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 cardioplectic 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
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 pO2 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 1. Exclusion Criteria for Fast-Track Recovery

<table>
<thead>
<tr>
<th>Variable</th>
<th>Fast-Track Recovery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mitral valve replacement</td>
<td></td>
</tr>
<tr>
<td>Redo grafts/valves</td>
<td></td>
</tr>
<tr>
<td>History of cerebrovascular attack</td>
<td></td>
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<tr>
<td>Emergency operation</td>
<td></td>
</tr>
<tr>
<td>Swan-Ganz catheter</td>
<td></td>
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<tr>
<td>Inadequate hemostasis</td>
<td></td>
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</tbody>
</table>

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

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

* 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 ±SD cost was £4182 ± £2284 ($6683 ± $3650) for the fast-track group, compared with £4553 ± £371 ($593) for the conventional group. 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*

<table>
<thead>
<tr>
<th></th>
<th>Fast-Track Group</th>
<th>Conventional Group</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>CICU stay</td>
<td>Mean  SD, h</td>
<td>Median (Range), h</td>
<td>Mean  SD, h</td>
</tr>
<tr>
<td></td>
<td>8.61  3.124</td>
<td>0 (0-196.50)</td>
<td>26.79  11.58</td>
</tr>
<tr>
<td>TRU stay</td>
<td>5.77  1.46</td>
<td>5.58 (2.17-9.50)</td>
<td>26.79  11.58</td>
</tr>
<tr>
<td>Total ICU stay</td>
<td>14.38 31.23</td>
<td>5.92 (2.83-202.00)</td>
<td>26.79  11.58</td>
</tr>
<tr>
<td>PCU stay</td>
<td>23.92 14.32</td>
<td>20.00 (0-69.58)</td>
<td>8.49  15.72</td>
</tr>
<tr>
<td>Ward stay</td>
<td>137.95 62.51</td>
<td>121.00 (69.50-424.17)</td>
<td>138.90 62.26</td>
</tr>
<tr>
<td>Total LOS</td>
<td>8.47 4.69</td>
<td>7.12 (4.90-42.83)</td>
<td>8.22  2.55</td>
</tr>
<tr>
<td>Total intubation time, h</td>
<td>3.36 2.54</td>
<td>2.75 (0.25-18.37)</td>
<td>5.11 2.87</td>
</tr>
</tbody>
</table>

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


