CURRENT CONCEPTS

COMMUNITY-ACQUIRED PNEUMONIA

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PNEUMONIA has been recognized as a common and potentially lethal condition for nearly two centuries. Comprehensive studies of the disease in the preantibiotic era showed mortality rates of about 1 per 1000 per year; over 80 percent of the cases were due to *Streptococcus pneumoniae*, and mortality rates were generally reported at 20 to 40 percent.[1,2] Community-acquired pneumonia (as distinguished from that acquired nosocomially or in a nursing home) continues to be a common and serious illness. Current estimates for the United States are 4 million cases annually, an attack rate of 12 per 1000 adults per year, about 600,000 hospitalizations per year, and an annual cost of $23 billion.[3,4] Pneumonia is the sixth leading cause of death in the United States and the most common cause of death due to infectious disease. Despite remarkable advances in the identification of new microbial pathogens and antimicrobial agents, few diseases are so characterized by disputes about diagnostic evaluation and therapeutic decisions.

CLINICAL DIAGNOSIS

Symptoms suggestive of pneumonia include fever combined with respiratory symptoms such as cough, sputum production, pleurisy, and dyspnea. Similar symptoms may be caused by acute bronchitis, sinusitis, and a variety of noninfectious diseases. Elderly patients often have fewer symptoms or less severe ones than younger patients. The physical findings include fever in 80 percent of patients; most have a respiratory rate exceeding 20 per minute, crackles are heard on auscultation in 80 percent, and up to 30 percent have signs of consolidation.[5]

EVALUATION

Most patients with community-acquired pneumonia are treated as outpatients and do not require extensive studies except for an x-ray film to establish the diagnosis, selected laboratory studies to determine the extent of disease and associated conditions, and microbiologic studies. Laboratory tests suggested for hospitalized patients are summarized in Table 1.

Chest Radiography

A chest film showing infiltrates is necessary to establish the diagnosis of pneumonia. False negative results can be attributed to dehydration, evaluation during the first 24 hours, pneumonia due to *Pneumocystis carinii*, or pneumonia with profound neutropenia. All these are rare except *P. carinii* pneumonia with negative chest films, which occur in 10 to 30 percent of cases.[6] Radiographic changes usually cannot be used to distinguish bacterial from nonbacterial pneumonia, but they are often important for evaluating the severity of illness, determining the need for diagnostic studies, and selecting antibiotic agents. Computed tomography is considered more sensitive than radiography for the detection of infiltrates and may be especially useful in detecting interstitial disease, empyema, cavitation, multifocal disease, and adenopathy.

Identification of Pathogens

The following comments regarding microbial causation are based on 15 studies of community-acquired pneumonia in North America in which at least 100 cases were reported during the 30-year period from 1965 to 1995.[7-21] Bias may arise from the fact that most reports are from academic centers, most have been restricted to the 20 to 30 percent of patients who are sufficiently ill to require hospitalization, some have been restricted to immunocompetent hosts, and only the more recent studies reflect the role of newly detected microbial agents and the influence of infection with the human immunodeficiency virus (HIV). A review of 385 consecutive admissions for community-acquired pneumonia at Johns Hopkins Hospital in 1991 indicated that 221 of the patients (57 percent) were classified as immunosuppressed and 180 (47 percent) had HIV infection.[21] These data highlight important changes in the characteristics of hosts and the distribution of pathogens, especially in inner-city tertiary care centers. By contrast, a study of pneumonia in 15 hospitals serving two counties in Ohio in 1991, including 3700 adult patients, showed minimal effects of known HIV infection.[4]

Confirmation that pneumonia is caused by a pathogen requires the recovery of a likely agent from an uncontaminated specimen (blood, pleural fluid, transtracheal aspirate, transthoracic needle aspirate, or metastatic site), positive results of selected serologic tests, or detection of an established pathogen that does not colonize the respiratory tract in respiratory secretions in the absence of disease. Pathogens in the last category include *P. carinii*, *Toxoplasma gondii*, strongyloides, legionella, *Mycoplasma pneumoniae*, *Mycobacterium tuberculosis*, influenza virus, respiratory syncytial virus, *Histoplasma capsulatum*, *Coccidioides immitis*, and *Blastomyces dermatitidis*.[22] Blood should be cultured from most patients who are hospitalized with community-acquired pneumonia. The cumulative frequency of positive blood cultures in 12 series that reported this information was 330 of 2935 patients (11 percent), with *Strep. pneumoniae* accounting for 222 (67 percent of the positive cultures).

The diagnostic value of Gram's staining and culture of expectorated sputum has been debated for two decades.[23,24] Common problems are that 10 to 30 percent

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of patients have a nonproductive cough, 15 to 30 percent have received antibiotic treatment before hospitalization, and negative results are reported for 30 to 65 percent of cultures of expectorated sputum. Several studies have shown that the yield of fastidious bacteria such as *Strep. pneumoniae* and *Haemophilus influenzae* is zero when virtually any specimen from the respiratory tract is collected after antibiotic therapy. The yield of *Strep. pneumoniae* in sputum from patients with bacteremic pneumococcal pneumonia is only about 50 percent.[25] Earlier reports show that far higher rates of positive cultures for *Strep. pneumoniae* can be achieved by careful attention to the procurement of the specimen, expedited transport and processing, the use of mouse inoculation, the use of techniques to detect pneumococcal polysaccharides, and careful examination of the plate for α-hemolytic streptococci.[2,5-8] Sputum cultures yielding *Staphylococcus aureus* (except in influenza epidemics) and gram-negative bacilli (except in cases of bronchiectasis or cystic fibrosis or in immunosuppressed hosts) often represent upper-airway contamination, especially with antecedent exposure to antibiotics. Few laboratories test for *Mycop. pneumoniae,* and even fewer for *Chlamydia pneumoniae*. Tests for legionella are readily available, but the assays offered and the quality of the work are highly variable. Edelstein advocates the restriction of testing for legionella in areas where incidence is low (<5 percent of all cases of pneumonia) to patients who are immunosuppressed, who do not respond to beta-lactam antibiotics, or who have a classic presentation.[26]

We advocate Gram's staining and culture of expectorated sputum with the proviso that the specimen be carefully procured, that cytologic screening confirm the presence of lower-airway secretions, and that the specimen be obtained before antibiotics are given. Advantages include the possible detection of penicillin-resistant *Strep. pneumoniae* (a finding that has obvious and important epidemiologic and therapeutic implications). The use of pretreatment specimens for culture precludes confounding by specimens obtained after antibiotic therapy, which are associated with high rates of deceptive results, and the failure to detect *Staph. aureus* or gram-negative bacilli in the pretreatment specimen nearly excludes these organisms from diagnostic consideration.

Gram's stains showing multiple polymorphonuclear leukocytes with large numbers of bacteria that have the morphologic characteristics of a likely pulmonary pathogen are an appropriate basis for making initial therapeutic decisions.[12,24] The experience of the microbiology laboratory at Johns Hopkins Hospital indicates that about 50 percent of sputum samples show likely pulmonary pathogens, and there is 90 percent correlation between the organisms identified on initial Gram's staining and those in subsequent culture. The quellung test uses polyvalent pneumococcal antiserum to detect capsular swelling of *Strep. pneumoniae* and is a reliable indicator of pneumococcal pneumonia when performed by experienced technicians.[12] Special stains for mycobacteria and legionella are important for selected patients. Serologic tests that require convalescent-phase serum are useless when therapeutic decisions need to be made, but this information may be important in clarifying epidemiologic implications. Acute-phase serum is usually adequate for the detection of hantavirus; the experience with serologic tests for IgM in detecting *Mycop. pneumoniae* varies.[27]

Assessment of Severity

The assessment of the severity of disease is important to guide decisions regarding hospital admission, admission to an intensive care unit, and antibiotic treatment (Table 1). The white-cell count is generally not useful in distinguishing causal agents, except that counts above 15,000 per cubic millimeter suggest bacterial infection and high and low values appear to be prognostic indicators. Anemia often indicates mycoplasma infection, chronic disease, or complicated pneumonia. A blood-chemistry panel may indicate involvement of multiple organs or reveal underlying diseases. Serologic testing for HIV, with informed consent, is advocated by the Centers for Disease Control and Prevention for hospitalized patients between the ages of 15 and 54 who are treated in hospitals with a prevalence of the acquired immunodeficiency syndrome of 1 per 1000 discharges or more.[28] In the absence of informed consent or when there is a delay in the reporting of HIV test results, lymphopenia (absolute lymphocyte count, <1000 per cubic millimeter) or a low CD4 cell count (<200 per cubic millimeter) supports the diagnosis of advanced HIV infection. Blood gas values are important prognostic indicators; hypoxemia with a partial pressure of oxygen below 60 mm Hg while the patient is breathing room air is a standard criterion for admission to the hospital and supports consideration of admission to the intensive care unit.[19,23]

Parapneumonic Effusions

Parapneumonic effusions are found in 30 to 50 percent of patients with community-acquired pneumonia. Thoracentesis should be performed in cases of large ef-

Table 1. Tests Recommended for Hospitalized Patients with Community-Acquired Pneumonia.

Chest radiography
Arterial-blood gas analysis
Complete blood count
Chemistry profile including renal- and liver-function tests and electrolyte levels
Serologic testing for human immunodeficiency virus (for patients 15 to 54 years old)
Blood culture
Gram's staining and culture of sputum, with or without staining and culture for acid-fast bacilli, tests for legionella (culture, direct fluorescent-antibody test, or urinary antigen assay), and measurement of mycoplasma IgM
Pleural-fluid analysis (if fluid is present), consisting of white-cell and differential counts; measurements of lactate dehydrogenase, pH, protein, and glucose; Gram's staining; staining for acid-fast bacilli; and culture for bacteria (aerobes and anaerobes) and mycobacteria

fusions, enigmatic pneumonias, and patients who fail to respond to standard treatment. It is customary to measure the following in pleural fluid: pH, glucose, protein, lactate dehydrogenase, and white-cell count; also standard are Gram's staining, staining for acid-fast bacilli, and culture for bacteria (aerobes and anaerobes), fungi, and mycobacteria. A pH above 7.3 predicts a response to antibiotic treatment, and lower pH values predict the need for a drainage procedure.[29,30]

Microbial Pathogens

Strep. pneumoniae accounted for over 80 percent of cases of community-acquired pneumonia in the era before penicillin.[2] U.S.-based studies in the past decade have shown yields of 5 to 18 percent,[4,12-21] although *Strep. pneumoniae* is still the single most common defined pathogen in nearly all studies of hospitalized adults with community-acquired pneumonia. Studies using more aggressive laboratory methods have shown higher yields,[31,32] as have studies using transtracheal aspiration to obtain uncontaminated specimens.[33,34] In studies of bacteremic pneumococcal pneumonia, the rate of false negative sputum cultures has been estimated at about 50 percent,[25] and the British Thoracic Society's pneumonia research committee concluded after discriminant functional analysis of data on 148 patients with no identifiable pathogens that most of the cases were probably due to *Strep. pneumoniae*.[35] These data suggest that the true prevalence of *Strep. pneumoniae* infection is seriously underrepresented in the results of current microbiologic tests.

Other bacteria commonly encountered in cultures of expectorated sputum are *Haem. influenzae, Staph. aureus,* and gram-negative bacilli; each accounts for 3 to 10 percent of cases, and the role of each is often disputed because of uncertainty about whether these microbes are the causal agents when they are recovered from expectorated specimens. Less common agents are *Moraxella catarrhalis, Strep. pyogenes,* and *Neisseria meningitidis*. Anaerobic bacteria are the dominant pathogens in patients with aspiration pneumonia, lung abscess, or empyema, but their role in uncomplicated pneumonia is not adequately appreciated. Our studies of transtracheal-aspiration fluid indicated that pneumonitis due to anaerobes cannot be distinguished clinically from other common forms of bacterial pneumonia.[36] One of the few studies to use transtracheal aspiration in unselected patients with community-acquired pneumonia found anaerobes in 33 percent,[37] and a yield of 22 percent was noted by Pollock et al. in quantitative cultures of bronchoscopic aspirates from 172 patients.[38] The implications are that anaerobes probably account for a substantial number of enigmatic pneumonias and that the diagnostic techniques now in common use cannot detect them.

Legionella, *Mycop. pneumoniae,* and *Chl. pneumoniae,* sometimes referred to as the "atypical agents," collectively account for 10 to 20 percent of all cases of pneumonia. All show great variations in frequency according to the patient's age and to temporal and geographic patterns. Techniques for diagnosing pneumonia due to these agents appear to be in evolution. Legionella is reported in 1 to 5 percent of hospitalized adults with community-acquired pneumonia, but geographic variation is substantial and detection is problematic; culture is probably the best method, but a survey of "otherwise sophisticated laboratories" showed that 32 percent were unable to grow legionella even from pure cultures; measurement of antigenuria is sensitive and easy, but it is limited to *L. pneumophila* serogroup 1 (which accounts for 70 to 90 percent of cases), and direct fluorescent-antibody staining of sputum is technically demanding, relatively subjective, and often considered unreliable for species other than *L. pneumophila*.[26] The frequency of infection with *Mycop. pneumoniae* among hospitalized adults with community-acquired pneumonia ranges from 1 percent to 8 percent, and it is much higher for young adults who are treated as outpatients. Diagnostic procedures include serologic tests, culture, and the polymerase chain reaction (PCR); our experience with all these tests has shown minimal concordance among their results.[27] *Chl. pneumoniae* reportedly accounts for 5 to 10 percent of cases of community-acquired pneumonia; diagnostic tests for this agent (serologic testing, culture, and PCR) are not offered by most laboratories, and there is substantial debate about their relative merits.[39]

Viral agents account for 2 to 15 percent of cases, most commonly influenza virus and, less commonly, parainfluenza virus and adenovirus. *P. carinii* is not included in most reviews of community-acquired pneumonia, but it accounted for 13 percent of all cases in the review from Johns Hopkins Hospital for 1991 and was second only to *Strep. pneumoniae*.[21] *Mycob. tuberculosis* usually accounts for 1 to 2 percent of cases; its detection is obviously important because of the need both to provide effective therapy and to protect the public health.

The pathogens responsible for community-acquired pneumonia, as identified both in studies from North America[7-21] and in a review by the British Thoracic Society,[40] are shown in Table 2.

Treatment

Therapeutic decisions are greatly simplified if the infecting pathogen is known. In general, tests that provide immediate information are desirable — such as Gram's staining with or without the quellung test, staining for acid-fast bacilli, direct fluorescent-antibody tests for legionella, or PCR (if available) for *Mycop. pneumoniae, Chl. pneumoniae,* and *Mycob. tuberculosis*. In the absence of guidance from the results of rapid diagnostic tests, recent guidelines for empirical decision making are available from the British Thoracic Society[40] and the American Thoracic Society.[23] Curiously, these two groups reviewed similar data and recommended quite different regimens (Table 3).

The conclusion of the British Thoracic Society was that empirical therapy "should always cover" *Strep.*

Table 2. Microbiologic Pathogens in Community-Acquired Pneumonia.

Microbial Agent or Cause	Prevalence (%)	
	North American studies*	British Thoracic Society†
Bacteria		
Streptococcus pneumoniae	20–60	60–75
Haemophilus influenzae	3–10	4–5
Staphylococcus aureus	3–5	1–5
Gram-negative bacilli	3–10	Rare
Miscellaneous‡	3–5	—
Atypical agents	10–20	—
Legionella	2–8	2–5
Mycoplasma pneumoniae	1–6	5–18
Chlamydia pneumoniae	4–6	—
Viruses	2–15	8–16
Aspiration	6–10	—

*Based on 15 published reports from North America.[7-21] None of these studies used techniques adequate to detect anaerobes in respiratory secretions; these organisms account for 20 to 30 percent of cases in some reports.[36,37] *P. carinii* is excluded but may account for up to 15 percent in recent reports from urban centers.[20]

†Based on an analysis of 453 adults in a prospective study of community-acquired pneumonia in 25 British hospitals.[30,40] Dashes indicate that the pathogen was not included in the study.

‡Includes *Moraxella catarrhalis,* group A streptococcus, and *Neisseria meningitidis* (each accounting for 1 to 2 percent of cases).

pneumoniae. The preferred regimen is penicillin or amoxicillin; erythromycin should be given if legionella or *Mycop. pneumoniae* is specifically suspected, and antibiotics directed against *Staph. aureus* should be considered during epidemics of influenza. By contrast, the American Thoracic Society recommended the use of macrolides, second- and third-generation cephalosporins, trimethoprim–sulfamethoxazole, and beta-lactam–beta-lactamase inhibitors. Agents active against legionella, *Mycop. pneumoniae,* and *Chl. pneumoniae* include new macrolides (clarithromycin and azithromycin), which are more expensive than erythromycin but better tolerated and purportedly more active against *Haem. influenzae*. About 30 percent of the strains of *Haem. influenzae* produce beta-lactamase and are resistant to ampicillin; most are susceptible to cephalosporins, doxycycline, and trimethoprim–sulfamethoxazole. Fluoroquinolones are effective against atypical agents and *Haem. influenzae*, but the currently available agents show reduced activity against *Strep. pneumoniae* and no activity against anaerobes.

An important variable in these recommendations is the prevalence of penicillin-resistant *Strep. pneumoniae*, which accounts for over 25 percent of pneumococcal isolates in some areas of the United States[41,42] and for higher rates in other areas of the world.[43] Alternative drugs are limited because of escalating resistance to trimethoprim–sulfamethoxazole, macrolides, and cephalosporins. Most strains (about 80 percent) have intermediate resistance to penicillin, and uncomplicated pneumonia caused by these strains may be treated with high doses of penicillin or selected cephalosporins, such as cefaclor or cefotaxime.[42] Despite this concern, a recent review found that mortality due to pneumococcal pneumonia involving resistant strains is similar to that for pneumonia involving sensitive strains, even when the treatment includes penicillins or cephalosporins.[43]

There is an unverified assumption that many or most patients with no bacteriologic diagnosis have infections involving atypical agents, such as legionella species, *Mycop. pneumoniae,* or *Chl. pneumoniae*. This assumption accounts for the frequent use of macrolides for enigmatic pneumonia, although limited studies in outpatients show that macrolides and beta-lactam agents are equally effective in adult outpatients with pneumonia.[44,45] Legionella is an important pulmonary pathogen that requires treatment with a macrolide or fluoroquinolone, but this applies only to hospitalized patients, since legionnaires' disease has not been observed in outpatients.

On the basis of these observations, we recommend that adults with community-acquired pneumonia receive treatment with antibiotic agents selected according to the results of microbiologic studies of sputum and blood cultures (Table 4). We recommend the following guidelines for the empirical selection of drugs:

For young adults treated as outpatients: the oral administration of a macrolide (erythromycin, clarithromycin,

Table 3. Recommendations for the Empirical Treatment of Community-Acquired Pneumonia.

British Thoracic Society*

Uncomplicated pneumonia of unknown cause without features indicating severe or nonpneumococcal disease
- *Preferred regimen:* an aminopenicillin — amoxicillin (500 mg orally 3 times/day) or ampicillin (500 mg intravenously 4 times/day) — or benzylpenicillin (1.2 g intravenously 4 times/day)
- *Alternative regimens:* erythromycin (500 mg orally or intravenously 4 times/day) or a second- or third-generation cephalosporin (cefuroxime or cefotaxime)

Severe pneumonia of unknown cause
- *Preferred regimen:* erythromycin (1 g intravenously 4 times/day) plus a second- or third-generation cephalosporin (cefuroxime [1.5 g intravenously/day] or cefotaxime [2 g intravenously 3 times/day])
- *Alternative regimen:* ampicillin (1 g), floxacillin (2 g), and erythromycin (1 g) — all intravenously 4 times/day

American Thoracic Society†

Pneumonia in outpatients without coexisting conditions, age ≤60 yr‡
- *Preferred regimen:* a macrolide — erythromycin; or either clarithromycin or azithromycin for patients with intolerance to erythromycin and for smokers (to treat *Haem. influenzae*)
- *Alternative regimen:* tetracycline

Pneumonia in outpatients with coexisting conditions, age ≥60 yr, or both‡
- *Regimen:* a second-generation cephalosporin; or trimethoprim–sulfamethoxazole; or a beta-lactam–beta-lactamase inhibitor with or without erythromycin or another macrolide if legionellosis is a concern

Pneumonia in hospitalized patients
- *Regimen:* a second- or third-generation cephalosporin; or a beta-lactam–beta-lactamase inhibitor with or without erythromycin if legionellosis is a concern; rifampin may be added if legionellosis is documented

Severe community-acquired pneumonia§
- *Regimen:* a macrolide (with rifampin if patient has legionellosis); a third-generation cephalosporin with antipseudomonal activity or another antipseudomonal agent, such as imipenem or ciprofloxacin; and an aminoglycoside

*From the British Thoracic Society.[40]

†From the American Thoracic Society.[23] Excludes patients at risk for HIV infection.

‡Coexisting conditions are defined as chronic obstructive lung disease, diabetes mellitus, renal insufficiency, congestive heart failure, hospitalization within previous year, post-splenectomy state, chronic alcoholism, malnutrition, altered mental status, or suspected aspiration.

§Defined by a respiratory rate >30 per minute, ratio of the partial pressure of oxygen to the fraction of inspired oxygen <250, need for mechanical ventilation, chest film showing bilateral or multiple-lobe involvement, systolic blood pressure <90 mm Hg or diastolic pressure <60 mm Hg, need for vasopressor agents for more than four hours, or renal failure.

Table 4. Antimicrobial Agents for Community-Acquired Pneumonia Caused by Microbial Pathogens.

PATHOGEN	DRUG OF CHOICE	ALTERNATIVE DRUGS	COMMENTS
Strep. pneumoniae	Penicillin	Cephalosporins Macrolides Doxycycline Vancomycin	For strains with intermediate levels of resistance to penicillin: high-dose penicillin, cefotaxime, or ceftriaxone For highly resistant strains: vancomycin
Haem. influenzae	Cephalosporin (second- or third-generation) Trimethoprim–sulfamethoxazole	Fluoroquinolone Doxycycline	Beta-lactamase production with amoxicillin resistance in 20 to 30% of strains
Staph. aureus	Oxacillin or nafcillin with or without gentamicin	Cefuroxime or cefazolin Vancomycin	Methicillin resistance rare in community-acquired strains
Mor. catarrhalis	Cephalosporin (second- or third-generation) Trimethoprim–sulfamethoxazole	Macrolide Fluoroquinolone Doxycycline	Beta-lactamase production with ampicillin resistance in 80 to 90% of strains
Anaerobes	Clindamycin	Penicillin plus metronidazole Beta-lactam–beta-lactamase inhibitor Penicillin or amoxicillin	Published experience limited except for penicillin and clindamycin
Gram-negative bacilli	Cephalosporin (second- and third-generation) with or without aminoglycoside	Fluoroquinolone Imipenem Anti-pseudomonal penicillin	In vitro sensitivity tests required
Legionella species	Erythromycin Ciprofloxacin	Clarithromycin or azithromycin	Experience extensive only with erythromycin Rifampin often added
Mycop. pneumoniae	Doxycycline Erythromycin	Clarithromycin or azithromycin Fluoroquinolone	
Chl. pneumoniae	Doxycycline Erythromycin	Clarithromycin or azithromycin Fluoroquinolone	
Nocardia	Sulfonamide Trimethoprim–sulfamethoxazole	Doxycycline Imipenem with or without amikacin	
Chl. psittaci	Doxycycline	Chloramphenicol	
Cox. burnetii	Doxycycline	Chloramphenicol	
Influenza A	Amantadine or rimantadine		Efficacy in primary influenza pneumonia not established
Hantavirus	Supportive care — inotropic and vasopressor agents	Ribavirin (experimental)	

or azithromycin) or doxycycline; for patients older than 25, oral amoxicillin or an oral cephalosporin is also acceptable.

For adults over 60 and those with coexisting illnesses who are treated as outpatients: oral cephalosporin or amoxicillin; for patients with penicillin allergy, oral macrolide or doxycycline.

For hospitalized patients: Second- or third-generation cephalosporin (cefuroxime, cefotaxime, or ceftriaxone) with or without erythromycin, given parenterally; parenteral therapy should continue until the patient has been afebrile for more than 24 hours and oxygen saturation exceeds 95 percent.[5]

Oral fluoroquinolones (ciprofloxacin and ofloxacin) are acceptable alternatives to macrolides for legionnaires' disease, and probably for *Mycop. pneumoniae* and *Chl. pneumoniae* as well. In areas with high rates of resistance among strains of *Strep. pneumoniae,* local sensitivity patterns should be taken into account. The duration of therapy is arbitrary, but 5 to 10 days is usually advocated for common bacterial pneumonias, 10 to 14 days for those caused by *Mycop. pneumoniae* or *Chl. pneumoniae,* and 14 to 21 days for legionnaires' disease.[5,23]

Criteria for defining failure to respond are not readily available, although previously healthy adults with pneumococcal pneumonia are usually afebrile within three days.[46] Older patients with pneumococcal pneumonia or bacteremic pneumococcal pneumonia and pneumonia due to gram-negative bacilli, *Staph. aureus,* or legionella usually respond more slowly. Radiographic changes are slow in comparison with the clinical response, so that worsening infiltrates in the first few days of treatment are the rule rather than the exception. Microbiologic tests for common bacterial pathogens in patients with poor responses are generally considered unreliable after antibiotics have been given. Fiberoptic bronchoscopy is often useful for the detection of underlying lesions such as neoplasms, for the detection of selected pathogens such as *Mycob. tuberculosis, P. carinii,* or pathogenic fungi, and occasionally for the detection of *Staph. aureus* or gram-negative bacilli, especially if quantitative cultures are performed.[47] A computed tomographic scan may identify undetected anatomical changes. The need for a follow-up x-ray film is a matter of debate, and the time required for the resolution of changes is often longer than anticipated.[48] Follow-up chest films are most justified for patients with a delayed response, an uncertain cause of pneumonia, or infection with penicillin-resistant *Strep. pneumoniae.* Long-term follow-up radiography to document pulmonary clearing is indicated for patients who have delayed responses, for those who may have bronchogenic neoplasms or other underlying disease, and for those with recurrent pneumonia.

The mortality rate among outpatients with community-acquired pneumonia is low, but for hospitalized patients it is 10 to 25 percent. Poor prognostic factors are summarized in Table 5.[5,16,20,23,49] The microbial pathogens most frequently associated with death are *Strep. pneumoniae* and legionella. Clinical factors that predict death in the hospital are an age of more than 65 years, abnormalities in the vital signs (respiratory

Table 5. Poor Prognostic Factors in Patients with Community-Acquired Pneumonia.*

Age	>65 years
Coexisting disease	Diabetes, renal failure, heart failure, chronic lung disease, chronic alcoholism, hospitalization within previous year, immunosuppression, neoplastic disease
Clinical findings	Respiratory rate >30/min Systolic blood pressure <90 mm Hg or diastolic pressure <60 mm Hg Temperature >38.3°C Altered mental status (lethargy, stupor, disorientation, or coma) Extrapulmonary site of infection — e.g., meningitis, septic arthritis
Laboratory tests	White-cell count <4000/mm^3 or >30,000/mm^3 Partial pressure of oxygen <60 mm Hg while breathing room air Renal failure Chest film showing multiple-lobe involvement, rapid spread, or pleural effusion Hematocrit <30%
Microbial pathogens	*Strep. pneumoniae* Legionella *Staph. aureus*

*Adapted from Marrie,[5] Farr et al.,[16] Fine et al.,[19] and Niederman et al.[23]

rate, >30 per minute; systolic blood pressure, <90 mm Hg; diastolic pressure, <60 mm Hg; or temperature, >38.3°C), altered mental status (lethargy, stupor, disorientation, or coma), and associated neoplastic disease. Each of these prognostic factors was statistically significant in the 1986–1987 study of pneumonia in Pittsburgh[18]; these findings were subsequently verified in an analysis of the 1989 MedisGroups Comparative Hospital Database made up of information on 14,199 patients treated in 78 hospitals.[20]

Prevention of pneumonia is obviously an important goal. Infection with influenza is a critical factor, especially in elderly patients who constitute the adult population group with the highest attack rate for community-acquired pneumonia and the group with the highest mortality due to the disease. *Strep. pneumoniae* continues to be the most common bacterial pathogen in virtually all studies of pneumonia and has aroused concern because of the dramatic increase in the rates of resistance to antibacterial agents among isolates. Given these observations, a high priority should be assigned to following the current guidelines for the administration of influenza vaccine and pneumococcal vaccine and for the judicious use of antimicrobial agents.

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