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The Hospital-patient One-year Mortality Risk score accurately predicted long-term death risk in hospitalized patients

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Abstract

Objective: Prognostication is difficult in a diverse patient population or when outcomes depend on multiple factors. This study derived and internally validated a model to predict risk of death from any cause within 1 year of admission to hospital.

Study Design and Setting: The study included all adult Ontarians admitted to nonpsychiatric hospital services in 2011 (n = 640,022) and deterministically linked administrative data to identify 20 patient and admission factors. A split-sample approach was used to derive and internally validate the model.

Results: A total of 75,082 people (11.7%) died within 1 year of admission to hospital. The final model included one dozen patient factors (age, sex, living status, comorbidities, home oxygen status, and number of emergency room visits and hospital admissions by ambulance in previous year) and hospitalization factors (admission service and urgency, admission to intensive care unit, whether current hospitalization was a readmission, and admission diagnostic risk score). The model in the validation cohort was highly discriminative (c-statistic 92.3), well calibrated, and used to create the Hospital-patient One-year Mortality Risk score that accurately predicted 1-year risk of death.

Conclusion: Routinely collected administrative data can be used to accurately predict 1-year death risk in adults admitted to nonpsychiatric hospital services.

Keywords: Risk model; Multivariable logistic regression; Risk score; Hospitalization; Discrimination; Calibration; Mortality; Administrative data; Risk index; Survival

1. Introduction

Given the multiple frequently correlated factors that influence mortality risk, it is not surprising that physicians find it difficult to estimate survival likelihood in particular patients. The correlation between clinician estimates and actual patient survival is low in cancer patients [1] in whom clinician survival predictions are usually optimistic [2–5] and inaccurate (despite highly accurate predictions of disease cure likelihood) [6]. Inaccurate physician prognostications have also been found in patients with congestive heart failure [7] and those admitted to the intensive care unit [8].

While physicians find it difficult to prognosticate in patients with a specific disease, one would expect it multiply difficult to do so in a diverse group of patients with an assortment of diseases. One such group is patients admitted to hospital, in which accurate estimation of mortality risk could serve three purposes. First, knowing the approximate probability of death within a year would allow patients and their physicians to make more informed decisions about their health care during the hospitalization and afterward. This could be especially relevant when deliberating interventions with no immediate influence on patient prognosis or symptoms. For example, patients with a high risk of death in the near future may choose to defer preventive treatments, screening interventions, or interventional procedures for presently asymptomatic conditions. Second, an accurate 1-year mortality risk assessment—especially if that risk is high—could motivate and inform discussions between patients and physicians regarding goals of care. Finally, an accurate model for 1-year mortality in admitted patients would provide an outcome by which health care performance could be compared between communities or hospitals.

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What is new?

Key finding

- The risk of death within 1 year of admission to hospital can be accurately estimated by a risk index (the Hospital-patient One-year Mortality Risk score) that quantifies the influence of a dozen patient and hospital factors to long-term survival.

What this adds to what was known?

- This finding shows that long-term mortality risk can be estimated in a diverse group of patients admitted to a hospital.

What is the implication and what should change now?

- The risk of death in 1 year for patients admitted to hospital can be estimated by determining the value of 12 factors.

At present, all options available for predicting death risk in patients admitted to hospital have limitations. Several studies have created multivariable models to predict risk of death *in hospital* in a broad assortment of patient populations [9−11]. Death in hospital is an important outcome, but variation in patient health status at hospital discharge—over time and between institutions—could make it a less reliable health indicator than longer term survival (which would be less sensitive to discharge thresholds). Population-based life tables provide extremely accurate 1-year survival estimates based on patient age and sex (and, in some countries, race) but do not account for patient severity of illness. Austin et al. derived and internally validated a model that used administrative data to predict 1-year survival in all—not just hospitalized—patients [12,13]. This model required the Johns Hopkins Adjusted Diagnosis Groups algorithm [14], which makes the model rather opaque (because we cannot know precisely how claims data get translated into Diagnosis Groups) and prohibits its use in real life. Long-term survival models have also been developed for patients with specific diseases such as congestive heart failure [15], acute myocardial infarction [16], and spinal cord injury [17].

In summary, no risk model is currently available to predict long-term survival in patients admitted to hospital. This study derived and internally validated such a model using administrative data.

2. Methods

This study used population-based health administrative databases in Ontario, Canada, in which the costs for all hospital and physician services are covered by a universal health care system. Databases used in this study included Discharge Abstract Database (DAD) that captures all hospitalizations; Registered Persons Database (RPD) that captures each person's date of death including those that occur out of province; Assistive Devices Program (ADP) that captures all patients on home oxygen; Continuing Care Reporting System (CCRS) that captures all registered nursing home and chronic hospital residents; Canadian Organ Replacement Register (CORR) that captures all patients on chronic hemodialysis; Same-Day Surgery (SDS) database that captures all encounters for surgical interventions in which patients are discharged from the institution on the same day as their intervention; Home Care Database (HCD) that captures all publicly funded in-home assistance; and the National Ambulatory Care Registry System (NACRS) that captures all visits to any emergency department (ED). All databases were linked deterministically via encrypted health care numbers. Details of the contribution of each database to the study are provided in Appendix A (see at www.jclinepi.com).

2.1. Study cohort

This study included all adult Ontarians with valid health card numbers who admitted to any acute-care hospital in Ontario between January 1 and December 31, 2011. This period was chosen because it was the latest calendar year for which data were complete for all people. Admissions to chronic hospitals or rehabilitation centers were not included. For people with more than one admission in 2011, one admission was randomly chosen to ensure that the study's unit of analysis was the person. Other admissions excluded from the study included those to psychiatric facilities (which are captured in a different database) and those for children aged <18 years of age (in whom the risk of death within 1 year is very low).

2.2. Study outcome

The outcome of the study was all-cause mortality within 1 year *of admission to hospital*. Outcome status was determined by linking to RPD.

2.3. Study covariates

The objective if the study was the prediction of mortality risk within 1 year of admission to hospital. Therefore, only variables whose value could be determined when a person was admitted to hospital, as well as those that were both clinically measurable and with a valid potential influence on patient survival, were considered for the study (see Appendix A at www.jclinepi.com). Patient age and sex were taken from DAD. DAD also provided the urgency of the index admission, admitting service, and whether the patient was admitted directly to the intensive care unit. All DAD encounters in the year before the patient's admission were used