A risk stratification tool predicted in-hospital mortality in acute decompensated heart failure

Clinical impact ratings: Hospitalists ★★★★★☆ Cardiology ★★★★★☆

QUESTION

In patients with acute decompensated heart failure (ADHF), does a user-friendly risk stratification tool predict in-hospital mortality?

METHODS

Design: 2 cohort studies, 1 for derivation and 1 for validation (Acute Decompensated Heart Failure National Registry [ADHERE]).

Setting: 263 centers in the United States.

Patients: Patients in the ADHERE registry were ≥ 18 years of age and had new-onset ADHF or decompensation of chronic HF with symptoms severe enough to require hospitalization. 33 046 hospitalizations (mean age 73 y, 52% women) from October 2001 to February 2003 formed the derivation cohort, and 32 229 hospitalizations (mean age 73 y, 51% women) from March to July 2003 formed the validation cohort.

Description of prediction guide: Classification and regression tree (CART) analysis was used to analyze 39 potential clinical variables of interest in the derivation cohort (demographics [5 variables], primary insurance, HF history [4 variables], medical history [17 variables], laboratory values [9 variables], and initial vital signs [3 variables]). Mortality was calculated for each terminal node in the CART and used to generate a risk stratification model. Patients in the validation cohort were classified into risk groups and compared with those in the derivation cohort.

Outcomes: In-hospital mortality.

MAIN RESULTS

Clinical outcomes were similar between the derivation and validation cohorts (in-hospital mortality [4.2% vs 4.0%], total hospital length of stay [5.9 vs 5.8 d], and intensive or coronary care unit length of stay [4.0 vs 3.7 d]). In the derivation cohort, the CART identified the single best predictor of in-hospital mortality as high blood urea nitrogen (BUN). Within the BUN node, the next best predictors were systolic blood pressure < 115 mm Hg and high serum creatinine. These nodes were used to stratify patients into high risk, 3 levels of intermediate risk, and low risk (Table). In both derivation and validation cohorts, the difference in mortality between risk groups was statistically significant for all groups except intermediate 2 and 3. Areas under the receiver-operating characteristic (ROC) curves for the derivation and validation cohorts were 68.7% and 66.8%, respectively.

CONCLUSION

In patients with acute decompensated heart failure, a user-friendly risk stratification tool predicted in-hospital mortality.

Source of funding: Scios Inc.

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Predictors of in-hospital mortality in acute decompensated heart failure*

Risk groups	Variables	Mortality	
		Derivation	Validation
High	BUN ≥ 15.35 mmol/L (≥ 43 mg/dL), SBP < 115 mm Hg, creatinine ≥ 243.1 µmol/L (≥ 2.75 mg/dL)	21.9%	19.8%
Intermediate 1	BUN ≥ 15.35 mmol/L, SBP < 115 mm Hg, creatinine < 243.1 µmol/L	12.4%	13.2%
Intermediate 2	BUN ≥ 15.35 mmol/L, SBP ≥ 115 mm Hg	6.4%	5.6%
Intermediate 3	BUN < 15.35 mmol/L, SBP < 115 mm Hg	5.5%	5.7%
Low	BUN < 15.35 mmol/L, SBP ≥ 115 mm Hg	2.1%	2.3%

*BUN = blood urea nitrogen; SBP = systolic blood pressure.

COMMENTARY

Using the large and unique ADHERE ADHF registry, Fonarow and colleagues developed a practical tool to stratify patients at risk for in-hospital death. Important questions about this analysis and its clinical application include: Is ADHERE a good dataset to use to develop this model? It is an excellent database to examine in-hospital mortality, although some limitations exist. An audit to verify that all eligible patients were included was not reported. Retrospective identification of patients based on diagnosis-related group discharge codes has limitations, especially in patients who die. Moreover, important factors were missing in many or most patients, including New York Heart Association class, cardiac markers, B-type natriuretic peptide (BNP), and ejection fraction. Ideally, a model intended for use at the time of admission should be developed in a prospectively identified population at admission.

Was the statistical approach appropriate? CART provides a model that is simple to understand and apply, but at a cost. Because it creates binary or categorical groupings of variables, information from continuous variables, such as age, may be diminished. The *c*-indices (area under the ROC curve) of 0.69 and 0.67 show that the classification is closer to random (*c*-index 0.50) than to perfect prediction (*c*-index 1.00). A *c*-index < 0.70 is generally considered to be of limited clinical value (1). The logistic regression model that included heart rate and age performed substantially better (*c*-index 0.76).

Do the factors in the model make clinical sense? This study reinforces the prognostic importance of renal insufficiency (BUN and creatinine elevation) and hemodynamic compromise (systolic hypotension) in HF. We can surmise from the logistic regression model that age is also important. Previous hospitalization and functional class were not evaluated. It is surprising that pulmonary edema and ejection fraction were not more important.

How can this and similar models be used in practice? This model will be of limited use in practice, but it is a step in the right direction. To be more useful, it needs better discriminatory ability, which might come from including BNP as well as heart rate and age as continuous variables. Models should also reflect the reality of changing clinical status, so that the early clinical course of the patient might provide information about subsequent risk. Models that accurately identify risk should facilitate more rational care for patients with acute HF.

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Reference
1. **Ohman EM, Granger CB, Harrington RA, Lee KL.** JAMA. 2000;284:876-8.