Pneumonia in Long-term Care

A Prospective Case-Control Study of Risk Factors and Impact on Survival

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Background: Pneumonia is a major cause of morbidity and mortality in long-term care facilities. Prior studies of pneumonia have failed to identify risk factors potentially amenable to intervention. Our objectives were to (1) identify modifiable risk factors for the occurrence of pneumonia and (2) determine the long-term impact of pneumonia on survival.

Methods: We performed a case-control study among residents of a Veterans Affairs long-term care facility. Case patients included all patients developing pneumonia from 2 days to 1 year after admission. Control subjects were matched for admission date, level of nursing care, and dependence in activities of daily living. Patients were followed up for 2 years or until death or discharge from the facility.

Results: We identified 104 case-control pairs. Risk factors significantly associated with pneumonia included witnessed aspiration (odds ratio, 13.9; 95% confidence interval, 1.7-111.0; \( P = .01 \)), sedative medication (odds ratio, 2.6; 95% confidence interval, 1.2-5.4; \( P = .01 \)), and co-morbidity score (odds ratio, 1.2; 95% confidence interval, 1.0-1.4; \( P = .05 \)). Mortality due to pneumonia was 23% at 14 days. Patients with pneumonia had a significantly higher mortality than did controls at 1 year (75% vs 40%; \( P < .001 \)); survival curves converged at 2 years. In a Cox proportional hazards regression model, an episode of pneumonia was independently associated with mortality during follow-up (odds ratio, 2.6; 95% confidence interval, 1.7-3.9; \( P < .001 \)).

Conclusions: Among long-term care patients closely matched for age, level of dependency, and duration of institutionalization, an episode of pneumonia was independently associated with mortality. Two identified risk factors, large-volume aspiration and receipt of sedating medication, are potentially amenable to intervention.

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PNEUMONIA is a leading cause of mortality,1,2 morbidity,3-6 and transfer to acute-care facilities7-9 among elderly patients residing in long-term care facilities. The incidence of pneumonia among residents of long-term care facilities ranges from 0.27 to 2.50 per 1000 patient-days,10 with a median reported incidence of 1 per 1000 patient-days. Several clinical series11-17 report short-term mortality from pneumonia ranging from 12% to 44%. The most important determinant of short- and long-term mortality is the patient’s functional status.11,13,14 Neither age nor underlying illness appears to have a significant impact after adjusting for level of dependency. Poor functional status is known to be a predictor of mortality in the general long-term care population.18,19 Thus, it is not clear whether an episode of pneumonia is an event that substantially shortens survival or is merely a marker of impending death due to profound debility.

Several studies20-26 have identified risk factors for the acquisition of pneumonia in long-term care facilities. These have included markers of poor functional status and difficulty with swallowing. Few, if any, of these factors are readily subject to modification. We conducted a prospective case-control study of pneumonia among residents of a Veterans Affairs long-term care facility to determine the following: (1) whether an episode of pneumonia is associated with excess mortality among patients with similar functional status; and (2) whether we could identify risk factors for pneumonia that are amenable to intervention, with the intent of reducing the incidence of pneumonia.

RESULTS

We enrolled a total of 104 case-control pairs from February 1, 1997, through January 31, 1998. There was an influenza outbreak, affecting 8 patients, that occurred...
PATIENTS AND METHODS

Patients residing at the HJ Heinz Division of the Veterans Affairs Medical Center, Pittsburgh, Pa, from February 1, 1997, through January 31, 1998, were included in the study. The facility has 360 beds and is staffed by full-time physicians and nurse practitioners. Clinical data, including vital signs, medications, laboratory results, radiology reports, and immunization status, are stored in a central computer shared with the geographically separate acute care division of the medical center. Patients were identified by regular examination of radiology and microbiology reports that were filed on the hospital computer, records of transfer to the acute-care facility, and regular visits to each ward by an experienced infection control nurse (C.B.). She identified patients who had a new fever or respiratory symptoms and those who were receiving antibiotics. Infectious disease specialists (E.N.V. and R.R.M.) reviewed the patients' medical records and chest radiographs. A patient was considered to have pneumonia if the following criteria were met: (1) the presence of a new pulmonary infiltrate on the chest radiograph or, in patients who did not have a radiograph done, documentation of a new finding of localized rales by physician examination; (2) the new onset of at least one of the following symptoms: fever (temperature, ≥38.3°C), hypothermia (temperature, ≤36.1°C), cough, dyspnea (patient complaint or observed respiratory distress), or tachypnea (respiratory rate, >24/min); and (3) the absence of evidence of a cause other than pneumonia (eg, congestive heart failure) after review of the medical record. Patients were excluded if they had been continuously institutionalized for more than 1 year before the episode of pneumonia. The facility maintains an active immunization program; the immunization status of patients is monitored as part of quality improvement activities. During the study, more than 95% of patients in the facility received an annual influenza virus vaccine, and had received a pneumococcal polysaccharide vaccine.

The onset of an episode of pneumonia at least 30 days after a prior episode and with at least an asymptomatic interval of at least 14 days was considered to be a separate episode. Patients were considered to have received antimicrobial therapy if they received antimicrobial agents for at least 72 hours or if they received an antimicrobial agent but did not survive for 72 hours from the time of diagnosis until death. Decisions regarding antimicrobial therapy and the decision to transfer the patient to the acute-care facility were made at the discretion of the attending physician.

The Activities of Daily Living (ADL) Index was used to score the level of patient debility.27 Patients were assigned an ADL score in each of the 6 major areas of activity, including bathing, dressing, toileting, transferring, continence, and feeding. An ADL score of 1 was assigned if patients were fully independent; 2, partially dependent; and 3, completely dependent in each area. Possible scores ranged from 6 to 18. A score of 6 indicated that the patient was independently mobile and capable of complete self-care, whereas a score of 18 indicated that the patient was confined to the bed, incontinent, and incapable of any activity without major assistance. The ADL score and nutritional data were obtained from monthly assessment forms located on the patient wards. The most recent ADL score and nutritional assessment within 1 month before the onset of pneumonia was considered to be the patient's baseline. Comorbidity was assessed using the Comorbidity Index of Charlson et al.28 This index assigns scores of 1 to 4 for each of 18 specific medical diagnoses. The index has been shown to correlate with long-term survival following acute medical illnesses.

Patients were matched for (1) age within 5 years, (2) admission date within 30 days, (3) ADL scores within 2 points, and (4) level of nursing care immediately before pneumonia onset (intermediate or nursing home). Clinical data collected included patient demographics, feeding method, nutritional status, immune status, and comorbid illnesses as assessed by the Comorbidity Index. Medications administered, the application of restraints, and episodes of aspiration that occurred within 14 days before the onset of pneumonia were recorded. An episode of aspiration required a note in the medical record by a physician or nurse documenting its occurrence. Malnutrition was defined as a body weight less than 80% of the ideal body weight. “Tranquilizers” included major (haloperidol and phenothiazines) and minor (benzodiazepines and barbiturates) tranquilizers.

Clinical data for cases and controls were entered into a computer database (Prophet System; AbTech Corporation, Charlottesville, Va). The McNemar matched χ2 test was used to evaluate paired data. Dichotomous variables were compared using the χ2 or the Fisher exact test. Continuous variables were compared using the t test or the Mann-Whitney test. Variables found to be significant at P≤.05 were entered into a stepwise logistic regression model. Kaplan-Meier probability curves were constructed using the date of pneumonia onset as the starting point and the date of death as the end point. The date of final follow-up or of discharge from the hospital was used as the end point for censored patients. Cumulative survival curves were compared using the Mantel-Cox log-rank test. Variables significantly associated with mortality during follow-up by univariate analysis were entered into a Cox proportional hazards regression model.

during the last month of the study on one of the facility's 8 floors. It was due to an influenza strain not included in that year's vaccine; it was promptly brought under control by administering amantadine hydrochloride to all at-risk patients.

One hundred patients (96%) had radiographic evidence of a new pulmonary infiltrate; the remaining patients did not undergo radiologic study but had new localized chest findings. Seventy-two percent of the patients had an abnormal body temperature (fever, 59%; and hypothermia, 17%). Fifty-four percent of the patients had a cough, 49% had dyspnea, and 63% had a documented respiratory rate greater than 24/min. The median age of cases was slightly older than that of controls. Case and control patients were similar in median ADL score and requirement for intermediate nursing care (Table). The mean Comorbidity Index score for case patients was 4.1 (median, 4; range, 1-12); and for control patients, 3.4 (median, 3; range, 0-9) (P=.03). Case patients were more likely than controls to have pressure sores and to be receiving food through a tube. In addition, cases were more likely than controls to have received tranquilizers, to have...
undergone physical restraint, and to have had a documented episode of aspiration in the 14 days preceding the onset date of pneumonia. By multivariate regression analysis, witnessed aspiration (odds ratio [OR], 13.9; 95% confidence interval [CI], 1.7-111.0; P = .01), receipt of tranquilizers (OR, 2.6; 95% CI, 1.7-3.9; P < .001), ADL Index score (OR, 1.1; 95% CI, 1.0-1.2; P = .02), and malnutrition (OR, 1.6; 95% CI, 1.1-2.4; P = .01) were independently associated with mortality. The comorbidity score was of borderline significance (OR, 1.1; 95% CI, 0.99-1.20; P = .07).

Of patients surviving the initial episode of pneumonia, 26 (25%) had a subsequent episode compared with 9 (9%) of the controls (P = .01).

Prior studies of pneumonia among long-term care patients have identified poor functional status, obstructive lung disease, tracheotomy, and difficulty with swallowing or eating as risk factors. None of these are likely to be modifiable; with the exception of influenza immunization, no effective strategy for the prevention of pneumonia in this population has been identified. A recent multicenter study by Loeb and colleagues identified older age, male sex, swallowing difficulty, and inability to take oral medication as independent risk factors. Receipt of an influenza virus vaccine was protective. Our findings were different in several important respects. We identified witnessed aspiration and the receipt of tranquilizing medication in the 2 weeks before the onset of pneumonia as independent risk factors. These differences are most likely due to differences in study design. Loeb and colleagues performed a longitudinal cohort study; variables were treated as intervals by considering the number of years that patients were exposed to them. We conducted a matched case-control study, and measured variables occurring in the 2-week period before the pneumonia onset date, when they might reasonably be expected to have a direct causal role in the occurrence of pneumonia. Thus, the prior study identified surrogate markers for aspiration (difficulty swallowing and inability to take oral medications) as independent risk factors, while we observed that an actual episode of witnessed aspiration was a significant risk factor. While feeding tube use, a surrogate marker for aspiration, was more common in our patients with pneumonia than in controls, it was not an independent risk factor for pneumonia.

Similarly, it is likely that we were able to identify receipt of tranquilizers as an independent risk factor because we recorded actual medication use immediately before the episode, rather than exposure over time. There was no association between antidepressant use and pneumonia. Tricyclic antidepressants have been largely replaced by selective serotonin reuptake inhibitors in our facility; the latter are generally much less sedating than the former. We were unable to assess the reduction in risk afforded by the influenza virus vaccine or the pneumo-

**Patient Characteristics Associated With Pneumonia**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Patients With Pneumonia (n = 104)</th>
<th>Control Patients (n = 104)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, median, y</td>
<td>75.0</td>
<td>72.5</td>
<td>.03</td>
</tr>
<tr>
<td>ADL Index score, mean</td>
<td>12.9</td>
<td>13.7</td>
<td>.35</td>
</tr>
<tr>
<td>Comorbidity Index score, mean</td>
<td>4.1</td>
<td>3.4</td>
<td>.03</td>
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<td>Intermediate care</td>
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<td>Feeding tube</td>
<td>23</td>
<td>9</td>
<td>.006</td>
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<td>Tracheotomy tube</td>
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<td>2</td>
<td>.11</td>
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<tr>
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<tr>
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<tr>
<td>Family visits &gt;1/wk</td>
<td>53</td>
<td>39</td>
<td>.07</td>
</tr>
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</table>

*Data are given as percentage of patients unless otherwise indicated. ADL indicates activities of daily living.
†Less than 80% of the ideal body weight.
‡Greater than 120% of the ideal body weight.
§Within 14 days of pneumonia onset.

**Comment**

Prior studies of pneumonia among long-term care patients have identified poor functional status, chronic obstructive lung disease, tracheotomy, and difficulty with swallowing or eating as risk factors. None of these are likely to be modifiable; with the exception of influenza immunization, no effective strategy for the prevention of pneumonia in this population has been identified. A recent multicenter study by Loeb and colleagues identified older age, male sex, swallowing difficulty, and inability to take oral medication as independent risk factors. Receipt of an influenza virus vaccine was protective. Our findings were different in several important respects. We identified witnessed aspiration and the receipt of tranquilizing medication in the 2 weeks before the onset of pneumonia as independent risk factors. These differences are most likely due to differences in study design. Loeb and colleagues performed a longitudinal cohort study; variables were treated as intervals by considering the number of years that patients were exposed to them. We conducted a matched case-control study, and measured variables occurring in the 2-week period before the pneumonia onset date, when they might reasonably be expected to have a direct causal role in the occurrence of pneumonia. Thus, the prior study identified surrogate markers for aspiration (difficulty swallowing and inability to take oral medications) as independent risk factors, while we observed that an actual episode of witnessed aspiration was a significant risk factor. While feeding tube use, a surrogate marker for aspiration, was more common in our patients with pneumonia than in controls, it was not an independent risk factor for pneumonia.

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mucococcal polysaccharide vaccine because of near universal (>95%) immunization of our patients.

Although the application of physical restraints was more common in our patients with pneumonia than in controls, restraints were not an independent risk factor for pneumonia. The number of patients who were restrained was low (14% of patients with pneumonia and 6% of controls). An association between physical restraint and nosocomial infection has been noted among elderly patients in acute-care hospitals.28 It is quite possible that enforced immobility might contribute to the occurrence of pneumonia among long-term care patients as well. This association remains to be confirmed; a study with a larger sample size will be required.

Our findings have important implications for the prevention of pneumonia in long-term care patients. With the exception of influenza immunization status, risk factors for pneumonia identified in prior studies, such as difficulty with swallowing and poor functional status, are not readily modifiable. However, episodes of overt aspiration may be preventable among patients with a tendency to aspirate. While there is no evidence that tube feeding prevents aspiration,30 clinical evaluation of other interventions is warranted. One potential strategy that should be investigated is the use of a formal swallowing evaluation to target patients at risk of aspiration. The results of such evaluations could be used to recommend a feeding prescription designed to minimize the risk of aspiration. Alternative management strategies for anxiety and disruptive behavior that do not rely on tranquilizers also deserve evaluation in the prevention of pneumonia. Confirmation of restraint as a risk factor for pneumonia would add another potentially effective intervention.

In our population, an episode of pneumonia had a short- and a long-lasting effect on survival among patients closely matched for age, duration of residence in the facility, and functional status. Patients with pneumonia had a significantly lower survival rate than did controls; this difference was apparent for up to 2 years after the episode. By Cox proportional hazards regression, there was an independent association between pneumonia and mortality during follow-up in a model that included degree of dependency in ADL and comorbidity score.

Our study was carried out in a Veterans Affairs facility in which the population, overwhelmingly male, is different from that typically found in community nursing homes. Thus, our findings should be confirmed in the general nursing home population. This should be a high-priority undertaking. If projections for the growth in the nursing home population are correct, 2 million lower respiratory tract infections will occur annually among long-term care patients by the year 2030.31 This represents an enormous burden in morbidity, mortality, and expenditure. Even a moderate reduction in this number would have a substantial impact.

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REFERENCES