Risk Factors for Mortality from Lower Respiratory Infections in Nursing Home Patients

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Background. Little is known about the factors that predict whether nursing home residents with lower respiratory infection (LRI) will do well or poorly, although this information is critically important when making treatment decisions.
Methods. Using nursing home and hospital medical records, we performed a case-control study to identify risk factors for death from LRI among residents of a 110-bed, midwestern community nursing home. Three experienced geriatricians aided in the development of an operational definition of an LRI. In a 3½ -year period, we identified 26 cases in which the patients died from LRI and 66 control episodes in which the patients recovered from LRI.
Results. Compared with those who survived, those who died were 14 times more likely to be totally dependent with respect to activities of daily living (ADL) than the group of patients least ALD-dependent (odds ratio [OR] = 14; 95% confidence interval [95% CI] = 2.85 to 68.87). After adjusting for ADL, mortality was significantly decreased when a broad-spectrum oral antibiotic (trimethoprim-sulfamethoxazole, cefaclor, amoxicillin-clavulanate, or ciprofloxacin) was used as the initial therapy (OR = .14; 95% CI = .02 to .81).
Conclusions. Better functional status and initial therapy with broad-spectrum oral antibiotics were strong predictors of surviving an LRI in this population of nursing home patients. The antibiotic effect may be a treatment effect or the consequence of underlying factors leading physicians to select particular antibiotics; however, it appears possible to identify low-risk persons who do not require the aggressive treatment and hospitalization that is often recommended for these patients. An approach to the treatment of nursing home LRI is suggested.
Key words. Nursing home; respiratory infection; activities of daily living, aged; antibiotic. *J Fam Pract 1992; 34:585–591.*

As many as 12% of hospitalizations among community nursing home residents result from lower respiratory infections (LRI).[1] Estimates of pneumonia incidence in some Veterans Administration (VA) chronic care nursing units have been over one per patient-year.[2,3] Death rates from lower respiratory infection as high as 82.6 deaths per 1000 patient-years have been reported.[4] Given the increasing size of the geriatric population,[5] if current patterns of hospital utilization continue, nursing home lower respiratory infections will consume even greater amounts of scarce medical resources.

Little is known, however, concerning which nursing home residents with LRI will do poorly with or without hospital care. Review articles uniformly recommend that almost all nursing home residents with pneumonia should be hospitalized or at least treated with broad-spectrum parenteral antibiotics.[6–9] The studies of LRI in nursing homes that have been cited in support of such assertions evaluated only those nursing home patients who were hospitalized.[10–12] Hospitalized patients are probably a more severely ill group since those who respond to therapy in the nursing home are not admitted for hospital care. In our experience, physicians commonly manage LRIs with oral antibiotics at the nursing home and achieve good outcomes.

If clinicians could identify those nursing home residents likely to die from an LRI, they would be faced with a clear choice of administering either aggressive inpatient therapy, which might or might not be successful, or palliative care in the nursing home with a high probability of death. Conversely, if clinicians could iden-

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tify persons at low risk for adverse outcomes even when treated within the nursing home, this would support the choice of nursing home management for selected residents who develop LRI. We are aware of only two studies of the predictors of LRI outcomes in the elderly. Both concern pneumonia in hospitalized patients.[13,14]

We used a case-control design to examine risk factors for mortality from lower respiratory infection in community nursing home patients. We hypothesized that inability to perform activities of daily living (ADL), poor nutritional status, extreme old age, and cognitive impairment would all predispose a patient to dying from LRI. Furthermore, because we expected that more aggressive antibiotic therapy would be associated with more severe illness, we hypothesized that patients who received more aggressive antibiotic therapy would be more likely to die.

Methods

We compared potential risk factors for mortality that were present in nursing home residents who died of lower respiratory infections (cases) with risk factors present in episodes where the person survived a lower respiratory infection (controls). Study cases and controls were identified from illnesses that occurred between January 1, 1986, and June 30, 1989, among residents of a 110-bed church-affiliated skilled and intermediate care facility in southeastern Michigan. Because mortality was the end point, some persons were included in both the case and control groups if they had experienced more than one episode of LRI while in the nursing home during the 3½ year period. Otherwise, a substantial portion of the person-time during which individuals were at risk for mortality (time during an LRI episode) would have been excluded for sampling controls.[15]

Data were collected by nursing home and hospital medical record review, including nurses' notes, physician progress notes, flow sheets, medication records, laboratory and x-ray film reports, and admission and discharge records. Cases (deaths from LRI) were identified from hospital transfers and nursing home deaths. Controls were identified from hospitalizations that did not end in death and from episodes of antibiotic therapy that were not associated with death.

Definition of Lower Respiratory Infection

Because there is no standard definition of an LRI in a nursing home patient,[16] an operational definition appropriate to the nursing home setting was developed. First, we formulated a tentative definition of an LRI based on the Centers for Disease Control (CDC) hospital nosocomial infection surveillance definition, which requires evidence of acute respiratory illness, exclusion of other conditions with similar signs and symptoms, and purulent sputum production or a "suggestive chest x-ray."[17] A panel of three geriatricians with extensive experience in the care of nursing home patients reviewed 23 nursing home medical records, four of which were included twice. Each panel member was asked to evaluate the probability that an episode was an LRI on a Likert scale of 1 to 6, ranging from "highly likely" to "highly unlikely." Based on the responses of the panel, we reformulated our original definition of an LRI to arrive at our final definition. There was good agreement between the final definition and the classification of LRI by the raters. If a mean score by the panel of less than 3 (3 = slightly likely to have been an LRI, 2 = moderately likely, 1 = highly likely) was counted as identifying an episode of LRI, agreement between the panel assignment and the final definition was present for 20 of 23 episodes (Cohen's kappa,[18] a measure of chance-corrected agreement, of .74).

Following the CDC definition, we defined an LRI to be present for a hospitalized nursing home resident if there was evidence of an acute infection with either purulent sputum production or a suggestive infiltrate on chest radiograph. In residents not hospitalized, one of the following was required for the patient to be included in the study:

1. An infiltrate suggestive of pneumonia on chest radiograph associated with acute respiratory symptoms or with an acute status change (diminished eating, diminished activity, worse cognitive function, temperature above 37.5°C [99.5°F], or less than 5 days between the onset of respiratory symptoms and the initiation of antibiotic therapy); *or*
2. Production of abnormal appearing sputum associated with an acute status change; *or*
3. Abnormal pulmonary auscultatory findings associated with an acute status change including fever or, in the absence of fever, findings that were not symmetrical (for example, rales heard only in lower left lung).

Our initial screening of nursing home records sought any episodes that could have possibly been considered a respiratory infection. Because of our interest in helping physicians make better treatment decisions, individuals deliberately not treated with antibiotics because of planned treatment limitation were excluded. In cases where an individual had multiple courses of antibiotic therapy, we required that a patient had taken no antibiotics for at least 7 days before an episode was considered distinct. Using these rules, we identified 156 potential

case and control episodes from the records of 98 nursing home patients. Five of these episodes were excluded because they were considered to have been a continuation of another episode or because the outcome could not be determined.

Using the final definition, 92 of the 151 episodes were classified as an LRI. Seven of the 59 excluded episodes involved a hospitalization where review of the hospital record did not support the diagnosis of LRI. Of the remaining 52 episodes, in only three instances was a chest radiograph taken (all negative), and in only 5 instances (none associated with an acute status change) was there a report of abnormal sputum production. Some of these 52 episodes lacked evidence of an acute status change (16 episodes; many of these were probably upper respiratory infections), some lacked evidence of abnormal pulmonary findings (25 additional episodes), and some lacked sufficient specific evidence of an LRI (9 episodes). The 92 episodes that met our definition of LRI occurred in 65 persons: 48 had one episode, 10 had two episodes, 5 had three episodes, 1 had four episodes, and 1 had five episodes. Sixteen of the episodes included in the study involved hospitalization.

Reliability of Data Abstraction

While initially reviewing records, information was also abstracted for analysis. The abstractor (P.C.) was blinded to the purposes of the study other than it involved lower respiratory infections. The abstractor performed a second review of 10 episodes to establish the intrarater reliability of data abstraction. For ordinal and interval variables, 90% of correlation coefficients were above .9 (range .82 to 1.00). In particular, for the number of ADL dependencies, the Spearman correlation coefficient was .99. For categorical variables, there was complete agreement 67% of the time, with no more than two disagreements out of ten in the other cases (κ = 0.57 to 1.0).

Exposure Variables

We evaluated ADL dependency, cognitive impairment, low weight or body mass index, decubitus ulcer, age, and nursing home diagnoses before the episode as potential predictors of mortality. Cognitive status and ADL dependency were ascertained as close as possible to 7 days before the beginning of antibiotic treatment. Data for this assessment were obtained from nurses' notes and flow sheets. Subjects were classified in regard to ADL according to a modified Katz scale (simply counting the number of dependencies).[19] Coma, confusion, disorientation, dementia, and agitation were considered abnormal cognitive statuses. The patient's weight at the time of the LRI as well as the patient's weight 6 and 12 months prior to the LRI was recorded if available. A body mass index (weight/height^2) was calculated based on recorded height (usually at admission) and most recent weight. This index provides a measure of adiposity; a low index suggests a very thin and possibly malnourished individual.[20] A decubitus ulcer was defined as a reported stage 1 (area of persistent erythema) or greater decubitus ulcer at the time of antibiotic theory.

We classified initial antibiotic use into three mutually exclusive categories: (1) *traditional oral antibiotics*: penicillin, ampicillin, amoxicillin, erythromycin, tetracycline, cephalexin; (2) *broad-spectrum oral antibiotics*: trimethoprim-sulfamethoxazole, cefaclor, amoxicillin/clavulanate, ciprofloxacin; and (3) *parenteral antibiotics*: gentamicin or parenteral cephalosporin. Traditional oral antibiotics are used as the reference stratum for comparing the effect of each of the other two groups.

Statistical Analysis

Crude odds ratios of death from LRI and 95% confidence intervals were computed for each potential risk factor of interest, and adjusted odds ratios and confidence intervals were computed for potential confounders using the Mantel-Haenzsel technique.[21] As a further evaluation of confounding, multivariate logistic regression was used. Ordinal variables were assessed with a test for trend. The unit of analysis was an episode of infection; thus, some persons were included in both the case and control groups. Because so few episodes involved hospitalization, no separate analyses were performed of whether risk factors differed in those hospitalized compared with those who received care exclusively in the nursing home. Statistical computations were performed using the following software packages: SAS,[22] Systat,[23] and dEPID.[24] Woolf/Taylor Series confidence intervals have been reported for crude odds ratios.

Results

Nursing home residents with LRI were a very elderly population with a mean age of 86.3 years (SD = 6.4 years). Twenty-six (28%) of the 92 episodes of LRI ended in death. Five (31%) of the 16 episodes of LRI involving hospitalization ended in death. All subjects were white, and 73 (79%) of the episodes occurred in women, while 19 (21%) occurred in men.

As shown in Figure 1, ADL score was strongly related to outcome: death occurred in only 6.7% of the episodes in which the individual was independent or

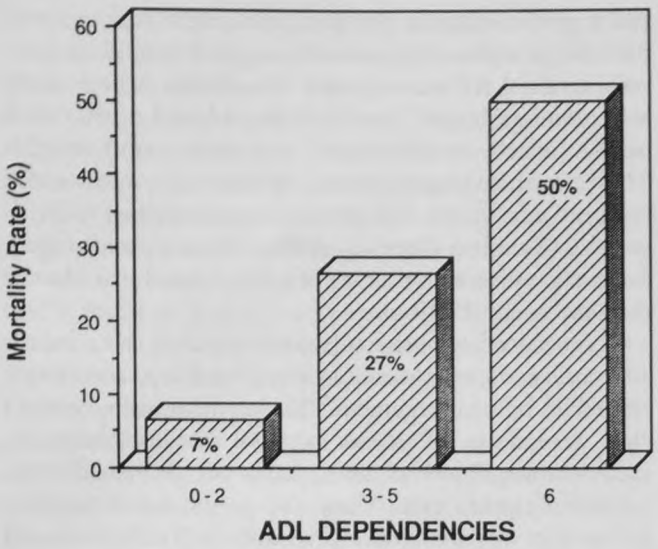

Figure 1. Mortality rate from lower respiratory infection in 92 nursing home patients according to activities of daily living (ADL) dependency. $P < .001$.

mildly dependent (zero to two dependencies) compared with 50% of episodes in which the individual was totally dependent, scoring six dependencies (Mantel-Haenzel test for trend, $\chi^2 = 14.2$, $P < .001$). Sixty-two percent of deaths from LRI occurred in the most dependent group, which accounted for only 35% of the episodes. Compared with those who survived, those who died were 14 times more likely to be in the most dependent group than in the least dependent group (OR = 14, 95% CI = 2.85 to 68.87). Furthermore, compared with those who survived, those who died were 5.1 times more likely to be in the intermediate dependency group than in the least dependent group (OR = 5.1; 95% CI = 0.98 to 26.43).

As age increased, so did the risk of death (Table 1), though with borderline statistical significance ($\chi^2 = 3.68$, $P = .055$). Compared with those who survived, however, those who died were 2.7 times as likely to be older than 90 years (OR = 2.7; 95% CI = 1.03 to 6.96).

Body mass index was also strongly associated with death: 48% of the episodes involving a patient in the lowest quartile of the body mass index ended in death while only 14% of the episodes involving a patient in the highest quartile ended in death ($\chi^2 = 4.87$, $P = .027$). The odds ratio for death from LRI for a patient in the lowest quartile, compared with the highest, was 5.76 (95% CI = 1.30 to 25.51).

Nursing home residents who died were 2.7 times as likely to have a decubitus ulcer as those who survived an LRI (OR = 2.72; 95% CI = 1.03 to 7.23). Feeding tubes, oxygen therapy, report of choking, and Foley catheters were all uncommon and, therefore, a larger study would be necessary to adequately evaluate these potential risk factors. Sex, impaired cognitive status, and designation of limited treatment ("do not hospitalize" order) were not significantly related to death from LRI when crude odds ratios were calculated.

Presence of a "do not hospitalize" order, however, varied as a risk factor for death from LRI depending on the age of the patient. Those who were less than 90 years of age, were *less* likely to die if they had a "do not hospitalize" order than were those without such an order (OR = .3; 95% CI = 0.07 to 1.19). Conversely, those aged 90 years or older were more likely to die if they had a "do not hospitalize" order (OR = 4.2; 95% CI = 0.84 to 21.05). Though neither of these odds ratios is statistically significant at the .05 level, the Breslow-Day test for homogeneity of the odds ratio provides strong statistical evidence that the odds ratios are different ($\chi^2 = 6.33$; $P = .012$).

Similarly, the association between death from an LRI and a subject's sex differs depending on the ADL score. In those totally dependent (six ADL dependencies), women were more likely to die of an LRI than men (OR = 4.2; 95% CI = 0.70 to 25.26); but among those with fewer than six ADL dependencies, men were more likely to die than women (OR = .24; 95% CI = 0.06 to 1.09). The Breslow-Day test again suggests significantly different odds ratios between the strata ($\chi^2 = 6.347$; $P = .012$).

For episodes in which the patient had a fever, the mean initial temperature was equal in case and control patients (38.2°C [101.2°F and 101.1°F, respectively]), but the mean value for the maximum temperature was slightly higher in the case study group (39.2°C [102.6°F], compared with patients in the control group 38.7°C [101.6°F], $P = .005$). In 21 of the 92 episodes, however, no information was available for either of these variables.

The type of antibiotics prescribed at the beginning of an episode shows a striking relationship to the outcome. Parenteral antibiotics were associated with a poorer outcome (Table 1); however, the result was not statistically significant and was markedly attenuated when controlling for ADL with the Mantel-Haenzsel technique (OR = 1.1; 95% CI = 0.22 to 5.77). In contrast, when similarly controlling for ADL, initial use of broad-spectrum oral antibiotics was associated with much lower odds of dying than use of traditional oral antibiotics (OR = 0.14; 95% CI = 0.02 to 0.81). Among residents not hospitalized, none of the 13 episodes involving initial use of broad-spectrum oral antibiotics and fewer than six ADL dependencies resulted in death. One individual was started on broad-spectrum

Table 1. Predictors of Mortality in Nursing Home Patients with Lower Respiratory Infection (n = 92)

Risk Factors (Exposure)	No. of Patients Exposed (% Mortality)	No. of Patients Unexposed (% Mortality)	Odds Ratio (95% CI)
Age groups (years)			
<80	16(19)	NA	Referent
80-<90	48(23)	16(19)	1.29(0.31–5.35)
≥90	28(43)	16(19)	3.25(0.75–14.02)
Body mass index			
Lowest quartile	21(48)	22(14)	5.76(1.30–25.51)*
Medium low quartile	23(22)	22(14)	1.76(0.37–8.46)
Medium high quartile	22(27)	22(14)	2.38(0.51–11.05)
Highest quartile	22(14)	NA	Referent
Initial antibiotics†			
Traditional oral	56(30)	NA	Referent
Parenteral	15(47)	56(30)	2.01(0.63–6.42)
Broad-spectrum oral	20(12)	56(30)	0.26(0.05–1.22)
Sex			
Female	73(27)	19(32)	0.82(0.27–2.44)
Conditions and treatments			
Decubitis ulcer present	25(44)	67(22)	2.72(1.03–7.23)*
Confused or comatose just before episode	49(31)	40(25)	1.32(0.52–3.38)
Limited care ("do not hospitalize" order)	38(26)	54(30)	0.85(0.34–2.15)
Foley catheter	9(44)	83(26)	2.22(0.55–9.02)
Oxygen use	16(44)	75(24)	2.46(0.80–7.56)
Choking reported	7(29)	78(24)	1.24(0.22—6.93)
Tube fed	2(0)	90(29)	—‡

*P < .05

†*Traditional oral antibiotics: penicillin, ampicillin, amoxicillin, tetracycline, erythromycin, or cephalexin. Parenteral antibiotics: gentamicin or parenteral cepholosporin. Broad-spectrum oral antibiotics: cefaclor, trimethoprin-sulfamethoxazole, amoxicillin-clavulanate, or ciprofloxacin.*

‡*Odds ratio not computed. Empty cell.*

NA denotes not applicable.

oral antibiotics and then hospitalized. That person survived the episode.

We also examined whether using only one episode per person would alter the results. Though there are some differences, odds ratios are similar for one episode as compared with all episodes.

To further examine the relationships of the predictor variables, we used multivariate logistic regression. Neither body mass index nor the presence of a decubitus ulcer was a significant predictor when controlling for ADL with logistic regression. These findings are consistent with results from stratified analysis, which showed that when controlling for ADL, dichotomous classifications of age, body mass index, and decubitus ulcer exhibited attenuated odds ratios and a loss of statistical efficiency.

The logistic regression model supported the very strong relationship between initial treatment with a broad-spectrum oral antibiotic and survival; the adjusted odds ratio when compared with treatment with traditional oral antibiotics was 0.09 (95% CI = 0.01 to 0.54). Initial treatment with parenteral antibiotics was a weak predictor and not statistically significant. The model also reiterated how much better the outcomes were for those in the most independent ADL group than those in the intermediate or fully dependent groups. Because of the small number of patients in each ADL classification, confidence intervals were very wide.

Discussion

Previous nursing home studies of lower respiratory infection either have been purely descriptive or have been focused on causative factors and microbial pathogens rather than on outcomes.[16] The ability to assess the risk of adverse outcome is crucial, however, to a treatment strategy for acutely ill nursing home residents with suspected LRI. Patients who are likely to do well may be candidates for nursing home therapy. Those who are likely to do poorly may be candidates for hospital admission if their preferences and their overall condition dictate aggressive treatment. Aside from decisions to limit treatment, there are multiple potential reasons for *not*

hospitalizing a nursing home resident, including cost, precipitation of acute confusion, and the increased possibility of iatrogenesis in the hospital environment.[25]

This study involved only white patients in a rural nursing home; therefore, the results should be generalized with caution. Our findings suggest, however, that a low-risk population can be identified in which patients with LRI can be appropriately treated with oral antibiotic therapy administered in the nursing home.

The study by Zweig et al[13] of elderly hospitalized patients identified the following as significant independent predictors of mortality: impaired consciousness, tachypnea, lower than normal body temperature, leukocyte count above 20,000 mm^3, and cyanosis. Starczewski and co-workers[14] identified tachycardia and acute confusion as significantly associated with mortality in those over 70 years of age at a general hospital in the United Kingdom. We were not able to adequately test many of these associations with our data. We did not find an association between cognitive status and outcome, but cognitive status was not consistently reported in nursing home records. Also, we examined cognitive status just before an episode as opposed to Zweig et al, who examined cognitive status at the time of hospitalization.

Based on the present study, Zweig's hospital study,[13] and suggestions from Bentley's review of pneumonia in the elderly,[7] factors that might turn out to be high-risk indicators in elderly nursing home patients with pneumonia include: (1) very dependent ADL status; (2) low body temperature; (3) depressed level of consciousness; (4) a leukocyte count of less than 5000 or greater than 20,000 mm^3; and (5) evidence of respiratory distress (cyanosis, respiratory rate greater than 30 breaths per minute, hypoxemia). Additionally, very high body temperature (eg, above 39.4°C [103°F]) is often associated with severe illness, though we are aware of no solid evidence linking it to mortality. These factors have never been tested jointly in any study and will likely not all turn out to be independently important; nonetheless, they may serve as basic guidelines for clinicians in the absence of better information.

In the current study, episodes where broad-spectrum oral antibiotics were the initial therapy had very low mortality, and this relationship was even stronger when controlling for ADL status. Our data do not identify how clinicians made their specific decisions about therapy. Therefore, we do not know whether this represents a treatment effect or a possible selection bias in which less severely ill individuals might have been treated with broad-spectrum oral antibiotics. Whether the result of a treatment effect or good clinical judgment, or both, the clinicians' treatment decisions were supported by the positive outcomes. This is particularly interesting when compared with the lack of a relationship between the initial use of parenteral antibiotics and LRI mortality when controlling for ADL status. We hypothesized that persons who were more severely ill would be more likely to receive parenteral antibiotics, and therefore those who were initially treated with parenteral antibiotics would have poorer outcomes. The absence of any evident relationship when controlling for ADL reemphasizes the importance of ADL status in identifying those persons likely to have the poorest outcomes.

Previous work has suggested that poor ADL status is a predictor of mortality in nursing home patients,[26] and Alvarez et al[2] found that a poor Karnofsky performance index (a global measure of ability to function) was a predictor of lower respiratory infections. However, to the best our our knowledge, this is the first study that relates ADL status to the outcome of LRI. Malnutrition has been linked to nursing home mortality.[27] Our data suggest that very thin persons are at significantly higher risk of dying from LRI; however, in multivariate analysis, body mass index did not remain an important predictor. Similarly, ADL status was a better predictor of mortality than was age. Age and body mass index might remain significant independent factors when controlling for ADL in a larger study.

The findings relating to subject's sex and treatment limitation are not obviously explained. In this population, persons younger than 90 years with limited treatment orders were less likely to die than those younger than 90 years without limited treatment orders. We also found that women with severe ADL impairment were more likely to die than severely impaired men, while men with absent to moderate ADL impairment were more likely to die than women of similar ADL status. These findings are intriguing but need to be replicated before much significance is attached to them.

The limitations of retrospective medical record review studies are well known. There is no way to ensure uniformity in what was recorded. Lacking adequate data to apply standard hospital LRI definitions, we went through a complex process to develop a nursing home LRI definition to establish eligibility for the study. Although the definition has not been previously used, it makes clinical sense (has face validity) and fits well with mean ratings by the panel. There was, however, significant variability in ratings between individual panel members. Clearly, having complete data to uniformly apply a more standard definition would have been preferable.

Furthermore, using medical records as a source for data could create a spurious association if one of the exposures of interest is selectively underreported in case or control patients. Nonetheless, as a basis for generating hypotheses for prospective studies, this type of investi-

gation has merit, and the strengh of the association of death with poor ADL status is unlikely to be wholly spurious. In fact, a strength of this study is that ADL status is apt to be better recorded on nursing home records than on hospital records. For both nursing home and hospital settings, future studies involving prospective data collection are needed to more precisely examine outcome predictors.

The episode as the unit of analysis raises the question of whether observations are truly independent; however, it is appropriate to consider the same person as a case and a control at different times, particularly in studies with mortality as the end point.[15] In support of our approach, when we analyzed only the last episode for each individual, we obtained substantially similar results.

Despite the limitations of our study, we did demonstrate that, at least in this nursing home, there was a significant subgroup of residents with LRI that did very well with treatment in the nursing home with broad-spectrum oral antibiotics. The results also support the usefulness of simple, available clinical data in predicting outcome from LRI. If this approach can be extended and confirmed, it will provide a powerful clinical and research tool. The ability to predict outcomes on the basis of data available at the beginning of an illness could significantly aid in decision making, in the stratification of persons by expected outcome in future studies, and in the outcome-based assessment of quality of care in nursing homes.

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