

Construction and Validation of an Automated Model for the Early Identification of Patients Hospitalized for Heart Failure

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Abstract.

In order to institute early hospital-wide interventions, we constructed a reliable automated model for identifying newly admitted patients with congestive heart failure using electronically captured administrative and clinical data.

Background.

Congestive heart failure (CHF) is a syndrome that incurs significant morbidity and mortality, with one-year mortality rates of 8-13%, and 3-month hospital readmission rates as high as 37% [1]. Optimal inpatient management strategies for CHF patients involve multiple medications, though high underutilization rates of several first-line therapies have been reported. These characteristics make CHF an ideal candidate for automated intervention, but lack of a method for the timely identification of patients admitted for CHF has limited the ability to institute interventions early in the hospitalization. The objective of this study was to construct a reliable method of detecting current CHF admissions using electronically stored data, including medications, laboratory values, and clinical from prior admissions.

Methods.

The study sample was comprised of all unique admissions to Barnes-Jewish Hospital for all patients over 18 years of age between January & June of 2003. The outcome, ICD-9 codes consistent with a diagnosis of CHF, were obtained for each admission. For each admission, demographic, administrative, medication, and laboratory data were collected and compiled. Using forward block-entry, a multivariate logistic regression model predicting a diagnosis of CHF was constructed, using demographic, administrative, and clinical variables. For each patient, the regression score was reconstituted, and subjected to receiver-operator characteristic (ROC) curve analysis. The model was validated using a similar independent sample comprised of unique admissions between July and December of 2003.

Results.

The study sample consisted of 18,596 unique

admissions, of which 2,076 were for CHF (11.2%). Prior admission for CHF was documented in 1,610 (8.6%) of the subjects. 56.8% of the sample was female, and median age was 54 years.

The best-fit model (Table 1) included 26 predictors, an interaction variable, and an intercept. Using ROC curve analysis, the area under the curve of the initial sample was 0.934. The C-statistic from the confirmatory sample was calculated as 0.937.

	Variable	OR	p-value
Demographics	Age (years)	1.034	<0.001
	Prior Admission to BJH For HF	5.437	<0.001
	Any prior admission	0.546	<0.001
	Total HF ICD-9 on record	1.109	<0.001
	Total ICD-9 on record	0.994	<0.001
	Ratio of HF ICD-9 / total ICD-9	7.486	0.008
Diuretics	Furosemide (intravenous)	5.801	<0.001
	Furosemide (oral)	2.687	<0.001
	Torsemide	1.034	0.001
ACE-I	Lisinopril	1.656	<0.001
	Enalapril	1.964	<0.001
	Ramipril	1.852	0.001
	Captopril	4.047	<0.001
ARB	Any ARB	1.47	0.001
Nitrates	Any Nitrate	1.703	<0.001
Beta blockers	Carvedilol	4.81	<0.001
	Metoprolol	1.369	<0.001
Other	Nesiritide	6.924	<0.001
	Digoxin	2.461	<0.001
	Dobutamine	2.705	<0.001
Labs, Current adm.	Digoxin level, ordered	2.571	<0.001
	BNP, ordered	3.507	<0.001
	Na < 130	1.841	<0.001
	Creatinine > 1.8	1.812	<0.001
Labs, Past adm.	BNP, ordered in past adm.	1.791	<0.001
	BNP > 800	1.625	0.002
	Troponin > 1.2	1.247	0.021

Table 1. Best-fit regression model

Conclusion.

For automated CHF interventions to be initiated, it is critical that eligible patients be identified early and reliably. A validated regression model using data that is readily available, such as the one described here, may serve this important function.

References.

[1] Vinson JM, Rich MW, Shah AS, et al. Early readmission of elderly patients with congestive heart failure. *Circulation* 2000; 102: 1126 – 1131.