Prediction of Hospital Readmission

for Heart Failure: Development of a

Simple Risk Score Based on Administrative Data

The purpose of this study was to develop a convenient and inexpensive method for identifying

an individual's risk for hospital readmission for congestive heart failure (CHF) using

information derived exclusively from administrative data sources and available at the time of

an index hospital discharge.

Rates of readmission are high after hospitalization for CHF. The signi®cant determinants of

rehospitalization are debated.

METHOD:

Administrative information on all 1995 hospital discharges in New York State which were

assigned International Classi®cation of Diseases±9 ±Clinical Modi®cation codes indicative of

CHF in the principal diagnosis position were obtained. The following were compared among

hospital survivors who did and did not experience readmission: demographics, comorbid

illness, hospital type and location, processes of care, length of stay and hospital charges.

Using multiple regression methods, a simple methodology was devised that segregated patients into low, intermediate and high risk for readmission.

CONCLUSION:

Patient characteristics, hospital features, processes of care and clinical outcomes may be used

to estimate the risk of hospital readmission for CHF. However, some of the variation in

rehospitalization risk remains unexplained and may be the result of discretionary behavior by

physicians and patients.

Table 1. Demographic Features and Comorbid Illnesses of

42,731 Patients Readmitted or Not Readmitted for Congestive

Heart Failure\*

Table 2. Processes of Care During the Index Hospital

Admission for 42,731 Patients Readmitted or Not Readmitted

for Congestive Heart Failure\*

Table 4. Calculation of Simple Risk Score for Readmission

Some definition may be useful for the project

Hospital length of stay was defined as the date of discharge or death minus the date of admission.

Coexistent illnesses were determined by searching the principal ICD-9-CM diagnosis code and up to 14 secondary diagnosis codes for each patient.

Total comorbid disease was quanti®ed according to the method of Charlson. To

achieve this, a Charlson Comorbidity Index (17), and its age-modi®ed variant (18), were calculated for each patient.

Process of care was determined by searching the principal procedure code and up to 14 secondary procedure codes for each patient. In some cases, similar procedures with closely

related codes were combined to yield clinically relevant composite rates of technical services.

**Statistical analyses.** Differences between patients readmitted

and those not readmitted were analyzed using chisquare

tables (categorical data) and Student unpaired *t* test

(interval data). To provide the opportunity to both develop

risk scores and test their validity within a single data set, all

patients were randomly assigned to either a derivation

subset or a validation subset. Among patients in the derivation

subset only, SAS's *PROC LOGISTIC* (19) was used

to determine which of the patient characteristics, hospital

features, processes of care and clinical outcomes had independent

predictive value for hospital readmission. All predictors

with a signi®cant or borderline statistical relationship

with rehospitalization at the univariate level (p # 0.10)

were entered as independent variables in a logistic regression

model for readmission. This technique yielded odds ratios

and con®dence intervals for readmission for every predictor

variable tested in the model. After identifying those variables

with signi®cant independent predictive value (p #

0.05 in the logistic regression model), two risk scoring

systems based on these variables were derived. The simple

risk score was computed by adding the number of positive

predictors for readmission present for each patient, then

subtracting the number of negative predictors present. The

modi®ed risk score assigned weights to each positive and

negative predictor based on the odds ratio for that variable

derived from the logistic regression model. The precision of

the single best prediction method developed using data from

the derivation subset only was then tested among patients in

the validation subset only by entering each patient's risk

score as the independent variable in a logistic regression

model for readmission. In interpreting results, a p value #

0.05 was considered statistically signi®cant. In this report,

results are displayed as mean 6 standard deviation.

1