and to develop a model that predicts mortality in rural elderly patients hospitalized for pneumonia based on data available at clinical presentation.

METHODS

Keller Memorial Hospital is an 80-bed rural community hospital in Fayette, Missouri, and serves Howard County, a primarily agricultural area with a stable population, of which approximately 20% are elderly. During the study period, the hospital was staffed by general practitioners and family physicians, including faculty and residents of a satellite practice of the University of Missouri–Columbia Department of Family and Community Medicine (members of the Fayette Medical Clinic). The hospital had neither an intensive care unit nor on-site specialists in pulmonary or critical care medicine.

The records were reviewed of all patients older than 60 years with a diagnosis of pneumonia who were cared for by physicians of the university satellite practice. One hundred fifty-two charts from January 1, 1980, to June 1, 1987, were reviewed. Twelve patients had pneumonia twice, and the second episode was excluded from analysis. Seven patients with hospital-acquired pneumonia were also excluded. The initial sample, therefore, included 133 different patients who had pneumonia listed as the major diagnosis. Patients admitted to the hospital with a clinical diagnosis of pneumonia based on history, physical examination, and radiological evidence of consolidation were included in the study.

Each chart was reviewed for clinical information available to the patient's physician within the first hours of admission. This information included demographic characteristics preexisting medical conditions, medications, signs and symptoms, and initial laboratory and radiographic findings. The reviewer then recorded whether each patient survived the hospitalization.

For patients who survived the hospitalization, the setting to which they were discharged was also recorded. In addition, 1-year follow-up was obtained by reviewing medical records, calling physicians' offices or patient family members, or directly contacting patients themselves. Whether the patient was alive 1 year after discharge was recorded for each case.

The study had a retrospective cohort design. Patients, described by admission characteristics, were followed over the course of the hospitalization to detect associations of these characteristics with mortality. Univariate analyses included *t* tests for comparisons of means, chi-square for comparing the distributions of dichotomous variables, and Mann-Whitney *U* statistics for comparing the distributions of ordinal variables.[2] Variables predictive of mortality during the hospitalization were identified, and odds ratios were calculated using stepwise multiple logistic regression analysis.[3] A risk of mortality score was also calculated using the weighted regression coefficients of the statistically significant variables in the logistic regression equation.

Selection of variables for consideration in the multiple logistic regression analysis was based on two principles. First, to examine possible confounders and to reduce the likelihood of chance associations with the outcome variable, only variables showing a statistically significant association with mortality in the univariate analyses ($P < .05$) were entered as independent variables. Second, variables with greater than 10% missing values were deleted. For variables with fewer missing values, the mean value was used to avoid having the missing data influence the relationship between the independent variable and the outcome variable.[4] There were no missing mortality data.

Another sample from the same population was studied to test the predictive model derived in the first part of the study. Physicians (not members of the study team) examined the admission records of 40 elderly patients with pneumonia admitted to the study hospital between July 1987 and February 1988. These physician reviewers were not aware of the predictive model, and they did not know whether the patient survived or died. Survival was independently recorded by one of the study physicians. As in the first part of the study, patients with hospital-acquired pneumonia were excluded.

RESULTS

Of the 133 subjects, 55% were women. Their ages ranged from 60 to 99 years (mean, 80 years), and 45% resided in nursing homes. Twenty-one (15.8%) died during the index hospitalization. Table 1 compares characteristics of patients who survived with those who died. Age was not associated with mortality in this sample of elderly people. Those who survived were more likely to be female and unmarried, but these differences were not statistically significant. People who lived in a nursing home at the time of admission were much more likely to die during their hospitalization than those living in the community. Of people living at home, equal proportions of both groups lived alone, with a spouse, or with other family members.

With regard to preexisting medical conditions, those who died were significantly more likely to have had previous diagnoses of coronary heart disease or dementia. They also tended to be more likely to have had congestive heart failure, chronic lung disease, a history of stroke, and previous pneumonia. There were no significant differences with regard to history of influenza, alcoholism,

TABLE 1. DEMOGRAPHIC CHARACTERISTICS, PREEXISTING MEDICAL CONDITIONS, AND MEASURES OF FUNCTIONAL STATUS ASSOCIATED WITH MORTALITY DUE TO PNEUMONIA

Characteristic	Percent Survived (n=112)	Percent Died (n=21)
Age (mean years)	80	81
Female	57	43
Married	34	50
Nursing home resident	40	76*
Coronary heart disease	48	76†
Congestive heart failure	33	48
Chronic lung disease	29	38
Dementia	24	52*
Stroke	28	38
Influenza	21	10
Alcoholism	2	5
Mental illness	21	14
Cancer	10	14
Smoking	25	10
Previous pneumonia	33	43
Hospitalized during past year	54	57
Urinary incontinence	33	57†
Fecal incontinence	21	38
Mobility		
Ambulatory	50	11*
Ambulatory with assistance	28	17
Wheelchair	5	17
Bed	17	55

*P < .01
†P < .05

TABLE 2. PHYSICAL FINDINGS ASSOCIATED WITH MORTALITY DUE TO PNEUMONIA

Finding	Groups: Percent Survived (n=112)	Groups: Percent Died (n=21)
Level of consciousness		
Alert	58	10*
Confused	32	29
Arousable	7	43
Comatose	2	18
Cachexia	12	27
Cyanotic	12	52*
Rales	69	71
Localized chest findings	45	19†
Heart murmur	24	14
Third heart sound	5	5
Arrhythmia	25	33
Temperature °C (mean °F)	38.0 (100)	37.0 (98.4)*
Respiratory rate (mean breaths per minute)	27	34*
Pulse rate (mean beats per minute)	93	97
Systolic blood pressure (mean mmHg)	135	114*

*P < .01
†P < .05

mental illness, smoking, cancer, or hospitalization during the past year. The use of medications was also examined. Mortality was not associated with the prior use of aspirin, psychotropic drugs, antibiotics, steroids, cardiac medications, recent influenza vaccine, or past pneumonia vaccine.

With regard to measures of functional status, those who died were nearly twice as likely to have had urinary or fecal incontinence at admission. The patient's mobility before hospitalization was also clearly associated with mortality; patients who died were more likely to be bedbound and less likely to be ambulatory than those who survived ($P < .001$, by Mann-Whitney U). This variable likely represents an important indicator of preexisting health status.

Table 2 shows physical findings associated with hospital mortality. A depressed level of consciousness, absence of fever, tachypnea, low systolic blood pressure, cyanosis, and diffuse abnormalities on chest examination were all significantly associated with mortality. While most patients had an increased respiratory rate (higher than 25), only about 70% in each group had rales detected on physical examination.

Table 3 indicates that none of the findings on chest x-ray examination were predictive of mortality, whereas elevated white cell count (a marked leukocytosis of $>20 \times 10^9$/L (20,000 mm^{-3}), a high proportion of band cells (higher than 0.20), impaired renal function, elevated serum glucose, and a low arterial pH were significantly associated with mortality. Since renal function tests and blood glucose determinations were not available for about one quarter of the patients, however, these variables could not be used in the multiple logistic regression analysis. Blood gases were obtained on admission for only 40 patients and were more likely to have been obtained in the patients who ultimately died and in the sicker patients who did not die.

Independent variables evaluated for their association with hospital mortality using stepwise multiple logistic regression included coronary heart disease, dementia, urinary incontinence, and mobility prior to hospitalization. Included also was level of consciousness, cyanosis, temperature (dichotomized at 37.0°C [98.6°F]), respiratory rate (dichotomized at 30 breaths per minute), and white cell count (dichotomized at 20×10^9/L [20,000 mm^{-3}]). Table 4 shows the results of the logistic regression analysis. Five variables—impaired level of consciousness, tachypnea, temperature lower than normal, high white cell count, and cyanosis—were all associated with mor-