Emergency Department and Inpatient Community-Acquired Pneumonia: Practical Decision Making and Management Issues

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Abstract The objective of this article is to review evidence behind community-acquired pneumonia disease management in the emergency department and inpatient setting. Focus was placed on recent guidelines from the American Thoracic Society, the Infectious Diseases Society of America (Mandell et al., Clin Infect Dis 44:S27–72, 2007), and the American College of Emergency Physicians (Nazarian et al., Ann Emerg Med 54:704–31, 2009). These guidelines were used to review the use of blood cultures, empiric antibiotic selection, indications for expanded testing, site-of-care decisions, and discuss clinical parameters for outpatient discharge. This review is intended for ED physicians as well as hospital non-intensive care providers.

Keywords Community-acquired pneumonia · Pneumonia guidelines · Blood cultures · Clinical decision rules · Empiric antibiotics · Length of stay

Introduction

Community-acquired pneumonia (CAP) is defined as an acute infection of the pulmonary parenchyma, which is presumed to be acquired outside hospital or healthcare facilities [1•]. It is a common and often serious illness that in 2007 accounted for nearly 1.1 million hospitalizations in

the United States [2]. CAP is the eighth leading cause of death [3] and is responsible for costs nearing \$9 billion [4]. Pneumonia is an infection of the alveolar portion of the lung, which leads to an inflammatory response filling the alveoli with infectious organisms, exudate, and white blood cells. This hinders gas-exchange and can result in clinical features such as productive cough, fever, dyspnea and septic shock. The organisms responsible for the disease are often bacterial but can involve fungal, viral, and parasitic etiologies. Chest radiograph is the most common modality used in diagnosing the disease. Although the diagnosis can be readily achieved, further diagnostic and management decisions can sometimes be complex.

In the current age of multiple subcategories of pneumonia, it is useful to identify patients who meet criteria for CAP. There are four widely recognized categories of pneumonia based on location and method of presumed acquisition: CAP, hospital-acquired pneumonia (HAP), healthcare associated pneumonia (HCAP), and ventilator-associated pneumonia (VAP) [5, 6]. The definitions of the sub-categories of pneumonia are as follows:

1. CAP—Acute lung parenchymal infection not meeting criteria for HCAP, HAP, and VAP
2. HAP—Pneumonia that occurs 48–72 h after admission to the hospital
3. HCAP—Pneumonia in a patient who has been hospitalized for two or more days within 90 days of the infection, resides in a long-term care facility, received intravenous antibiotic therapy, chemotherapy, or wound care within 30 days of the infection, or a patient that regularly attends a hospital hemodialysis clinic
4. VAP—Pneumonia that develops 48–72 h after endotracheal intubation

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Patients presenting with clinical findings of pneumonia fall into one of these four categories, each category having different pathogen profiles and management strategies. This review focuses primarily on patients presenting with bacterial causes of CAP.

There have been multiple guidelines published in the last 10 years addressing management of CAP. In 2007, the ATS/IDSA published consensus guidelines discussing CAP in adults [7]. The ACEP also published guidelines for CAP in 2009 [1•]. These guidelines were used to establish practical recommendations discussed in this article.

Blood Cultures

Obtaining routine blood cultures in CAP has historically been a controversial issue. The cost and yield of blood cultures has led to the questioning of their utility as standard of care. Ideally, when cultures are positive, antibiotic selection can be optimized to target the causative pathogen. True positive blood cultures can also assist in epidemiologic monitoring of pathogens. Alternative views question the cost-effectiveness of routine blood cultures because of low yield and high false positive rates.

A number of studies have investigated the impact of blood cultures on antibiotic management in CAP. The yield of positive results range from 0 % in low risk populations [8] to 33 % in ICU patients [9]. Typical overall rates of yield are <16 % and blood cultures change antibiotic selection in <5 % of cases [1•]. In 2003, Campbell et al. [10] studied 760 patients with CAP and found only 3/760 (0.4 %) blood cultures resulted in pathogens that required expanding empiric antibiotic selection. Similar studies show rates of resistant organisms ranging from 0 to 2.7 % [11–15]. False-positive rates with routine blood cultures in CAP have been found to be near true-positive rates [12, 13, 15, 16].

The Joint Commission currently supports two performance measures addressing blood cultures for patients with CAP [17]:

1. The collection of blood cultures prior to antibiotic administration, when ED blood cultures are drawn
2. For patients who were transferred to or admitted to the ICU within 24 h of presentation: blood cultures should be performed within 24 h prior to or 24 h after hospital arrival

The second performance measure has come into question, as it essentially requires physicians to predict the course of a patient over a 24 h time period. Although several prediction scores exist to address the need for critical care in patients with CAP, none are 100 % predictive.

Both the ATS/IDSA and ACEP guidelines argue against obtaining routine blood cultures from the ED [1•, 7]. The ATS/IDSA guidelines recommend obtaining blood cultures in the following conditions:

1. Cavitory infiltrates
2. Leukopenia
3. Active alcohol use
4. Chronic severe liver disease
5. Asplenia
6. Positive test result for pneumococcal urinary antigen
7. Pleural effusion
8. Patients admitted to the ICU

Blood cultures are optional for all other patients presenting with CAP. ACEP guidelines [1•] give a Level C recommendation for obtaining blood cultures in patients with:

1. Severe disease
2. Immunocompromise
3. Significant comorbidities
4. Other risk factors for infection with resistant organisms

Severe disease is defined as those patients presenting with hypothermia, hypotension, tachycardia, and pneumonia severity index (PSI) scores putting the patient in class IV or V. Liver disease, hyponatremia, leukopenia or leukocytosis were stated as independent predictors of bacteremia with resistant organisms.

Empiric Antibiotic Selection

Empiric antibiotic selection for CAP is based on the likely pathogen, treatment setting, patient comorbidities and exposures, as well as patient allergies. These factors, coupled with the complexities of hospital formularies, make prescribing patterns variable from institution-to-institution and physician-to-physician. Understanding indications for certain classes of antibiotics can help decrease initial treatment failure and expedite outpatient disposition while maximizing cost-effectiveness.

Predicting the causative organism is the biggest challenge facing a physician choosing empiric antibiotic treatment. The most common bacterial cause of CAP is *Streptococcus pneumoniae*. Other common bacterial organisms include Methicillin-sensitive *Staphylococcus aureus* (MSSA), Methicillin-resistant *Staphylococcus aureus* (MRSA), *Haemophilus influenzae*, *Moraxella catarrhalis*, and *Klebsiella pneumoniae*. Other less common bacterial causes include *Chlamydia pneumoniae*, *Legionella pneumophila*, *Pneumocystis jirovecii*, and *Mycobacterium tuberculosis*. The incidences of causative

agents vary with time and location. Knowledge of local epidemiologic surveillance patterns and resistance should be the ultimate guide when choosing empiric antibiotic therapy.

Two of the pathogens above warrant further discussion: *S. pneumoniae* and MRSA. Both of these organisms are common in the community population and have emerging resistance to traditional antibiotic regimens. *S. pneumoniae*, as mentioned above, is the most common causative organism in CAP worldwide [7, 18–21]. It is a gram-positive, alpha-hemolytic member of the genus *Streptococcus* and, despite its name, causes not only pneumonia but also various other infections from cellulitis to endocarditis. Antimicrobial resistance patterns for *S. pneumoniae* are a serious health concern and may impact empiric regimens in the near future. In 2013, the SENTRY Antimicrobial Surveillance Program reported alarming rates of resistance among *S. pneumoniae* isolates [22•]. Over a 14-year period, 18,911 samples of *S. pneumoniae* were collected, with nearly three-fourths of the isolates from the lower respiratory tract. Amoxicillin/clavulanate showed a decreased susceptibility from 90.9 to 82.2 % over this period. Susceptibility for Ceftriaxone decreased from 97.3 % in 1998 to 87.2 % in 2011. Levofloxacin, on the other hand, only showed slight reduction in susceptibility rate, declining from 99.8 to 98.8 % over the same years.

Staphylococcus aureus is another organism that less-commonly causes pneumonia but has a changing resistance pattern over the last decade. Most practicing physicians face Methicillin-resistant *Staphylococcus aureus* (MRSA) on a regular basis. Nosocomial strains of *S. aureus* have demonstrated resistance for some time. In the late 1990s, strains of community-acquired infections attributed to *S. aureus* were mostly methicillin-sensitive with <10 % of culture-positive isolates demonstrating methicillin-resistance [23]. However, between 2006–2009, MRSA accounted for over 40 % of *S. aureus* obtained in the community setting. Recently this pathogen has obtained its own designation, community-acquired MRSA (CA-MRSA). CA-MRSA, for unclear reasons, shows tendency toward increased virulence in comparison to healthcare-associated MRSA (HCA-MRSA) [24].

In 2011 the Infectious Disease Society of America published clinical practice guidelines focused on MRSA [25•]. Section IV of the guidelines discusses patients hospitalized with CAP. Recommendations include empiric antibiotic coverage for MRSA in three situations:

1. CAP requiring intensive care unit admission
2. Necrotizing or cavitary infiltrates
3. Presence of empyema

The traditional gold standard for intravenous treatment of suspected MRSA pneumonia is vancomycin [24].

However there appear to be high rates of vancomycin failure (>40 %) in patients with MRSA pneumonia, especially when associated with bacteremia [24, 26]. The IDSA recommendations in 2009 that specifically address MRSA bacteremia recommend high dosing at 15–20 mg/kg [27]. An area under the curve to minimum inhibitory concentration ratio (AUC/MIC) ≥ 400 also has been associated with improved outcomes in MRSA bacteremia [28, 29].

Linezolid is a synthetic oxazolidinone antibiotic also approved for treatment of MRSA suspected pneumonia. In several trials, linezolid has proven to be as efficacious as vancomycin in treatment of MRSA pneumonia [30–34]. The benefit of linezolid is its 100 % bioavailability, making easy transition to outpatient oral therapy. It has relatively few side effects and 60-day mortality rates similar to vancomycin [35]. The downside of linezolid is its relative expense compared to vancomycin. Unfortunately, most of the studies comparing both vancomycin and linezolid are based on nosocomial infections and their efficacy in CA-MRSA pneumonia is unknown.

Streptococcus and *Staphylococcus* sp. account for a significant amount of CAP, but not all. Fortunately many other bacterial pathogens have shown stable resistance patterns in the early 2000s [36, 37, 38•]. Empiric regimens covering atypical pathogens (*Legionella* sp., *Chlamydia* sp., and *Mycoplasma* sp.) have been shown to decrease time to clinical stability, length of hospitalization, and patient mortality [39]. Typically these regimens include a macrolide antibiotic or a respiratory fluoroquinolone.

Assuming a patient with CAP presenting to the emergency department with characteristics representing low risk of resistant organisms, two empiric regimens predominate for inpatient non-ICU treatment:

1. Third-generation cephalosporin combined with macrolide antibiotic
2. Respiratory fluoroquinolone as sole therapy

Cephalosporins combined with macrolide antibiotics have dual coverage for *S. pneumoniae* as well as atypical organisms. Respiratory fluoroquinolones combine high efficacy against both *S. pneumoniae* and atypicals in one agent. Both regimens have been shown to be efficacious with little difference in outcome [7, 40, 41]. For the occurrence of a patient allergic to one or more of these agents, further regimens should be discussed with appropriate consultants (e.g. Infectious Disease). Ertapenem in combination with a macrolide antibiotic can circumvent fluoroquinolone and/or cephalosporin allergies and provide efficacious coverage [7].

Patients with severe CAP prompting ICU admission require broader spectrum empiric antibiotics that cover for more virulent organisms. This includes coverage for MRSA, *Pseudomonas* sp., and resistant *S. pneumoniae*.

Antibiotic considerations should include vancomycin or linezolid for MRSA if appropriate. Piperacillin/tazobactam, cefepime, meropenem or imipenem plus a respiratory fluoroquinolone are recommended choices if *Pseudomonas* sp. is suspected. Aminoglycosides alone have also been recommended in treatment of *Pseudomonas* sp. Local resistance patterns for *S. pneumoniae* should be considered in severe CAP.

There are a few newer antibiotics on the horizon that are showing promise in treating CAP. Parenteral 2-aryl carbapenems that have broad-spectrum activity against CAP pathogens are currently in development [42]. In 2010, ceftaroline received Food and Drug Administration approval for treatment of CAP. Surveillance programs from 2008 to 2010 showed increased activity of ceftaroline against ceftriaxone-resistant pneumococcal isolates as well as good activity against β -lactamase producing strains of *H. influenzae* and *M. catarrhalis* [43]. Ceftobiprole, a broad-spectrum parenteral cephalosporin is another potential agent in development against usual CAP pathogens as well as MRSA [44]. Other antibiotic classes with developing agents include ketolides, quinolones, and investigational semi-synthetic pleuromutilin antibiotics [44].

After clinical stabilization, the next steps are to transition to oral therapy and decide on duration of treatment. It is important that the patient demonstrate clinical response to the empiric regimen, otherwise change in treatment regimen must be made based on further diagnostic workup. If clinical response is obtained from the empiric regimen, the ATS/IDSA guidelines recommend staying within the class of antibiotics for oral therapy [7]. Patients initially treated with a parenteral β -lactam and macrolide can continue with a macrolide-only regimen.

Indications for Expanded Testing

There are a myriad of additional testing modalities that can be used in CAP to aide in management. The ATS/IDSA guidelines discuss some of these including urinary antigen testing (UAT), bronchoalveolar lavage (BAL), thoracentesis with pleural fluid cultures, sputum cultures, and miscellaneous testing. Table 1 provides a summary of their recommendations.

There are currently two FDA-approved immunochromatographic urine tests applicable to CAP. UAT for *Legionella* sp. is available and can detect most common species of this organism with a 70 % sensitivity [38•]. *S. pneumoniae* UAT is also available showing sensitivity ranging from 50 to 80 % [45–47]. The advantage of UAT is quick turnaround and ability to detect *S. pneumoniae* even after antibiotics have been initiated [48]. The downside of UAT is that it rarely changes empiric selection as

most regimens target *S. pneumoniae* and *Legionella* sp. among other organisms. UAT may have a theoretical benefit in epidemiologic studies monitoring pathogen prevalence and response to therapies. Further research is needed to identify the exact relevance of urinary antigen testing in clinical CAP.

Polymerase chain reaction (PCR) assays may benefit clinical management of CAP in the near future. Viral panel testing is currently widely available via PCR techniques and can rapidly identify common respiratory viral pathogens. These tests can be helpful, especially with influenza virus, however further investigation is needed to identify their impact. Further PCR assays to rapidly detect *M. Tuberculosis*, *Bordetella pertussis*, *C. pneumoniae*, *Mycoplasma pneumoniae*, and MRSA are showing early promise to help clinically distinguish these important pathogens [38•, 49, 50].

The serum marker procalcitonin has recently been proposed to be useful in distinguishing bacterial from non-bacterial causes of CAP as well as monitoring therapy. Using procalcitonin levels to direct therapy has been shown to reduce unnecessary antibacterial exposure and antibacterial-associated adverse events [51]. Utilizing procalcitonin as a serum marker of therapy efficacy has also led to shortened duration of antibacterial therapy [52].

The utility of sputum cultures has been debated for some time. Obtaining sputum cultures is a non-invasive means of perhaps identifying the causative organisms. Their yield, however, is dependent on timing and skill in sample collection. Frequently patients are unable to provide adequate specimens in a timely fashion [53]. Results obtained after initiation of antibiotic therapy should be interpreted with caution as they can represent inaccurate results [53–55]. Combining gram staining of the sample with culture can be beneficial. Gram staining has a rapid turnover and can influence empiric antibiotic choices, especially when uncommon or highly resistant pathogens are found [7]. This can be particularly important with organisms such as MRSA. The gram stain can also help identify true-positive culture results. Endotracheal aspirates and BAL increase positive yield but are much more invasive and resource intensive.

Site-of-care Decisions

The disposition of an emergency department patient with CAP can impact multiple factors including length-of-stay, mortality, and overall cost of illness. Decision making points include: inpatient versus outpatient care and ICU versus general ward care. It is important for both emergency and inpatient physicians to know when a patient could potentially benefit from ICU care rather than general ward, and vice versa. Patients admitted to general wards

Table 1 Recommendations for further testing in patients with CAP

Indication	Blood culture	Sputum culture	Legionella UAT	Pneumococcal UAT	Other testing
Intensive care unit admission	X	X	X	X	A
Failure of outpatient antibiotic therapy		X	X	X	
Cavitary infiltrates	X	X			B
Leukopenia	X			X	
Active alcohol abuse	X	X	X	X	
Chronic severe liver disease	X			X	
Severe obstructive/structural lung disease		X			
Asplenia (anatomic or functional)	X			X	
Recent travel (within past 2 weeks)			X		C
Pleural effusion	X	X	X	X	D

Adapted with permission from ATS/ISDA Guidelines [7] for CAP treatment

A, Endotracheal aspirate if intubated, consider bronchoalveolar lavage; B, Fungal and tuberculosis cultures; C, See supplementary table; D, Thoracentesis with pleural fluid cultures

and then require transfer to ICU care within 48 h have increased mortality rates when compared to patients directly admitted to the ICU [56–59]. On the other hand, limited ICU resources should be reserved for only those patients that truly need increased care. The complex nature of site-of-care optimization has led to the development of multiple clinical decision rules in the past several years.

The first decision to be made is if the patient requires hospitalization. Inpatient treatment has been estimated to be ~25 times more expensive than outpatient treatment [60]. The bulk of cost in treating CAP is due to inpatient care rather than outpatient treatment. Thus it stands to reason that if ED physicians can safely discharge patients for outpatient treatment the cost benefits could be substantial. Two clinical decision rules can aide in deciding which patients need admission and which can be treated in the outpatient setting: the Pneumonia Severity Index (PSI) and the Confusion, Uremia, Respiratory rate, Blood Pressure, and age ≥ 65 Score (CURB-65).

The PSI, formerly known as the Pneumonia Patient Outcomes Research Team (PORT) system, is based on 19 variables including clinical, laboratory, and demographic characteristics. Step I of the PSI identifies those patients that are extremely low risk of mortality and can safely be discharged. Step II assigns a classification from II to V based on the 19 variables involved in the scoring system. Classes I–III are considered mild CAP and outpatient treatment can be considered, whereas classes IV and V are recommended for inpatient treatment [61, 62]. The PSI is widely used and calculators are available online to assist in the day-to-day use of the criteria [63].

The limitation of the PSI is that it requires significant input of patient characteristics and laboratory values. This can be time-consuming and cumbersome for emergency department physicians looking for a quick, easy decision rule. In 2003 the CURB-65 [64] score was developed. This decision rule offers a quick, simple alternative to the PSI.

It involves five parameters, which are easily obtained in the emergency department:

1. Confusion/altered mental status
2. Uremia (BUN > 19 mg/dl)
3. Respiratory rate ≥ 30 breaths per minute
4. Blood pressure (Systolic < 90 or diastolic < 60 mmHg)
5. Age ≥ 65

Each parameter counts for 1 point with the overall score determining recommended site-of-care based on risk of death at 30 days (ROD): outpatient (score 0–1; 0.7–3.2 % ROD), inpatient (score 2–3; 3.0–17.0 % ROD), and ICU (score 4–5; 41.5–57.0 % ROD). In 2010 a meta-analysis showed that both PSI and CURB-65 scores were accurate in predicting 30-day mortality and there were no significant differences in overall test performance between the two prediction rules [65].

Both the CURB-65 and PSI scores were developed looking at factors that affect 30-day mortality. In 2008, the Systolic blood pressure, Multilobar involvement, Albumin, Respiratory rate, Tachycardia, Confusion, Oxygen level, pH (SMART-COP) decision rule was developed to assist in predicting which patient will require invasive respiratory or vasopressor support [66]. SMART-COP is a relatively easy tool consisting of 8 parameters that can assist in deciding ICU necessity:

1. Systolic blood pressure < 90 mmHg (2 points)
2. Multilobar infiltrates (1 point)
3. Albumin < 3.5 g/dL (1 point)
4. Respiratory rate ≥ 25 breaths/min* (1 point)
5. Tachycardia—heart rate ≥ 125 beats/min (1 point)
6. Confusion (1 point)
7. Oxygen saturation ≤ 93 %** (2 points)
8. pH < 7.35 (2 points)

*Respiratory rate ≥ 30 breaths/min if patient is age > 50 ,

**Oxygen saturation ≤ 90 % if patient is age > 50

In the validation portion of the study, scores ≥ 3 identified the majority of patients (98 %) who ended up benefiting ICU level care while the CURB-65 and PSI scores fared worse [66].

The ATS/IDSA 2007 guidelines identify two major and 9 minor criteria for CAP patients needing ICU admission [7]. Two major criteria include invasive mechanical ventilation and need for vasopressor support. If a patient requires either then ICU admission is warranted. The minor criteria include:

1. Respiratory rate ≥ 30 breaths/min
2. $\text{PaO}_2/\text{FiO}_2 \leq 250$
3. Multilobar infiltrates
4. Confusion and/or disorientation
5. $\text{BUN} \geq 20$ mg/dL
6. Leukopenia ($\text{WBC count} < 4 \times 10^9$ cells/L)
7. Thrombocytopenia (platelet count $< 100 \times 10^9$ platelets/L)
8. Hypothermia (core temp < 36 °C)
9. Hypotension requiring aggressive fluid resuscitation

The guidelines suggest that any patient with 3 or more minor criteria on presentation should be admitted to the ICU. The rates of ICU admission in an observational study looking at the minor criteria rose from 0 % in patients with 0 criteria met, to 44 % in patients with more than three criteria [67].

The Risk of Early Admission to the Intensive Care Unit score (REA-ICU) is a clinical prediction tool derived with the goal of identifying patients at risk for admission to the ICU within 3 days of emergency department presentation [59]. In comparison to SMART-COP, this prediction rule takes into account comorbid conditions as well as age, sodium level, male sex, and the presence of pleural effusion. It has more parameters than SMART-COP (11 versus 8) and in a validation study it did not perform better than SMART-COP or the ATS/IDSA criteria [59].

There are several other clinical prediction rules proposed to help site-of-care decisions. It is important to point out that these decisions are generic and do not always pertain to every clinical situation. For example, low CURB-65 scores indicating outpatient management may not be applicable to the homeless population without access to healthcare. The overall situation must be considered prior to applying clinical decision rules in order to maintain safety for all patients.

Clinical Parameters for Discharge

The cost of hospitalization for CAP is estimated at \$1.1 billion dollars annually in the United States. Reducing length of stay (LOS) by one-half day could result in over

\$800 million dollars saved each year [68]. Cost and hospital over-crowding puts increasing focus on discharging CAP patients once clinically stable. Reducing LOS may also benefit in decreasing nosocomial complications and improving patient satisfaction. Yet, decreasing LOS cannot come at the price of diminishing quality of care and patient safety. Now more than ever, inpatient providers are under pressure to find the appropriate optimization of these variables.

As discussed earlier, the first clinical decision is appropriate empiric antibiotic coverage. Improving empiric choices through antibiotic stewardship programs is one area of intervention showing promising results in reducing LOS [69]. Antibiotic stewardship programs can allow individual hospitals to identify local variations in practice that may result in inappropriate initial management that could delay final discharge and, more importantly, decrease morbidity. Stewardship programs can also help eliminate unnecessary testing, further decreasing cost of care and delay in discharge. Length of treatment is another area of guidance that can be monitored with stewardship programs as well as local variations in antibiotic resistance.

Once a patient is admitted for CAP, LOS is determined mostly by the duration of therapy [70]. Duration of therapy is extremely variable and many times not based on evidence. Non-respiratory specialty physicians are more likely to use prolonged antibiotic therapy leading to increased LOS despite the patient showing signs of clinical stability that can be transitioned to outpatient therapy [58, 59]. Less than 1 % of patients demonstrate serious clinical deterioration once clinical stability is achieved [71]. This leads to the question: what are signs of clinical stability that can be used to identify dischargeable patients?

Several studies have attempted to answer this question. In 2001 Rhew et al. [72] performed a meta-analysis that recommended several criteria for early switch to oral antibiotics and discharge. These criteria included resolution of respiratory symptoms, resolution of fever, ability to tolerate oral antibiotics, normalizing white blood cell count, hemodynamic stability, stable or improving chest x-ray, stable comorbid diseases, baseline mental status, and no other sites of infection. A prospective study performed in 2007 showed a reduction in LOS of 0.74 days with no significant mortality events when several of these criteria were implemented [70]. Importantly, a high level of patient satisfaction was also achieved. Carratala and colleagues [73] recently developed a 3-step critical pathway to decrease LOS in CAP patients. Their pathway includes early mobilization of the patient out of bed. The second step is transition to oral antibiotics after the following goals are met:

1. Improving cough, pain, or dyspnea
2. Absence of fever for ≥ 16 h

3. Normalizing white blood cell count
4. Negative blood cultures
5. Intact gastrointestinal absorption

Finally, the third step in their pathway is discharge when the patient has an oxygen saturation above 90 %, their comorbid conditions are stabilized, and their social needs are addressed. Their prospective, randomized trial showed a 2-day decrease in intravenous antibiotic therapy and a 2.1-day reduction in LOS. Interestingly, patients assigned to the control group showed a statistically significant increase in adverse drug reactions. No differences were found in readmission rate, case fatality rate, and patient satisfaction.

It is important to realize that both studies mentioned above have limitations and to date, no consensus guideline exists on when a patient may be safely discharged from the hospital. The main point of both articles is that creating objective criteria for discharge are not only important to curb variability in care, but may result in safely reducing LOS. Future research into this subject will hopefully establish generalizable care objectives that physicians may follow in order to reduce the burden of CAP on the healthcare system.

Conclusion

CAP is an illness most emergency department and inpatient physicians face on a frequent basis. The disease process is continually changing can cause significant morbidity and mortality for our patients. It is important to keep up-to-date on changing therapies, testing strategies, and care standards. This review will hopefully help providers meet high quality standards while helping to control the increasing cost burden CAP places on our society. Future research may help site-of-care decisions as well as provide us with further testing modalities to optimize treatment regimens.

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