Preventing Mismanagement of Community-Acquired Pneumonia at an Urban Public Hospital*  

Implications for Institution-Specific Practice Guidelines

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**Study objectives:** To assess institutional performance of key diagnostic and therapeutic interventions and to identify areas amenable to improvement in the management of community-acquired pneumonia (CAP).

**Design:** A chart-based retrospective study.

**Setting:** Cook County Hospital, a large, urban, public teaching hospital.

**Patients:** Adult inpatients with a hospital discharge diagnosis of CAP.

**Interventions:** None.

**Measurements and results:** Fifty hospital admissions were reviewed. Only 25 patients (50%) had two specimens obtained for blood culture, and sputum was sent for Gram’s stain and culture for only 11 patients (22%). Approximately one third of the patients had portable anterior-posterior instead of standard posterior-anterior and lateral chest radiographs performed. Physicians in the emergency department (ED) tended to be less likely to note the presence of multilobar infiltrates or pleural effusions than the attending radiologists. The antibiotic regimens employed in the ED and on the inpatient wards were widely variable. The mean time from hospital entry until administration of the first dose of antibiotics was 5.5 h for the 18 patients for whom treatment was initiated in the ED vs 16.1 h for the 27 patients admitted through the ED for whom therapy was deferred until ward admission (p<0.001, Student’s t test).

**Conclusions:** Institutional variations in the performance of basic diagnostic and therapeutic interventions for patients with CAP may be substantial. The local performance of these key processes of care should be assessed to help direct the formulation of institutional practice guidelines for the management of CAP. *(CHEST 1998; 113:194S-198S)*

Despite the frequency with which community-acquired pneumonia (CAP) is encountered, the empiric data necessary to define optimal strategies for diagnosis and treatment are not yet available. Consequently, it has been necessary to rely largely on expert opinion in the development of practice guidelines for the management of CAP. Comprehensive guidelines have been published recently in the United States, Canada, and Great Britain. But because these general guidelines are based on imperfect data sources—indeed, efforts to validate aspects of the American Thoracic Society guidelines have been undertaken only recently—and because they may be misused by overzealous administrators or litigators, it is not clear that they will be beneficial in the aggregate. In addition, in presenting specific recommendations for diagnostic tests and antibiotic regimens, these guidelines assume that institutions are able to implement their recommendations accurately and efficiently.

However, the care of hospitalized patients with CAP is a deceptively complex process, requiring the coordination of care in the emergency department (ED) and on the inpatient ward, with contributions from pharmacy, laboratory, and radiology services. Errors or inefficiencies in the performance of any of these functions may adversely affect the outcomes and/or costs of care for CAP. Thus, attention to the processes of care, in addition to its content, is important in assessing the need for institutional practice guidelines. Indeed, the few published studies demonstrating a salutary effect of practice guidelines for CAP involved narrowly focused efforts to
modify key aspects of management such as reducing the time to initiate antibiotic treatment,7,8 or to convert from parenteral to oral antibiotic therapy.9,10 In each instance, careful review of the institution’s performance in managing CAP allowed for the identification of those aspects that were most amenable to improvement. Importantly, the stated goals of the guidelines were usually to reduce length of hospital stay9,10 and/or costs;8 in only one study was a beneficial effect on patient survival suggested.7

Previous internal audits of antibiotic therapies at our institution suggested excessive delays in the administration of antibiotics (D.N.S., unpublished data; 1995). We conducted a retrospective study of patients admitted to Cook County Hospital with CAP to assess our institution’s performance with respect to this and other basic aspects of pneumonia care, and to determine the need for institutional guidelines for empiric therapies. In addition, we attempted to identify clinical variables associated with the successful and efficient performance of key diagnostic and therapeutic interventions.

**Materials and Methods**

Adult inpatients with a hospital discharge diagnosis of CAP (International Classification of Diseases, ninth edition, code 481—“lobar pneumonia, pneumococcal or organism unspecified”) admitted to Cook County Hospital between October 1, 1994, and March 31, 1995, were selected in descending alphabetical order of their last names until 50 eligible patients had been accrued. The criteria for enrollment were that possible or definite pneumonia was listed as an admitting diagnosis and that the patient chart was available for review. Exclusion criteria were age <18 years, initial admission to an ICU, hospitalization within the prior 3 weeks, record of cancer chemotherapy within 2 weeks, or a WBC count <1,000 cells per cubic millimeter. Patients with other immunocompromising conditions, including infection with HIV, were included because of the frequency with which community-acquired bacterial pneumonia is seen in such patients.11

Demographic, clinical and laboratory variables, and details of antibiotic treatment were recorded by experienced data abstractors and all charts were overread by a physician investigator (D.N.S.). A comorbidity index based on the sum of weighted scores given to common diseases12 and the APACHE II (acute physiology and chronic health evaluation) severity of illness score13 were calculated for all patients. The time of entry to the hospital was taken as the time of the first notation in the ED nursing flow sheet or as the time of hospital admission for the five patients not admitted through the ED. Microbial etiology of pneumonia was designated as definitive, presumptive, or unknown as defined by Mundy et al.13 Chest radiograph reports were scored as being normal or as reporting infiltrates that were localized, multilobar, or diffuse (each being mutually exclusive), and/or showing possible or definite pleural effusion.

For continuous variables, the two-tailed significance of the difference between two group means was tested at 95% confidence level using the t test statistics; unequal variance t test values were used when Levene’s test for equality of variances was significant at a level of p≤0.05. χ2 statistics or two-tailed Fisher’s Exact Test was used to test associations between categorical variables as appropriate.14 Statistical analyses were performed using software (SPSS for Windows; SPSS Inc; Chicago). Data are presented as mean±SD unless otherwise indicated.

**RESULTS**

Fifty patients were studied; 45 were admitted from the ED (90%) and 5 from ambulatory clinics (10%). The mean age was 51 years; 33 patients (66%) were male, and 40 (80%) were African-American. A history of pulmonary disease was documented in 24 patients (48%). Thirty patients (60%) were current smokers, 21 (42%) used alcohol, and 3 (6%) were active injection drug users. Other comorbid diseases were infrequent (data not shown). Only three patients (6%) were known to be infected with HIV at presentation, none of whom had had a history of AIDS; a fourth patient was diagnosed as having HIV and AIDS during the hospital stay. The mean comorbidity index was 1.0 (range, 1 to 4), corresponding to an average of one non-life-threatening chronic disease per patient. The distribution of presenting symptoms and signs was typical for patients with CAP (data not shown). The mean APACHE II score was 10.0±5.3. Only one patient (2%) died, and the mean length of hospital stay was 5.1±3.0 days.

No blood cultures were obtained for 13 patients (26%), 1 blood culture was obtained for 12 (24%), and ≥2 blood cultures were obtained for 25 patients (50%). One or more routine sputum cultures were obtained for only 11 patients (22%). A definitive microbiological diagnosis was made for only two patients (4%), one with Klebsiella pneumoniae bacteremia and another with Pneumocystis carinii isolated from BAL. A presumptive diagnosis based on expectorated sputum cultures could be made for an additional four patients (8%). The 25 patients from whom two or more blood cultures were obtained had higher peak mean temperatures at hospital entry (38.6±1.1°C) than did those with zero or one set of blood cultures (38.0±1.1°C, p=0.04).

Chest radiographs were obtained at the time of admission for all 50 patients; 16 (32%) were portable anterior-posterior, 31 (62%) were standard posterior-anterior and lateral views, and the type could not be determined for 3 (6%). In general, the ED physicians tended to be less likely than the attending radiologists to note the presence of multilobar infiltrates or pleural effusions (Fig 1). Of the eight patients with possible or definite pleural effusions reported by the attending radiologists, only two underwent thoracentesis, after delays in excess of 48 h in both cases. Compared with patients for whom posterior-anterior and lateral chest radiographs were obtained, patients for whom portable
anterior-posterior radiographs were obtained had significantly higher peak heart rates (118±30 vs 100±16 beats/min, p=0.01) and APACHE II scores (13.1±4.5 vs 8.6±5.3, p=0.005), and tended to be older (57.8±17.7 vs 48.2±15.0 years, p=0.056).

All patients received IV antibiotic therapy initially. A large assortment of antibiotic regimens were administered in the ED and inpatient wards, and the regimens given on the ward were often different from those given in the ED (Fig 2). Antibiotics prescribed at hospital discharge were similarly variable (data not shown). Apart from a single case of pneumonia due to P carinii, antibiotic regimens were not modified in response to microbiological findings.

The mean time to the initial dose of antibiotics was 12.8±9.9 h (range, 1.9 to 51.2 h). Among the 45 patients admitted through the ED, 18 (40%) received the first dose of antibiotics while still in the ED, and 27 (60%) received the first dose after admission to the medical ward. Administration of antibiotics in the ED was associated with a statistically significant reduction in the time to receipt of the first dose of antibiotics as compared with initial administration on the inpatient ward (5.5±3.1 vs 16.1±13.7 h, p<0.001). As compared with patients given their first dose of antibiotics after admission to the medical ward, the linear trend of the comorbidity index was significantly higher in those who received antibiotics in the ED (p=0.03, Mantel-Haenszel test for linear trend), although the mean comorbidity scores themselves were not; significant differences in other clinical or demographic variables were not seen (Table 1).

**Discussion**

The acquisition of material for culture, the use of accurate chest radiographs, and the timely administration of effective antibiotic therapy are widely viewed as basic to the treatment of patients with CAP. This study has identified deficiencies in the performance of these key diagnostic and therapeutic interventions in our institution. Improvements in these areas through directed clinical practice guidelines may be both achievable and clinically important.

The performance of two sets of blood cultures for patients with CAP is recommended because they are highly specific and allow for the “streamlining” of antibiotic therapy when positive. Unfortunately, their sensitivity is only about 15%, and their importance in determining the outcomes of patients with CAP is unknown but has been questioned. Although the value of sputum Gram's stain and culture in the treatment of individual patients is more controversial, sputum culture results are a vital source of data regarding the local prevalence of antibiotic-resistant strains of Streptococcus pneumoniae and Haemophilus influenzae. Only three quarters of our patients had blood cultures performed, and sputum was rarely obtained for culture. The use of blood cultures for our patients seemed to have been governed largely by the presence or absence of fever. However, the absence of fever is associated with an increased risk of death in patients with CAP and may therefore be a poor criterion for the performance of this test.

Because interobserver variability in the interpretation of chest radiographs of patients with suspected CAP is substantial, and because certain radiographic findings are correlated with a poor prognosis, obtaining radiographs of the highest possible quality may be important. About one third of our
Table 1—Clinical and Demographic Variables for Patients Who Did and Did Not Receive Antibiotics in the ED

<table>
<thead>
<tr>
<th>Clinical/Demographic Variables</th>
<th>Mean Values Among Patients Who Received Antibiotics in the ED (n=18)</th>
<th>Mean Values Among Patients Who Did Not Receive Antibiotics in the ED (n=27)</th>
<th>p Value (Student's t Test or χ² Test as Appropriate)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, yr</td>
<td>54.5</td>
<td>47.5</td>
<td>0.144</td>
</tr>
<tr>
<td>Female, %</td>
<td>50.0</td>
<td>28.6</td>
<td>0.142</td>
</tr>
<tr>
<td>Nonwhite race, %</td>
<td>88.9</td>
<td>89.3</td>
<td>0.755</td>
</tr>
<tr>
<td>Temperature, °C</td>
<td>38.7</td>
<td>38.2</td>
<td>0.123</td>
</tr>
<tr>
<td>Heart rate, beats/min</td>
<td>107.6</td>
<td>109.8</td>
<td>0.743</td>
</tr>
<tr>
<td>Respiratory rate, breaths/min</td>
<td>27.2</td>
<td>24.7</td>
<td>0.272</td>
</tr>
<tr>
<td>Lowest systolic BP, mm Hg</td>
<td>115.8</td>
<td>113.7</td>
<td>0.767</td>
</tr>
<tr>
<td>Lowest diastolic BP, mm Hg</td>
<td>65.8</td>
<td>70.3</td>
<td>0.304</td>
</tr>
<tr>
<td>WBC/mm³</td>
<td>13,100</td>
<td>11,700</td>
<td>0.439</td>
</tr>
<tr>
<td>Comorbidity index</td>
<td>1.3</td>
<td>0.7</td>
<td>0.058</td>
</tr>
<tr>
<td>APACHE II score</td>
<td>11.9</td>
<td>9.4</td>
<td>0.107</td>
</tr>
</tbody>
</table>

patients had chest radiographs obtained using portable, anterior-posterior technique rather than the recommended posterior-anterior and lateral views. Portable radiographs, which are less sensitive in the detection of pneumonic infiltrates because of the absence of a lateral view, are less specific because of greater variation in technical performance and quality. However, they may be the only feasible radiographic method for patients who are severely debilitated or critically ill. Indeed, the patients in our study for whom they were obtained had higher heart rates and APACHE II severity of illness scores, and they tended to be older than the patients who received standard posterior-anterior and lateral radiographs, although none required admission to an ICU. Whether posterior-anterior and lateral radiographs can be obtained safely for more patients and whether improvements in accuracy will lead to improvements in patient outcomes remain to be investigated.

Of additional concern regarding radiographic diagnosis was the suggestion of discrepant interpretations of chest radiographs on the part of the ED physicians and the attending radiologists. Of the 36 chest radiographs for which interpretations from both the ED physicians and radiologists were available, multilobar infiltrates were noted 11 times by the attending radiologists compared with only 3 times by the ED physician, and pleural effusions reported three times by the attending radiologists were not commented on by the ED physicians. Failure to recognize pleural effusions in patients with CAP is particularly worrisome as timely thoracentesis is necessary both to exclude empyema and to contribute toward establishing a bacteriologic diagnosis. That none of the eight patients with pleural effusions recognized by the attending radiologists underwent thoracentesis within 48 h of admission suggests that the discrepancy in radiograph interpretations may have adversely affected patient treatment. Moreover, both multilobar infiltrates and pleural effusions may be associated with a higher risk of mortality and are therefore relevant to the assessment of prognosis in patients with CAP.

Inconsistencies and delays in the administration of antibiotics were also documented in this study. Although most patients received regimens that included a third-generation cephalosporin or a β-lactam/β-lactamase inhibitor combination consistent with published guidelines, up to 22% received erythromycin alone (Fig 2), a regimen with relatively poor activity against H influenzae and other Gram-negative pathogens and that deviates from published guidelines. Importantly, failure to use antibiotic regimens recommended in the guidelines from the American Thoracic Society may be associated with higher mortality rates. These data support the need for more uniform and consistent antibiotic regimens for CAP as articulated in the general guidelines, and for further work toward their validation.

Perhaps most important were the delays in the administration of antibiotics that we observed. In particular, patients not treated in the ED waited >16 h on average to receive their first dose of antibiotics, while the 18 patients treated in the ED usually were treated in <6 h. Similar delays in the initiation of antibiotic therapy have been reported elsewhere. Although it is not known whether delays in therapy of this magnitude adversely affect patient outcomes, and our study was too small to address the issue, it is intuitive that timely treatment should reduce both the risk of complications and death, and should lead to a shorter length of stay and related hospital costs. Moreover, case-fatality rates among patients with CAP (13.7% in a recent meta-analysis) are comparable to those in patients hos-
pitalized with acute myocardial infarction, a disease for which interventional trials involving thousands of patients have shown that significant reductions in mortality are achieved when therapies are begun as early as possible.23

Our study has several limitations. First, its retrospective design increases the possibility of error in recording clinical variables. Second, the radiographic findings were abstracted from physician interpretations recorded in the charts rather than from blinded review of the radiographs themselves. Most importantly, the accuracy of the diagnosis of CAP in individual patients is difficult to confirm using a retrospective study design, and the International Classification of Diseases, ninth edition, discharge code upon which patient enrollment was based in our study has been shown to be relatively inaccurate.24 However, we were able to confirm that each patient was assigned a diagnosis of CAP on admission, and since the primary aim of our study was to describe the quality of care received by patients hospitalized at our institution with CAP rather than its clinical epidemiology, the validity of our findings should not be unduly compromised by this limitation.

Published general guidelines for the management of CAP22-4 assume institutional competence in translating their recommendations into management strategies that will be equally effective in, and coordinated between, the varied clinical settings within which patients with CAP are treated (eg, ED, inpatient medical ward, and ambulatory clinic). Our study demonstrates the need to carefully assess institutional proficiency in the performance of these basic aspects of pneumonia care, and to incorporate the findings generated thereby into institutional practice guidelines, critical pathways, or other strategies for quality improvement in the management of CAP. Although the benefits of such interventions in terms of the outcomes and costs of care have not yet been defined, they may be substantial.

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