

Risk Stratification Model for 30-Day Heart Failure Readmission in a Multiethnic South East Asian Community



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There are limited accurate 30-day heart failure (HF) readmission risk scores using readily available clinical patient information on a well-defined HF cohort. We analyzed 1,475 admissions discharged from our hospital with a primary diagnosis of HF between 2010 and 2012. HF diagnostic criteria included satisfying clinical Framingham criteria, elevated serum N-terminal pro-natriuretic peptide, and evidence of cardiac dysfunction on transthoracic echocardiography. The patients were randomly divided into 2 groups; 60% were used as the derivation cohort and 40% as the validation cohort. Bivariate analysis and logistic regression were used to develop the model. Weighted risk scores were derived from the odds ratio of the logistic regression model. Total risk scores were computed by simple summation for each patient. The 7 significant independent predictors of 30-day HF readmission used to derive the risk scoring tool were the number of previous HF-related admission in the preceding 1 year, index admission length of stay, serum creatinine level, electrocardiograph QRS duration, serum N-terminal pro-natriuretic peptide level, number of Medical Social Service needs, and β blocker prescription on discharge. The area under the curve was 0.76. Sensitivity and specificity were 78.3% and 60.7%, respectively. The positive predictive value and negative predictive value were 18.9% and 96%, respectively. The actual observed and predicted 30-day heart failure readmission rates matched. In conclusion, we have developed the first 30-day HF readmission risk score, with good discriminatory ability, for an urban multiethnic Asian heart failure cohort with stringent diagnostic criteria. It consists of 7 easily obtained variables. © 2017 Elsevier Inc. All rights reserved. (Am J Cardiol 2017;119:1428–1432)

The lifetime risk for a patient of developing heart failure (HF) is 1 in 5 at the age of 40 years.¹ For the person and society, HF imposes a huge economic burden. The global cost to society is estimated at \$108 billion per annum and this is expected to increase.² One of the primary drivers of this cost is readmission for recurrent HF after a discharge for HF decompensation.³ There are multiple publications on HF readmission risk scores in Europe and North America,⁴ but there are no published reports on HF readmission risk scores in an Asian population. The aim of this study was to develop a validated risk score to predict short-term (30-day) HF readmission in patients discharged from hospital with decompensated HF, using readily available and accessible clinical patient information in our hospital.

Methods

This is a retrospective observational study of patients discharged from Changi General Hospital with a primary diagnosis of HF between January 1, 2010, and December 31, 2012. Changi General Hospital is a 1,000-bed acute care hospital in eastern Singapore. It has an established HF program incorporating a protocolized clinical management pathway to manage patients admitted to the cardiology department with a primary diagnosis of HF. This is an evidenced-based, multidisciplinary and multimodality program based on existing international guidelines and best practice recommendations on HF management.^{5–9} It emphasizes evidenced-based therapeutics, clinical stabilization, and secondary prevention.

Approval to conduct this study, with waiver of consent, was obtained from our center's centralized institutional review board.

All patients 21 years or older admitted to the department of cardiology with a principal discharge diagnosis of HF were included in this study. The decision of principal discharge diagnosis was made by the patient's attending cardiologist based on clinical grounds. Diagnosis of HF was reviewed independently and contemporaneously and agreed upon by both the attending cardiology team and the HF team. The diagnosis of HF was made if the patient satisfied the clinical Framingham criteria,¹⁰ had an elevated serum

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N-terminal pro-natriuretic peptide (NT-ProBNP) level more than the age-specific cut-off level,¹¹ and evidence of cardiac dysfunction on transthoracic echocardiography, be it systolic or diastolic dysfunction.⁸ Patients were excluded if they had end-stage renal disease (estimated glomerular filtration rate <15 ml/min/1.73 m² or were on dialysis treatment). Ethnicity was as stated in the patient's National Registration Identity Card (which is issued to all citizens and permanent or work permit residents residing in Singapore). Diagnoses of comorbidities were determined by the patient's attending cardiology team. Cases excluded from this analysis included elective admissions, death during the index admission, death without admission, discharged against doctor's advice or discharged to other health care facilities, and those not residing in Singapore for more than 1 year after discharge.

The primary outcome was HF hospitalization within 30 days (30-day HF readmission). Rehospitalization was determined by reviewing electronic medical records.

Events were captured through review of electronic and manual medical health records. Routine data collection was conducted using a uniform case report form for documentation of approximately 160 variables comprehensively recording administrative and clinical information. Data variables for capture were identified and selected with reference to the literature^{12–14} and the clinical experience of local cardiologists. Variables documented included demographics (age, gender, ethnic group), clinical information (number of preceding HF admissions in 6 months, 12 months; length of hospital stay; type of in-patient ward), clinical parameters (New York Heart Association class, Framingham criteria, systolic and diastolic blood pressure, weight, etiology of HF), echocardiography (ECG)-derived variables (left ventricular ejection fraction [LVEF]), ECG variables (presence of sinus rhythm, QRS duration, heart rate), commonly used blood investigations (serum urea, sodium, potassium, creatinine, albumin, troponin-T, NT-ProBNP, hemoglobin), and psychosocial parameters such as the number of medical social service needs and medications upon discharge. Medical social service needs (reasons for referral) included assistance in psychological, parasuicide, family violence, postdischarge care, adjustment to illness, employment, accommodation, financial, and family or interpersonal relationships issues.

The eligible cohort of patients was randomly divided into 2 groups; 60% were used as the derivation cohort and the remaining 40% were used as the validation cohort. Continuous variables were expressed as a mean (SD) or as a median (interquartile range).

Bivariate analysis and logistic regression were used to develop the model. Weighted risk scores were derived from the odds ratio of the logistic regression model. Total risk scores were computed by simple summation for each patient. Discriminatory powers of the models were evaluated using the following measures: sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and area under the curve (AUC).

Using the derivation cohort, the 3 risk levels were used to establish a risk scoring system by dividing patients' risk scores into 3 categories correspondingly using a regression model.

Readmission risk was stratified into low risk (<10%), medium risk (10% to 30%), and high risk (>30%) based on the arbitrary selected readmission risk levels.¹⁵

The discriminatory power and predictive ability of the readmission risk levels were evaluated using the sensitivity, specificity, PPV, NPV, and AUC, and the adjacent levels of the risk scoring system were compared using a chi-square test. The risk scoring tool was assessed in a validation cohort. Given the good agreement between the derivation and validation cohorts, the final risk scoring tool was developed by pooling the 2 together to derive averaged sensitivity, specificity, PPV, NPV, and AUC. The final 7-variable risk scoring tool was derived using the entire cohort.

p Value <0.05 was accepted as statistically significant. Statistical Packages for Social Sciences (SPSS) v19 was used for data analysis.

Results

A total of 1,475 admissions (by 1,098 unique patients) from 2010 to 2012 were included in this analysis. For the entire cohort, the mean (SD) age was 69.4 (13.1) years, with 63.8% being ≥65 years old. Men constituted 58.4% of the cohort. Ethnic Chinese, Malays, and Indians constituted 54.6%, 30.1%, and 8.1% of the cohort, respectively. Mean (SD) LVEF was 35.2% (17.4), with 28.5% of patients with heart failure with preserved ejection fraction (HFPEF) (LVEF ≥50%) and 40.5% of patients with severely impaired systolic function (LVEF <30%). Mean (SD) serum creatinine was 134.3 (70.3) μmol/L, with 41.8% having serum creatinine >125 μmol/L. Mean (SD) serum NT-ProBNP was 6,192 (7,163) pg/ml.

This group was divided into a derivation cohort (n = 888) and a validation cohort (n = 587). The derivation cohort and validation cohort had similar characteristics.

The 30-day all-cause mortality rate was 1.5%. The 30-day HF readmission rate was 9.9%.

The characteristics of those readmitted (n = 146) and those not readmitted (n = 1,329) for recurrent decompensated HF within 30 days of discharge from the index HF admission are presented in Table 1. The proportions of patients who (1) required medical social services, (2) had a history of cerebrovascular disease, and (3) had a history of diabetes mellitus were significantly higher in those who were readmitted compared with those who were not. The mean number of HF admissions in the preceding 1 year and the mean length of stay of index admission were also significantly higher in those readmitted. The mean LVEF in those who were readmitted compared with those who were not readmitted was not significantly lower. The proportion of patients with heart failure with preserved ejection fraction was similar in those readmitted and those not readmitted (29.9% vs 28.3%, respectively, p = 0.7). Mean serum urea, creatinine, troponin T, and NT-ProBNP levels were significantly higher in those who were readmitted compared with those who were not. The proportions prescribed angiotensin converting enzyme inhibitor/angiotensin receptor blocker and β blockers were significantly lower in those readmitted compared with those who were not (63.7% vs 75.3%, p <0.01 and 78.1% vs 85.0%, p = 0.04, respectively).

On multivariable logistic regression analysis, significant independent predictors of 30-day HF readmission were

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