Pneumonia: Bugs, Drugs, and Laboratory Duds

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INTRODUCTION

In 1987 the Joint Committee on Accreditation of Healthcare Organizations (JCAHO) initiated core measures to evaluate the quality of care for specific disease entities,[1] such as community acquired pneumonia (CAP). CAP is broadly defined by the Infectious Disease Society of America (IDSA) as an acute infection of the pulmonary parenchyma , accompanied by the presence of an acute infiltrate on chest radiograph or auscultary findings typical of pneumonia. The IDSA also states that patients residing in an acute or chronic care facility are excluded from the diagnosis of CAP.[2] The core measures set out by the JCAHO for CAP are oxygen assessment, pneumococcal vaccination screening, blood cultures, advice on smoking cessation, and antibiotic administration in less than 8 hours.[1] This review will discuss the etiology of pneumonia, emergency department (ED) evaluation, disposition, treatment options, and vaccination. By reviewing the literature as it pertains to pneumonia, clinicians may decide for themselves whether to adopt the core measures outlined by the JCAHO.

ETIOLOGY

The most common microorganism to produce infectious pneumonia is Streptococcus pneumoniae (pneumococcus).[3,4] This agent is much more common in bacteremic patients accounting for two thirds of the septic cases.[5] Haemophilus influenzae, and Staphylococcus aureus are other pathogens in CAP.[6] Nontypable strains of Haemophilus influenzae are the second most common organism identified in CAP and are common in patients with chronic obstructive pulmonary disease (COPD), in diabetics, and in malnourished patients.[7] Staphylococcal pneumonias, while classified as typical, can be necrotizing causing large pneumocelles and effusions.[8] Elderly persons who have developed influenza pneumonia are at higher risk to develop staphylococcal pneumonia.[9] Intravenous drug users can develop septic emboli in the lungs from tri-cuspid endocarditis.

The term "atypical pneumonia" refers to a lung infection characterized by cough, fever, and at times sore throat. Mycoplasma pneumoniae is the prototype for atypical pneumonia, but it can present like pneumococcus, leading many to abandon the term atypical altogether. Next to S. pneumoniae, it is one of the most common causes of CAP in previously healthy patients under 40.[10] Common symptoms include a prodrome with fever, headache, chills, and sore throat followed by a dry cough.[11] Initially influenza, Chlamydia, and Legionella were included pneumonias exclusively under this category, but it is now known these organisms can present in either a typical or atypical pattern. Chlamydia pneumonia previously known as TWAR was initially named for the two strains from which it was identified (*tw 183* and *ar 89)*. This organism usually causes a mild sub-acute pneumonia, but in hospitalized patients it can be found as a co-infection with S. pneumoniae.[12] Legionella is noted to cause 2 to 6% of infections in a hospital based series, with mortality as high as 25%.[13] Legonnaire's Disease is described as pneumonia ranging from cough to mutisystem organ dysfunction. Legionella also causes Pontiac Fever, a self-limited flu like illness without pneumonia. Epidemiologic risk factors identified by the IDSA for Legionella include: renal failure, immune compromise, and changing of household plumbing. One study notes the presence of high fever, hyponatremia, abnormal mental status, and LDH >700 u/ml as being predictive of legionosis.[14]

Other pneumonia pathogens identified by the IDSA and the American Thoracic Society (ATS) include: Moraxella catarrhalis, Klebsiella pneumoniae, and Pseudomonas species. Moraxella catarrhalis is frequently seen in patients with COPD. It is also frequently seen as a co-infection with haemophilus influenzae or streptococcus pneumoniae.[15] Fortunately M. catarrhalis generally responds to the same antibiotics as its co-infectors. Klebsiella pneumoniae rarely causes pneumonia in the immunocompetent host, but can cause severe pneumonia in patients with COPD, alcoholism, or diabetes. There is rising resis-

tance to this organism due to the fact that it is largely hospital acquired. [16] Pseudomonas species are identified by the ATS as a risk in patients with structural lung disease, malnutrition, exposure to wide spectrum antibiotics for more than seven days in the last month, and in patients taking more than 10 mg of prednisone per day. With such a wide spectrum of infecting organisms it is necessary to perform a directed ED evaluation as opposed to a "shotgun" approach.

EMERGENCY DEPARTMENT (ED) EVALUATION:

The basic work-up for pneumonia has traditionally consisted of a complete blood count, chemistry, chest radiograph, possibly an arterial blood gas sample, and a blood culture. Over the years a tremendous amount of literature has been published regarding the appropriateness of these tests and incorporated into algorithms for the ED evaluation. The recommendations for testing by the IDSA, the ATS, and JCAHO are outlined below.

A chest radiograph is strongly encouraged by the ATS and the IDSA. The basis for the ATS and IDSA recommendations for radiographs stems from multiple studies showing the poor correlation of physical exam findings to radiograph findings. However, it has been shown that in patients with normal vital signs and lung sounds, the diagnosis of pneumonia can be safely excluded in the immunocompetent adult without a radiograph.[17] Similarly, a chest radiograph should not be ordered on everyone with a simple cough. Many patients with a cough merely have bronchitis or reactive airways and can be managed with close follow up. In patients who have abnormal vital signs or physical exam findings, however, a chest radiograph is highly recommended.[7]

Blood cultures are considered a core measure by the JCAHO and considered a measure of the quality of care by the IDSA and the ATS. Data supporting this expensive and time consuming test on a routine basis is questionable. For example the rates of positive culture in the setting of CAP are notoriously as low as 11%. [18] Anaerobic cultures are part of the standard culture set and have a lower yield than their aerobic counterparts. Most cases of anaerobic bacteremia have historical features that allow you to determine which patients might benefit from their use. [18] The IDSA, ATS, and JCAHO have recommended blood cultures on all patients admitted with CAP. It is universally acknowledged that this routine expensive test will be of low yield and often grows the most common pathogen S. pneumoniae. The reasons for this recommendation lie in the hope of identifying resistant organisms and or the presence of bacteremia. It would seem reasonable to acquire blood cultures

Characteristic	Points Assigned
Age	
Men	Age (years)
Women	Age – 10
Nursing Home Resident	+10
Coexisting Illness	
Neoplastic Disease	+30
Liver Disease	+20
CHF	+10
Cerebrovascular Disease	+10
Renal Disease	+10
Physical examination findings	
Altered mental status	+20
Respiration >30	+20
Systolic blood pressure <90	+20
Temperature <35 C or >40C	+15
Pulse >125	+10
Laboratory and Radiologic findings	
Arterial pH <7.35	+30
BUN >30	+20
Sodium <130	+20
Glucose >250	+10
Hematocrit <30%	+10
PaO2 <60	+10
Pleural Effusion	+10
Mortality PredictionClass	**Mortality (%)**
I (0 points)	**0.1**
II (<70 points)	**0.6**
III (71-90 points)	**0.9**
IV (91-130 points)	**9.3**
V (>130 points)	**27**

Table 1. Factors associated with mortality in the PORT Criteria [20]

Drug resistant Pneumococcus	Age>65, B-lactam therapy within the last 3 months, alcoholism, immune suppressive illness, multiple medical comorbidities,exposure to a child in Day care
Enteric gram negative bacteria	Residence in a nursing home, underlying cardiopulmonary disease, multiple medical comorbidities
Pseudomonas Aeruguinosa	Structural lung disease (bronchiectasis), corticosteroid use, broad spectrum antibiotics for > 7 days in the last month, and malnutrition

Table 2. The ATS has structured their risk factor profile into 4 groups the lowest of which has no cardiopulmonary disease and no modifying factors specific bacteria (listed below) [6]

when there is a suspicion of resistant organisms (table 2), or in patients with high risk for bacteremia.

Sputum gram stain and culture are not a core measure stated by the JCAHO, but are recommended by the IDSA. The ATS has stated in their policy statement that they should not be performed unless you suspect a drug resistant bacteria or if the patient is going to be admitted to the ICU. The literature on sputum testing is split with both the ATS and the IDSA citing supporting documents. The use of this test is probably beneficial in only the sickest of patients.

Some newer tests such as PCR and urine assays may be useful in identifying the causative agent in pneumonia. Currently at most hospitals PCR is cost-prohibitive and used only for TB. Urine Legionella tests look for 3 of the most common serotypes. The pneumococcus urine assay has an 86% sensitivity (95% CI 71-94%) and a 94% specificity (95% CI 91-96%).

ED PATIENT DISPOSITION

The question as to whether to send a patient home or to admit a patient is complex. One of the frequently cited risk assessment tools for patient disposition is the Pneumonia Outpatient Research Team Criteria also known as the "PORT Criteria". The PORT scoring system uses demographic factors, coexistent illness, physical examination findings, and laboratory test results as well as radiographic findings, to risk stratify patients into five risk classes for pneumonia and 30-day mortality (Table 1). The criteria are discussed briefly here. The reader is encouraged to view the original article for the algorithm and mortality statistics. Like any practice parameter, it requires a change in habits. Factors associated with non-adherence to

A parameter considered a core measure by JCAHO and recommended by the ATS and the IDSA is the monitoring of oxygenation of the patient. Pulse oximetry is an excellent tool in the evaluation of oxygenation. At arterial oxygenation above 70%, the oxygen saturation recorded by pulse oximeters differs by less than 3% from the co-oximeter saturation of the arterial blood gas (ABG). An ABG may be performed on patients when there is a concern over ventilation, low saturations, or poor response to oxygen therapy. Additionally, some of the information provided in the ABG can be employed in a scoring system used to predict mortality (Table 1). Whichever method used to evaluate oxygenation, it is important to document the effect of supplemental oxygen.

CAP guidelines include patient age >65, involvement of a primary care physician, male, and multi lobar disease. [21] Some of the criticisms of this scoring system include the reliance of a blood gas instead of pulse oximetry and the excessively complex nature of the scoring system. There are other decision analysis tools such as the ATS guidelines (Table 2), but the PORT findings are supported by the IDSA and embraced by the JCAHO. This does not necessarily make it "standard of care", but all clinicians should be aware of the factors that these guidelines cite for mortality and that they may be cited as a type of standard. Some hospitals have adopted the JCAHO recommendations on pneumonia (largely IDSA) as a core measure. This implies the charts may be audited for these criteria as a standard of care by a quality improvement director or an outside agency. Ignoring the recommendations by the IDSA, JCAHO, and the ATS could spell disaster. These recommendations extend to treatment such as antibiotics and vaccination.

TREATMENT OPTIONS, ANTIBIOTIC RESISTANCE, AND VACCINATION

Pneumococcal resistance to penicillin has become a global problem. Penicillin resistant bacteria are also often resistant to multiple antibiotics. In a 1999 CDC report strains of pneumococcus that were deemed resistant to penicillin had very low susceptibility to macrolides, sulfur antibiotics, and cephalosporins. This left the quinolones and vancomycin as the last resort for these multidrug resistant strains. [22] Newer extended spectrum quinolones have become the mainstay for life threatening infections like pneumonia due to the suspicion of resistant pneumococcus to traditional therapy. Unfortunately quinolone resistance can arise from one or two point mutations on the bacteria's DNA encoding topoisomerase, the enzyme that uncoils the DNA. This resistance is much easier to acquire than the typical resistance pneumococcus needs to evade penicillin. The traditional accepted mechanism of streptococcal resistance required large gene sequences to alter the penicillin binding protein. [23] Recent data supports the hypothesis that resistance to quinolone antibiotics can be selected in drug resistant strains of pneumococcus. [24] For this reason it is recommended that only the sickest patients receive quinolone antibiotics.

Mechanisms of drug resistance to other antibiotics are varied. Macrolide resistance typically occurs through alteration of ribosomal binding sites, which is also used to evade tetracyclines and aminoglycosides. Beta-lactamase is another method of penicillin and cephalosporin resistance, it is classically seen in staphylococcal species. Beta-lactamase is an enzyme that splits the amide bond of the beta lactam ring; this enzyme is excreted theoretically providing resistance to neighboring bacteria. Enzymatic aminoglycoside resistance as seen in Klebsiella pneumoniae and other gram negative rods alters the drug preventing transport across the plasma membrane. The major mechanism of enteric gram negative resistance to tetracyclines is by an efflux pump. [25] This information is useful to create your department's biogram and thus aid in choices of empiric therapy.

Given that isolation of a pathogen is not likely, empiric therapy for community acquired pneumonia is the rule. It is reasonable to target pneumococcus, but consider some of the traditional atypical bacteria as possibilities. Some authorities like the ATS have recommended the newer macrolides as a reasonable choice, but in some patients this may be cost prohibitive. [26] Doxycycline has been studied as a reasonable cost effective approach at one third the cost. [27]

Saving quinolone antibiotics for the sickest patients will hopefully stem the emergence of resistance decrease mortality. In a recent study it was shown that mortality is three times higher if the pneumococcus is penicillin resistant and seven times higher if ceftriaxone resistant. [28] These numbers are the genesis for microbial testing and pneumoccal vaccination recommendations that are embraced by the Centers for Disease Control, IDSA, ATS, and JCAHO.

The pneumoccocal vaccine currently covers 23 of the 90 possible strains of pneumococcus and has been shown to be effective for preventing bacteremic pneumococcal disease pneumococcus. The ability of the patient to be vaccinated in the ED has been shown to be both feasible and beneficial[29] and should be considered in the emergency department.

CONCLUSION

Currently pneumonia continues to be one of the most common infections we face in the ED. The changes in this disease include the resistance patterns of different species of bacteria, evolving use of laboratory tests, and mandates by the JCAHO listed as the standard of care. With so many pitfalls in this disease it is no wonder Sir William Osler described pneumonia as the "captain of the men of death".

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