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Randomized Assessment of Resource Use in Fast-track Cardiac Surgery 1-Year after Hospital Discharge

Davy C. H. Cheng, M.D. M.Sc. F.R.C.P.C. Claus Wall, M.Sc.† George Djaiani, M.D., D.E.A.A., F.R.C.A.,‡ Raul A. Peragallo, M.D.,§ Jo Carroll, R.N.,‖ Cindy Li,# David Naylor, M.D., F.R.C.P.C.***

Background: **The authors assessed the safety and resource use associated with fast-track cardiac anesthesia (FTCA) after coronary artery bypass graft surgery (CABG) over a 1-yr period.**

Methods: **One hundred twenty patients were initially randomized to FTCA (n = 60) or conventional anesthetic (n = 60) for primary elective CABG surgery. Patients were followed for 1-yr after index surgery through linkage to universal administrative databases. Acute care hospital readmission rates and length of stay (LOS) and the downstream use of health resources were compared. Resource use was analyzed as use of hospital and rehabilitation center bed-days, expenditures on physician services, and use of cardiac drugs.**

Results: **There were no deaths during the 1-yr follow-up after initial discharge; 15 (25%) patients from both groups were readmitted to acute care hospitals in the follow-up period. The mean LOS for acute care readmission was 0.3 (1.0) in the FTCA and 1.6 (6.3) days in the conventional group at 3 months; *P* = 0.01, 95% CI (0.1, 5.7) and 0.8 (1.8) and 2.9 (9.6) days at 12 months; *P* = 0.01, 95% CI (0.2, 7.5). Two (3.3%) patients in the FTCA group and 9 (15%) patients in the conventional group were transferred to rehabilitation facilities. The LOS was 0.3 (1.5) and 2.3 (5.7) days respectively; *P* = 0.001, 95% CI (0.6, 4.0). Specialist visits were more frequent in the FTCA group 6.2 (13.2) *versus* 1.9 (2.2) visits respectively; *P* = 0.002, 95% CI (−9.0, −1.3). Percentage reduction of FTCA cost was 68% at 3 months, *P* = 0.0002 and 49.5% at 1-yr, *P* = 0.004 after index hospital discharge.**

Conclusions: **Fast-track cardiac anesthesia is a safe practice that decreases resource use for a 1-yr period after index hospitalization.**

THE increased demand for cardiac surgical procedures coincides with the growing elderly population in North America.[1] Coronary revascularization surgery is increasingly performed on patients aged 65 and older, with extensive coronary artery pathology, impaired left ventricular function, decreased physiologic reserve, and multiple comorbid conditions.[2–5] It is estimated that approximately half a million patients undergo cardiac surgical procedures in the US annually, costing approximately $9 billion per year. To contain these burgeoning costs, there has been widespread adoption of fast-track cardiac surgery (FTCS) pathways. Fast-track cardiac anesthesia (FTCA) with early tracheal extubation is an essential part of the FTCS process.[6]

In a previously reported randomized trial, we demonstrated that FTCA in patients after conventional coronary artery bypass graft (CABG) surgery does not lead to any short-term increases in perioperative morbidity, mortality, and resource use.[7,8] However, there has been no rigorous long-term follow up to ensure that this new clinical practice does not lead to out-of-hospital morbidity and resource use. We have accordingly extended our randomized comparison to assess the safety and resource use associated with early extubation and fast-track cardiac surgery over a 1-year period.

Methods

Patient Enrollment

After institutional review board approval and written informed consent, 120 patients younger than age 75, who were initially randomized to an FTCA group or a conventional anesthetic management group for primary elective CABG surgery[7,8] between 1993 and 1995, were followed for 1-year after index surgery.

Patient Management on the Index Admission

Study Groups. Premedication included 2 mg sublingual lorazepam 1 to 2 h before surgery. Radial and pulmonary artery pressure was monitored in all patients.

FTCA Group

Anesthesia was induced with fentanyl 15 μg/kg and pancuronium 0.15 mg/kg, and maintained with 0.5–2.0% end-tidal isoflurane. A propofol 2–6 mg $\cdot$ kg^{-1} $\cdot$ h^{-1} infusion was commenced after initiation of cardiopulmonary bypass (CPB) and continued until 1–4 h postoperatively in the postcardiac surgery unit (PCSU). Postoperative analgesia was maintained with intravenous morphine 1–4 mg/h. Patients were assessed for tracheal extubation within 1–6 h after arrival in PCSU.

Conventional Group

Anesthesia was induced with fentanyl 50 μg/kg and pancuronium 0.15 mg/kg and maintained with midazolam 0.1 mg/kg and 0.5–2.0% end-tidal isoflurane as required. Postoperative analgesia and sedation were achieved with morphine 2–10 mg/h and midazolam 1–3 mg/h.

* Professor of Anesthesia, University of Toronto, Toronto, and University of Western Ontario, London, Ontario. † Health Information Coordinator, Institute for Clinical Evaluative Sciences, Toronto. ‡ Assistant Professor of Anesthesia, ** Professor of Medicine and Dean, Faculty of Medicine, University of Toronto, Toronto. § Cardiac Anesthesia Fellow, ‖ Research Nurse Coordinator, Toronto General Hospital, University Health Network, Toronto. # Biostatistician, Institute for Clinical Evaluative Sciences, Toronto.

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Address reprint requests to Dr. Cheng: Department of Anesthesia & Perioperative Medicine, London Health Sciences Centre, University Campus, 339 Windermere Road, 3CA 19, London, Ontario, N6A 5A5, Canada. Address electronic mail to davy.cheng@uwo.ca. Individual article reprints may be purchased through the Journal Web site, www.anesthesiology.org.

Patients were assessed for tracheal extubation at 7:00 AM the next morning.

Both groups received indomethacin 50–100 mg suppositories for analgesia. Shivering was treated with meperidine 25–50 mg. Sedation was titrated to maintain a Ramsey score of 3 to 4.[9]

Surgical Procedure

All patients underwent a median sternotomy, with harvesting of saphenous veins and internal thoracic arteries as conduits. Myocardial protection was achieved with intermittent antegrade cold blood cardioplegia infusion through the aortic root, and systemic temperature was allowed to drift to 33°C during CPB. Hematocrit was maintained between 20–25%. CPB flow was maintained at 2.0–2.5 $l \cdot min^{-1} \cdot m^{-2}$ and perfusion pressure between 50 and 70 mmHg. Patients were rewarmed to 37°C before removal of the aortic cross-clamp and weaning from CPB. Management of the separation from CPB and in particular, the choice of inotropes was at the discretion of the anesthesia care team.

Data Sources and Linkage

Perioperative data collection during the surgical course from hospital admission to discharge has been previously described.[7,8] Follow-up data were obtained through linkage to administrative databases held at the Institute for Clinical Evaluative Sciences [ICES], which serves as Ontario's main nongovernmental health data custodian. The relevant databases are listed as follows:

1. Canadian Institute for Health Information (CIHI) Hospital Discharge database: includes computerized abstracts of all general, rehabilitation, and convalescent hospital admissions and major outpatient procedures.
2. Ontario Drug Benefit Claims database: includes prescription drug use among trial enrollees aged 65-yr and older.
3. Ontario Health Insurance Plan (OHIP) database: inpatient and outpatient claims for physician services.
4. Ontario Registered Persons database: serves as both a linkage file and an accurate source for vital statistics.

Patients' names, chart numbers, dates of birth, gender, and dates of admission and discharge were obtained from the prospective randomized trial database and medical records for the index admission. These identifiers were linked to the Registered Persons Database to obtain an encrypted health care number. As a safeguard against violation of patient confidentiality, these names were then stripped from the file and the anonymized file was transferred to another programmer at ICES. The resulting file was then used to follow health service use by those individuals over a 1-year period from index hospital discharge.

Outcome Measures

We predetermined that three temporal periods would be examined. The 0- to 3-month period reflects the continuing recovery phase and early postoperative complications with short to medium term effects. The 0- to 12-month period reflects the additional effect of ongoing disease processes, late complications, complications with long-term consequences, and overall patient health and severity of illness. Along with these two periods, we also examined the 3- to 12-month period (reported selectively below) to isolate any late effects.

Morbidity and Mortality. Major morbidity was assessed by comparing rates of readmission for primary cardiac diagnoses and the downstream use of major procedures (*i.e.*, coronary angiograms, PTCA, and repeat CABG). Mortality data were also examined.

Resource Use. We examined overall counts of any physician visits (both in general and also considered separately for family physicians/GPs *vs.* specialists); numbers of readmissions to, and transfers to other acute care institutions or to rehabilitation or convalescent facilities after the index CABG; at any point during the defined follow-up periods and for the full year.

Average resource use was also analyzed as hospital-bed days per enrollee; Ministry of Health expenditures per patient on physician services as calculated from the relevant Ontario Health Insurance Plan (OHIP) fee schedule on claims submitted for trial enrollees; and average drug ingredient expenditures for cardiac drugs per enrollee aged 65 or older, as determined from Ontario Drug Benefit claims. All costs are in Canadian dollars.

Statistical Analysis

Analyses of the data were performed before breaking the randomization code, thus the identity of the two groups under study was not known during the analysis. The SAS statistical software package (SAS Institute, Cary, NC) was used for data extraction and analysis. Since the data were not normally distributed, the nonparametric bootstrap analysis[10] was carried out to compare the means of the different study outcomes between the FTCA and conventional. Five thousand bootstrap resample was used in the analysis. *P* values and 95% confidence intervals are reported for each outcome. Data are expressed as mean (SD) or else indicated.

Results

The study population consists of 120 elective CABG patients, evenly randomized according to a computer-generated code into the early and conventional studied groups. The two groups had comparable demographic data: age (59.3 ± 8.8 *vs.* 61.2 ± 8.7 yr old), weight (79.5 ± 14.4 *vs.* 78.7 ± 13.7 kg), equal distribution of

Table 1. Readmission to Acute Care Hospitals within One Year after Index CABG Surgery

	FTCA (n = 60)	Conventional (n = 60)	*P* (Bootstrap)	Difference of Mean (Conventional minus FTCA) (Bootstrap 95% CI)
0–3 Months	—	—	—	—
Patients, n	5 (8.3%)	8 (13.3%)	—	—
Hospital LOS, d	—	—	—	—
Sum	15	94	—	
Mean (SD)	0.3 (1.0)	1.6 (6.3)	0.01	(0.1, 5.7)
0–12 Months	—	—	—	—
Patients, n	15 (25%)	15 (25%)	—	—
Hospital LOS, d	—	—	—	—
Sum	50	174	—	—
Mean (SD)	0.8 (1.8)	2.9 (9.6)	0.01	(0.2, 7.5)

Data expressed as mean (SD in parentheses).

CABG, coronary artery bypass grafting; FTCA, fast track cardiac anesthesia; LOS, length of stay.

ventricular function grade, number of grafts (median 3.7 [range 1–5] *vs.* median 3.7 [range 1–5]), CPB time (84.8 ± 28.3 *vs.* 86.8 ± 25.5 min), aortic cross clamp time (62.1 ± 19 *vs.* 64.1 ± 19.5 min), and treated complications in the intensive care unit (ICU) postoperation respectively.

Postoperative extubation time (4.1 ± 1.1 *vs.* 18.9 ± 1.4 h, $P < 0.02$), and hospital lengths of stay (7.55 ± 2.87 *vs.* 9.95 ± 7.10 days, $P < 0.02$) were significantly shorter in the FTCA group. Nine patients in each group did not satisfy extubation criteria within the defined period after surgery; however, these patients had comparable causes of extubation failure (resternotomy for bleeding, low cardiac output syndrome, significant A-a oxygen gradient, pneumonia, CVA). A total of four patients died in the hospital after surgery. Three patients were in the conventional group and one in the FTCA group. The causes of death were perioperative myocardial infarction (one patient in each group) and stroke (two patients in the conventional group).

Long-term Outcome

Mortality. None of the remaining 116 patients who were discharged from the hospital died during the 12-month follow-up period.

Readmission to Acute Care Hospitals

During the first 3 months after discharge, 5 (8.3%) patients from the FTCA group and 8 (13.3%) from the conventional group were readmitted to acute care hospitals. By 1 yr, the FTCA and conventional groups increased to 15 (25%) and 15 (25%) patients respectively (table 1). However, the mean length of stay for acute care readmission was significantly shorter in the FTCA group than in the conventional group at 3 months and at 12 months (table 1). The discharge diagnoses for readmissions to acute care hospitals are listed in table 2.

Admission to Rehabilitation Facilities

Two patients from the FTCA group and nine patients from the conventional group were transferred to rehabilitation facilities after discharge from the index surgery

Table 2. Frequency of Readmission Diagnoses to Acute Care Hospitals during One-Year Period after Index CABG Surgery

Diagnosis	Codes ICD9-cm	FTCA (n = 60)	Conventional (n = 60)
0–3 Months			
n		5	8
Myocardial infarction	410/411	1	1
Arrhythmia	4294	0	1
Nausea and vomiting	7870	1	0
Coagulation deficit	2869	0	1
Chest pain- non-specific	7865	0	1
Intestinal vasculopathy	5571	0	1
Irritable bowel syndrome	5641	0	1
Diverticulosis	5621	0	1
Peritonitis	5409	1	0
Pancreatic pseudocyst	5772	0	1
Bladder carcinoma	1889	1	0
Pneumonia	486	0	1
Blood in stool	5781	0	1
Surgical Convalescence	V660	1	0
3–12 Months			
n		10	9
Angina	413	1	0
Pulmonary embolism/infarct	4151	1	0
Congestive heart failure	4280	1	0
Coronary atherosclerosis	4140	2	2
Pacemaker implantation	9967	0	1
Chest pain, nonspecific	7865	2	1
Abdominal pain	7890	0	1
Pancreatic pseudocyst	5772	0	1
Irritable bowel syndrome	5641	0	2
Arthritis	7194	1	0
Psychiatric disorder	2961	0	1
Retinal detachment	3619	0	1
Prostate cancer	185	1	0
Unilateral Inguinal hernia	5509	1	0
Hyperplasia of prostate	600	1	0
Gastritis	5354	0	1

CABG, coronary artery bypass grafting; FTCA, fast track cardiac anesthesia; ICD9CM, International Classification of Diseases 9th edition Clinical Modification, patients may have more than one admitting diagnosis.

Table 3. Admission to Rehabilitation Centers within One Year of Index CABG Surgery

	FTCA (n = 60)	Conventional (n = 60)	*P* value (Bootstrap)	Difference of Mean (Conventional minus FTCA) (Bootstrap 95% CI)
Patients, n	2 (3.3%)	9 (15%)	—	—
LOS, d	—	—	—	—
Sum	17	136	—	—
Mean (SD)	0.3 (1.5)	2.3 (5.7)	0.001	(0.6, 4.0)

Data expressed as mean (SD in parentheses). All the admissions to rehabilitation centers occurred immediately or shortly after the index discharge

CABG, coronary artery bypass grafting; FTCA, fast track cardiac anesthesia; LOS, length of stay.

of the acute care hospital (table 3). The number of patients did not change during the follow-up period. Differences in average transfer rates rehabilitation center LOS and total rehabilitation center LOS all favored the FTCA group (table 3).

Physician Visits

Frequency of outpatient physician visits during the 3 month and 1-yr periods after index CABG surgery are shown in table 4. There was increased frequency of outpatient specialist visits in the FTCA *versus* the conventional group; but there was no difference between the two groups with respect to general practitioner visits from index surgery to 1-yr follow-up.

OHIP Claims

Claims submitted to OHIP for procedure fees and professional services are summarized in table 5. Both groups were comparable with respect to out-of-hospital incurred OHIP costs during the 3 and 12-month follow-up periods, but the in-hospital OHIP claim numbers and costs favor the FTCA group.

Drug Use

A list and frequency of the most commonly prescribed cardiac drugs are shown in table 6. There was a similar distribution of cardiovascular drug use for patients aged 65 and older between the two groups. The most commonly used drugs after hospital discharge included aspirin, β-blockers, and digitalis preparations.

Total Cost after Index CABG Surgery

Total cost was based on in-hospital and out-of-hospital OHIP charges, rehabilitation facilities, and indirect hospital budget costs. Daily cost in a surgical ward of an acute care hospital has been previously estimated[7] as $518.90 and that of rehabilitation center as $400.00. Patients in the FTCA group used significantly fewer resources at both the 3 month and 1-yr follow-up periods (table 7).

Discussion

This study provides data concerning resource use during a 3-month and 1-year follow-up of patients after index CABG surgery randomized to FTCA *versus* conventional anesthetic management. Our findings indicate that FTCA patients require significantly less resource use during both the first 3-months until 1-yr after elective CABG surgery.

Perioperative Morbidity and Resource Use in FTCS

The strongest predictors of cost for cardiac surgical patients are hospital LOS, intensive care unit (ICU) LOS, operating room time, patient age, and postoperative

Table 4. Frequency of Outpatient Physician Visits at 3 and 12 Months after Index CABG Surgery

	FTCA (n = 60)	Conventional (n = 60)	*P* value (Bootstrap)	Difference of Mean (Conventional minus FTCA) (Bootstrap 95% CI)
0–3 Months				
General practitioner	6.0 (3.4)	5.5 (4.1)	0.24	(−1.8, 1.0)
Specialists	1.5 (2.7)	0.9 (1.0)	0.06	(−1.5, 0.1)
Others	0.9 (1.2)	0.7 (1.1)	0.14	(−0.7, 0.2)
0–12 Months				
General practitioner	17.2 (10.5)	16.5 (12.9)	0.57	(−4.0, 4.7)
Specialists	6.2 (13.2)	1.9 (2.2)	0.002	(−9.0, −1.3)
Others	2.4 (2.0)	2.3 (2.8)	0.41	(−1.0, 0.8)

Data expressed as mean (SD in parentheses).

Specialists include: cardiovascular and thoracic surgery, cardiology, neurology, psychiatry, physical medicine, and respiratory diseases.

Others include: other physicians not in the other two groups and non-medical practitioners.

CABG, coronary artery bypass grafting; FTCA, fast track cardiac anesthesia.

Table 5. Number of Physician OHIP Claims for the Inpatients and Outpatients during the 3 and 12 Months Follow-up after Index CABG Surgery

	FTCA (n = 60)	Conventional (n = 60)	*P* (Bootstrap)	Difference of Mean (Conventional minus FTCA) (Bootstrap 95% CI)
0–3 Months				
In-patient, mean (SD)				
OHIP claims, n	0.8 (3.4)	4.7 (16.5)	0.01	(0.8, 13.9)
OHIP costs per patient, $	37.6 (170.9)	163.9 (649.4)	0.02	(0.2, 496.5)
Out-patient, mean (SD)				
OHIP claims, n	22.3 (14.2)	25.8 (25.2)	0.15	(−2.8, 12.2)
OHIP costs per patient, $	479.6 (49.2)	492.4 (50.0)	0.44	(−126.3, 146.9)
0–12 Months				
In-patient, mean (SD)				
OHIP claims, n	2.2 (4.8)	6.4 (19.1)	0.01	(0.4, 13.9)
OHIP costs per patient, $	96.5 (222.1)	318.5 (933.8)	0.01	(29.7, 784.9)
Out-patient, mean (SD)				
OHIP claims, n	71.9 (45.5)	69.5 (67.4)	0.55	(−17.4, 26.9)
OHIP costs per patient, $	1363.3 (102.3)	1241.5 (109.5)	0.27	(−383.9, 214.1)

Data expressed as mean (SD in parentheses).

$, Canadian dollars; CABG, coronary artery bypass grafting; FTCA, fast track cardiac anesthesia; OHIP, Ontario health insurance plan.

complications.[7,11,12] Our earlier studies have demonstrated that early extubation anesthesia shortened postoperative LOS, resulting in reduction in health care resource use with associated potential cost savings.[7,8] The predominant saving was from reduction in ICU costs. Other savings were reduced costs for respiratory therapy and laboratory blood tests. In our experience, early extubation allowed an increase in caseload with significantly fewer cardiac surgery cancellations (0.3% *vs.* 2.0%) when compared with the conventional extubation practice. The ICU readmission rate was actually 28% lower among patients undergoing early extubation anesthesia.[7] In 885 consecutive CABG patients undergoing FTCA, 25% had delayed extubation, 17% had prolonged ICU LOS, and 2.6% died. The risk factors of delayed extubation were increased age, female gender, postoperative use of intraaortic balloon pump, inotropes, bleeding, and atrial arrhythmia. The risk factors of prolonged ICU LOS were those of delayed extubation plus preoperative myocardial infarction and postoperative renal insufficiency. The risk factors of mortality were female gender, emergency surgery, and poor left ventricular function.[13] This further supports the perioperative safety and effectiveness of FTCA. The fast-track cardiac anesthesia has also been demonstrated to have a lower incidence of the feared complication of intraoperative recall in cardiac surgery.[14]

Table 6. Frequency of Ontario Drug Benefit Claims Users by Drug Group for the 3- and 12-Month Follow-up Periods in Patients Over 65 Years of Age.

Drug Groups	FTCA (n = 17)	Conventional (n = 24)
0–3 months		
Nitrates	1	2
Calcium channel blockers	1	2
β blockers	6	8
Antiarrhythmics	4	7
Ace inhibitors	2	2
Lipid lowering	2	0
Digitalis	5	11
Diuretics	0	4
Aspirin	15	17
Warfarin	0	1
0–12 months		
Nitrates	3	5
Calcium channel blockers	2	3
β blockers	6	10
Antiarrhythmics	5	7
Ace inhibitors	4	3
Lipid lowering	4	1
Digitalis	6	11
Diuretics	1	4
Aspirin	16	19
Warfarin	0	2

FTCA, fast track cardiac anesthesia.

Long-Term Outcomes in FTCS

Does this promising strategy promote significant cost saving or merely cost shifting? The work by Jenkins *et al.* antedates the reintroduction of early extubation practice.[15] Wahl *et al.* found significant impact on long-term survival and functional ability in a small cohort of patients sustaining major complications requiring prolonged ICU stays after cardiac surgery.[16] Wahl *et al.* did not specifically address the impact of early *versus* conventional extubation. In an observational study, Lahey *et al.* reported a 20.9% hospital readmission rate, and 49% readmission rate to outside hospitals after FTCS. However, their study covered only a 30-day post-discharge period and the sole outcome measure was in-patient hospital readmission data.[17]

Ott *et al.* reported a 29% discharge rate in 100 patients by postoperative day 3,[18] while Walji *et al.* coined a new acronym of "ultra-fast tracking" and reported that 56% of 258 patients could be discharged by postoperative day 4

Table 7. Cost Analysis During the 3- and 12-Month Follow-up Periods after the Index CABG Surgery

FTCA (n = 60)	Conventional (n = 60)	P (Bootstrap)	Difference of Means (Conventional and FTCA) (Bootstrap 95% CI)	FTCA cost (% Reduction)
0–3 Months, $760.36 (1,021.4)	2,376 (4,754.2)	0.0002	(608.8, 3462.2)	68%
3–12 Months, $1,245.2 (1,282.7)	1.595.5 (2,950.3)	0.17	(−346.0, 1540.9)	22%
0–12 Months, $2,005.5 (1,746.5)	3,971.5 (7,095.9)	0.004	(498.7, 4909.5)	49.5%

Data expressed as mean (SD in parentheses).

$, Canadian dollars; CABG, coronary artery bypass grafting; FTCA, fast track cardiac anesthesia.

with 23% discharged by postoperative day 2.[19] Again, long-term outcome data for these reports are lacking.

The Canadian health care system, with its universal public coverage of hospital and physician services, generates administrative data that are a unique tool for longitudinal follow-up of patients and resource use analysis. Drawing on linkage from a randomized trial to these administrative databases, we have now demonstrated that FTCA does not lead to increases in costs during the 1-yr follow-up after CABG surgery.

The major costs after discharge from hospital were attributable to physician OHIP billings for outpatients and hospital costs for readmitted patients. It is difficult to determine in advance which patients are more likely to require readmission to either acute care hospital or a transfer to rehabilitation facilities after surgery. We found that 25% of patients in both groups were readmitted to acute care hospitals during the 1-yr follow-up period. Readmission rates were similar between the two groups although the readmission diagnoses varied widely. Fewer than half of all readmissions were related to coronary artery disease. These findings are in concordance with other studies of similar patient populations.[17,20,21] Significantly fewer patients were transferred to rehabilitation centers, comprising 3.3% and 15% in the FTCA and conventional groups respectively. Actual dollar costs were defined as a sum of OHIP charges and direct fixed costs per each day of stay. Although the OHIP charges were similar between the two groups, savings in the FTCA group were made by a reduction in hospital budget expenditure, primarily caused by decreased LOS in the rehabilitation centers.

The number of CABG surgeries continues to increase in our aging population. This surgery consumes more health-care resources than any other single treatment.[22] The 1-year follow-up usage costs rank fourth after operating room coasts, cardiovascular ICU costs, and postoperative ward costs in elective CABG surgery. Patient readmissions to acute care hospitals and rehabilitation facilities were the two major contributors to the total postdischarge costs. Further research should be directed to provide a method to identify individuals at risk for substantial long-term morbidity and necessity for readmission to health care facilities.

Limitations of the Study

One limitation of our study is that the drug costs after CABG surgery were not analyzed for all subjects. However, the drug usage in patients 65 yr or older was not different between the two groups. A second limitation is that our results cannot be generalized and apply only to the patient population studied (< 75 yr olds undergoing elective CABG surgery). Finally, this study is not designed to determine differences in the incidence of complications such as myocardial infarction, cerebrovascular accident, and death.

We emphasize that we are not seeking to reduce all services to a single dollar denominator. Cost of cardiac surgery may be calculated precisely in some circumstances, with individual assessments of direct and indirect variable and fixed costs. However we believe a pragmatic approach to profiling major resource consequences and third party payer expenses is sufficient for our purposes.

Strengths of the Study

Our sample size is inevitably constrained by the original sample size of the randomized trial. Our statistical approach was to minimize tests with *P* values, but to emphasize the absolute and relative intergroup differences, and to look for consistency in the comparisons drawn. If, as we expected, virtually none of the comparisons showed any meaningful differences, this could be taken as strong *prima facie* evidence in support of the null hypotheses that motivate the study. Since the data were not normally distributed, sensitivity analysis using a permutations test was carried out, which showed that similar results were obtained. The nonparametric bootstrapping method we use in calculating the *P* values and the 95% confidence intervals for the difference of means between groups is a very robust and powerful data-based simulation approach.[10] Five thousand bootstrap resamples were used in the computation in this study.

No other randomized data are available for linkage to such a comprehensive group of administrative databases. It will be difficult to ever answer these questions definitively using nonrandomized data alone, because of the potential for confounding by selection biases. Thus, while an observational long-term comparison of the two extubation strategies could have greater power, its findings would be considerably more credible if they were consistent with findings from this randomized comparison.

Conclusions

In this prospective randomized study, we have demonstrated that fast-track cardiac anesthesia and surgery is a safe practice that decreases resource use after patient discharge from the index hospitalization over a 1-year follow-up period.

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