Community-Acquired Lower Respiratory Tract Infection In The Elderly: A Community-Based Study Of Incidence And Outcome

Margaret S. Houston, MD, Marc D. Silverstein, MD, and Vera J. Suman, PhD

Background: We studied the incidence, characteristics, and survival of elderly patients from a defined community who had pneumonia or bronchitis (lower respiratory tract infection).

Methods: This study was a population-based retrospective cohort study of residents of Rochester, Minnesota, aged 65 years or older with a first episode of pneumonia or bronchitis during the calendar year 1987.

Results: Overall age- and sex-adjusted incidence rates for an initial episode in a calendar year were 5452 per 100,000: 2420 per 100,000 (95 percent confidence interval, 2056 to 2783 per 100,000) for bronchitis and 3032 per 100,000 (95 percent confidence interval, 2639 to 3425 per 100,000) for pneumonia. After exclusion of eight cases diagnosed at autopsy, the overall 30-day mortality was 10.7 percent. Patients with pneumonia had lower survival than expected for the Minnesota white population (log-rank statistic = 117.38, $P < 0.0001$). The observed survival of patients with bronchitis was also significantly less than expected (log-rank statistic = 6.25, $P = 0.012$).

Conclusion: Lower respiratory tract infections are common in the elderly. Most patients in this study were not hospitalized, and atypical presentations were not observed. Early mortality (30 days) was high. Among elderly patients with either pneumonia or bronchitis, the survival was lower than expected. This study confirmed the need for population-based studies, because more than two-thirds of patients would have been missed if only hospitalized patients were included. (J Am Board Fam Pract 1995; 8:347-56.)

Community-acquired lower respiratory tract infections (LRTIs), including bronchitis and pneumonia, occur frequently in the elderly and are responsible for considerable morbidity and mortality. Older people as a group are less resilient than younger people, have more underlying illnesses, and could be more likely to die after LRTI.[1] Pneumonia is reported to be the leading infectious cause of death and the fourth leading cause of death overall in persons older than 65 years.[2] The incidence of pneumonia[3] and the mortality from pneumonia[4] appear to increase with age.

Population-based studies can describe the spectrum of LRTI in a representative population, minimize the bias inherent in studies of hospitalized or other selected patients, and provide age-and sex-specific incidence. Although pneumonia is a common and serious problem, only a few data are available from population-based studies. Such studies require a well-defined population and access to complete medical records so that data on all members of the population are available.

Clinicians need information on the clinical characteristics and outcomes of patients with LRTI to diagnose cases and to decide who should be hospitalized or treated in the community or in the nursing home. The spectrum of LRTI varies enormously; bronchitis is often clinically indistinguishable from pneumonia, but because both can be serious in the elderly, it is important to study the entire spectrum of LRTI.

Traditionally the diagnosis of pneumonia is based on signs of chest parenchymal involvement, confirmed by chest radiograph, although signs of parenchymal involvement might be insensitive or nonspecific. In the community or nursing home setting, not all patients undergo chest radiography, even though they might be treated with antibiotics. Thus, studies that require radiographic confirmation might underestimate the occurrence of pneumonia and exclude both mild cases in ambulatory patients with good outcomes and

severe cases in nursing home residents with poor outcomes. There is, therefore, a need for studies to use diagnostic criteria that will include the full spectrum of disease.

Elderly residents of the community at large or of a nursing home can acquire LRTI, but not all are hospitalized. Studies based on hospitalized or nursing home patients focus on a limited segment of the population. Incidence and outcomes reported in such studies depend on local patterns of triage and admission, which change over time, as evidenced by the introduction of diagnosis-related groups (DRGs) and the shift to treatment in the ambulatory setting. The investigator thus needs to include patients whose care is provided in the community or nursing home and patients in the hospital setting.

This study was designed to examine LRTI in the residents of a well-defined population, including the full spectrum of community patients (ambulatory, nursing home, and hospitalized) with the full spectrum of illness (from mild bronchitis to severe pneumonia). Our goals were first to select a community-based cohort of elderly residents with pneumonia or bronchitis and then to use this cohort to describe the clinical characteristics of the illness and to estimate incidence rates, 30-day mortality rates, and long-term survival after an episode of LRTI.

Methods
Study Design
This study is a population-based retrospective cohort study of residents of Rochester, Minnesota, with pneumonia or bronchitis in 1987. Because LRTI is a potentially recurrent illness, particularly in patients 65 years of age or older, we chose to study only the first episode during the calendar year.

Study Setting
This study included all elderly residents of Rochester, Minnesota, the county seat of Olmsted County, which had a population of 70,745 in the 1990 census. Resources of the Rochester Epidemiology Project, a project funded by the National Institutes of Health, make it possible to conduct population-based studies in Olmsted County. Such studies are possible because almost all medical care to Olmsted County residents is provided by a small number of health care facilities, which

include the Mayo Clinic and the Olmsted Medical Group with their affiliated hospitals. The Mayo Clinic established a medical records system more than 85 years ago, incorporating all inpatient and outpatient information in a single dossier-type medical record. All medical records are easily retrievable for review. All diagnoses and surgical procedures from these medical records are also available in an index stored on a computer. This index includes diagnoses made for outpatient or clinic consultations, emergency department visits, nursing home care, hospitalizations, autopsy examination, and death certification. In addition, the medical records of other medical care providers in the area who have served Olmsted County residents are also indexed and retrievable. Thus, essentially all details of medical care provided to the residents of Olmsted County are available for study.

Patients
Medical records of elderly patients aged 65 years or older in Rochester, Minnesota, during a 1-year period (1987) who had a possible LRTI were selected through a linked medical diagnostic index and screened by a physician investigator (MSH) for potential eligibility in the study. Records of potential cases were reviewed in detail by a trained, experienced nurse-abstractor to pick out those that met the study definition. Further sampling was done from a list of supplementary diagnoses to ensure cases were not missed or miscoded as upper respiratory tract infections; no additional cases were found. The year 1987 was chosen as a typical, nonepidemic year for influenza. We searched the medical diagnostic index at our institution for diagnoses of pneumonia (with or without infectious cause), bronchopneumonia, pneumonitis, aspiration pneumonia, acute bronchitis, or acute exacerbation of chronic bronchitis. Other chronic bronchitis entities were not included.

Definitions of Lower Respiratory Tract Infection
For inclusion in the study, a potential case had to have symptoms, signs, or other findings of pneumonia or bronchitis, such as a positive chest radiograph. A classification system was developed to use all available data, including symptoms, signs, chest radiograph, or autopsy report. Because this was a retrospective study of actual practice, not all

patients received all tests. *Definite pneumonia* included autopsy-proven cases, as well as those with a positive chest radiograph. *Probable pneumonia* included cases with such symptoms as rigors, hemoptysis, chest pain, chills, cough, congestion, fever, and shortness of breath accompanied by such signs as crackles, rhonchi, consolidation, or tachypnea (providing strong supporting evidence of pneumonia) but lacking a chest radiograph to confirm the diagnosis. For analysis, these two categories were considered *pneumonia*. All other patients with a history suggestive of lower respiratory tract infection who lacked criteria to be included as definite or probable pneumonia were analyzed together as *bronchitis*.

Data Collection

Data collected by the trained nurse-abstractor included date of birth; sex; residence in a nursing home; underlying medical problems, such as cardiovascular, pulmonary, endocrine, renal, or neuropsychiatric illness; previous hospitalizations; smoking status; medications; clinical presentation; radiographs; number of office visits; hospitalization; and outcome, such as death and vital status at 1 year of follow-up. Data were directly entered from medical records into a computer data set by the nurse-abstractor.

Analysis

For estimating incidence rates, the entire population of Rochester, Minnesota, 65 years or older, was considered to be at risk. The denominators for the incidence rates were the age- and sex-specific person-years among Rochester residents in 1987, as obtained by linear interpolation between decennial census data.[5] Incidence rates were age- and sex-adjusted to the 1990 US white population. Confidence limits for the incidence rates were constructed assuming a Poisson distribution for the rates. Patients with pneumonia diagnosed at autopsy were excluded from the analysis of 30-day mortality after diagnosis and from the analysis of survival after diagnosis. The 30-day mortality

rates were calculated using case deaths (all causes) within 30 days of the date of the diagnosis as the numerator and the identified cases as the denominator. The Kaplan-Meier method was used to estimate survival from the time of diagnosis to death by any cause. Expected survival for a cohort of age- and sex-matched individuals from the Minnesota white population was derived.[6] Observed and expected survival curves were compared using a one-sample log-rank test.[7] Confidence intervals for proportions were constructed assuming a binomial distribution. Statistical analyses were performed using SAS.[8]

Results

Patients

We screened 1838 medical records; 497 potential cases were reviewed, and 421 patients met the study definition. Of these 421 Rochester patients with LRTI, 261 were women and 160 were men: 117 women and 61 men had bronchitis, and 144 women and 99 men had pneumonia. Alternatively, approximately 1 of every 34 adults aged 65 years or older has at least one episode of pneumonia each year.

Of the total population with LRTI, the majority — 309 (73 percent) — lived in the community (Figure 1). Patients who lived in a nursing home were classified as having pneumonia more often than bronchitis: 86 (77 percent) of the 112 had pneumonia. In contrast, community patients were equally likely to have either disease: 157 (51 per-
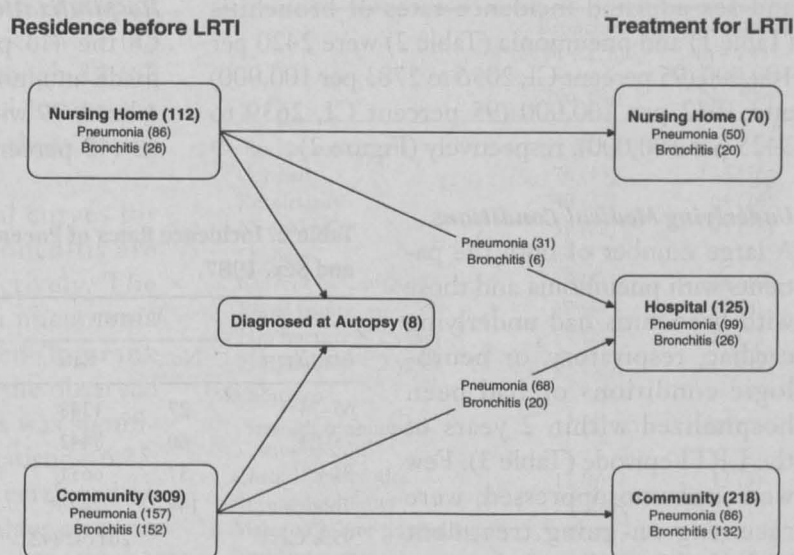

Figure 1. Residence of 421 patients before diagnosis of lower respiratory tract infection (LRTI), types of LRTI, and location of treatment.

Table 1. Incidence Rates of Bronchitis in Rochester, Minnesota, by Age and Sex, 1987.

Age, Years	Women		Men		Total	
	No.	Rate	No.	Rate	No.	Rate
65–74	52	2404	25	1685	77	2111
75–84	38	2180	31	4095	69	2760
85+	27	3151	5	2075	32	2914
Total	117	2398*	61	2522*	178	2420†
95% CI‡		1944–2852		1888–3156		2056–2783

*Rates per 100,000 age-adjusted to 1990 US white population.
†Rates per 100,000 age- and sex-adjusted to 1990 US white population.
‡CI, confidence interval.

cent) of the 309 had pneumonia. In 8 patients (5 resided in a nursing home and 3 in the community) the diagnosis was first made at autopsy.

Among the 107 patients residing in the nursing home in whom the diagnosis was made before death, 70 (50 pneumonia, 20 bronchitis) were treated in the nursing home and 37 (31 pneumonia, 6 bronchitis) were hospitalized. Among the 306 patients residing in the community in whom the diagnosis was made before death, 218 (86 pneumonia, 132 bronchitis) were treated in the community and 88 (68 pneumonia and 20 bronchitis) were hospitalized.

Incidence

The overall age- and sex-adjusted incidence rate was 5452 per 100,000 (95 percent confidence interval [CI], 4916 to 5987 per 100,000). The age- and sex-adjusted incidence rates of bronchitis (Table 1) and pneumonia (Table 2) were 2420 per 100,000 (95 percent CI, 2056 to 2783 per 100,000) and 3032 per 100,000 (95 percent CI, 2639 to 3425 per 100,000), respectively (Figure 2).

Underlying Medical Conditions

A large number of both the patients with pneumonia and those with bronchitis had underlying cardiac, respiratory, or neurologic conditions or had been hospitalized within 2 years of the LRTI episode (Table 3). Few were immunosuppressed, were receiving on-going treatment with antibiotics or psychoactive drugs, or were current smokers. Table 4 shows the relation of

comorbid conditions with age. Those in the oldest age group had less respiratory illness, current smoking, and steroid use and more cardiac disease, recent hospitalizations, use of major tranquilizers, and, particularly, neurologic illness (dementia or previous stroke).

Clinical Picture

The clinical signs of LRTI present on examination at the onset of pneumonia and bronchitis are shown in Tables 5 and 6. Data on the 8 patients in whom diagnosis at autopsy was made were excluded. The presence or absence of every clinical sign was not always documented in the medical records of each patient, so the percentages shown were calculated assuming that a clinical sign was negative if not recorded. In the pneumonia group, at least 38 percent had even a low-grade fever, and 26 percent had a minimal elevation in respiratory rate; 66 percent did have at least a mild elevation of heart rate, and about one-half had rales or rhonchi. Overall, most of the clinical signs usually reported in patients with pneumonia were found in fewer than one-half of the patients, an indication of the need for careful clinical observation in making the diagnosis of pneumonia.

Hospitalization

Of the 413 patients in whom the diagnosis was made antemortem, 125 (30 percent) were hospitalized: 99 with pneumonia and 26 with bronchitis (42 percent of those with pneumonia and 15

Table 2. Incidence Rates of Pneumonia in Rochester, Minnesota, by Age and Sex, 1987.

Age, Years	Women		Men		Total	
	No.	Rate	No.	Rate	No.	Rate
65–74	27	1248	34	2291	61	1673
75–84	60	3442	35	4624	95	3800
85+	57	6651	30	12,448	87	7923
Total	144	2426*	99	4084*	243	3032†
95% CI‡		2011–2842		3279–4889		2639–3425

*Rates per 100,000 age-adjusted to 1990 US white population.
†Rates per 100,000 age- and sex-adjusted to 1990 US white population.
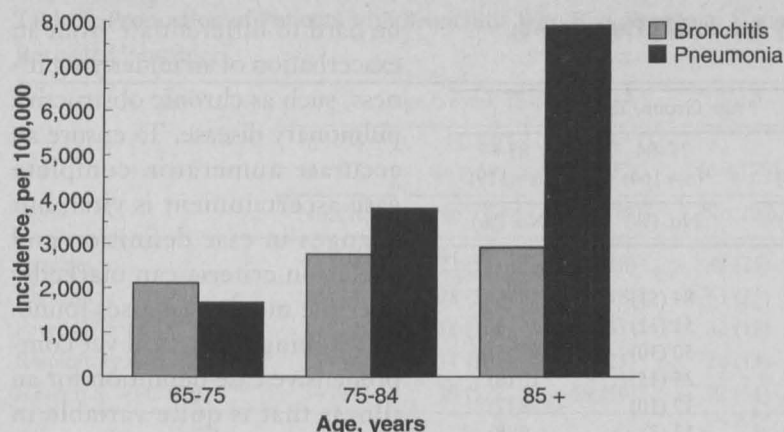‡CI, confidence interval.

Figure 2. Unadjusted incidence rates for lower respiratory tract infections.

percent of those with bronchitis). Hospitalization rates were highest among the patients with pneumonia who were 75 to 84 years old (Figure 3). Fewer patients with bronchitis in any age group were admitted to the hospital. The median stay was 8.0 days for the 99 hospitalized patients with pneumonia and 6.5 days for the 26 hospitalized with bronchitis.

30-Day Mortality and Survival Rates

There were 44 deaths within 30 days of the diagnosis of LRTI (Table 7). Thirty-day mortality for elderly patients with pneumonia was 13 percent, or, alternatively, 1 of every 8 patients died within 30 days of the onset of pneumonia. Elderly patients with pneumonia had reduced survival; survival after an episode of pneumonia was 70 percent at 1 year, 62 percent at 2 years, and 54 percent at 3 years. Of 125 hospitalized patients, 17 (18 percent) died within 30 days. Although 34 (67 percent) of the 51 deaths occurred in nursing home residents, only 33 percent of those deaths occurred in the hospital.

Observed and expected survival curves for patients with pneumonia and bronchitis are shown in Figures 4 and 5, respectively. The observed survival of patients with pneumonia was significantly less than expected (log-rank statistic = 117.38; $P<0.001$). Also, the observed survival of patients with bronchitis was significantly less than expected (log-rank statistic = 6.25; $P = 0.012$). When analysis was restricted to patients who survived at least 30 days after an episode of LRTI, the survival of patients with pneumonia was still significantly less than expected (log-rank statistic = 44.36; $P<0.001$),

but that for patients with bronchitis was not significantly different from expected (log-rank statistic = 0.145; $P=0.699$).

Discussion

We conducted a population-based study of LRTI in the elderly, including ambulatory, hospitalized, and nursing home patients. We found that LRTI was common. Although some episodes of bronchitis likely did not come to medical attention, there were more patients with pneumonia than bronchitis. Fewer than one-half of all Rochester residents with pneumonia were hospitalized. Surprisingly, overall, an atypical presentation was not seen. Early mortality was high and contributed to 52 of the 196 observed deaths (including patients who had the diagnosis at autopsy). Patients who are alive 30 days after an episode of pneumonia still have significantly lower survival than expected.

Knowledge about common, potentially serious illnesses, such as pneumonia, is important. Community-based studies provide the most unbiased information because all members of the community are included; in our study these included

Table 3. Underlying Medical Conditions, by Diagnosis, in 421 Patients with Lower Respiratory Tract Infections.

	Bronchitis (n = 178)	Pneumonia (n = 243)
	No. (%)	No. (%)
Comorbid conditions		
Cardiac	76 (43)	136 (56)
Respiratory	40 (22)	64 (26)
Neurologic	39 (22)	93 (38)
Diabetes	24 (13)	32 (13)
Current cancer (any)	9 (5)	24 (10)
Renal failure	9 (5)	19 (8)
Hip fracture <2 years	4 (2)	13 (5)
Hospitalized <2 years	63 (35)	117 (49)
Medications		
Steroids or immuno-suppression	12 (7)	14 (6)
Chronic antibiotics	11 (6)	13 (5)
Recent antibiotics	25 (14)	32 (13)
Major or minor tranquilizers	15 (8)	44 (18)
Antidepressants	6 (3)	11 (5)
Habits		
Current smoker	25 (14)	25 (10)

Table 4. Underlying Medical Conditions, by Age, in 421 Patients with Lower Respiratory Tract Infections.

	Age Group, Years		
	65–74 (n = 138)	75–84 (n = 164)	85+ (n = 119)
	No. (%)	No. (%)	No. (%)
Comorbid conditions			
Cardiac	52 (38)	84 (51)	76 (64)
Respiratory	37 (27)	51 (31)	16 (13)
Neurologic	13 (9)	50 (30)	69 (58)
Diabetes	21 (15)	25 (15)	10 (8)
Current cancer (any)	8 (6)	17 (10)	8 (7)
Renal failure	7 (5)	12 (7)	9 (8)
Hip fracture <2 years	3 (2)	7 (4)	7 (6)
Hospitalized <2 years	42 (31)	73 (45)	65 (54)
Medications			
Steroids or immunosuppression	13 (9)	9 (5)	4 (3)
Chronic antibiotics	5 (4)	11 (7)	8 (7)
Recent antibiotics	15 (11)	23 (14)	19 (16)
Major or minor tranquilizers	12 (9)	24 (15)	23 (19)
Antidepressants	3 (2)	10 (6)	4 (3)
Habits			
Current smoker	27 (20)	20 (12)	3 (3)

community patients, hospitalized patients, and nursing home patients. As shown in Figure 1, a considerable number of elderly patients with LRTI were ambulatory community patients — patients not included in other studies.

There are few, if any, reported incidence rates for pneumonia and bronchitis in defined American populations. Such rates are necessary to understand the magnitude of this clinical problem and to plan for resource utilization. Incidence rates for pneumonia and bronchitis are difficult to determine because complete medical records for defined populations with known age and sex distributions are generally not available in the United States.

There are several problems in studying a common, variable illness, such as lower respiratory tract infection. First, there is considerable variation in the definitions. The most common criteria for pneumonia are a combination of positive signs or symptoms and other supporting evidence (most commonly a chest radiograph with new findings not consistent with other disease processes).[9-14] Bronchitis is more difficult to define and can

be hard to differentiate from an exacerbation of an underlying illness, such as chronic obstructive pulmonary disease. To ensure an accurate numerator, complete case ascertainment is vital, but changes in case definition and exclusion criteria can markedly alter the number of cases found. Developing a practical yet comprehensive case definition for an illness that is quite variable in presentation, management, and outcome has been one of the problems in studying LRTI. Even though our data were retrospective, we believe that we have developed a reasonable, practical, useful definition. Because the differences between bronchitis and pneumonia might be unclear at times, our study included the entire spectrum of bronchitis and pneumonia.

Second, there are many potential sources of bias. Restrictive study criteria can lead to the exclusion of patients whose conditions are diagnosed clinically but lack confirmatory tests as basic as a chest radiograph. Many studies have included only hospitalized patients,[9-11,13,15-24] even though it is likely that the sickest patients are admitted to a hospital. Others have excluded nursing home patients[9,22] (and even more frequently do not mention whether nursing home patients are included) because of potential differ-

Table 5. Proportion of Patients with Pneumonia Who Had Abnormal Signs Recorded*: by Age.

	Age Group, Years			Total
	65–74 (n = 58)	75–84 (n = 93)	85+ (n = 84)	(n = 235)
Signs	No. (%)	No. (%)	No. (%)	No. (%)
Crackles	32 (55)	50 (54)	55 (64)	137 (58)
Rhonchi	31 (53)	35 (38)	41 (49)	107 (46)
Fever (37.5°C)	18 (31)	34 (37)	40 (48)	92 (39)
Respiratory rate ≥25/min	11 (19)	26 (28)	25 (30)	62 (26)
Heart rate ≥80/min	33 (57)	66 (71)	61 (73)	160 (68)

*The percentage of all patients in each age stratum, excluding patients in whom diagnosis was first made at autopsy.

Table 6. Proportion of Patients with Bronchitis Who Had Abnormal Signs Recorded*: by Age.

	Age Group, Years			Total
	65–74 (n = 77)	75–84 (n = 69)	85+ (n = 32)	(n = 178)
Signs	No. (%)	No. (%)	No. (%)	No. (%)
Crackles	13 (17)	23 (33)	9 (28)	45 (25)
Rhonchi	26 (34)	25 (36)	12 (38)	63 (35)
Fever (37.5°C)	11 (14)	11 (16)	10 (31)	32 (18)
Respiratory rate ≥25/min	5 (6)	11 (16)	8 (25)	24 (13)
Heart rate ≥80/min	34 (44)	39 (57)	19 (59)	92 (51)

*The percentage of all patients in each age stratum, excluding patients in whom diagnosis was first made at autopsy.

ences in presentation and outcome. Our study included all patients from a well-defined community, including ambulatory, hospitalized, and nursing home patients.

With few exceptions,[9,12,13,24-28] most studies of pneumonia do not focus on the elderly, but include adults of all ages. Results obtained from younger patients might well not be valid for older patients; mortality, for example, increases with age.[4,23,29] The number of elderly patients included in these studies might be small, depending on the study design, and thus not appropriate for subgroup analysis. Results are often not stratified by age, and age-specific incidence rates are not available. Specific data for the elderly were supplied by this study.

As expected, the incidence rates for a first episode of LRTI were high and increased with age, especially for patients with pneumonia. The rates would be even higher if subsequent episodes in the year were included. Although pneumonia rates increased markedly with age, caution is needed in interpreting the relation between pneumonia risk and age as such, because the three age groups studied had different burdens of underlying illness. The hospitalization rate was high, particularly for patients with pneumonia, and the length of stay considerable, even for patients with bronchitis, which is of serious concern in times of cost management. Many patients with pneumonia are not

hospitalized and appear to do well. It might be possible to recognize which low-risk patients do not require hospitalization and thereby save health care costs.

Underlying medical conditions, with the exception of neurologic disease, cardiac disease, and recent hospitalizations, were not markedly more common in patients with pneumonia than in those with bronchitis. Given the substantial burden of disease in the elderly, it is not surprising that there is relatively little difference between groups for most conditions. As expected, neurologic disease, cardiac disease, recent hospitalizations, and the use of major tranquilizers occurred more often among older patients. The smaller proportion of patients with underlying respiratory illness and steroid use was likely due to survivor effect: patients with chronic obstructive pulmonary disease and conditions requiring steroid use could die as a result of these conditions, and therefore these conditions are less frequent among survivors. The smaller proportion of current smoking in the oldest patients was likely due either to lack of access to cigarettes or to survivor effect.

Clinical signs were difficult to quantify because of missing data; for example, in many cases temperature was not recorded. Clinical signs are

Figure 3. Proportion hospitalized, by age, among patients with lower respiratory tract infection. In the age group 65 to 74 years, 6 patients had bronchitis and 20 had pneumonia; in the age group 75 to 84 years, 16 had bronchitis and 48 had pneumonia; and in the age group 85 years or older, 4 had bronchitis and 28 had pneumonia.

Table 7. 30-Day Mortality, by Age, in Patients with Lower Respiratory Tract Infection.*

Age Group, Years	Pneumonia			Bronchitis		
	No.	Deaths, %	95% CI†	No.	Deaths, %	95% CI†
65–74	3/58	5	1–14	4/77	5	1–13
75–84	15/93	16	9–25	4/69	6	2–14
85+	13/84	15	9–25	5/32	16	5–33
Total	31/235	13	9–18	13/178	7	4–12

*Excluding patients in whom diagnosis was made at autopsy.
†CI, confidence interval.

more likely to be recorded when present than when absent, especially in the sickest patients, who are the most likely to receive a complete evaluation in or out of the hospital. The assumption was made that if a clinical sign was not recorded, it was considered to be negative. As a result, the presence of clinical signs could have been underestimated. Clinical signs did not change with age; this finding does not support the clinical concept that atypical presentation increases with increasing age. Comparison of signs in patients with pneumonia and in those with bronchitis was not possible because clinical signs were among the criteria used to determine the diagnostic category.

In this study, we used 30-day all-cause mortality rates, which approximate deaths due to the episode of illness. Some deaths that occurred within the 30 days might, of course, be attributed to other causes, and, in the elderly, most deaths likely have a multifactorial cause. The 30-day

mortality does, however, give a sense of the seriousness of this condition in the elderly. Patients with pneumonia, not surprisingly, had a much higher 30-day mortality than patients with bronchitis. Although two-thirds of deaths within 30 days occurred in nursing home residents, a small minority of these patients were transferred to a hospital before death.

The survival curves show a substantial reduction in survival in patients with pneumonia in the first 30 days after diagnosis. Even among patients who survived for 30 days, subsequent survival was lower than expected, a finding suggesting that elderly patients with an episode of pneumonia have an increased mortality risk compared with the general population. This increased risk might not be due to the episode of LRTI but to underlying illnesses.

The strength of this study was that it was community-based, allowing generalization of these results to other similar populations. The major limitation, as of any retrospective study, was missing data: either data that were collected but not recorded in the medical record or data that were never collected. Although the medical records system in this community is known to be among the most detailed and accurate available, there might be some bias in assignment to diagnostic categories because fewer chest radiographs were done in nursing home residents.

Conclusion

This study confirmed the need for population-based studies, in that more than two-thirds of patients, those who were not hospitalized, would have been missed using a more typical study design with only hospitalized patients. As expected, incidence rates were high and increased with age, a finding confirming the clinical impression that LRTI is a common illness in the elderly. Patients with pneumonia were
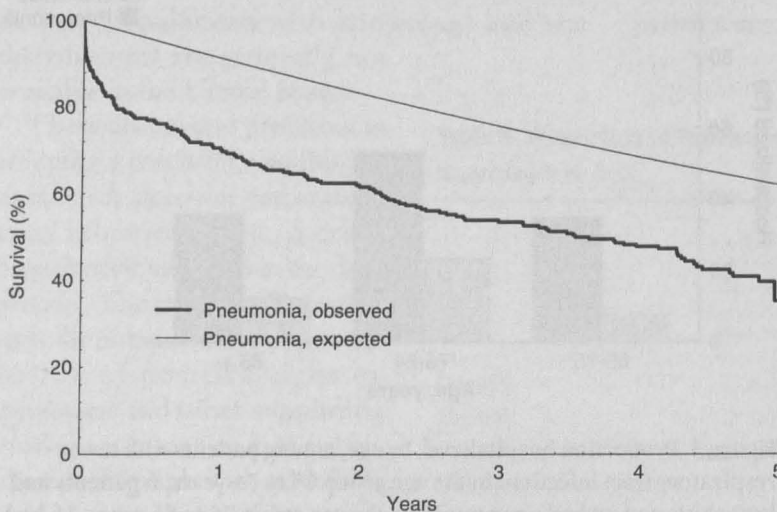
Figure 4. Kaplan-Meier survival of patients with pneumonia compared with expected survival.
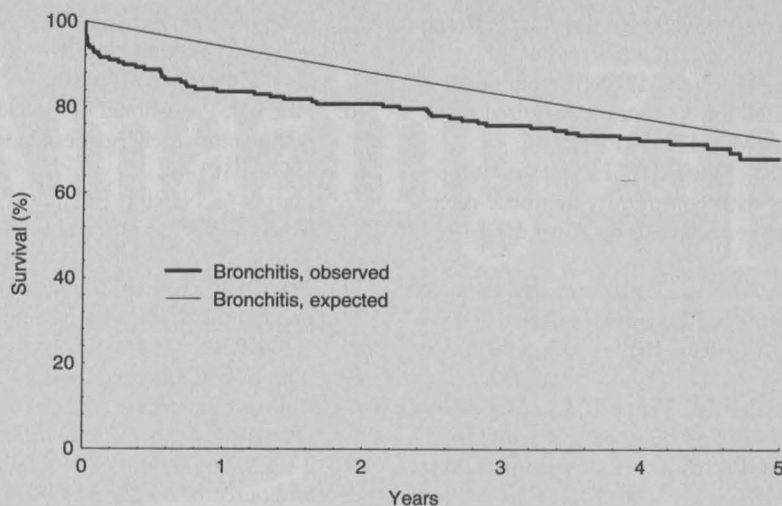
Figure 5. Kaplan-Meier survival of patients with bronchitis compared with expected survival.

more likely to have cardiac or neurologic disease or recent hospitalizations than were patients with bronchitis. The presence of clinical signs changed little with age; only a small number had a fever or increased respiratory or heart rates.

References

1. Dubois RW. Methods to assess the quality of care for elderly patients with pneumonia. Semin Respir Infect 1990; 5:322-6.
2. Fein AM, Feinsilver SH, Niederman MS. Atypical manifestations of pneumonia in the elderly. Clin Chest Med 1991; 12:319-36.
3. Ishii T, Hosoda Y, Maeda K. Cause of death in the extreme aged — a pathologic survey of 5106 elderly persons 80 years old and over. Age Ageing 1980; 9:81-9.
4. Fedullo AJ, Swinburne AJ. Relationship of patient age to clinical features and outcome for in-hospital treatment of pneumonia. J Gerontol 1985; 40:29-33.
5. Bergstralh EJ, Offord KP, Chu CP, Beard CM, O'Fallon WM, Milton LJ 3d. Calculating incidence, prevalence and mortality rates for Olmsted County, Minnesota: an update. Rochester, MN: Technical Report No. 49, Medical Research Statistics, Mayo Clinic, April 1992.
6. Therneau T, Sicks J, Bergstralh E, Offord J. Expected survival based on hazard rates. Rochester, MN: Technical Report No. 52, Mayo Foundation, 1994.
7. Fleming TR, Harrington DP. A class of hypothesis tests for one- and two-sample censored survival data. Commun Stat 1981; 10A:763-94.
8. SAS Institute. SAS/STAT user's guide. Version 6, vol. 2, 4th ed. Cary, NC: SAS Institute, 1989.
9. Ebright JR, Rytel MW. Bacterial pneumonia in the elderly. J Am Geriatr Soc 1980; 28:220-3.
10. Garb JL, Brown RB, Garb JR, Tuthill RW. Differences in etiology of pneumonias in nursing home and community patients. JAMA 1978; 240: 2169-72.
11. Levy M, Dromer F, Brion N, Leturdu F, Carbon C. Community-acquired pneumonia: importance of initial noninvasive bacteriologic and radiographic investigations. Chest 1988; 93:43-8.
12. Harkness GA, Bentley DW, Roghmann KJ. Risk factors for nosocomial pneumonia in the elderly. Am J Med 1990; 89:457-63.
13. Venkatesan P, Gladman J, Macfarlane JT, Barer D, Berman P, Kinnear W, et al. A hospital study of community acquired pneumonia in the elderly. Thorax 1990; 45:254-8.
14. Mehr DR, Foxman B, Colombo P. Risk factors for mortality from lower respiratory tract infections in nursing home patients. J Fam Pract 1992; 34:585-91.
15. Berntsson E, Blomberg J, Lagergard T, Trollfors B. Etiology of community-acquired pneumonia in patients requiring hospitalization. Eur J Clin Microbiol 1985; 4:268-72.
16. Dorff GJ, Rytel MW, Farmer SG, Scanlon G. Etiologies and characteristic features of pneumonias in a municipal hospital. Am J Med Sci 1973; 266:349-58.
17. Gleckman R, DeVita J, Hibert D, Pelletier C, Martin R. Sputum Gram stain assessment in community-acquired bacteremic pneumonia. J Clin Microbiol 1988; 26:846-9.
18. Macfarlane JT, Finch RG, Ward MJ, Macrae AD. Hospital study of adult community-acquired pneumonia. Lancet 1982; 2:255-8.
19. Sullivan RJ Jr, Dowdle WR, Marine WM, Hierholzer JC. Adult pneumonia in a general hospital: etiology and host risk factors. Arch Intern Med 1972; 129:935-42.
20. Carr B, Walsh JB, Coakley D, Mulvihill E, Keane C. Prospective hospital study of community acquired

lower respiratory tract infection in the elderly. Respir Med 1991; 85:185-7.

21. Farr BM, Sloman AJ, Fisch MJ. Predicting death in patients hospitalized for community-acquired pneumonia. Ann Intern Med 1991; 115:428-36.

22. Fine MJ, Smith DN, Singer DE. Hospitalization decision in patients with community-acquired pneumonia: a prospective cohort study. Am J Med 1990; 89:713-21.

23. Marrie TJ, Durant H, Yates L. Community-acquired pneumonia requiring hospitalization: 5-year prospective study. Rev Infect Dis 1989; 11: 586-99.

24. Starczewski AR, Allen SC, Vargas E, Lye M. Clinical prognostic indices of fatality in elderly patients admitted to hospital with acute pneumonia. Age Ageing 1988; 17:181-6.

25. Zweig S, Lawhorne L, Post R. Factors predicting mortality in rural elderly hospitalized for pneumonia. J Fam Pract 1990; 30:153-9.

26. Fine MJ. Pneumonia in the elderly: the hospital admission and discharge decisions. Semin Respir Infect 1990; 5:303-13.

27. Harper C, Newton P. Clinical aspects of pneumonia in the elderly veteran. J Am Geriatr Soc 1989; 37:867-72.

28. Marrie TJ. Epidemiology of community-acquired pneumonia in the elderly. Semin Respir Infect 1990; 5:260-8.

29. The British Thoracic Society and the Public Health Laboratory Service. Community-acquired pneumonia in adults in British hospitals in 1982-1983: a survey of aetiology, mortality, prognostic factors and outcome. Q J Med 1987; 62:195-220.