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Predicting 1-Year Mortality Rate for Patients Admitted With an Acute Exacerbation of Chronic Obstructive Pulmonary Disease to an Intensive Care Unit: An Opportunity for Palliative Care

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Abstract

The objective of this study was to develop a model to aid clinicians in better predicting 1-year mortality rate for patients with an acute exacerbation of chronic obstructive pulmonary disease admitted to the medical intensive care unit (ICU) with the goal of earlier initiation of palliative care and end-of-life communications in this patient population. This retrospective cohort study included patients from a medical ICU from April 1, 1995, to November 30, 2009. Data collected from the Acute Physiology and Chronic Health Evaluation III database included demographic characteristics; severity of illness scores; noninvasive and invasive mechanical ventilation time; ICU and hospital length of stay; and ICU, hospital, and 1-year mortality. Statistically significant univariate variables for 1-year mortality were entered into a multivariate model, and the independent variables were used to generate a scoring system to predict 1-year mortality rate. At 1-year follow-up, 295 of 591 patients died (50%). Age and hospital length of stay were identified as independent determinants of mortality at 1 year by using multivariate analysis, and the predictive model developed had an area under the operating curve of 0.68. Bootstrap analysis with 1000 iterations validated the model, age, and hospital length of stay, entered the model 100% of the time (area under the operating curve=0.687; 95% CI, 0.686-0.688). A simple model using age and hospital length of stay may be informative for providers willing to identify patients with chronic obstructive pulmonary disease with high 1-year mortality rate who may benefit from end-of-life communications and from palliative care.

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Chronic obstructive pulmonary disease (COPD), the fourth ranked cause of death in the United States, is a heterogeneous disease with an unpredictable course.[1,2] Previous work oriented toward prognosis and advance care planning aimed to identify factors associated with mortality during and after a hospitalization for an acute exacerbation of COPD.[2-10] Despite our increased understanding, there remains a disconnect between this knowledge and its application to patient care. Clinicians struggle to reliably predict outcomes for patients hospitalized with a COPD exacerbation.[1,11,12] In particular, a hospital admission for a COPD exacerbation that requires intensive care represents a significant milestone that may merit advanced care planning and could be an opportunity to initiate end-of-life communications. Early referral to palliative care has been shown to improve quality of life, patient satisfaction, and survival in patients with incurable lung cancer.[13-15] Interestingly, when compared with those with a malignancy, despite equal or higher ratings of symptom severity, including pain and dyspnea, patients with COPD are less likely to be offered palliative care services.[16-18] It has been demonstrated that patients with COPD and their health care providers are hesitant to discuss goals of care and palliative treatment and are more likely to have conversations about end-of-life care when these patients are in extremis or hospitalized than when stable in the outpatient setting.[17,19]

The objective of this study was to develop a model with simple variables robust enough to predict mortality rate at 1 year in a patient population with high risk of death, like those

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with an acute exacerbation of COPD requiring admission to an intensive care unit (ICU), in a time frame appropriate to initiate palliative care. The latter could have a substantial effect on the quality of life of patients and caregivers and on our health care system by avoiding unnecessary hospitalizations.

PATIENTS AND METHODS

This retrospective cohort study reviewed admissions to the medical ICU of a tertiary academic medical center from April 1, 1995, to November 30, 2009. Data were abstracted from an Acute Physiology and Chronic Health Evaluation III (APACHE III) database for patients 18 years or older. This study was approved by the Mayo Foundation Institutional Review Board (number 1283-01).

Baseline demographic characteristics collected included age, sex, and race. Factors from the hospital course retrieved from the database were ICU admission diagnosis, Sequential Organ Failure Assessment (SOFA) score on admission, APACHE III score on admission, ICU and hospital length of stay, and the use and duration of invasive or noninvasive mechanical ventilation. ICU, hospital, and 1-year mortality data were collected by reviewing survival status and date of death in the medical record.

Data were summarized as mean ± SD, median (interquartile range), or percentage. Univariate analysis was performed to identify variables associated with 1-year mortality. Those of statistical significance were then entered into a stepwise multivariate logistic regression analysis to identify independent variables affecting 1-year mortality. Once the independent variables were identified, we transformed the continuous predictor variables into categorical variables by using their quartile values. Nominal logistic analysis was performed by using the subgroups to predict 1-year mortality. The odds ratio for 1-year mortality for each subgroup was then used to assign a score for each quartile, a method previously reported.[20] Odds ratios were rounded up or down to assign a score. Those odds ratios with a 95%CI crossing 1 were not assigned points. The scores for all the independent predictor variables were added, and a total mortality score was generated for each patient. The capability of the scoring system was evaluated by using area under the operating curve (AUC).

Bootstrap analysis was performed for confirmation of internal validity of the model because it has been shown to be an acceptable means to internally validate predictive models.[21] This is a statistical method that randomly samples with replacement a study sample of the same size from the original study sample from which the prediction model was developed. The bootstrap samples are similar but not identical to the study sample and a model is created from each bootstrap sample with its own AUC. The AUC from a bootstrap analysis reflects how the model would likely perform when applied to similar individuals from a new or external population.[22]

Model calibration was evaluated on the basis of goodness of fit by using the Hosmer-Lemeshow chi-square statistic, with lower chi-square values and higher *P* values indicative of better fit. Model discrimination was assessed on the basis of receiver operating characteristics-AUC, with a receiver operating characteristic -AUC of 0.5 indicative of the effects of chance alone and a receiver operating characteristic-AUC of 1 indicative of faultless discrimination. A Cox proportional hazards regression model comparing years 1995-2000, 2001-2005, and 2006-2009 was used to determine whether the year of admission affected the mortality rate. A Kaplan-Meier survival curve for the 1-year period was constructed.

RESULTS

There were 25,287 admissions to the medical ICU, based on the documented admission diagnosis by ICU nurses trained in APACHE definitions; 761 admissions (3%) were for acute exacerbation of COPD. Of these admissions, 130 patients had more than 1 episode of care in the ICU, and for these patients, data from only the first hospital admission were used for analysis. After excluding 40 patients lost to follow-up at 1 year, a total of 591 patients were included in the analysis. Similar to previous studies, the population analyzed represents a small portion of all ICU admissions.[2,23]

Among the 591 patients, 51% were men, 93% were Caucasian, and the mean age was 70±11 years. The mean APACHE III and SOFA scores on the day of admission were 41±19 and 3±2, respectively. At 1 year from the time of ICU admission, 295 of 591 patients had died (50%). Forty-one patients (7%) died while in the ICU, and 87 patients (15%) died