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Original article

A scoring system to predict in-hospital death in oldest-old patients with infections in Taiwan

Hsin-Hao Chen, MD [a], Lee-Ching Hwang, MD, PhD [a,b,*], Jin-Jin Tjung, MD [a], Ching-Ping Hsu, MD, MedSc [a,b]

[a] Department of Family Medicine, Mackay Memorial Hospital, Taipei, Taiwan
[b] Mackay Medical College, New Taipei City, Taiwan

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ABSTRACT

Background: The elderly population has the highest number of in-patient claims accounting for over 40% of in-patient medical expenses in Taiwan, and infectious diseases are one of the most common causes of hospitalization in elderly patients. The aims of the study were to identify independent predictors of mortality, and to develop a simple scoring system for use in a busy clinical medical setting.
Methods: All patients aged 75 years and older presenting to our emergency department or outpatient clinics who were subsequently admitted due to infections between March and July 2009 were enrolled.
Results: A total of 981 patients were included, and the mortality rate was 9.2%. Logistic regression revealed seven independent predictors of mortality [odds ratio (95% confidence interval)]: albumin <3 g/dL [3.72 (1.97–7.00)], creatinine >1.5 mg/dL [2.94 (1.69–5.09)], total dependence on admission [1.64 (1.11–2.43)], systolic blood pressure <100 mmHg [4.46 (2.02–9.84)], white blood cell count ≥10 or ≤4 × 10^9/L [2.23 (1.23–4.04)], total bilirubin >1.2 mg/dL [2.37 (1.31–4.31)], and malignancy history [2.73 (1.4–5.30)]. These were given weighting by discriminant analysis and used to create a receiver operating curve with an area under the curve of 0.820. The model was simplified and each variable was assigned scores of 3 or 4 to form an index predicting in-hospital mortality. Mortality increased with score: 0.9% for score <5; 6.9% for 6 to 11; 21.4% for 12 to15, 53.7% for 16 to 19, and all three subjects whose score was >19 died during hospitalization.
Conclusion: Our scoring system derived from seven readily available variables including activity level, malignancy history, systolic blood pressure, and a small number of laboratory parameters predicted in-hospital mortality in oldest-old patients with infections. This system may allow for the identification of high-risk patients soon after admission.

1. Introduction

Globally, the population of the elderly is growing by 2% each year, considerably faster than the population as a whole.[1] In the more developed regions, almost one-fifth of the population was aged 60 or older in 2000, and by 2050, this proportion is expected to reach one-third.[1] This trend is consistent with the growing number of elderly people in Taiwan, which is expected to reach 41.6% in 2060. [2] Moreover, the National Health Insurance Statistics, 2010[3] reported that the elderly population had the highest in-patient claims accounting for 44% of in-patient medical expenses in Taiwan.

Infectious diseases are one of the most common causes of hospitalization in elderly patients. Epidemiologically, the respiratory tract, urinary tract, and soft tissue are the most common sites of infection.[4] Accurate identification and risk assessment of elderly patients with infections is a particular challenge, because symptoms and signs tend to be more subtle and masked than in younger patients.[5] Recent studies have shown that early recognition, aggressive resuscitation, and appropriate antibiotic administration for patients with infection in the emergency department improves outcomes for sepsis.[6] Therefore, early identification of those most at risk of a poor outcome is important; however, very few studies have been designed to assist physicians in identifying the elderly population with the most adverse prognosis.

Several comorbidities, such as cardiovascular disease, diabetes, stroke, and lung disease significantly increase mortality in the elderly.[7] Some studies have demonstrated that, even more than

* Corresponding author. Department of Family Medicine, Mackay Memorial Hospital, No. 92, Section 2, ChungShan North Road, Taipei 10449, Taiwan.
E-mail address: hlc@ms2.mmh.org.tw (L.-C. Hwang).

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comorbidities, the condition most associated with a risk of death in these patients is functional status prior to admission.[8] As to infection-related deaths, unstable vital signs, preexisting terminal illness, and abnormal platelet count have been reported to increase the risk of mortality.[5,9] Several studies have also reported that age, comorbidity, nutrition status, the number of organ dysfunctions,[10–15] and abnormal glucose level[16,17] are the most important predictors for hospital mortality in patients with infection or sepsis; however, these studies were not geriatric specific.

Acute infectious disease is one of the main causes for in-hospital death of nonagenarians,[18] so it is important to develop an outcome prediction instrument for elderly patients with infection. Such a tool would help identify the most at-risk patients and guide triage and treatment decisions. In addition, it should be elderly specific, simple to use, and based on information readily available to physicians. To the best of our knowledge, no hospital-based data in Taiwan are available on the risk factors for predicting mortality in elderly patients admitted due to infection. Therefore, the aims of the present study were to analyze the basic aspects and mortality rate in the oldest-old patients with infections in Taiwan, to identify the independent predictors of mortality, and to develop a simple scoring system for use in a busy clinical medical setting.

2. Methods

2.1. Subjects

This study is a retrospective analysis performed at a metropolitan tertiary-care hospital with the largest number of medical, surgical and intensive specialties in northern Taiwan. The inclusion criteria included all patients aged 75 years and older presenting to the emergency department or outpatient clinics, who were subsequently admitted due to infection between March and July 2009. We initially collected all 7 discharge international classifications of disease (ICD revision 9, the web site is http://www.cdc.gov/nchs/icd/icd9.htm) diagnoses codes from the patients hospitalized during this time. We then enrolled eligible patients whose diagnosis was consistent with an infectious disease (ICD 9 code, 0090: infectious colitis, enteritis, and gastroenteritis; 0092: infectious diarrhea; 038: septicemia; 320: bacterial meningitis; 481–486: pneumonia, 49121: obstructive chronic bronchitis with acute exacerbation; 4941: bronchiectasis, with acute exacerbation; 513: lung abscess; 540: acute appendicitis; 56211: diverticulitis of colon; 567: peritonitis; 57400: calculus of gallbladder with acute cholecystitis; 575: cholecystitis; 5761: cholangitis; 590: pyelonephritis; 595: cystitis; 599: urinary tract infection; 682: cellulitis and abscess).

2.2. Definitions and subject assessment

The staff took the patients' history and performed a thorough physical examination including the activity level when the patients were admitted, and vital signs were also collected at the same time. Blood tests including hemoglobin, white blood cell (WBC) count and differential, platelet count, liver function test (alanine transaminase, aspartate transaminase, total bilirubin), renal function test (creatinine), plasma glucose, albumin, total cholesterol, uric acid, and C-reactive protein were measured within 12 hours after admission. Two blood samples for culture before administration were also collected of antibiotics, and a positive blood culture was defined as one or more positive cultures for a commonly accepted pathogen or two positive cultures for coagulase-negative staphylococci or *Candida* spp.

Infections were classified according to the source, including lower respiratory tract, intraabdominal, urinary tract, skin and soft tissue, and mixed sources. Cases of suspected infection with no clear source, such as patients admitted for sepsis were classified as unrecognized. The demographic data collected included sex, age, smoking, and alcohol drinking habits. Whether or not the patient had had a fever of more than 38 °C in the 10 days prior to admission was also recorded. Comorbidities included diabetes, heart disease, malignancy, and chronic lung disease. The main outcome variable was in-hospital death.

2.3. Data analysis

A descriptive analysis of the data regarding infection source and culture was carried out, and various clinical and laboratory variables chosen to test their association with in-hospital death. The means of continuous variables were compared using independent Student t tests, and the Chi-square test was used for categorical variables. Multiple logistic regression models were created to determine the independent predictors of all-cause mortality. Statistical significance was set at $p < 0.05$. All data analyses were performed using SPSS version 18.0 (SPSS Inc., Chicago, IL, USA).

Cut-off values of the significant continuous variables for predicting in-hospital death were set according to commonly accepted reference values and previous studies.[5,9,11,13] They were adjusted them using binary categories of risk factors and the analysis was performed iteratively for all-cause death to maximize the statistical power. All eight independent risk factors were then subjected to discriminant analysis using SPSS to give a standard weighting coefficient for each variable. These weightings were used to construct receiver operating characteristic curves to examine the relationship between sensitivity and specificity, and to determine whether the area under the curve was high enough to construct a useful predictive model.[19] The model was restricted to include seven of the most highly weighted variables (excluding age) and the weightings were empirically rounded up or down, so that these could be added together to give a maximum score of 25.[15,20] Finally the score for each patient was calculated and divided them into five subgroups to determine the utility of the scoring system in predicting in-hospital death in this population.

The study was conducted following the ethical principles outlined in the Declaration of Helsinki, and it was approved by Scientific Research Ethics Committee of the hospital. It was not possible to obtain formal informed consent from these patients due to particular design of the study.

3. Results

During the study period, there were a total of 3945 oldest-old patient admissions, and 981 (24.9%) were enrolled in the study. The mean ± SD age was 83.2 ± 5.9 years, 51% were female, and the mortality rate was 9.2%. Respiratory tract infection was the most common infectious source regardless of the outcome, followed by the urinary tract infection and mixed infection source. With regards to blood cultures, there were predominantly negative results in both survivors and nonsurvivors, and Gram-negative microorganisms were the most commonly isolated from positive cultures.

The characteristics of the study patients that were significant predictors of in-hospital death on a univariate basis are described in Table 1. The total admission fee of those who died in hospital was nearly double that of those who remained alive during hospitalization. Older age, female gender, malignancy history, and total dependence on admission were significantly associated with mortality. Neither smoking nor the majority of comorbidities were associated with death, whereas systolic blood pressure (SBP) and a number of laboratory values proved significant in univariate analysis.