

## A Clinical and Economic Evaluation of Fast-Track Recovery after Cardiac Surgery

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### ABSTRACT

**Background:** In the last 5 decades, the care of cardiac surgical patients has improved with the aid of strategies aimed at facilitating patient recovery. One of the innovations in this context is “fast-tracking” or “rapid recovery.” This process refers to all interventions that aim to shorten a patient’s stay in the intensive care unit (ICU) through accelerating the patient’s transfer to a step-down or telemetry unit and to the general ward.

**Methods:** Patients were allocated to 2 groups. The fast-track group (n = 84) went through an independent theatre recovery unit (TRU). The patients were then transferred on the same day to an intermediate care unit and transferred on the following day to the ward. The intensive care group (52 patients) went to the ICU for at least 1 day, after which they were transferred to the ward.

**Results and Discussion:** The fast-track pathway significantly reduced the length of stay (LOS) in an intensive care facility ( $P < .001$ ). The duration of intubation was reduced from a median of 4.08 hours (range, 1.17-13.17 hours) in the intensive care group to 2.75 hours (range, 0.25-18.57 hours) in the fast-track group ( $P < .001$ ). However, the median values for total hospital LOS, incidences of complications, reintubation, and readmission were similar for the 2 groups. The incidence of failure in the fast-track group was 10%. The mean (SD) cost of the perioperative care was £4182 ± £2284 (\$6683 ± 3650) for the fast-track patients, compared with £4553 ± £1355 (\$7277 ± \$2165) for the intensive care group.

**Conclusion:** Fast-track recovery after cardiac surgery decreases the intensive care LOS and the total duration of intubation. It is a cost-effective strategy compared with

conventional recovery protocols; however, it does not reduce the total hospital LOS or the incidence of complications.

### INTRODUCTION

In the last 5 decades, the care of cardiac surgical patients has improved with the aid of strategies aimed at facilitating patient recovery. These strategies include reducing preoperative anxiety, limiting postoperative pain, using epicardial pacing electrodes effectively, extubating patients within several hours after surgery, preserving blood volume, providing patient education, and meeting familial needs [Brown 2000]. A further innovation in this context is “fast-tracking” or “rapid recovery.” These terms refer to all interventions that aim to shorten a patient’s stay in the intensive care unit (ICU) by accelerating their transfer to a step-down or telemetry unit and to the general ward [Staples 1997]. Typically, patients are extubated in the operating room or within several hours postoperatively, transferred to a less-intensive unit within 12 to 36 hours, and discharged from the hospital within 36 to 72 hours [Cheng 1995].

Such fast-tracking strategies are thought to offer the benefits of improving the quality of patient care, increasing the rate of recovery, and reducing costs to both the patient and the hospital [Cheng 1995].

The objective of this study was to evaluate the clinical and economic outcomes of fast-track recovery for determining the future utility of fast-track recovery following cardiac surgery.

### METHODS

This prospective observational study was undertaken after approval was given by the Institutional Ethics Committee. Over a 6-month period (between November 2009 and May 2010), all patients who underwent cardiac surgery were screened for eligibility for fast-track recovery. The patients were assessed with respect to an agreed list of criteria (Table 1) before and at the end of their respective operations.

All patients underwent their operations with cardiopulmonary bypass and cardioplegic arrest. All operations were performed either at a normal temperature (normothermia) or with moderate hypothermia (32°C).

Fast-track patients went through the theatre recovery unit (TRU), which is independent of the cardiac ICU (CICU) and

*This paper was presented at the 20th World Congress of the World Society of Cardiothoracic Surgeons, Chennai, India.*

*Received February 22, 2011; received in revised form May 2, 2011; accepted June 14, 2011.*

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Table 1. Exclusion Criteria for Fast-Track Recovery

Mitral valve replacement
Redo grafts/valves
History of cerebrovascular accident
Emergency operation
Swan-Ganz catheter
Inadequate hemostasis

has a 1:1 nursing provision. Patients were then transferred on the same day to an intermediate care unit (the progressive care unit [PCU]) and subsequently to the general ward.

The patients in the control group underwent recovery via the conventional pathway: to the CICU, where they stayed for at least 1 day, and then either directly to the general ward or first to the PCU, if indicated.

The fast-track recovery pathway has a limited capacity of 2 beds and operates between 0800 and 1830 hours on weekdays only. The last time for admission to the TRU is 1430 hours.

All anesthetics used were short-acting inhalation agents; short-acting sedation with propofol and morphine-based analgesia were also used. No epidurals were used. Blood preservation was accomplished through the routine use of cell saver procedures. Patients in the fast-tracking group were extubated if they exhibited cardiovascular stability (heart rate, 60-100 beats/min; mean arterial pressure, 60-95 mm Hg), chest drain drainage of <100 mL/hour, and a Glasgow Coma Score of 15.

Patients who exhibited cardiovascular stability, a fraction of inspired oxygen 70%, and a pO<sub>2</sub> value of 75 mm Hg after extubation were transferred to the PCU. The PCU is a 6-bed high-dependency unit within the cardiac ward with a 1:2 nursing policy. The PCU had facilities for continuous monitoring of vital signs (electrocardiography, urinary output, arterial and central venous pressures, oxygen saturation, and arterial blood gases). Cardiovascular support was also available in the form of inotropes and vasoconstrictors. Mechanical ventilation was not provided, but some respiratory support was given via a continuous positive airway pressure. Any patient who did not satisfy the PCU criteria was transferred to the CICU instead. Such patients were regarded as having failed fast-track recovery and were similar to CICU patients in terms of their care and discharge.

Once in the ward, both fast-track patients and conventional patients were treated according to standard practice. The patients' conditions were then nursed on the basis of a 1:4 or 1:5 nurse-to-patient ratio. Patients finally were assessed for discharge individually after their clinical and social situations had been considered.

#### Data Collection

One primary researcher and 2 assistants collected the data. Data were collected prospectively from patient notes (including medical and nursing notes, ICU charts, the units' log books) and directly from the nursing and medical teams.

Table 2. Demographics of the Patients in the Conventional and Fast-Track Groups\*

Variable	Fast-Track Group (n = 84)	Conventional Group (n = 52)	P
Age, y			
Mean SD	63.3 9.3	62.9 8.6	.708
Median (range)	64.0 (40-80)	63.5 (42-77)	
EuroSCORE			
Mean SD	2.65 2.08	2.42 1.89	.647
Median (range)	2.00 (0-9)	2.00 (0-6)	
Male sex, n	65 (77.4%)	46 (88.5%)	.105
CABG, n	73 (87%)	45 (87%)	.951
Valve, n	10 (12%)	6 (12%)	.949
ASD, n	1 (1%)	1 (1%)	.730

\*CABG indicates coronary artery bypass grafting; ASD, atrial septal defect.

#### Costs

Cost evaluation was done by means of a top-down costing method [Jegers 2002]. This method takes an overview of the costs and then analyzes the different expenditures that make up the total cost. It produces an average cost per patient-day by dividing the total expenditure of a unit over a given period by the number of patient-days of care provided within the same time period. The finance department of the hospital calculated the average cost of the units by using the cost blocks approach. The total perioperative care for each patient was calculated by multiplying each unit cost by the time spent in that unit and then summing all of the unit costs.

#### Statistical Analysis

Data were subjected to an intention-to-treat analysis with the aid of SPSS software (version 14; SPSS, Chicago, IL, USA). Preoperative and intraoperative factors were compared via unpaired Student *t* tests for parametric data and with Mann-Whitney rank sum tests for nonparametric data. A *P* value <.05 was defined as statistically significant.

One-way and multiway sensitivity analyses were performed to assess the uncertainty of the calculated unit costs and to test the robustness of the economic evaluation. This analysis was carried out by varying the parameters within an assumed range that presents the maximum uncertainty of the figures; thus, the maximum uncertainty of the unit costs was assumed to be ±50%.

In the 1-way sensitivity analysis, we changed 1 variable (unit cost) at a time and recalculated the total costs for both groups. We then compared the groups again with the same statistical method. Every unit cost was assessed twice by assuming a lowest cost and a highest cost. The multiway sensitivity analysis was done by changing all of the variables (all unit costs) to the lowest assumed values and recalculating everything. The sensitivity analysis was then repeated by changing to the highest assumed values.

**RESULTS**

Between November 2009 and May 2010, 136 patients were identified as suitable for fast-tracking. Eighty-four patients were fast-tracked, and 52 went through the conventional pathway. The 2 groups were comparable with respect to age, sex, EuroSCORE, and the operations performed (Table 2). The median age was 64.0 years for the fast-track group and 63.5 years for the conventional group (Table 2).

Although clinically suitable for fast-tracking, patients in the conventional group were not fast-tracked for several reasons: The operation finished after 1430 hours (n = 35), there was a lack of beds in the TRU (n = 14), there was a lack of staff in the TRU (n = 2), and 1 patient was a carrier of methicillin-resistant Staphylococcus aureus and required an isolated room in the CICU.

Eight patients failed fast-tracking (ie, they were transferred from the TRU to the CICU), and 5 patients required readmission to a higher level of care (4 from the fast-tracking group and 1 from the conventional group).

Apart from 1 death, all patients were discharged in a satisfactory condition. The patient who died was a 74-year-old man who underwent a coronary artery bypass grafting operation. He developed a pneumothorax after removal of his chest drains; the pneumothorax was treated successfully after insertion of an intercostal drain. On the sixth postoperative day, however, the patient experienced cardiac arrest secondary to ventricular fibrillation and could not be resuscitated.

The 2 groups were significantly different ( $P < .001$ ) with respect to the duration of intubation and the length of stay (LOS) in the ICU but were similar with respect to the length of hospital stay and the incidences of complications (Tables 3 and 4).

The unit costs for the 2 recovery pathways were £1489 (\$2380) for the CICU and the TRU, £648 (\$1036) for the PCU, and £460 (\$735) for the ward. The total cost of perioperative care of cardiac surgery for the fast-track patient was £371 (\$593) less on average than for the conventional recovery pathway. The mean ( $\pm$ SD) cost was £4182  $\pm$  £2284 (\$6683  $\pm$  \$3650) for the fast-track group, compared with £4553  $\pm$  £1355 (\$7277  $\pm$  \$2165) for the conventional pathway group ( $P < .001$ ).

All sensitivity analyses demonstrated that the fast-track pathway was cheaper than the conventional pathway. The cost differences ranged from £166 (\$265) to £1324 (\$2116), and the mean difference was £623 (\$996). The differences in cost were significant in all analyses apart from the minimum CICU cost of £166 (\$265).

**DISCUSSION**

Major improvements in preoperative workup, anesthesia, myocardial protection, intensive care, and postoperative management have contributed to a decline in the morbidity and mortality associated with cardiac surgery [Yusuf 1994]. Consequently, the focus has shifted in recent years from reducing morbidity and mortality to reducing the escalating costs of perioperative care. In the last decade, fast-track or rapid-recovery pathways following cardiac surgery have become a common practice in many cardiac units. These changes aid in maximizing the use of the scarce resources for perioperative care.

The research we have described represents the first pragmatic prospective controlled study with an economic and clinical evaluation of the post-cardiac surgery fast-track recovery model using the TRU. It is important to have an accurate and comprehensive cost accounting for this recovery model in the current climate. Many of the previous studies reflected practices in the 1990s and therefore had limitations. Previous studies reported the difference in cost between units but did not perform an economic evaluation for the interventions [Chong 1992; Jindani 1993; Westaby 1993; Massey 1994]. Furthermore, the many changes that have occurred in the clinical and financial systems have made reevaluation of the fast-track system necessary. This study has shown that the model of fast-tracking through the TRU significantly decreased the ICU LOS. The total duration of intubation was significantly reduced from a median of 4.08 hours (range, 1.17-13.17 hours) to 2.75 hours (range, 0.25-18.57 hours). The reduction in hospital stay was not influenced significantly, however: a median of 7.12 days (range, 4.90-42.83 days) for the fast-track group, compared with 7.47 days (range, 5.75-17.10 days) for the conventional group. This result confirms previous findings that early extubation per se does not lead to a shorter hospital LOS [Ranucci 2007]. Our results are similar

Table 3. Comparisons of Durations of Intubation, Intensive Care Unit (ICU) Stays, and Hospital Stays\*

	Fast-Track Group		Conventional Group		P
	Mean SD, h	Median (Range), h	Mean SD, h	Median (Range), h	
CICU stay	8.61 31.24	0 (0-196.50)	26.79 11.58	22.71 (14.42-50.50)	<.001
TRU stay	5.77 1.46	5.58 (2.17-9.50)	0 0	0 (0)	<.001
Total ICU stay	14.38 31.23	5.92 (2.83-202.00)	26.79 11.58	22.71 (14.42-50.00)	<.001
PCU stay	23.92 14.32	20.00 (0-69.58)	8.49 15.72	0 (0-65.50)	<.001
Ward stay	137.95 62.51	121.00 (69.50-424.17)	138.90 62.26	121.50 (46.50-363.83)	.786
Total LOS	8.47 4.69	7.12 (4.90-42.83)	8.22 2.55	7.47 (5.75-17.10)	.645
Total intubation time, h	3.36 2.54	2.75 (0.25-18.57)	5.11 2.87	4.08 (1.17-13.17)	<.001

\*CICU indicates cardiac intensive care unit; TRU, theatre recovery unit; PCU, progressive care unit; LOS, length of stay.

Table 4. Incidences of Complications in the Conventional (n = 52) and Fast-Track (n = 84) Groups

Complication	Fast-Track Group, n (%)	Conventional Group, n (%)	P
Death	1 (1.12)	0 (0)	.430
Myocardial infarction	0 (0)	0 (0)	
Stroke	0 (0)	0 (0)	
Reexploration for bleeding	1 (1.12)	1 (1.92)	.730
Excessive medical bleeding	5 (5.95)	5 (9.62)	.426
Reintubation	4 (4.77)	3 (5.77)	
Atrial fibrillation	23 (27.38)	12 (23.08)	.577
Other arrhythmias	1 (1.12)	3 (5.77)	.125
Pneumothorax	2 (2.40)	0 (0)	.262
Pericardial effusion	1 (1.12)	0 (0)	.430
Renal dysfunction	2 (2.40)	1 (1.92)	.860
GI* complications	5 (5.95)	3 (5.77)	.965
Infections			
Chest infection	11 (13.10)	5 (9.62)	.540
Leg wound infection	1 (1.12)	2 (3.85)	.306
Sternal wound infection	3 (3.6)	1 (1.92)	.580
Other infections	8 (9.52)	3 (5.77)	.435
Other complications			
Poor gas exchange	10 (11.90)	7 (13.46)	.790
Prolonged air leakage	0 (0)	1 (1.92)	.202
Pulmonary edema	0 (0)	1 (1.92)	.202
Urinary retention	0 (0)	1 (1.92)	.202
Confusion/agitation	3 (3.6)	0 (0)	.430
Unresponsiveness	1 (1.12)	0 (0)	.172

\*GI indicates gastrointestinal.

to those of other studies [Chong 1992, 1993; Jindani 1993; Westaby 1993; Massey 1994; Hadjinikolaou 2000; Moon 2001; Calafiore 2002; Flynn 2004; Naughton 2005]. It is important to note that the LOS in our study was defined as the time from admission until discharge and was not just the postoperative stay. This difference translates into 1 extra day, compared with the studies that evaluated only the postoperative LOS.

Many previous reports defined early extubation in fast-track mode as <8 hours [Hawkes 2003]. Early extubation is the standard practice in our unit. The total duration of intubation was further reduced in our study, in both the conventional and fast-track groups, compared with the intubation times described in previous reports [Ott 1997; Hawkes 2003; Booth 2004].

Some studies reported discharge after 3 or 4 days [Ott 1997; Booth 2004]; however, the majority of the patients in these studies required close follow-up. In our study, patients were discharged only when they were entirely fit. They underwent just a routine follow-up at 6 weeks.

The groups did not differ with respect to their complication rates, which were similar to those reported for previous studies [Chong 1992, 1993; Jindani 1993; Westaby 1993; Massey 1994; Ott 1997; Hadjinikolaou 2000; Moon 2001; Calafiore 2002; Booth 2004; Flynn 2004; Naughton 2005; Ranucci 2007]. We found a 10% rate of fast-track failure requiring admission to the CICU. Many of these patients had borderline discharge criteria and were admitted to the CICU as a precaution. This study showed that the main reasons for not fast-tracking patients were the limited working hours for the unit and the lack of beds. These are important factors to take into consideration in redesigning services to increase fast-track throughput.

### Limitations

This study has some limitations. First, as with previous studies, patients were not randomized to management groups. Nevertheless, the way our unit functions by accepting 2 patients at a time and only before 1430 hours allowed the creation of a pragmatic control group. Sample selection was rigorous, and there was no evidence of selection bias. Second, the sample size in the study was relatively small, yet the study was able to detect a statistically significant difference with respect to ICU stay and the total duration of intubation.

### Future Studies

Our study did not look at the effect of fast-tracking on reducing the cancellation rate and its implications for savings; however, gross figures from a local audit suggest a reduction in the cancellation rate of approximately 40%. Even without taking that finding into account in the economic evaluation, our results have shown significant economic value to fast-tracking. If those cancellation savings are included, the economic benefit will be larger.

## CONCLUSION

In conclusion, fast recovery through the recovery unit after cardiac surgery decreases the intensive care LOS and the total duration of intubation. Fast-tracking is a cost-effective strategy compared with the conventional recovery route; however, there is no significant difference between the 2 pathways with respect to the total hospital LOS or the incidences of complications. The findings of this study should encourage other units to adopt a similar fast-track approach to improve outcomes and decrease the costs of cardiac surgery.

## REFERENCES

- Booth JE, Roberts JA, Flather M, et al. 2004. A trial of early discharge with homecare compared to conventional hospital care for patients undergoing coronary artery bypass grafting. *Heart* 90:1344-5.
- Brown MM. 2000. Implementation strategy: one-stop recovery for cardiac surgical patients. *AACN Clin Issues* 11:412-23.
- Calafiore AM, Scipioni G, Teodori G, et al. 2002. Day 0 intensive care unit discharge: risk or benefit for the patient who undergoes myocardial revascularization? *Eur J Cardiothorac Surg* 21:377-84.

- Cheng DC. 1995. Pro: early extubation after cardiac surgery decreases intensive care unit stay and cost. *J Cardiothorac Vasc Anesth* 9:460-4.
- Chong JL, Grebenik C, Sinclair M, Fisher A, Pillai R, Westaby S. 1993. The effect of a cardiac surgical recovery area on the timing of extubation. *J Cardiothorac Vasc Anesth* 7:137-41.
- Chong JL, Pillai R, Fisher A, Grebenik C, Sinclair M, Westaby S. 1992. Cardiac surgery: moving away from intensive care. *Br Heart J* 68:430-3.
- Flynn M, Reddy S, Shepherd W, et al. 2004. Fast-tracking revisited: routine cardiac surgical patients need minimal intensive care. *Eur J Cardiothorac Surg* 25:116-22.
- Hadjinikolaou L, Cohen A, Glenville B, Stanbridge RD. 2000. The effect of a 'fast-track' unit on the performance of a cardiothoracic department. *Ann R Coll Surg Engl* 82:53-8.
- Hawkes CA, Dhileepan S, Foxcroft D. 2003. Early extubation for adult cardiac surgical patients. *Cochrane Database Syst Rev* 2003:CD003587.
- Jegers M, Edbrooke DL, Hibbert CL, Chalfin DB, Burchardi H. 2002. Definitions and methods of cost assessment: an intensivist's guide. ESICM Section on Health Research and Outcome Working Group on Cost Effectiveness. *Intensive Care Med* 28:680-5.
- Jindani A, Aps C, Neville E, et al. 1993. Postoperative cardiac surgical care: an alternative approach. *Br Heart J* 69:59-63.
- Massey D, Meggit G. 1994. Recovery units: the future of postoperative cardiac care. *Intensive Crit Care Nurs* 10:71-4.
- Moon MC, Abdoh A, Hamilton GA, et al. 2001. Safety and efficacy of fast track in patients undergoing coronary artery bypass surgery. *J Card Surg* 16:319-26.
- Nalysnyk L, Fahrback K, Reynolds MW, Zhao SZ, Ross S. 2003. Adverse events in coronary artery bypass graft (CABG) trials: a systematic review and analysis. *Heart* 89:676-772.
- Naughton C, Cheek L, O'Hara K. 2005. Rapid recovery following cardiac surgery: a nursing perspective. *Br J Nurs* 14:214-9.
- Ott RA, Gutfinger DE, Miller MP, et al. 1997. Coronary artery bypass grafting "on pump": role of three-day discharge. *Ann Thorac Surg* 64:478-81.
- Ranucci M, Bellucci C, Conti D, Cazzaniga A, Maugeri B. 2007. Determinants of early discharge from the intensive care unit after cardiac operations. *Ann Thorac Surg* 83:1089-95.
- Staples JR, Ramsay JG. 1997. Advances in anaesthesia for cardiac surgery: an overview for the 1990s. *AACN Clin Issues* 8:41-9.
- Westaby S, Pillai R, Parry A, et al. 1993. Does modern cardiac surgery require conventional intensive care? *Eur J Cardiothorac Surg* 7:313-8.
- Yusuf S, Zucker D, Peduzzi P, et al. 1994. Effect of coronary artery bypass graft surgery on survival: overview of 10-year results from randomised trials by the Coronary Artery Bypass Graft Surgery Trial Lists Collaboration. *Lancet* 344:563-70.