

Prospective evaluation of patients readmitted after cardiac surgery: Analysis of outcomes and identification of risk factors

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Objective: Reducing hospital readmissions after adult cardiac surgery is necessary as part of the solution to achieving improved efficiency in health care. Patients who had undergone cardiac surgery were studied to develop strategies that may diminish the need for hospital readmission.

Methods: Over a 25-month period, 2096 patients underwent cardiac surgical procedures; 102 of these patients required readmission within 30 days of discharge. Time-matched patients (n = 249), not readmitted, served as a control group. Patient demographics and perioperative variables were analyzed by univariate analyses. Logistic regression analysis identified independent risk factors for readmission.

Results: The most common diagnoses given for readmission were congestive heart failure (26 of 102, 25%), infection (23 of 102, 23%), and arrhythmias (15 of 102, 15%). The comorbidities more prevalent among readmitted patients were diminished ejection fraction (44% ± 17% vs 56% ± 13%; $P < .0001$), chronic obstructive pulmonary disease (23 of 102, 23% vs 23 of 249, 9%; $P = .0008$) and chronic renal insufficiency (26 of 102, 26% vs 24 of 249, 10%; $P = .0001$). Multivariate logistic regression identified chronic obstructive pulmonary disease (odds ratio [OR], 2.0; $P = .05$), diminished ejection fraction (OR, 0.8; $P < .0001$), a lower education level (OR, 0.5; $P = .0001$), and a prolonged length of stay (OR, 1.6; $P = .009$) as predictive of readmission. Failure to see a physician early in the postoperative period was associated with a 6-fold increase in the risk of readmission ($P < .0001$).

Conclusions: Patients readmitted after cardiac surgery have specific comorbidities and are of lower socioeconomic status. They are admitted most commonly for exacerbation of congestive heart failure or infectious reasons. This study suggests that seeing a physician early after discharge may have an impact on reducing readmissions after cardiac surgery. (*J Thorac Cardiovasc Surg* 2014;147:1013-20)

Reducing hospital readmissions has been targeted by Medicare as a top strategic priority in an effort to improve patient care and decrease health dollar expenditures.¹ The rate of unplanned rehospitalizations within 30 days of discharge among US Medicare patients has been estimated to be approximately 20% with associated costs of greater than \$12 billion per year.² Although the legitimacy of hospital readmissions as a suitable marker for the quality of care provided by hospitals remains controversial, the recent passage of the Patient Protection and Affordable Care Act, which links hospital reimbursement to quality metrics such as the 30-day readmission rate, has placed

reducing readmissions at the forefront of most hospital administrations.³

Initial efforts to reduce readmissions have targeted common medical conditions such as congestive heart failure (CHF), pneumonia, and acute myocardial infarction, but substantial interest has also developed in using a hospital's 30-day readmission rate as a metric for quality performance among patients undergoing surgical procedures.⁴⁻⁷ Cardiac surgery is likely to receive considerable attention because of the cost associated with its procedures and the high-risk patient population.⁸ However, less data are available regarding readmission after cardiac surgery and few reports use prospective data to address this issue. The purpose of this study was to prospectively identify risk factors for readmission for patients undergoing cardiac surgery.

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Disclosures: Authors have nothing to disclose with regard to commercial support.

Read at the 93rd Annual Meeting of The American Association for Thoracic Surgery, Minneapolis, Minnesota, May 4-8, 2013.

Received for publication May 6, 2013; revisions received Oct 13, 2013; accepted for publication Oct 26, 2013; available ahead of print Dec 23, 2013.

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0022-5223/\$36.00

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<http://dx.doi.org/10.1016/j.jtcvs.2013.10.066>

METHODS

Between April 2011 and March 2013, 2096 patients underwent cardiac surgical procedures at a single tertiary care institution. The study group included patients who were readmitted to the hospital within 30 days of a cardiac procedure (n = 102). Readmitted patients were identified as follows:

1. Using automated billing software that identified any patient admission to Barnes Jewish Hospital (BJH) within 30 days of a previous admission during which a cardiac surgical procedure was performed (n = 70).

Abbreviations and Acronyms

CHF	= congestive heart failure
COPD	= chronic obstructive pulmonary disease
EF	= ejection fraction
LVAD	= left ventricular assist device
STS	= Society of Thoracic Surgeons

- During routine outpatient follow-up when patients were queried on having been readmitted to an outside institution within 30 days of discharge (n = 18).
- As part of a random phone survey of 100 patients, conducted after discharge, when patients were queried directly about any postoperative admission after discharge (n = 14).

No differences in baseline demographics were identified among readmitted patients identified by phone versus other methods (data not shown). The medical charts of all readmitted patients were prospectively reviewed by a cardiac surgeon (H.S.M.) and the primary reason for readmission was determined. Readmission diagnoses were grouped into 6 discrete categories: infectious, acute CHF, chronic CHF, arrhythmia, bleeding complication, and other.

The discharge process for patients on the cardiac surgical service during the study period was directed by a multidisciplinary team that included social workers, case managers, physical therapists, and nursing staff. Suitability for discharge was determined daily and patients were either deemed suitable for home discharge (with or without ancillary services) or to an extended care facility. Standards for discharge readiness were not different based on discharge location. Typically, patients were seen between 3 and 4 weeks after the date of discharge regardless of discharge location.

A control group of patients who were not readmitted was identified by randomly visiting all surgeons' office hours during the study period and identifying patients not readmitted within 30 days of discharge (n = 163). No attempt was made to match control patients to study group patients. Patients also identified by the 100-patient random phone survey as not having been readmitted were included as part of the control group (n = 86). Perioperative data for both groups were extracted from the Society of Thoracic Surgeons (STS) database and a patient questionnaire was prospectively administered to all patients with regard to non-STS variables (socioeconomic, medical compliance, physician providers) at either the time of readmission (for the readmitted group) or at the time of routine outpatient follow-up (control group).

The study was approved by the Washington University Human Research Protection Office and all patients provided informed consent for participation.

Statistical Methods

Comparisons were performed between patients who were readmitted (n = 102) and patients who were not readmitted (n = 249). The analyses of continuous variables were performed using *t* tests except for cases where required conditions were not satisfied (and for ordinal variables); a Wilcoxon test was used as a nonparametric alternative. In general, between groups comparisons of categorical variables were analyzed by χ^2 testing unless precluded by sample size, in which case a Fisher exact test was used. Statistically significant variables by univariate analysis ($P < .05$) were considered for inclusion in stepwise multivariable logistic regression models predicting readmittance. The stepwise method selected variables for inclusion or exclusion from the model in a sequential manner based on the significance level of .10 for entry and .15 for removal. In cases of high intercorrelations of 0.70 or higher among some variables (ie, education and income levels), only a single measure was included. Adjusted odds ratios and associated 95% confidence intervals are reported for

variables in the multivariable model, adjusted for all variables in the model. Two separate multivariate models were created to assess preoperative and perioperative characteristics associated with 30-day readmission. Data analysis was generated using SAS software, version 9.3 of the SAS System for Linux (SAS Institute Inc, Cary, NC).

RESULTS

The readmission rate approximated by the random phone survey was 14%. Of all patients readmitted, 23% (n = 23) were readmitted to an institution other than BJH. The most common readmission diagnoses were acute CHF (n = 12), chronic CHF (n = 14), surgical site infection (n = 11), other infection (n = 12), arrhythmia (n = 15), and bleeding complications (n = 11). Seventy percent of all readmissions (n = 71) occurred between days 0 and 15 after discharge (Figure 1). The median duration of a readmission hospitalization was 6 days (1-49 days), and 49% (n = 50) of patients required a procedure during the readmission; the most common being chest tube insertion or thoracentesis (n = 15), cardioversion or permanent pacemaker placement (n = 9), or wound debridement (n = 7). Three percent of patients (n = 3) died during the readmission.

Univariate analysis identified the comorbidities of chronic obstructive pulmonary disease (COPD), chronic renal insufficiency, New York Heart Association class III or IV, peripheral vascular disease, and a lower ejection fraction (EF) as more prevalent among patients requiring readmission after surgery (Table 1). Similarly, readmitted patients reported lower annual incomes, were less likely to have more than high school education, or have established cardiology care preoperatively (87% vs 94%; $P = .03$) (Table 1).

Perioperative data (Table 2) demonstrated that readmitted patients were more likely to have undergone either cardiac transplantation (n = 2) or insertion of a left ventricular assist device (LVAD; n = 16), had a longer index hospital length of stay, and spent a greater number of hours being ventilated in the intensive care unit. No other differences were identified among the postoperative complications listed. Readmitted patients were more often discharged to a location other than home, more often prescribed warfarin but less likely to take their medications as prescribed (Table 3). In contrast, patients who were not readmitted were significantly more likely to have seen a physician early after discharge from the hospital compared with the study group.

The logistic regression models for preoperative and perioperative variables are shown in Table 4. By multivariate analysis, the presence of moderate or severe COPD or diminished EF were predictive of readmission. Similarly, a higher education or presence of an established cardiologist preoperatively remained protective of subsequent readmission. Perioperatively, the presence of a longer hospital length of stay or having been discharged to a location

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