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Nursing Home–Acquired Pneumonia

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Pneumonia is the most serious of the common infections that occur in nursing homes, with a high case-fatality rate and considerable mortality among survivors. Risk factors for nursing home–acquired pneumonia (NHAP) have been defined, and prediction models for death due to NHAP have been developed. The bacterial etiology of NHAP has been debated, but "typical" bacterial pathogens (*Streptococcus pneumoniae, Haemophilus influenzae,* and *Moraxella catarrhalis*) are most important. Clinical presentation of NHAP is said to be "atypical," but this may be confounded by dementia in the nursing home resident. A recent guideline has made recommendations regarding the minimal diagnostic workup when a resident has a suspected case of pneumonia. Until recently, most guidelines for the treatment of pneumonia did not specifically address NHAP; there is some evidence that use of a quinolone alone may be an acceptable first choice of therapy for most cases. Pneumococcal and influenza vaccination have been the primary prevention measures. However, additional methods to prevent NHAP should be evaluated, including improving the oral hygiene of residents and instituting pharmacological interventions.

Pneumonia is the second most common cause of infection among nursing home residents, and it is associated with the highest mortality rate for any infection that occurs among such individuals. Survivors experience significant morbidity [1]. Pneumonia is also a common reason for transfer of individuals from a nursing home to the hospital [2]. In this report, nursing home–acquired pneumonia (NHAP) is reviewed, with particular attention given to the diagnosis, management, and prevention of this infection.

INCIDENCE

The reported incidence of NHAP has ranged from 0.3–2.5 episodes per 1000 days of resident care [2, 3]. The variation in incidence may be related to differences in incidence over time, study design, number of facilities evaluated, intensity of surveillance, or facility affiliation (Veterans Affairs vs. community). Two studies conducted prospective surveillance for NHAP [4, 5]. At one proprietary nursing home in 1984–1987, the incidence of NHAP was 1 episode per 1000 days of resident care [4]. At 5 nursing homes in Toronto, Ontario, Canada, from 1993 through 1996, the incidence of NHAP was 0.7 episodes per 1000 days of resident care [5].

RISK FACTORS

Four studies have used multivariate analysis to identify risk factors for NHAP [5–8]. Independent predictors of NHAP have included poor functional status [6, 7], presence of a nasogastric tube [6], difficulties swallowing [5, 7], occurrence of an unusual event defined as confusion, agitation, falls, or wandering [7], chronic lung disease [8], tracheostomy [8], increasing age [5], and male sex [5]. Thus, debilitated nursing home residents, especially those at high risk for aspiration, are most likely to develop pneumonia.

PATHOGENESIS

Most episodes of NHAP are caused by aspiration of oropharyngeal flora into the lung and by failure of host defense mechanisms to eliminate aspirated bacteria [9]. Yamaya et al. [10] recently reviewed new insights into aspiration among elderly individuals. So-called silent aspiration of oropharyngeal flora is said to be an important risk factor for community-acquired

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pneumonia (CAP) in the elderly population. It has been observed that diseases of the CNS, such as stroke, frequently are complicated by pneumonia, especially those diseases that are associated with dysphagia or basal ganglia infarcts [10].

According to many authors, acute aspiration of gastric contents, although well described, is a less common cause of "pneumonia" in nursing home residents than is silent aspiration of oropharyngeal flora [11]. The chemical inflammatory response (pneumonitis) that occurs in the lung after aspiration of gastric contents may lead to signs and symptoms identical to bacterial pneumonia [12]. However, initially, no bacterial infection develops in association with pneumonitis, and antibiotic therapy is not indicated [12]. Although it can be difficult to distinguish between bacterial pneumonia and aspiration pneumonitis, especially if the aspiration is not witnessed, there are clues (e.g., emesis or coughing while eating, followed by the development of respiratory distress and fever within a few hours) that aspiration has occurred. Using specific definitions, Pick et al. [11], in a prospective study that involved one Veteran Affairs nursing home, found that most episodes of definite aspiration of gastric contents were unwitnessed.

Using the definitions of Pick et al. [11] and a definition for "suspected" aspiration of gastric contents, Mylotte et al. [13] retrospectively studied 195 patients with presumed NHAP who were admitted to the hospital; they found that two-thirds of the patients who had radiological evidence of an infiltrate had aspiration pneumonitis rather than pneumonia. Thus, it appears that aspiration pneumonitis may occur more commonly than previously has been recognized and that it may be misclassified as "pneumonia" and treated with antibiotics. However, if one could make this distinction accurately, there is the potential to reduce exposure to antibiotics and lessen the risk of development of antibiotic resistance.

ETIOLOGY

The etiology of NHAP has been the subject of debate for some time, especially regarding the importance of aerobic gram-negative bacilli as causative agents. According to Muder [2], when strict criteria were used to evaluate sputum specimens obtained from residents with NHAP, gram-negative bacilli were isolated from 0% to 12% of residents. When less-strict or no criteria were used, gram-negative bacilli were much more commonly isolated (in 9%–55% of residents). Overall, *Streptococcus pneumoniae* is the most common bacterial pathogen isolated among nursing home residents with pneumonia, followed by nontypeable *Haemophilus influenzae* and *Moraxella catarrhalis* [2]. In carefully performed studies, atypical organisms, including *Legionella* species, *Chlamydia pneumoniae,* and *Mycoplasma* species, were rarely identified, and aerobic gram-negative bacilli were infrequently identified as a cause of NHAP in nursing home residents [5, 14, 15].

MORTALITY

For residents admitted to the hospital for treatment of NHAP, the mortality rate ranged from 13% to 41%, compared with a mortality rate of 7%–19% for residents treated in the nursing home only [2, 5, 16, 17]. Several studies have defined the risk factors for death among nursing home residents with NHAP or lower respiratory tract infection. Prepneumonia functional status (low, medium, or high dependence) was an important predictor of death due to NHAP in several studies reviewed by Muder [2]. Other predictors of death include dementia [16], an increased respiratory rate [16, 17], increased pulse [16], a change in mental status [16], witnessed aspiration [18], use of sedatives [18], and the comorbidity score [18]. The variation in risk factors for death observed in these studies is the result of differences in study design, facility type (Veterans Affairs vs. community), and the size of the study population.

Physicians have difficulty in accurately assessing the severity of CAP and the probability that a patient will die of the disease [19], and this is true for NHAP as well [20]. To deal with this problem, Fine et al. [19] derived and validated a model for determining the 30-day mortality rate for those with CAP; this model has been validated in individuals with NHAP [21]. However, this model [19, 21] has limited usefulness for nursing home residents because it requires laboratory testing that is infrequently performed. Naughton et al. [16] derived a simplified model for prediction of the 30-day mortality rate associated with NHAP; the model does not require the use of laboratory tests and has the potential to be used by nursing home staff. The predictors in this model are as follows: respiratory rate, >30 breaths/min; pulse, >125 beats/min; acute change in mental status; and history of dementia [16]. The probability of death among residents with ≥ 2 predictors at the time of onset of pneumonia was >30%. Mehr et al. [22] have also developed a model for prediction of mortality among nursing home residents with lower respiratory tract infection (pneumonia or bronchitis), but their model requires laboratory testing.

CLINICAL MANIFESTATIONS

The dogma has been that nursing home residents with pneumonia have an "atypical" presentation, which means that the symptoms and signs usually associated with lower respiratory tract infection occur less frequently among nursing home residents than among age-matched community-dwelling elderly or younger persons [2]. On the basis of a summary of the findings of several studies, the presentation of NHAP included

cough in ~60% of nursing home residents, dyspnea in 40%, fever in ~65%, and altered mental status in 50%–70%. Johnson et al. [23] found that nonspecific symptoms (e.g., generalized weakness, decreased appetite, falls, delirium, and incontinence) were more common in the presentation of pneumonia in elderly individuals, compared with individuals <65 years of age; however, this was the result of a confounding effect of dementia. Mehr et al. [24] have developed a clinical prediction rule to identify nursing home residents at high risk for pneumonia among those with ≥1 respiratory symptom or an acute change in clinical status. However, this rule requires prospective validation before it can be recommended for general use.

DIAGNOSIS

Several studies have suggested that infections that occur in nursing homes may not be adequately evaluated before antibacterial therapy is initiated. The lack of adequate workups for infections in nursing homes is the result of several factors, including lack of physician evaluation, poor or inadequate evaluation by staff, and lack of availability of laboratory facilities [25]. Recently, an expert panel developed a practice guideline for the evaluation of fever and infection in nursing home residents [25]. The panel recommended the following diagnostic studies for nursing home residents with clinically suspected pneumonia: WBC count with differential; pulse oximetry (for residents with a respiratory rate >25 breaths/min); chest radiography (for patients with documented or suspected hypoxemia); and Gram staining and culture of respiratory secretions. However, it is difficult to obtain a sample of respiratory secretions from nursing home residents for Gram stain and culture; there is evidence that this is not routinely done in nursing homes [26] or in hospitals [21].

Consideration should also be given to an assessment of the hydration status of the resident (e.g., by determination of the blood urea nitrogen level), because dehydration commonly occurs in association with fever and infection [27]; a blood urea nitrogen concentration of >50 mg/dL (>18 m*M*) should be considered evidence of moderate dehydration. Blood cultures should not be routinely performed for residents treated in the nursing home, because the yield is exceedingly low for those with NHAP [21]. Because on-site evaluation by physicians is infrequent in nursing homes, the practice guideline stresses the importance of the hierarchy of the evaluation beginning at the level of the nursing aide and progressing to the charge nurse and, ultimately, to the physician [25]. One caveat to keep in mind when evaluating nursing home residents who have evidence of lower respiratory tract infection is that pulmonary tuberculosis can mimic bacterial pneumonia in this population, especially progressive primary tuberculosis that involves the lower lobes [28].

THERAPY

Once the diagnosis of NHAP is suspected or established and there are no advance directives to the contrary, there are 4 major decisions to consider in addition to the actual choice of a specific antibacterial agent: (1) treatment location (nursing home vs. hospital), (2) initial route of administration (oral vs. parenteral) of treatment for individuals receiving treatment in the nursing home; (3) the timing of the switch from parenteral therapy to orally administered therapy for individuals receiving parenteral therapy in the nursing home or hospital; and (4) duration of treatment [20].

Treatment location. In recent studies, 63%–78% of NHAP episodes were treated in the nursing home [2, 3, 21]. However, how physicians decide whether to hospitalize residents who have suspected pneumonia has not been extensively studied. By use of multivariate analysis, Fried et al. [29] found that, at one nursing home, evaluation done in the evening and a respiratory rate >40 breaths/min predicted transfer of residents with NHAP to the hospital. In a separate analysis of nursing home residents with "mild pneumonia" (which was defined by a respiratory rate of <40 breaths/min), Fried et al. [30] found that a significantly greater proportion of survivors treated in the nursing home had no change in functional status or had better function at 2 months of follow-up (55%), compared with those who were treated in the hospital initially (39%; $P = .005$). Hospitalization only affected the immediate mortality of those with severe pneumonia (defined by a respiratory rate of ≥40 breaths/min) in this study. These findings suggest that, for the majority of residents with NHAP, who usually have mild to moderate infection, receiving treatment in the nursing home may be preferable to receiving treatment in the hospital [30]. Prospective studies are needed to determine which residents would benefit from hospitalization for treatment of NHAP.

Treatment in the nursing home. Parenterally administered antibiotics (usually given via intramuscular injection) have been prescribed for the treatment of 16%–44% of episodes of NHAP initially treated in the nursing home [2, 3, 20]. There was no significant difference in mortality between nursing home residents who were initially treated with an orally administered agent and those who were initially treated with an intramuscularly administered agent [20]. In one study [20], investigators were unable to define factors that were predictive of prescription of a parenterally administered antibiotic for the initial treatment of pneumonia in nursing home residents, and this may explain the wide variation in the use of this approach in published studies. Understanding how physicians decide which route of administration of antibiotics should be used in the initial treatment of pneumonia in nursing home residents requires more study.

Timing of the switch to oral therapy. Timing of the switch

from parenteral therapy to oral therapy is dependent on stabilization of the resident's clinical condition (i.e., the resident shows improvement in signs and symptoms, is afebrile for 16 h, has no other acute life-threatening complications, and is able to take oral medications) [31]. In a retrospective study that specifically addressed the issue of the timing of the switch to oral therapy, 75% of residents who were prescribed an intramuscularly administered antibiotic while in the nursing home received this therapy for ≤3 days, whereas, in the hospital, the median duration of intravenously administered antibiotic therapy was 5 days (75% percentile, 7 days) [20]. Therefore, for residents treated in the nursing home, the switch to use of an oral agent should be assessed beginning on day 2 of parenteral therapy; for hospitalized individuals, the switch should be assessed beginning on day 3 of parenteral therapy.

Duration of treatment. Duration of treatment of NHAP has not been evaluated in randomized clinical trials. One study retrospectively assessed the duration of therapy for NHAP [20]. The 75th percentile for duration of therapy was 10 days for individuals receiving treatment for NHAP in the nursing home. For individuals initially receiving treatment in the hospital, the 75th percentile for the total duration of treatment (intravenous plus oral treatment) was 14 days.

Choice of antimicrobial agent. The argument has been made that NHAP should be considered separately from CAP in terms of treatment [32]. The most recent treatment guidelines for CAP have given this distinction some recognition and have made recommendations specifically for NHAP [33, 34]. For example, the guideline of the American Thoracic Society indicates that residence in a nursing home is a modifying factor that increases the risk of pneumonia due to enteric gram-negative bacilli [34]. In early 2000, the first guideline specifically for treatment of NHAP was published [20]; this guideline was based on community practice rather than on the recommendations of an expert panel. The CAP treatment guideline of the Canadian Infectious Diseases Society made specific recommendations for NHAP [35]. This latter guideline recommended use of an orally administered quinolone (levofloxacin, gatifloxacin, or moxifloxacin) as the preferred regimen and amoxicillin-clavulanate plus a macrolide as the second choice for treatment of pneumonia in the nursing home [35]. For treatment of NHAP in the hospital, the first choice was a quinolone alone, and the second choice was a second- or third-generation cephalosporin plus a macrolide. Other CAP guidelines made similar recommendations, except that no preference for a specific regimen was stated [33, 34].

Because there are so few randomized trials of treatment of NHAP, the choice of treatment should be based on likely potential pathogens, the likelihood of antibiotic resistance, ease of administration, and adverse effect profiles of various agents. In terms of potential pathogens, the focus should be on adequate coverage for *S. pneumoniae,* nontypeable *H. influenzae,* and *M. catarrhalis.* In a review of studies of NHAP that assessed the adequacy of sputum cultures microscopically [2], gram-negative aerobic bacilli or methicillin-resistant *Staphylococcus aureus* were uncommon causes of NHAP; such organisms do not usually warrant empiric therapy. In my opinion, the most logical and straightforward approach is to use a quinolone (levofloxacin, gatifloxacin, or moxifloxacin) as initial therapy in the nursing home or hospital. For the busy practicing clinician, this appears to be the most practical approach for the treatment of NHAP. The quinolones have excellent activity against both the common and uncommon bacterial pathogens (including enteric gram-negative bacilli) that cause NHAP, require only once-a-day dosing, and have relatively few side effects.

Despite the value of quinolones for the treatment of pneumonia [33–35], there has been concern about resistance developing among pneumococci in association with increasing use of these agents, especially in the elderly population [36]. Because of this concern, the US Centers for Disease Control and Prevention's Active Bacterial Core Surveillance has been monitoring trends in pneumococcal resistance to quinolones in the United States since 1995 [37]. This surveillance program found that the percentage of pneumococcal organisms resistant to levofloxacin has remained <0.5% (as of 2000). These findings indicate that the use of empiric therapy with a quinolone (levofloxacin, gatifloxacin, moxifloxacin) is appropriate for NHAP [37]. For the small group of nursing home residents who are admitted to an intensive care unit for initial therapy, the treatment recommendations in the CAP guidelines [33–35] should be followed.

Managing volume depletion. A factor that has received little attention in the management of NHAP is the resident's hydration status. Fever and tachypnea associated with NHAP can lead to considerable insensible water loss, and oral intake of liquids may be decreased with any infection in nursing home residents. However, bedside evaluation of the hydration status of nursing home residents is not particularly useful in identifying which residents are dehydrated. An objective assessment of the hydration status of the resident with pneumonia should be performed (e.g., by measuring the serum blood urea nitrogen level). The management of volume depletion associated with NHAP in the nursing home is also problematic, especially if the resident has decreased mentation. Because intravenous administration of fluids for hydration usually is not an option for nursing home residents, alternative methods, such as clysis [38], deserve further study.

PREVENTION

Vaccination. The burden of pneumococcal disease, in terms of incidence and mortality, is greatest in the elderly population

and is the rationale for recommending pneumococcal vaccination for this group. However, the efficacy of pneumococcal vaccine in the elderly population has been the subject of considerable debate as a result of the lack of prospective, randomized controlled trials [39, 40]. Despite this limitation, experts recommend vaccination of all elderly people because the vaccine is safe, inexpensive, and cost effective [41, 42]. Unfortunately, the immunogenicity of pneumococcal vaccine decreases with age, and efficacy diminishes fairly rapidly after vaccination, especially when individuals are vaccinated for the first time at an advanced age [43]. For individuals ⩾65 years of age who were vaccinated before 65 years of age, the US Centers for Disease Control and Prevention's Advisory Committee on Immunization Practices has recommended that a one-time revaccination be done ⩾5 years after the initial vaccination was received [41]. Nevertheless, on the basis of published retrospective studies of the efficacy of pneumococcal vaccine, the rapid loss of efficacy (especially among individuals who were of advanced age when first vaccinated), and evidence of the safety of revaccination, an argument can be made for periodic revaccination of nursing home residents (e.g., every 5 years). However, because it is unlikely that studies of the efficacy of revaccination in the elderly will be performed in the foreseeable future, each clinician must make a decision about this approach after weighing the benefits and risks.

The morbidity and mortality associated with infection with influenza virus are greatest among the elderly population. However, the efficacy of the influenza vaccine in preventing acute influenza in this population is probably no greater than 40% [44]. Nevertheless, there are several important benefits of administration of influenza vaccination to elderly nursing home residents, including decreasing the likelihood of outbreaks, decreasing the number of hospitalizations by 50%–60%, and decreasing the mortality rate by as much as 80% [44]. Loeb et al. [5] found that influenza vaccination significantly reduced the risk of NHAP developing. On the basis of these findings, annual vaccination against influenza is strongly recommended for all nursing home residents, unless there is a contraindication.

Oral hygiene. Overall, oral hygiene is poor among nursing home residents, and it has been hypothesized that poor oral hygiene in this group increases the rate of colonization of dental plaque and oral mucosa by potential respiratory pathogens [45]. Because aspiration of oropharyngeal flora into the lung is the major route of pathogenesis of NHAP [9], colonization of dental plaque and oral mucosa represents the reservoir of potential pathogens that can reach the lung. Therefore, for nursing home residents, maintaining good oral hygiene has the potential benefit of reducing colonization with respiratory pathogens and thereby reducing the occurrence of NHAP. A recent study in Japanese nursing homes demonstrated that residents randomized to follow an intensive oral care regimen had a significantly lower proportion of episodes of pneumonia than did residents following a standard oral care regimen [46]. Further investigation of the link between oral hygiene and development of NHAP is warranted, as are studies of practical methods to improve oral hygiene in nursing home residents.

Controlling gastroesophageal reflux. Gastroesophageal reflux has been estimated to occur in one-third of the elderly population. Aspiration of material from the stomach can damage the trachea in those with gastroesophageal reflux. The simplest approach to dealing with gastroesophageal reflux is to elevate the head of the bed and minimize the use of nasogastric tubes. Use of agents to decrease reflux should be considered, but, currently, there is no evidence that such treatment reduces the risk of either aspiration of gastric contents or pneumonia.

Pharmacologic interventions. Yamaya et al. [10], in a review of the literature on interventions to prevent pneumonia in the elderly population, quoted studies (which had been published as letters to the editor) that suggested that angiotensin-converting enzyme inhibitors, which increase the sensitivity of the cough reflex and improve the swallowing reflex in elderly persons who are prone to aspiration, decrease the risk of pneumonia. They also quoted other unpublished studies that suggested that amantadine, when given orally, significantly reduced rates of pneumonia in patients with stroke. Although these observations are provocative, none of these interventions can be recommended at this time, because these studies have not been published in their complete form.

Feeding tubes. One of the primary reasons given for the use of feeding tubes is to reduce the risk of aspiration among residents with dysphagia. However, there now is evidence that feeding tubes do not prevent aspiration in residents with dementia [47]. In addition, there is no evidence that a jejunostomy is associated with lower rates of pneumonia than is gastrostomy. There appears to be a limited role for tube feeding among residents with dysphagia and advanced dementia, and some have suggested that their use should be discouraged [47].

CONCLUSIONS

There are many unresolved issues with regard to NHAP [48], and the research agenda for this infection recently has been developed by an expert panel [49]. First, there is a lack of consistent data on the microbial etiology of NHAP, and, in practice, there is no accurate method for identifying the etiology of an individual case. Second, there are few clinical trials of antimicrobial agents for the treatment of NHAP; the optimum regimen (drug, dose, and duration) has not been determined. This forces physicians to use empiric therapy for NHAP much of the time. Third, it remains unclear how physicians determine the need for hospitalization among those with NHAP or how

physicians decide when to use the parenteral, rather than the oral, route of antibiotic administration for treatment provided in the nursing home. Fourth, methods (clinical and laboratory) need to be developed to distinguish between aspiration pneumonitis and pneumonia in nursing home residents [13]. Fifth, measures for the prevention of NHAP, other than vaccination, have not been studied to any extent (e.g., improving oral hygiene or using pharmacologic agents).

The aging of the US population will result in an increased number of people in nursing homes in the next 30 years. As a result of this increase, it has been estimated that almost 2 million episodes of NHAP will occur annually [48]. Thus, there is an urgent need to "develop medically sound, cost-effective strategies for the evaluation, management, and prevention of NHAP" [48, p. 96]. However, the first step will be recognition by funding sources, governmental agencies, academicians, and practitioners that NHAP is an entity separate from community- and hospital-acquired pneumonia.

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