Obstacles to Early Discharge After Cardiac Surgery

Nancy J. Nickerson, RN, BSN; Suzan F. Murphy, RN, BSN; Víctor G. Dávila-Román, MD; Kenneth B. Schechtman, PhD; and Nicholas T. Kouchoukos, MD

Abstract

Context: Cardiovascular disease and cardiac surgery, in particular, are associated with a large expenditure of healthcare resources. Identifying the factors that affect length of stay for patients hospitalized for cardiac surgery and ways to safely and effectively shorten stays could have significant impact on healthcare costs.

Objective: To identify obstacles to and the effects of early discharge on outcome after cardiac surgery.

Study Design: A prospective approach using a protocol consisting of modifying anesthesia, limiting the use of postoperative narcotics, early extubation, and early mobilization, with a goal of discharge at < 5 days.

Patients and Methods: The study group consisted of 422 consecutive patients (age range 15-89 years, 65% males): coronary artery bypass graft (CABG) (n = 290), valve procedures (n = 54), and CABG + valve procedures (n = 78). The discharge criteria included hemodynamic stability, normal bowel function, independence in activities of daily living, absence of fever, and no incision problems.

Results: Predictors of prolonged postoperative stay were prolonged intensive care unit stay (P < 0.0001), postoperative atrial fibrillation (P = 0.0006), preoperative congestive heart failure (P = 0.002), combined CABG and valve procedure (P = 0.005), prolonged ventilator support (P = 0.01), increasing age (P = 0.012), history of peripheral vascular disease (P = 0.02), and female gender (P = 0.025). The 30-day readmission rate for the early discharge group was 7.8% vs 16.2% for the late discharge group (P = 0.01). The mortality rate for the entire group was 3.3%.

Conclusion: We have identified several obstacles to early discharge after cardiac surgery. Future efforts can be directed toward minimizing their impact on postoperative length of stay.

(Am J Managed Care 1999;5:29-34)

Cardiovascular disease is the leading cause of morbidity and mortality and expenditure of healthcare resources in the United States. The number of patients undergoing cardiac surgery exceeds 600,000 per year, and cardiac surgical care is associated with an annual cost exceeding $5 billion.[1] Escalating medical costs and widespread application of managed care have been an impetus for improvement in efficiency throughout the healthcare delivery system. Thus, identification of strategies that decrease the cost associated with cardiac surgery while maintaining or improving the quality of care is important.

"Fast track" protocols that include early extubation, change in anesthesia management, and early ambulation are associated with a shorter intensive care unit (ICU) stay and postoperative length of stay (LOS), with an implied cost savings.[2-5] Earlier published studies indicate early extubation is safe and advantageous in the majority of cardiac surgery patients.[2] No significant increases in the early readmission or mortality rates have been reported with these changes.[3,5-7]

The purpose of our study was to identify the clinical predictors that have a negative effect on early discharge after cardiac surgery. In addition, we sought to determine whether an early discharge program is associated with a reduction in ICU stay and postoperative LOS, while maintaining quality of care.

··· METHODS ···

Patient Selection

From October 1994 through July 1995, we enrolled 422 consecutive patients, mean age of 65 ± 12 years (range 15-89) and predominately male (65%), in the early discharge program.

Coronary artery bypass graft (CABG) surgery was performed in 290 patients (69%), isolated valve surgery in 54 patients (19%), and combined CABG and valve procedures in 78 patients (13%). The exclusion criteria were emergent surgery, cardiogenic shock, or hospital mortality.

The baseline characteristics and perioperative data elements were obtained by concurrent chart audit,

Table 1. Univariate Associations With ICU and Postoperative LOS

Continuous variables	LOS in ICU Correlation Coefficient	P	Postoperative LOS Correlation Coefficient	P
Days in ICU			0.641	< 0.0001
Age	0.179	0.0002	0.250	< 0.0001
Ventilator hours	0.587	< 0.0001	0.466	< 0.0001
Left ventricular function	0.151	0.002	0.149	0.002

Categorical variables	(n)	LOS in ICU Mean ± SD	P	Postoperative LOS Mean ± SD	P
Gender	Male (274)	2.27 ± 2.4	< 0.0001	7.47 ± 6.4	< 0.0001
	Female (148)	3.29 ± 3.7		9.66 ± 7.3	
Race	Black (45)	2.98 ± 2.6	0.169	8.84 ± 5.3	0.145
	Other (377)	2.59 ± 3.0		8.17 ± 7.0	
Morbid obesity	Yes (69)	3.14 ± 4.1	0.099	8.36 ± 5.5	0.850
	No (353)	2.53 ± 2.7		8.22 ± 7.0	
Diabetes	Yes (115)	3.21 ± 4.2	0.086	8.85 ± 6.5	0.068
	No (307)	2.41 ± 2.3		8.01 ± 6.9	
History of hypertension	Yes (273)	2.86 ± 3.4	0.025	8.49 ± 6.8	0.118
	No (149)	2.20 ± 1.9		7.78 ± 6.8	
Previous stroke	Yes (19)	1.89 ± 0.94	0.176	6.21 ± 1.5	0.849
	No (403)	2.66 ± 3.03		8.34 ± 6.9	
Chronic obstructive pulmonary disease	Yes (44)	3.16 ± 2.7	0.043	8.86 ± 4.3	0.097
	No (377)	2.57 ± 3.0		8.18 ± 7.0	
Peripheral vascular disease	Yes (57)	3.75 ± 4.3	0.009	11.7 ± 12.1	0.001
	No (365)	2.45 ± 2.7		7.70 ± 5.3	
Preoperative congestive heart failure	Yes (191)	3.25 ± 3.5	< 0.0001	10.1 ± 9.0	< 0.0001
	No (231)	2.12 ± 2.3		6.7 ± 3.5	
Procedure	CABG (290)	2.32 ± 2.3	< 0.0001	7.17 ± 4.7	< 0.0001
	Valve (54)	2.06 ± 1.6		7.98 ± 3.5	
	CABG + valve (78)	4.18 ± 4.9		12.4 ± 11.7	
Return surgery for bleeding	Yes (11)	4.00 ± 3.3		10.9 ± 6.3	
	No (411)	2.59 ± 3.0	0.019	8.17 ± 7.0	0.052
Postoperative atrial fibrillation	Yes (110)	3.70 ± 4.0		10.5 ± 8.5	
	No (312)	2.25 ± 2.4	0.0008[1]	7.46 ± 5.9	<0.0001
Perioperative myocardial infarction	Yes (4)	6.25 ± 3.4	0.010[2]	10.5 ± 2.4	0.033
	No (418)	2.59 ± 2.9		8.22 ± 6.8	
Previous cardiac surgery	Yes (55)	2.95 ± 4.0		8.27 ± 4.6	
	No (367)	2.58 ± 2.8	0.772	8.24 ± 7.1	0.493

ICU = intensive care unit; LOS = length of stay.

using the Society of Thoracic Surgeon definitions and guidelines (Table 1). Left ventricular function was quantified according to the classification of the Coronary Artery Surgery Study.[8]

Patient Management

Intraoperative anesthesia was modified by using short-acting anesthetics, including propofol, and by minimizing or avoiding the use of narcotics. No other intraoperative techniques were altered.

A short-acting anesthetic infusion (propofol) was continued postoperatively until the weaning procedure was initiated. An indomethacin suppository, for pain control, was given prior to discontinuing the propofol and then the weaning process began. Narcotic sedation was avoided or minimized to allow for early extubation. Patients were targeted for extubation within 6 to 10 hours postoperatively, exclusive of vasoactive and inotropic drug use, or intra-aortic balloon pump support.

An activity regimen was initiated after extubation. The patient was assisted to the sitting position on the side of the bed and up in a chair within 24 hours after surgery. Ambulation was gradually advanced to 4 times a day.

With minimal narcotic use, nausea and other gastrointestinal discomforts were diminished, enabling the start of a clear liquid diet in the immediate post-extubation period.

Discharge Protocol and Outpatient Follow-up

The established discharge criteria were stable hemodynamics, afebrile for the past 24 hours, no incision problems, independence in the activities of daily living, oral food intake, and normal bowel function.

Education on activity, diet, and how to identify possible incision problems, including written information, was given throughout the postoperative course and re-emphasized to the patient and family members at discharge. Phase I cardiac rehabilitation was started during the hospital stay. When appropriate, home care nursing was arranged with the initial visit scheduled for the first day after discharge.

Open lines of communication between the patient and hospital were established promptly after discharge. The nurse clinician called within 24 to 48 hours after discharge to provide additional education and to screen for any potential problems. If a problem was identified by the patient, family member, or the home care nurse, the nurse clinician gave instructions to contact the surgeon's office and arrangements were made for the patient to be seen expeditiously. The referring cardiologist and internist were informed of the patient's progress via telephone, fax, and mail.

The surgeon saw the patient for follow-up 4 to 6 weeks after surgery.

Statistical Methods

The data elements (Table 1) were analyzed using SAS version 6.11 (SAS, Cary, NC). The results are expressed as mean ± standard deviation, and standard errors for regression analyses were reported when appropriate. Student's t test or Wilcoxon's test were used in comparing two means. Chi-square tests were used in comparing proportions. The log of postoperative and ICU length of stay was used in the analyses because both variables were more normally distributed after logarithmic transformation. Analyses of covariance were used to produce significant predictors for both the logarithm of the number of days in the ICU and the logarithm of the number of postoperative days. These analyses produced a model of the form $\text{Log}(\text{LOS}) = {}_0 + {}_1X_1 + {}_2X_2 + {}_3X_3 + ...$ Using this model, the predicted increase in LOS associated with a predictor X_i is found by exponentiating and is given by $\exp(_i)$. Ninety-five percent confidence bounds on the expected increase in the number of postoperative days were then computed as $\exp[_i + 1.96\text{SE}(_i)]$.

In all analyses, age was evaluated in decades. Consequently, the associated expected increase in LOS or the associated odds ratio reflects the added number of postoperative or ICU days that result from a 10-year increase in age. Similarly, the left ventricular function score was evaluated using five incremental units. Because the effect of the surgical procedure on length of stay was similar for isolated CABG and isolated valve surgery, these two surgical procedures were combined in the multivariate analyses and the variable was treated, dichotomously, as isolated CABG or valve procedure vs the combined CABG + valve procedure.

··· RESULTS ···

Effects on Stay

By univariate analysis, gender, history of congestive heart failure, combined CABG and valve procedure, number of hours on the ventilator, age, postoperative atrial fibrillation, left ventricular function, peripheral vascular disease, and perioperative myocardial infarction were significant predictors of increased ICU stay ($P < 0.01$). These variables, with the addition of ICU stay, were also predictive of increased postoperative LOS (Table 1).

The significant independent predictors of increased postoperative LOS are prolonged ICU stay, postoperative atrial fibrillation, combined CABG and valve procedure, preoperative congestive heart failure, history of peripheral vascular disease, female gender,

increasing age, and prolonged ventilator support (Table 2). Each decade of age increased the postoperative LOS by 3.67%. The mean postoperative LOS was 8.24 ± 6.8 days. One hundred and thirty-eight patients (33%) were discharged in 5 days or less.

The predictors of increased ICU stay were also analyzed because of the significant impact of the ICU stay (33% increase) on the overall postoperative stay. Table 3 shows the results of stepwise analysis of covariance.

The independent predictors associated with an increased stay in the ICU were perioperative myocardial infarction, the combined CABG and valve procedure, female gender, postoperative atrial fibrillation,

left ventricular dysfunction, and the number of hours on the ventilator. Perioperative myocardial infarction is a highly significant predictor ($P = 0.005$) of an increased stay in the ICU, but there were only four events. Consequently, we cannot be certain of the true magnitude this event has on the increase in LOS in the ICU. An increase from 1 to 2.7 days in the ICU will yield an expected increase of 2.75 days in the postoperative stay. The mean LOS of stay in the ICU was 2.63 ± 3.0 days. The independent predictors were similar to those identified for the postoperative LOS with the additional risk factors of perioperative myocardial infarction and left ventricular dysfunction (Table 3). Extubation in 10 hours or less was accomplished in 43% and 47% had an ICU stay of 1 day or less.

Effects on Cost

Using the HBO cost accounting system, (HBO & Co., Atlanta, GA) the hospital costs (not charges), both direct and indirect, per patient for diagnosis-related groups (DRG) 106 and 107 were analyzed. To assess the cost savings realized by the initiation of the early discharge program, we compared the first quarter of 1994, which was prior to the implementation of the program, to the first quarter of 1995. An overall cost savings of $3942 and $2028 per patient for DRG 106 and 107, respectively, was realized. During the same time intervals, the mean postoperative LOS for the group of patients undergoing only CABG decreased by 2.1 days. A decrease in postoperative LOS was seen in all decades of age ($P = 0.0002$). The most significant reduction in LOS was seen in the octogenarians (n = 18) with a shortened postoperative LOS from 12.7 to 8.1 days.

Mortality

The mortality rate for the entire group of 422 was 3.3% compared to 3.4% for the previous time period ($P = NS$).

Table 2. Independent Predictors of Postoperative Length of Stay (LOS)

Variable	Increase in Postoperative LOS (days)	% Increase	P
ICU LOS	2.75	33.4	< 0.0001
Postoperative atrial fibrillation	1.16	14.1	0.0006
CABG + valve	1.21	14.7	0.005
Preoperative congestive heart failure	1.02	12.4	0.002
Peripheral vascular disease	0.99	12.1	0.02
Female gender	0.67	8.2	0.025
Age	0.3	.37	0.012
Ventilator hours	0.07	0.8	0.01

ICU = intensive care unit; CABG = coronary artery bypass graft.

Table 3. Independent Predictors of Length of Stay in the ICU

Variable	Increase in ICU (days)	% Increase	P
Perioperative myocardial infarction	3.21	122	0.005
CABG + valve	0.73	27.9	0.0008
Female gender	0.56	21.3	0.001
Postoperative atrial fibrillation	0.56	21.3	0.002
Left ventricular dysfunction	0.27	10.2	0.01
Hours on ventilator	0.15	5.8	< 0.0001

ICU = intensive care unit; CABG = coronary artery bypass graft

Patient Satisfaction

The National Research Group, an independent agency, conducted a satisfaction survey, after patients were discharged from the hospital. Quality of care, recommendation to family and friends, advocation, and return to the hospital were the areas surveyed, and the mean scores were in the very good to excellent range.

··· DISCUSSION ···

In the era of managed care, cost containment is an essential part of healthcare delivery. Decreasing LOS can be one method to reduce the cost in cardiac surgery. Clinical pathways and the use of home care nurses have contributed to lowering LOS with no adverse change in the rate of complications.[9]

Substantial cost savings can be achieved with the early discharge program.[4] We were able to use cost provided by the hospital accounting system, which does not include the surgeon or anesthesiologist fees. Other reported studies used the Medicare cost-to-charge ratio to determine savings.[10] Smith and colleagues reported increased cost with older age, female gender, diabetes, and lower left ventricular ejection fraction; we found these variables to negatively impact LOS, which is a determinant of an increase in cost.[10,11] Smith's group also found significant differences in costs among surgeons, but the individual surgeon's impact on cost was not analyzed due to the small numbers of surgeons involved.[10] Katz and colleagues[12] found a 10% to 20% higher cost in the 70 years and older age group, but we have shown that the LOS can be decreased in all age groups with the early discharge program, which will equate to a costs savings.

We have shown that a reduction in postoperative LOS can be achieved safely in a large number of patients and in all age groups without any preselection process. Even though advanced age was associated with a longer postoperative LOS, we were able to decrease LOS in all age groups. The mean postoperative LOS in the septuagenarians and the octogenarians who underwent only CABG was decreased by 1 day and 4.6 days, respectively. Ott and colleagues had a LOS of 8 days in a group of patients older than 70 years undergoing isolated CABG vs 5.7 days in the younger group.[13] Similar studies have reported a greater LOS for the elderly population.[12]

We found prolonged ventilatory support to be a predictor of increased ICU and postoperative LOS. Change in anesthesia, using shorter-acting inhalation anesthetics and minimal narcotics, facilates early extubation. The patients have less sedative effect and are more alert.[7] Criteria for early extubation remains the same as for standard extubation.[2,4] Good pain control and preoperative communication with patients about their expected perioperative course help alleviate their anxiety, which facilitates early extubation.[14]

There are reported differences in "fast track" protocols. Normothermia has been advocated by some surgeons.[4,15] We and others have found that hypothermia, utilizing its myocardial protection, can be used routinely with successful early extubation and discharge.[5,13] An important aspect of early extubation, however, is to have the patient normothermic before weaning is attempted.

Early extubation was accomplished in 43% of the 422 patients in our study. Cheng et al report an extubation rate of 82% in a selected group of patients younger than 75 years of age who underwent elective CABG.[16] Reintubation rates have not been shown to be higher in patients achieving early extubation vs those undergoing standard extubation.[17] Arom and colleagues[11] reported reintubation rates of < 1%, while Chong et al. reported a rate of 1.8%.[18]

Intraoperative fluid restriction has been recommended to reduce extravascular fluid accumulation.[5,7] Steroids have also been used to decrease the occurrence of the inflammatory response with cardiopulmonary bypass.[4,5,19] Others use metoclopramide to stimulate bowel function.[5,7] The prophylactic use of digoxin for the prevention of postoperative atrial fibrillation has also been advocated.[4,5] We did not use steroids, metoclopramide, or prophylactic digoxin and no fluid restriction was implemented. In a meta-analysis, digoxin was not shown to reduce the likelihood of the development of supraventricular tachycardia after CABG.[20] Without these additional modifications, our results are comparable.

Current studies reported in the literature have not consistently found gender to significantly impact LOS or costs, but in our study female gender was an independent predictor for increased LOS in the ICU and postoperatively.[12,21-23] Late extubation has a negative impact on LOS and females have been found to have longer intubation times.[17]

Readmission and mortality are outcomes that address quality and cost concerns. No significant difference has been found in readmissions between the patients in the early discharge group compared to the group with longer LOS.[7,23] In our series, the readmission rate for the early discharge group was 7.8%, lower than the 16.2% rate for the group with the postoperative LOS of 6 days or longer. Our most common readmission diagnosis was atrial fibrillation.

We found no increase in our mortality rate after implementation of the early discharge program. The mortality rate for the entire group of 422 was 3.3% compared to 3.4% from the previous time period. Others have reported similar results, validating that early discharge can be accomplished safely.[3-5]

LOS in the ICU has an impact on the postoperative LOS.[7,16,21] In our study population, 47% had an ICU stay of 1 day or less. Patients with a perioperative myocardial infarction had the largest increase in ICU length of stay (3.21 days). Previous observations have found female patients to have longer intubation times, and we noted that both female gender and intubation time prolonged the ICU stay. Because the operating room and the ICU are high-cost areas for cardiac surgery, efforts to decrease the time in the ICU will improve hospital resource consumption.

Future studies should address areas of patient functional ability (status) after patients are discharged home and the psychological implications of early discharge. Anxiety levels, as well as the understanding and retention of discharge instructions, need to be examined. Readmission diagnoses and possible interventions to avoid hospitalization can be identified. Follow-up by a home care nurse might be helpful in early identification and treatment of problems to avoid readmissions. Further efforts are needed to identify the interventions that may decrease both the ICU and postoperative LOS in the female and older populations.

Acknowledgments

··· REFERENCES ···

1. American Heart Association. Heart and Stroke Facts. Dallas, TX: American Heart Association; 1997.
2. Hickey RF, Cason BA. Timing of tracheal extubation in adult cardiac surgery patients. J Card Surg 1995;10: 340-348.
3. Marquez J, Magovern J, Kaplan P, Sakert T, Gravlee GP. Cardiac surgery "fast tracking" in an academic hospital. J Cardiothorac Vasc Anesth 1995;9:34-36
4. Engelman RM. Mechanisms to reduce hospital stays. Ann Thorac Surg 1996;61:S26-S29.
5. Krohn BG, Kay JH, Mendez MA, Zubiate P, Kay GL. Rapid sustained recovery after cardiac operations. J Thorac Cardiovasc Surg 1990;100:194-197.
6. Hamilton A, Norris MN, Wensel R, Koshal A. Cost reduction in cardiac surgery. Can J Cardiol 1994;10: 721-727.

7. Engelman RM, Rousou JA, Flack JE, et al. Fast-track recovery of the coronary bypass patient. Ann Thorac Surg 1994;58:1742-1746.
8. Principal Investigators of CASS and Their Associates. National Heart, Lung, and Blood Institute Coronary Artery Surgery Study (CASS): A multicenter comparison of the effects of randomized medical and surgical treatment of mildly symptomatic patients with coronary artery disease, and a registry of consecutive patients undergoing coronary angiography. Circulation 1981;63(suppl I):1-81.
9. Riegel B, Gates DM, Gocka I, et al. Effectiveness of a program of early hospital discharge of cardiac surgery patients. J Cardiovasc Nurs 1996;11:63-75.
10. Smith LR, Milano CA, Molter BS, et al. Preoperative determinants of postoperative costs associated with coronary artery bypass graft surgery. Circulation 1994;90(5) (part 2):II124-II128
11. Arom KV, Emery RW, Petersen RJ, Schwartz M. Cost-effectiveness and predictors of early extubation. Ann Thorac Surg 1995;60:127-132.
12. Katz NM, Hannan RL, Hopkins RA, Wallace RB. Cardiac operations in patients aged 70 years and over: Mortality, length of stay, and hospital charge. Ann Thorac Surg 1995;60:96-101.
13. Ott RA, Gutfinger DE, Miller MP, Alimadadian H, Tanner TM. Rapid recovery after coronary artery bypass grafting: Is the elderly patient eligible? Ann Thorac Surg 1997;63:634-639
14. Riley J. Fast track cardiac care. Nurs Stand 1995;49: 55-56
15. Butler J, Chong GL, Pillai R, Westaby S, Rocker GM. Early extubation after coronary artery bypass surgery: Effects on oxygen flux and haemodynamic variables. J Cardiovasc Surg 1992;33:276-280
16. Cheng DC, Karski J, Peniston C, et al. Early extubation after coronary artery bypass graft surgery reduces costs and improves resource use: A prospective, randomized, controlled trial. Anesthesiology 1996;85:1300-1310.
17. Chong JL, Grebenik C, Sinclair M, et al. The effects of a cardiac surgical recovery area on the timing of extubation. J Cardiothorac Vasc Anesth 1993;7:137-141.
18. Chong JL, Pillai R, Fisher A, et al. Cardiac surgery: Moving away from intensive care. Br Heart J 1992;68: 430-433.
19. Engelman RM, Rousou JA, Flack JE III, et al. Influence of steroids on complement and cytokine generation after cardiopulmonary bypass. Ann Thorac Surg 1995;60: 801-804.
20. Andrews TC, Reimold SC, Berlin JA, Antman EM. Prevention of supraventricular arrhythmias after coronary artery bypass surgery. Circulation 1991;84(suppl III): III236-III244.
21. Mounsey JP, Griffith MJ, Heaviside DW, Brown AH, Reid DS. Determinants of the length of stay in intensive care and in hospital after coronary artery surgery. Br Heart J 1995;73:92-98.
22. Moyer JA. Factors related to length of ICU stay for CABG patients. Dimen Crit Care Nurs 1994;4:194-200.
23. Lazar HL, Wilcox K, McCormick JR, Roberts AJ. Determinants of discharge following coronary artery bypass graft surgery. Chest 1987;92:800-803.