella* urinary antigen assay result is highly specific for pneumonia caused by *L pneumophila* serogroup 1 [56]. A negative urinary antigen result for *Legionella* can be seen in mild *L pneumophila* serogroup 1 disease or in pneumonia caused by other serogroups or species of *Legionella* [57]. In the United States, most cases of Legionnaire's disease are caused by *L pneumophila* serogroup 1 [58].

Influenza antigen detection is useful early in an influenza community outbreak. There are 15 rapid antigen detection kits approved by US Food and Drug Administration (FDA) [59]. The sensitivity is approximately 75%. Influenza antigen detection can also be useful in immune-compromised patients who have pneumonia, because antigen detection is associated with influenza replication. Antiviral therapy should be administered, and a search for a secondary bacterial pneumonia should be initiated.

Polymerase chain reaction (PCR) assays for a wide array of respiratory pathogens have been reported in the literature; however, to date, they

have not been clinically available to ED physicians. Costs and logistical problems should be solved in the future, however.

Rapid antigen detection of MRSA is being developed and would be a useful addition [60,61]. Current empiric regimens do not cover for MRSA. Currently, the sputum Gram stain is the most rapid diagnostic test for staphylococcal pneumonia.

Using serum markers to predict poor outcomes and adjunctive therapy

Inflammatory markers are elevated in patients who have CAP [39]. C-reactive protein and procalcitonin are more elevated initially in those with poorer outcomes [62]. These markers may be useful in evaluating immunomodulating therapy with such agents as activated protein C [63] or steroids [64–66]. Research continues into the possible role of adjunctive immunomodulating therapy in patients who have severe CAP. A review by Gorman and colleagues [67] states that with current data, corticosteroids cannot be recommended for adjunctive treatment of severe CAP.

Summary

Pneumonia is a common disease seen in the ED. More structured approaches to patients who have pneumonia have evolved. Recent 2007 CAP guidelines from the ATS, IDSA, and CDC are summarized. The importance and outline for a local CAP protocol are discussed. An approach to the patient who has pneumonia is presented, including the differential diagnosis, CAP or non-CAP disease, severity of pneumonia, site of care, initial therapy, and unusual circumstances.

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