REVIEW

Pneumonia in Residents of Long-Term Care Facilities: Epidemiology, Etiology, Management, and Prevention

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Pneumonia is a leading cause of morbidity and mortality among patients in long-term care facilities; the median reported incidence is 1 per 1,000 patient-days. Risk factors include functional dependency, chronic pulmonary disease, and conditions causing aspiration. The frequency of etiologic agents varies widely among reports; for example; *Streptococcus pneumoniae* ranges from 0% to 39% of cases, and gram negative bacilli ranges from 0% to 51% of reported cases. Viral respiratory infections, particularly influenza and respiratory syncytial virus, typically occur in outbreaks. Mortality varies from 5% to 40%; functional status is the major determinant of survival. Many patients receive inadequate initial evaluations, and as many as 40% receive no physician visit during the episode. Although transfer to an acute care facility occurs in 9% to 51% of cases, most transferred patients could be managed in the nursing home with minimal additional support. Appropriate evaluation includes examination by a practitioner, recording of vital signs, chest radiograph, and examination of an adequate sputum sample, if available. Patients without contraindications to oral therapy or severe abnormalities of vital signs (pulse >120 beats per minute, respirations >30 per minute, systolic blood pressure <90) may initially receive oral therapy. Appropriate oral agents include amoxicillin/clavulanate, second generation cephalosporins, quinolones active against *S pneumoniae*, or trimethoprim/sulfamethoxazole. Appropriate parenteral agents include beta-lactam/beta-lactamase inhibitor combinations, second or third generation cephalosporins, or quinolones. Pneumococcal and influenza vaccines should be administered to all residents. Future studies should focus on identifying risk factors for pneumonia that are amenable to intervention and to identifying highly effective, preferably oral, antimicrobial regimens in randomized trials. **Am J Med. 1998;105:319–330.** ©1998 by Excerpta Medica, Inc.

Pneumonia is the leading cause of death (1,2) and among the leading causes of transfer to acute care facilities (3–5) in patients living in long-term care facilities. This is not surprising, as most nursing home patients are elderly and have underlying illnesses and functional deficits. As the population ages, the demand for long-term care services will likely increase. Recent surveys indicate that infection rates in these facilities are rising in association with an increase in the level of care required by patients (6,7). As a result, the number of cases of pneumonia occurring in long-term care will undoubtedly increase for the foreseeable future.

The purpose of this review is to outline the current state of knowledge about the epidemiology, etiology, management, outcome, and prevention of pneumonia occurring among long-term care patients. The review presents specific recommendations in the areas of management and prevention, and it outlines suggested priorities for future investigation.

METHODS

Articles were identified by Medline search and by review of bibliographies contained in articles retrieved. Articles providing data on the incidence, epidemiology, clinical presentation, treatment, and outcome of pneumonia in long-term care patients were reviewed. With regard to microbial etiology, articles were included if etiologic data based on sputum culture, blood culture, or special tests for viral and "atypical" pathogens were provided. The criteria used for judging adequacy of the sputum sample were specifically noted.

EPIDEMIOLOGY

The incidence of pneumonia among long-term care patients ranges from 0.27 to 2.5 per 1,000 patient-days (8–23); the median reported incidence is 1 per 1,000 patient-days. In many reports, criteria for lower respiratory infection included cases with bronchitis, as chest radiographs

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Table 1. Published Studies of Etiology of Pneumonia Acquired in Long-term Care Facilities, 1978–1994

Author	Year	Reference	Number of Patients	All Patients Hospitalized?	VA	Sputum Criteria*	Blood Culture Results Included	*Streptococcus pneumoniae*
Garb	1978	57	50	yes	no	none	yes	26%
Magnussen	1980	22	11	no	yes	none	no	0
Gambert	1982	58	34	no	yes	other	no	21%
Nicolle	1984	9	22	no	yes	no	yes	17%
Setia	1984	59	10	no	no	—	yes	0
Finnegan	1985	66	36	no	yes	no	yes	25%
Marrie	1986	60	74	yes	no	strict	yes	4%
Alvarez	1988	15	414	no	yes	no	yes	25%
Peterson	1988	61	123	yes	no	strict	yes	10%
Marrie	1989	27	131	yes	no	strict	yes	7%
Jacobson	1990	17	22	no	yes	no	no	23%
Fang	1990	26	46	yes	no	other	yes	20%
Hirata-Dulas	1991	62	50	yes	no	strict	yes	16%
Muder[†]	1992	7	18	no	yes	—	yes	39%
McDonald	1992	63	136	no	yes	other	no	4%
Philips	1993	64	104	no	yes	no	no	30%
Drinka	1994	65	60	no	yes	strict	no	8%
Smith	1994	23	115	no	no	no	yes	1%

* Strict criteria = >25 polymorphonuclear leukocytes and <10 epithelial cells per 100-power field; other = less stringent criteria applied; none = no criteria for sputum adequacy stated.

[†] Only bacteremic cases included.

VA = Department of Veterans Affairs facility.

were not uniformly obtained. Jackson et al (19) reported each separately and found a pneumonia rate of 1.5 per 1,000 patient-days and a bronchitis rate of 1.0 per 1,000 patient-days. Although veterans facilities account for a disproportionate number of reports, the rates for Veterans and private facilities overlap. There is no clear association between pneumonia incidence and facility size.

The incidence of pneumonia among residents of long-term care facilities is many-fold higher than among persons residing in the community. Expressed as annual rates of infection, the reported annual incidence in long-term care residents ranges from 99 to 912 per 1,000 persons, with a median reported rate of 365 per 1,000. In contrast, the annual incidence of pneumonia in the community is approximately 12 per 1,000 persons (24,25), rising to 34 per 1,000 in those 75 years of age and older.

Infection is a major reason for transfer of nursing home residents to acute care hospitals, and pneumonia is the leading cause of infection requiring transfer (3–5). Ten percent to 18% of all patients admitted to hospitals for pneumonia are nursing home residents (26–28). In reported series, 9% to 51% of patients acquiring pneumonia in long-term care facilities were transferred to hospitals (29–33). The average charge generated by such an admission has been estimated to be approximately $10,000 (34).

The risk of acquiring pneumonia increases with age (24). Lung capacity and cough reflex decline with age; several defects in host immunity also occur (35). The elderly also have an increased frequency of co-morbidities

that contribute to the risk of pneumonia, including cardiac disease, pulmonary disease, diabetes, neurologic disorders, and malignancy. The elderly are more likely to develop nosocomial pneumonia (36).

There are only a few studies that have specifically examined risk factors for lower respiratory infection in long-term care facilities (15–17,37–39), just three of which (15,16,38) performed a multivariable analysis of risk factors. Several classes of risk factors have been identified. Not surprisingly, profound debility, as measured by a Karnofsky score of <40 (15), bedfast status (37,38), urinary incontinence (37), or deteriorating health status (16) has been a consistent risk factor. Three studies identified chronic obstructive lung disease (17,38,39), and two studies identified tracheostomy (17,38) as risk factors for pneumonia. Two studies found that factors associated with aspiration, including difficulty with oral secretions (16) and nasogastric tube feeding (15) increased the risk of pneumonia. A retrospective analysis of nursing home patients undergoing videofluoroscopy found that feeding tube placement was associated with pneumonia in patients with demonstrated aspiration (40). Two studies reported contradictory findings regarding the association between pulmonary infection and prior pneumococcal vaccine (15,39).

The association between nasogastric feeding and pneumonia raises the question of whether alternative methods of feeding might be associated with a lower incidence of pneumonia. Although data are limited, the occurrence of aspiration following gastrostomy tube feeding appears to

Haemophilus Influenzae	Moraxella catarrhalis	Staphylococcus aureus	Gram-negative Bacilli	Legionella	Mycoplasma	Chlamydia	Other	Viral	Unknown
6%	0	26%	51%	—	—	—	—	—	0
0	0	27%	55%	—	—	—	—	—	—
15%	0	0	6%	—	—	—	—	—	59%
0	0	3%	34%	—	—	—	—	—	—
0	0	30%	50%	—	—	—	—	—	—
8%	0	0	3%	—	—	—	6%	—	56%
0	0	1%	8%	4%	—	—	8%	9%	—
22%	0	6%	26%	—	—	—	—	—	10%
7%	4%	2%	9%	—	—	—	—	—	—
1%	0	2%	8%	0	1%	—	23%	—	59%
18%	5%	5%	9%	—	—	—	—	—	41%
9%	0	6%	11%	6%	0	6%	15%	—	26%
10%	0	4%	12%	—	—	—	—	—	78%
6%	0	33%	22%	0	—	—	—	—	0
7%	1%	7%	23%	—	—	—	7%	—	53%
19%	4%	11%	26%	—	—	—	9%	—	—
7%	5%	2%	0	0	0	0	8%	—	72%
0	0	2%	3%	—	—	—	20%	—	74%

be similar to that observed with nasogastric tube feeding (41), and the incidence of pneumonia is likewise comparable (40,42–45). Use of a feeding jejunostomy does not appear to reduce the risk of pneumonia (46).

Few, if any, of these risk factors are subject to modification. Thus, with the possible exception of immunization, opportunities for intervention to reduce the risk of pneumonia appear to be limited.

There are several potential sources for organisms causing respiratory infection, including a patient's endogenous nasopharyngeal flora. Debility increases the likelihood of colonization of the pharynx with enteric organisms (47). Enteral feeding mixtures can become contaminated with bacteria during use (48,49). Patient to patient transmission of primary respiratory pathogens such as influenza virus (50,51) and *Mycobacterium tuberculosis* (52) occurs readily in the closed and densely populated nursing home environment. Long-term care patients are frequently colonized with multiply resistant strains of *Staphylococcus aureus* and gram-negative bacilli (53,56); patients with pressure ulcers and indwelling urinary catheters often serve as reservoirs of such strains.

ETIOLOGY

Although many studies have reported the etiology of pneumonia in the long-term care setting (7,9,15,17,22, 23,26,27,57–66), solid data to base treatment upon are lacking. Adequate sputum samples are difficult to obtain due to poor cough reflex and abnormal mental status. For example, Drinka et al (65) reported adequate sputum samples in only 28% of patients enrolled in a prospective nursing-home study. Another nursing-home based study reported that 42% of patients produced sputum with a potential pathogen, whereas 53% did not produce any sputum (66). Two studies of hospitalized nursing home residents reported obtaining adequate samples in only 35% (60) and 22% (27) of patients. In another study, adequate sputum samples were obtained in only 42% of patients despite attempts by a respiratory therapist using saline nebulization and nasotracheal suctioning (62).

The interpretation of culture results in these patients is problematic. Studies based on sputum culture may underestimate the contribution of the *Streptococcus pneumoniae,* which is recovered from the sputum in only half of the cases of bacteremic pneumonia (67). Studies based on blood culture results overestimate the contribution of the pneumococcus and *S aureus*, since these agents are more likely to be associated with bacteremia than are most other pathogens (26). The upper airways of nursing home patients are frequently colonized with enteric bacilli (47) and staphylococci, including methicillin-resistant strains (53). Finally, many patients receive empiric oral antibiotic therapy in the nursing home before diagnostic tests are performed (26,57).

Table 1 summarizes studies reporting the etiology of nursing-home acquired pneumonia. Eight studies reported using criteria for the adequacy of sputum samples, of which five studies (27,60–62,65) used the stringent criteria of more than 25 leukocytes and with fewer than 10 epithelial cells per 100-power field. The other three studies (26,58,63) used less stringent criteria and the remainder did not state any criteria. Ten studies included cases diagnosed by blood culture, and two were studies of

bacteremia that included cases of pneumonia. *S pneumoniae* was the most frequent pathogen identified in nine reports, and was isolated in 0% to 39% of cases. Outbreaks of invasive pneumococcal infection have been reported in nursing homes among unimmunized residents (17,68–70); attack rates ranged from 3% to 20%. One outbreak (69) was caused by a multiply antibiotic-resistant strain. Gram negative bacilli (excluding *Haemophilus influenzae*) were the most frequent pathogens in five reports, with isolation rates of 0% to 55%. Rates of isolation for *H influenzae* ranged from 0% to 22%. While most *H influenzae* infections of adults are due to non-typable strains, clusters of respiratory infection and bacteremia due to *H influenzae* type b have been reported (71,72). Rates of isolation for *S aureus* ranged from 0% to 39% of cases; up to one third of invasive staphylococcal infections in long-term care patients may be due to methicillin resistant strains (7).

The role of anaerobic bacteria is uncertain. Aspiration is usually considered a major risk factor for pneumonia in the institutionalized elderly. One study (27) reported that clinically defined aspiration was the cause of pneumonia in 15% of patients; presumably, anaerobic bacteria played a pathogenic role in these cases. However, few patients underwent procedures to recover anaerobic bacteria from the lower airways.

Several studies attempted to identify infections caused by viruses or atypical pathogens such as *Legionella*, *Mycoplasma,* or *Chlamydia* spp. Fang et al (26) reported *Legionella* species as the etiology in 6% of cases. Marrie et al (60) reported that 4% of 74 cases admitted to a general hospital in Canada were caused by *Legionella*; they later reported not finding any cases of *Legionella* infection in 131 patients admitted to the same hospital (27). Fang et al (26) reported *C pneumonia* as the etiologic agent in 6%. Drinka et al (65) found no cases of *Legionella* or *Chlamydia* infection. *M pneumoniae* appears to be an uncommon cause of pneumonia in these patients (27,65).

Marrie et al (60) isolated a virus from the oropharynx in 9% of hospitalized cases. All but one of the isolates was herpes simplex virus-1; this most likely represented oral shedding of the virus. In a subsequent study using paired acute and convalescent sera, the same investigators found evidence of fourfold rises in titre in 16% of patients (27). Of the 21 cases, rises in titre were seen to influenza A in 11, influenza B in 3, parainfluenza type 3 in 2, and cytomegalovirus in 5.

Despite the limited number of studies that have documented the frequency of viruses in the etiology of lower respiratory infections in long-term care facilities, it is clear that viral respiratory tract infection causes considerable morbidity and mortality (50,51,73). Influenza A typically causes epidemic illness with attack rates ranging from 19% to 60%. (50,51,74,77); as many as half of symptomatic patients may have evidence of pneumonia (50). Institutional influenza outbreaks occur during the typical

influenza season (December to March). Respiratory syncytial virus has also been reported to cause epidemic infection in long-term care facilities (78–80). Its clinical presentation is similar to that of influenza (81–82), although infection may be associated with protracted respiratory symptoms lasting about 1 month (83). Radiographic evidence of pneumonia is present in 5% to 55% of affected patients (79,80,83). Parainfluenza virus also causes epidemic disease in nursing home patients (84). Symptoms include fever, cough, sore throat, and rhinorrhea; 13% to 29% of patients show evidence of pneumonia.

Tuberculosis occurs as both an endemic and an epidemic infection in long-term care facilities (52,85–86). Tuberculosis rates among elderly nursing home residents are fourfold to fivefold higher than those experienced by elderly persons living in the community (85). Clinical and radiologic presentation may be atypical in the elderly; confusion with bacterial pneumonia may occur.

Despite the uncertainties inherent in these etiologic studies, some practical conclusions appear warranted. *S pneumoniae* is an important cause of pneumonia in long-term care facilities. The relative frequency of pneumonia due to gram-negative bacilli in long-term care residents appears to be higher than that reported in community-dwelling residents. *S aureus* accounts for 30% to 50% of bacteremic pneumonias; in many nursing homes, a high proportion of staphylococcal isolates are methicillin-resistant. Viral pneumonia in this setting may occur in either a sporadic or epidemic fashion. The seasonal and epidemic nature of influenza may facilitate recognition even in the absence of specific virologic confirmation. The relative contribution of atypical bacterial pathogens, such as *Legionella*, *Chlamydia*, and *Mycoplasma*, remains to be determined. However, there are several reports of *Legionella* infection occurring in long-term care facilities in association with colonization of the facility's water system (87,88).

CLINICAL PRESENTATION AND OUTCOME

Pneumonia in long-term care patients may have an atypical presentation (27,33,60,61,63,64). Patients 65 years of age and older presenting with pneumonia tend to have fewer symptoms than do younger adults, even after controlling for severity of illness and comorbid conditions (89,90). The elderly often have lower baseline body temperature and a lower peak temperature response to infection (90,91). Only about two thirds of nursing home patients with pneumonia will have a temperature >38°C at presentation (Table 2). Many patients have neither cough nor dyspnea; the absence of dyspnea may be due to frequency of abnormal mental status, noted in 21% to 73%

Table 2. Presentation of Pneumonia in Long-term Care Patients*

Author	Year	Reference	Number of Patients	Cough	Dyspnea	Fever	Confusion	Leukocytosis
Marrie	1986	60	74	62%	—	64%	53%	81%
Peterson	1988	61	123	64%	32%	59%	21%	80%
Marrie	1989	27	131	62%	—	64%	48%	81%
McDonald	1992	63	136	—	—	89%	56%	—
Philips	1993	64	104	100%	—	68%	—	80%
Muder	1996	30	108	63%	42%	66%	—	73%
Marrie	1997	89	71	62%	39%	64%	70%	—

* See Table 1 for additional details. Muder (1996) included all patients; Marrie (1997) included patients who were hospitalized.

of patients. A decline in mentation or activity level may be the only presenting feature.

These clinical features are similar to those reported in studies of community acquired pneumonia in the elderly, in whom absence of fever or respiratory symptoms is relatively common (93–97).

Pneumonia is the leading cause of death among nursing home residents. In autopsy series, pneumonia was the cause of from one third to almost one half of all deaths (1,2). Clinical series report that 26% to 44% of deaths are related to pneumonia (9,14,20). Reported acute mortality rates range from 5% to 40% per episode. Relatively low mortality rates (4.5% to 8%) were reported in controlled trials (61,62,64) in which the most seriously ill patients were excluded. Mortality in hospital based series ranged from 20% to 40% (26,57,60,89) and from 6% to 28 % for nursing home based series (30–33,37,66,98). The mortality of bacteremic pneumonia in these patients is as high as 50% (7).

The most important determinant of pneumonia outcome is a patient's functional status. Several studies have reported a significant association between dependency in activities in daily living and short-term mortality (30,32,33). Neither age nor underlying medical illness appears to have a significant effect after adjusting for level of dependency. Functional status is also a key determinant of long-term survival (33,89). Approximately 60% of patients with multiple dependencies will die within 12 months of an episode of pneumonia, and fewer than one quarter will be alive at 2 years. During that time, recurrent pneumonia is common, as is transfer to a hospital for other acute illness (33). It is not clear whether the initial episode of pneumonia contributes to a patient's subsequent decline and demise, or whether it serves as a marker for debility that is incompatible with long-term survival.

EVALUATION OF PATIENTS

Patients in nursing homes often receive incomplete evaluations for episodes of infection (37,99,100). Many facilities do not have full time physicians; in those that do, physicians are not typically on site 24 hours a day. In a

1-year survey of infections in Maryland nursing homes, only 59% of patients with lower respiratory infection received a physician visit, and only 37% had a chest radiograph (100). Another study found that 17% of nursing home patients with pneumonia received only a telephone evaluation by a physician (32). Sputum cultures were obtained in a minority of patients (99,100).

An inadequate evaluation can have several adverse consequences. The antibiotic therapy that is prescribed may be inappropriate (100-102). In one study, 51% of antibiotic prescriptions were either inappropriate or completely unjustified (101). Nursing home patients may be transported to hospitals via ambulance for evaluation and treatment that could have been initiated in the nursing home (3). In a retrospective study, lack of evaluation by a physician or nurse practitioner for pneumonia was associated with failure of initial treatment, defined as death or requirement for hospitalization (31).

Hospitalizations of nursing home patients tend to be relatively prolonged. In a recent study, mean length of stay was 7.6 days, with an average charge of $10,000 per episode even after initiation of clinical guidelines for in-hospital management (34). Others have reported average hospital stays as long as 10.6 days (98).

Based on the recommendations of a panel of infectious disease specialists and geriatricians, Warren and colleagues (100) have recommended a minimal diagnostic evaluation for suspected pneumonia in a nursing home patient. These include recording of temperature, evaluation by a physician, sputum culture, and chest radiograph. To these should be added determination of pulse and respiratory rate because of their association with outcome (discussed below) and the need for parenteral therapy.

Examination of a properly prepared sputum gram stain is desirable, should sputum be available. The gram stain provides essential information for determining the adequacy of the sputum collection and the reliability of the culture. A sample with >25 polymorphonuclear cells and <10 squamous epithelial cells per 100-power field is representative of the lower respiratory flora (103). This recommendation may be controversial, given the diffi-

culty of obtaining an adequate sputum sample. Few long-term care facilities have on-site microbiology facilities. There are no data to demonstrate that sputum examination or culture favorably influences the outcome of pneumonia in these patient populations. However, identification of a predominant organism in an adequate sample is a reasonable way to decide upon initial therapy, and permits recognition of multiply resistant organisms that are being isolated with increasing frequency in long-term care facilities (54–57,104).

Whether other specific diagnostic tests for the etiology of pneumonia are indicated is uncertain. There are few studies that have specifically sought to determine the frequency of *Chlamydia*, *Mycoplasma,* and *Legionella* in long- term care (26,65). Cultures or immunologic tests to identify viral respiratory pathogens are unlikely to be useful unless the clinical circumstances suggest an outbreak, in which case testing for influenza may have value (105,106).

A less thorough evaluation than that outlined above may be appropriate if it has been determined that a patient will not receive specific therapy for infection, in which case evaluation and treatment would be aimed at relieving discomfort.

MANAGEMENT

As noted, 9% to 51% of patients acquiring pneumonia in long-term care facilities are transferred to hospitals (30–33,37). The decision to transfer is generally based on the judgment of a physician or other health care provider. There is no evidence that transfer improves survival. Mortality rates for patients treated in the nursing home are similar to those for patients treated in hospitals. However, direct comparisons are difficult because of several confounding factors. Transferred patients may be more seriously ill than patients not transferred (32) or may have failed initial therapy (31). On the other hand, some patients are not transferred due to a prior decision that aggressive therapy was not appropriate. One study found that adverse outcomes, defined as death or decline in functional status within 2 months, were more frequent among pneumonia patients transferred to a hospital than among those treated in the nursing home (107). This difference in outcome persisted after controlling for functional status, underlying disease and other factors contributing to a poor outcome, although there may have been other differences between the hospital and nursing home treatment groups. However, hospitalization of the elderly is associated with a variety of adverse consequences, including deconditioning, delirium, malnutrition, and urinary incontinence (108), that can contribute to functional decline and increasing dependency that may not be reversible.

There are insufficient data to identify which patients would benefit from hospitalization for pneumonia. One study (107) indicated that patients with a respiratory rate ≥40 per minute were more likely to die in the short term if treated in the nursing home than in the hospital, although 2-month survival was not affected.

Most patients with pneumonia could be treated without transfer to a hospital if a few services were available in the nursing home. A physician, nurse practitioner, or physician's assistant should be available to evaluate a patient suspected of having pneumonia on a timely basis, that is, the same day. Portable radiography should be available. Finally, the facility should have the ability to administer intramuscular or intravenous antimicrobials as well as supplemental oxygen. The ability to provide minimal laboratory testing, including sputum examination and culture, complete blood count, and indices of renal function is desirable. These could be obtained through contract with an independent laboratory.

These capabilities should not be difficult to provide, as they are available at many physicians' offices. Subacute units within the facility, organized to provide a higher level of care than that available on nursing home units, may facilitate the on-site treatment of pneumonia, which is likely to be more economical than treatment in an acute care hospital. There is, however, a financial disincentive to treating acute infections in the nursing home, which is not reimbursed for the additional care needed by the patient during such an episode. A pilot study that provided such reimbursements showed that many acute episodes can be managed in the nursing home, with a reduction in hospital admissions and considerable cost savings (99). Lower respiratory infection was the most frequent acute illness in this study, accounting for 29% of all episodes.

Given the uncertain etiology of most cases of pneumonia in long-term care patients, selection of appropriate antimicrobial therapy is difficult. If an adequate sputum sample is available for gram stain and culture, therapy can be directed toward a specific etiologic agent. Unfortunately, adequate sputum samples are obtainable from fewer than half of the patients. Empiric therapy should take into account studies indicating that, while *S pneumoniae* and *H influenzae* are important pathogens, gram-negative bacilli and *S aureus* appear to be more frequently isolated than is the case with community-acquired pneumonia. Mehr and colleagues (27) reported that, when adjusted for functional status, patients receiving initial therapy with broad spectrum oral antimicrobials (trimethoprim-sulfamethoxazole, cefaclor, amoxicillin/clavulanate, or ciprofloxacin) had a significantly lower mortality than did patients initially treated with traditional antimicrobials (penicillin, ampicillin, amoxicillin, erythromycin, tetracycline, cephalexin).

Several controlled trials of therapy have been published. One hospital-based study showed that treatment with oral ciprofloxacin was comparable to treatment with intramuscular cefamandole (41). Another found that in-

travenous, followed by oral, ciprofloxacin was comparable to intramuscular ceftriaxone (62). A large nursing home based study (64) found similar success rates for intramuscular cefoperazone (90%) and intramuscular ceftriaxone (94%). None of these studies reported that methicillin-resistant *S aureus* was a cause for bacteriologic failure, although superinfection with *S aureus* (methicillin susceptibility not stated) apparently occurred in a few patients.

Many long-term care facilities have limited ability to administer intravenous antimicrobial therapy. Although clinical trials indicate that intramuscular therapy is fairly well tolerated in these patients, individual patients, particularly those with poor muscle mass, may not tolerate repeated injections. In addition, most oral regimens are less costly than parenteral regimens. Thus, initial oral therapy, or early conversion from parenteral to oral therapy has obvious advantages.

In a retrospective review of patients who were initially treated with oral therapy in community nursing homes, Degelau and colleagues (31) developed a discriminant rule for failure of initial oral therapy, defined as hospitalization within 14 days or death within 3 days. The predictors were temperature $\geq 100.5°$ F, pulse ≥ 90 beats per minute, respiratory rate ≥ 30 beats per minute, dependence in feeding, and requirement for mechanically altered diet. Treatment failures occurred in only 11% of patients with none of these factors, but in 60% of those with 3 or more. However, this study was retrospective, there was no comparison group of patients who received parenteral therapy in the nursing home, and a high proportion of patients appear to have received oral ampicillin or amoxicillin, agents that may have poor efficacy. The overall mortality for patients in whom treatment was initiated in the nursing home was 13%, compared with 18% for patients transferred to a hospital at onset. Thus, with the exception of patients who have conditions that are likely to interfere with oral or gastric administration or intestinal absorption, it is not clear that a group requiring initial parenteral therapy can be identified. Nevertheless, it is reasonable to administer parenteral therapy, at least initially, to patients with respiratory distress or evidence of circulatory compromise. Hypotension and anoxia may lead to inadequate splanchnic blood flow, compromising oral bioavailability of antimicrobials.

Ideally, the specific antimicrobial chosen would depend on the results of sputum examination and culture, and on a knowledge of the patterns of antimicrobial susceptibilities in the given facility. Appropriate oral agents include trimethoprim/sulfamethoxazole, amoxicillin/clavulanate, second generation cephalosporins, or quinolones. There are no controlled trials directly comparing these agents. However, the antimicrobial spectra, side effect profiles, and cost of the various agents may assist in the selection of initial oral therapy. Trimethoprim-sulfamethoxazole has activity against *S pneumoniae, H influ-*

enzae, and many members of the Enterobacteriaceae. In addition, it is relatively inexpensive and can be given twice daily (109). Oral administration of amoxicillin/clavulanate is frequently followed by diarrhea; oral cephalosporins are fairly expensive. One potential drawback with quinolone therapy is that many agents of this class, such as ciprofloxacin and ofloxacin, have marginal activity against *S pneumoniae* (110). Bacteriologic failures may occur (62,111). It is therefore reasonable to add an agent with good activity against gram-positive organisms, such as clindamycin or penicillin, to quinolone therapy (112). Newer quinolones such as sparfloxacin, trovofloxacin, levofloxacin, and grepafloxacin are more active in vitro against *S pneumoniae* than are the older agents (113–115) and may be preferable. Although these agents are effective in the treatment of community-acquired pneumonia, they have not yet been evaluated for use in the long-term care setting.

For patients needing parenteral therapy, use of a second or third generation cephalosporin that can be given by the intramuscular route once or twice daily is appropriate. Other potentially useful broad-spectrum parenteral agents include ticarcillin/clavulanate, piperacillin/tazobactam, and quinolones.

Current data do not support the routine empiric use of vancomycin. However, vancomycin should be instituted if methicillin-resistant *S aureus* is recovered from an adequate sputum sample. It is uncertain whether addition of a macrolide agent active against *Legionella, Chlamydia,* or *Mycoplasma* is warranted. There is little evidence that these agents are frequent causes of pneumonia in long-term care facilities.

Patients given initial parenteral therapy may be switched to an oral regimen once clinical response occurs, including resolution of fever and improvement in respiratory signs and symptoms, if there is no evidence of gastrointestinal dysfunction that would lead to poor drug absorption (116).

These guidelines for the evaluation and management of patients with pneumonia are summarized in Figure 1.

PREVENTION

Pneumococcal infection accounts for a substantial proportion of respiratory infections among the institutionalized elderly. Residence in a nursing home is associated with an increased risk of invasive pneumococcal disease (7). This is not surprising, since advanced age and underlying illnesses, such as cardiac and pulmonary disease, increase both the risk and case-fatality ratio of pneumococcal disease (117). Furthermore, the closed environment of the nursing home facilitates patient to patient spread of pneumococci leading to outbreaks (17,68–70). Although the frequency of penicillin resistant pneumococci among nursing home isolates is unknown, penicil-
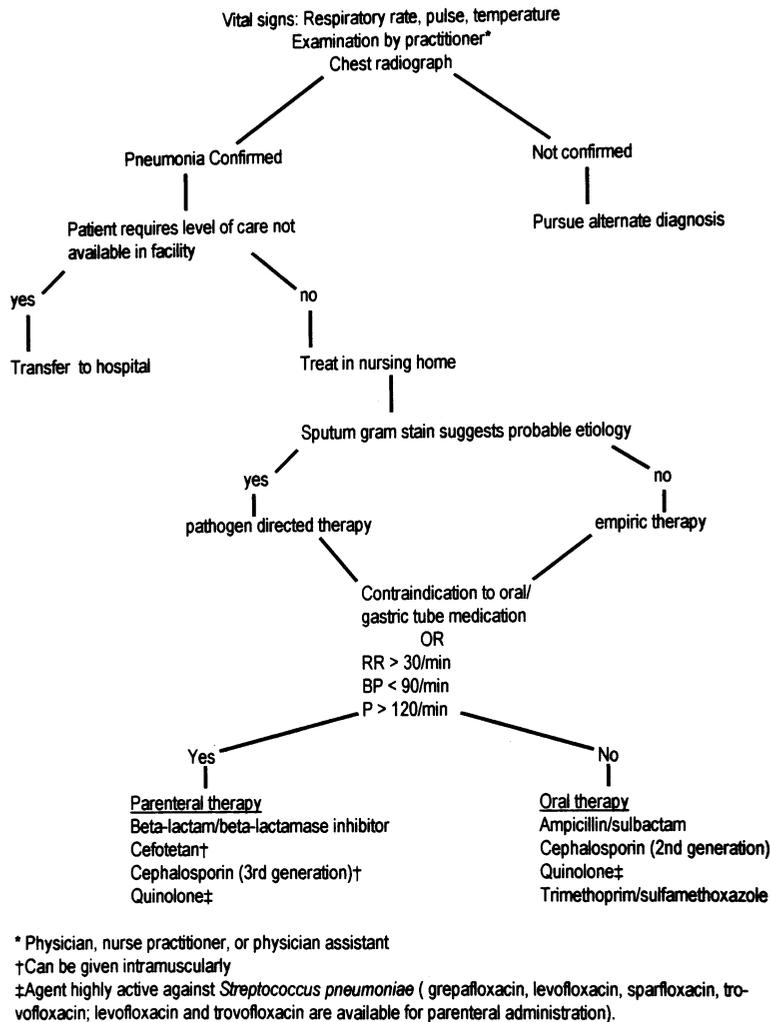
Vital signs: Respiratory rate, pulse, temperature
Examination by practitioner*
Chest radiograph

Pneumonia Confirmed

Not confirmed

Pursue alternate diagnosis

Patient requires level of care not available in facility

yes

no

Transfer to hospital

Treat in nursing home

Sputum gram stain suggests probable etiology

yes

no

pathogen directed therapy

empiric therapy

Contraindication to oral/gastric tube medication
OR
RR > 30/min
BP < 90/min
P > 120/min

Yes

No

<u>Parenteral therapy</u>
Beta-lactam/beta-lactamase inhibitor
Cefotetan†
Cephalosporin (3rd generation)†
Quinolone‡

<u>Oral therapy</u>
Ampicillin/sulbactam
Cephalosporin (2nd generation)
Quinolone‡
Trimethoprim/sulfamethoxazole

* Physician, nurse practitioner, or physician assistant
†Can be given intramuscularly
‡Agent highly active against *Streptococcus pneumoniae* (grepafloxacin, levofloxacin, sparfloxacin, tro-vofloxacin; levofloxacin and trovofloxacin are available for parenteral administration).

Figure 1. Suggested approach to the long-term care patient with suspected pneumonia. Antimicrobials are listed in alphabetical order and not in order of preference. *Physician, nurse practitioner, or physician assistant. †Can be given intramuscularly. ‡Agent highly active against *Streptococcus pneumoniae* (grepafloxacin, levofloxacin, sparfloxacin, trovofloxacin; levofloxacin and trovofloxacin are available for parenteral administration).

lin resistance is being identified with increasing frequency in the United States (118,119). A 23-valent vaccine containing the polysaccharide antigens of pneumococcal serotypes that cause more than 90% of invasive infections is currently licensed. The efficacy of pneumococcal vaccine among high risk patients has been the subject of some controversy. Several randomized studies in older adults failed to show efficacy (120,121). Case-control and indirect cohort studies indicate an efficacy of 60% to 70% in preventing invasive pneumococcal infection (122–124). Efficacy is lower in patients with disorders of the immune system or who are receiving immunosuppressive therapy. Although these studies did not specifically include nursing home residents, they included large numbers of the elderly and those with underlying disease associated with aging. It is likely that the vaccine has a similar efficacy in immunocompetent nursing home patients. Vaccine effi-

cacy declines somewhat with time since immunization (122).

The Advisory Committee on Immunization Practices recommends assessment of the pneumococcal vaccine status of all residents of long-term care facilities (125). Patients who are 65 years of age or older should receive the vaccine if they have not been previously immunized, have unknown immunization status, or have not received the vaccine within 5 years and were <65 years of age at the time of vaccination. Patients younger than 65 years of age who have chronic conditions, including cardiovascular disease, chronic obstructive pulmonary disease, diabetes, liver disease, renal failure, malignancy, asplenia, or other immunocompromised states, are also candidates for pneumococcal immunization.

Annual immunization against influenza in recommended for residents of nursing homes (126). Employees

should be immunized as well. Estimates of vaccine efficacy in nursing home patients vary widely; overall vaccine efficacy is about 27% (127). Outbreaks of influenza A can still occur in facilities in which a high proportion of patients have been immunized (51,105,128–130). Reasons for vaccine failure include diminished efficacy in the aged and chronically ill, antigenic drift of epidemic strains, failure to immunize large numbers of patients, and failure to immunize the staff. Although immunization is only modestly effective in reducing episodes of symptomatic influenza infection, it does reduce the serious sequelae of influenza. Studies have reported that influenza-related pneumonias are reduced by 40% to 50% and influenza-related deaths are reduced by 70% to 80% following immunization of nursing home patients (50,51,128,131).

Current evidence indicates that the most cost effective strategy involves a twofold approach (127,132). All patients without contraindications should receive influenza vaccine in the fall; new admissions should be given the vaccine through the end of influenza season. Identification of several cases of influenza A within a facility should prompt administration of amantadine prophylaxis to all residents regardless of immunization status. (Neither agent is effective in the prophylaxis of influenza B.) Identification of influenza requires monitoring of patients for compatible symptoms during the influenza season and coordination with local public health authorities for notification of influenza outbreaks in the community. Recognition of an outbreak may be facilitated by the use of rapid immunological tests for influenza virus in respiratory secretions (105,106). Detailed recommendations for management of influenza outbreaks in nursing homes, including dosage and potential side effects of amantadine in the elderly, have been published (132).

AREAS FOR FUTURE INVESTIGATION

With the exception of pneumococcal immunization and influenza control strategies, there is little evidence on which to base preventive recommendations. As previously noted, poor functional status, tendency to aspirate, and chronic lung disease are the major risk factors for pneumonia. These factors are not readily modified. Well-conducted case-control studies to identify potentially modifiable risk factors for pneumonia are practical and relatively economical to perform. Other worthwhile avenues of investigation include identification of patients who require parenteral as opposed to oral therapy, and those who would clearly benefit from transfer to an acute care facility.

Use of feeding tubes is associated with an increased risk of pneumonia. There is no evidence to suggest that a given method of tube feeding, such as jejunostomy, is associated with a reduced risk of infection or other complications as compared with gastrostomy or nasogastric tube feeding (46). However, data are limited and based on uncontrolled observations. A randomized controlled trial has not been conducted. Jejunostomy tubes are more difficult to place and to maintain, and are unlikely to be a practical solution. Improved methods of enteral feeding are needed.

Use of histamine receptor 2 (H-2) blockers as prophylaxis against upper gastro-intestinal bleeding increases the risk of pneumonia in critically ill patients by facilitating gastric colonization with enteric organisms (133). An association between pneumonia and H-2 blockers has not been identified in nursing home patients. However, a recent analysis of pneumonia in a long-term VA facility reported that 42% of pneumonia patients were receiving H-2 blockers immediately before the onset of pneumonia. Many patients had no documented indication for this class of agent (33).

There is suggestive evidence that use of physical or chemical restraints may increase the risk for pneumonia. Physical restraint of the elderly is associated with an increased risk of nosocomial infection (134). Use of benzodiazepines is associated with a risk of aspiration and subsequent pneumonia (41). Alternative methods of behavior control among agitated or disruptive patients could, in addition to improving the patients' quality of life and the ease of nursing care, reduce the risk of pneumonia.

Few adequate comparative trials of antimicrobial therapy for pneumonia have been performed in these patients. Candidate agents should have good activity against gram positive and gram negative organisms. The option of both intramuscular and oral administration would be of great practical benefit. However, there are several obstacles to performing controlled trials of therapy in this setting, including the inability to make a precise etiologic diagnosis in many patients and the difficulty in obtaining informed consent from patients who have a high frequency of dementia.

Other worthwhile avenues of investigation include identification of patients who require parenteral as opposed to oral therapy, and those who would clearly benefit from transfer to an acute care facility. Improvements in management of nursing home acquired pneumonia could potentially lead to improved survival, lower rates of transfer to hospitals for acute treatment, preservation of function, and decreased cost. As the population ages and the demand for long-term care increases, the need for carefully done studies will become more urgent.

ACKNOWLEDGMENT

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