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Derivation of data-driven triggers for palliative care consultation in critically ill patients

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ABSTRACT

Purpose: To examine the ability of existing triggers for intensive care unit (ICU) palliative care consultation to predict 6-month mortality, and derive new triggers for consultation based on risk factors for 6-month mortality.
Materials and methods: Retrospective cohort study of NY state residents who received intensive care, 2008–2013. We examined sensitivity and specificity of existing triggers for predicting 6-month mortality and used logistic regression to generate patient subgroups at high-risk for 6-month mortality as potential novel triggers for ICU palliative care consultation.
Results: Of 1,019,849 patients, 195,847 (19.2%) died within 6 months of admission. Existing triggers were specific but not sensitive for predicting 6-month mortality, (sensitivity 0.3%–11.1%, specificity 96.5–99.9% for individual triggers). Using logistic regression, patient subgroups with the highest predicted probability of 6-month mortality were older patients admitted with sepsis (age 70–79 probability 49.7%, [49.5–50.0]) or cancer (non-metastatic cancer, age 70–79 probability 51.5%, [51.1–51.9]; metastatic cancer, age 70–79 probability 60.3%, [59.9–60.6]). Sensitivity and specificity of novel triggers ranged from 0.05% to 9.2% and 98.6% to 99.9%, respectively.
Conclusions: Existing triggers for palliative care consultation are specific, but insensitive for 6-month mortality. Using a data-driven approach to derive novel triggers may identify subgroups of patients at high-risk of 6-month mortality.

Integration of specialized palliative medicine teams within the intensive care unit (ICU) may potentially improve the value of care in certain patients. Several studies have demonstrated the benefit of specialized palliative care in reducing length of stay, decreasing non-beneficial resource utilization, and increasing use of hospice without sacrificing quality of care [1-3]. Many critically ill patients may benefit

Abbreviations: ICU, intensive care unit; SPARCS, Statewide Planning and Research Cooperative; GCS, Glasglow Coma Score; AUC, area under the curve.

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from these services, as 14% of all admissions to ICUs within the U.S. meet screening criteria, or triggers, for palliative care consultation [4]. Moreover, many patients who survive critical illness go on to suffer from substantial symptomatology and impairments in quality of life [5-8], and palliative care consultants may be best poised to attend to these needs.

Despite these potential benefits, palliative care consultation in the ICU remains underutilized [9]. Although the use of triggers to identify patients with potential palliative care needs is gaining acceptance, existing triggers for consultation have not been formerly validated. Such "validation" may be difficult secondary to a lack of an accepted definition of palliative care need, as well as a lack of consensus regarding when palliative care should be used. However, in the past decade, two states (California and New York) have enacted laws mandating that physicians discuss end-of-life care options for patients who are likely to die within six months [10-12]. Traditionally tied to the initiation of the hospice benefit, 6-month mortality represents a concrete, objective and measurable outcome that is likely to be associated with substantial palliative care need. While palliative care is appropriate for patients with serious illness and need not be tied to a terminal condition, demonstrating that existing triggers are associated with long-term mortality may increase adoption of such methods to deliver palliative care to critically ill patients. Therefore, we had two primary aims in this study: to examine the ability of existing triggers for palliative care consultation to predict 6-month mortality and 2) to derive novel "data-driven" triggers from demographic and clinical characteristics, based on an ability to predict 6-month mortality.

1. Methods

1.1. Patients and data collection

The study protocol was reviewed and approved by the institutional review board of Columbia University Medical Center (IRB-AAAJ2158 New York, NY). Written informed consent was waived. Data for this study came from the New York Statewide Planning and Research Cooperative System (SPARCS) for the years 2008–2013. SPARCS is a comprehensive data reporting system that collects patient-level data including patient characteristics, diagnoses and treatments, services, and charges for every hospital discharge in New York State (NY). Data from SPARCS were also linked to NY State and New York City Vital Records to obtain 6-month mortality data for all patients. The cohort consisted of all patients over the age of 18 with an acute care hospitalization with admission to an ICU (defined by ICU bed utilization billing codes). As we did not have data regarding deaths and rehospitalizations occurring outside the state, we excluded patients with a primary residence outside of NY [13].

Patient-level covariates available for inclusion in regression models were age, gender, race (White, Black, and other), insurance (private, Medicare, Medicaid, self-pay, other), type of patient (non-surgical, surgical) and number of Elixhauser comorbidities [14]. We also examined all specific Elixhauser comorbidities, as well as the top ten diagnoses and procedures associated with the highest rates of dying within 6 months.

We identified existing triggers for palliative care consultation in the ICU that were available in the SPARCS database (age > 80 with two or more life-threatening comorbidities, active stage IV malignancy, status post cardiac arrest, intracerebral hemorrhage requiring mechanical ventilation, global cerebral ischemia, multi-system organ failure and advanced stage dementia; for detailed definitions, see additional methods in the supplementary material) [4]. We excluded seven objective triggers (ICU admission after hospital stay ≥10 days, ICU stay >1 month, Glasglow Coma Score (GCS) = 3, GCS ≤ 8 for >1 week in a patient age > 75 years, >3 ICU admissions during the same hospital stay, mechanical ventilation ≥7 days, ICU length of stay >50% of average) that could not be identified using variables in the SPARCS database [15].

1.2. Statistical analysis

We summarized demographic and clinical characteristics for the cohort, stratified by 6-month mortality. We assessed the association of each existing trigger with 6-month mortality by calculating sensitivity, specificity and area under the receiver operating characteristics curve (AUC).

For the purposes of deriving novel triggers, we randomly divided the cohort into derivation and validation subsets. We also summarized demographic and clinical characteristics for these derivation and validation cohorts. To derive novel triggers for palliative care consultation, we generated a logistic regression model with mortality occurring within 6 months of the admission date of the hospitalization that required ICU care as the primary outcome. In this model, we included age, gender, race and insurance, as well as other variables (listed above) that had a standardized difference in 6-month mortality >0.2 [16]. Cluster-robust standard errors were used to adjust for clustering by hospital [17]. We identified conditions strongly associated with 6-month mortality (defined as variables with an odds ratio ≥ 2) and combined them with other patient characteristics to create high-risk subgroups [18]. We then used the model to generate the predicted probability of dying within 6 months of hospital admission for these subgroups to create novel palliative care triggers for use on ICU admission.

For all covariates, no covariate was missing for >1% of patients. Patients missing data for particular covariates were handled using listwise deletion in regression analyses. Model discrimination was assessed using the AUC, and overall model fit was assessed using the Brier score, as the Hosmer-Lemeshow goodness-of-fit test may perform poorly in large sample sizes [19,20]. Multi-collinearity between covariates was assessed using variance inflation factor and tolerance values [21].

1.3. Secondary analyses

As a secondary confirmatory analysis, we used a recursive partitioning model to identify combinations of patient characteristics predictive of 6-month mortality (see supplementary material for further details). Also, given that survivors of critical illness go on to have substantial morbidity and mortality [5-8,22], we created another model to derive novel triggers for use upon ICU discharge to determine if additional patient subgroups could be identified. For this model, we excluded patients who died during hospitalization or those who were discharged to hospice, and the outcome was dying within 6 months of discharge from the hospitalization requiring ICU care. We included all variables from the initial "admission" model, as well as variables related to the care delivered during hospitalization and discharge (for further details, see supplementary material). We then used the same methodology enumerated above to generate patient subgroups with a high predicted probability of dying within 6 months of hospital discharge. Database management and statistical analysis were performed using SAS 9.4 (SAS institute, Cary, NC), Stata 13.1 (StataCorp LP, College Station, Tex) and R version 3.3.1 (R Foundation for Statistical Computing, Vienna, Austria).

2. Results

2.1. Baseline characteristics of the cohort

The cohort consisted of 1,019,849 critically ill patients NY State from 2008 to 2013, of whom 195,847 (19.2%) died within 6 months of their admission which included receipt of care in an ICU. Patients who died within 6 months were older (73.0 vs 61.6 years), had a higher number of comorbidities (49.8% versus 29.5% for ≥4 comorbidities) and were more likely to be non-surgical (45.8% versus 30.8%). Patients who died within 6 months were also more likely to receive mechanical ventilation