Fast-track paediatric cardiac surgery: the feasibility and benefits of a protocol for uncomplicated cases

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Abstract

Objective: Fast-track patient pathways for cardiac surgery are used in adult practice and by necessity is a mainstay in the developing world. We aimed to introduce a fast-track protocol for uncomplicated paediatric open-heart surgery cases and to subsequently review the results of this change in practice. Methods: A fast-track protocol co-ordinated by the Advanced Nurse Practitioners was introduced in January 2006 for children aged over 6 months undergoing uncomplicated open-heart procedures. We conducted a review of prospectively collected data on all included patients. The setting was a tertiary paediatric cardiac surgical centre in the UK. The outcome measures for audit were: patient fitness to leave the intensive care unit (ICU) on the day of surgery and hospital length of stay. Results: Included children had a mean age 6 (standard deviation (SD) 4.9) years and mean weight 22.7 (SD 17.6) kg. Of the 194 patients included, 153 (79%) were fit to leave the ICU on the day of surgery. Patients undergoing surgery for ventricular septal defect: odds ratio (OR) 2.8 (95% CI: 1.2—5.6) P = 0.01, and left ventricular outflow tract obstruction: OR 5.5 (95% CI: 1.4—21.2) P = 0.01, were more likely to be unfit than atrial septal defect and right ventricular outflow tract obstruction. Patients undergoing surgery in the afternoon were more likely to be unfit than those undergoing surgery in the morning: OR 2.3 (95% CI: 1.2—4.8) P = 0.03. No relationship was found between age or weight and fitness to fast track. Median length of hospital stay for the whole cohort was 3 (range: 2—11) days. After adjustment for case mix, there was significant evidence that length of hospital stay reduced as experience with the protocol increased over the series of patients RC = 0.02 (95% CI: −0.01 to −0.03) P < 0.01. Conclusion: A fast-track programme can be implemented safely and effectively if the appropriate support including a step-down ward area is put in place. Greater experience with this type of protocol leads to reductions in the length of hospital stay for children aged over 6 months undergoing uncomplicated open-heart surgery. Fast-track cases should be performed in the morning.

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1. Introduction

Fast-track cardiac surgery may be defined as a reduction in the patient journey time from admission to discharge and may be broken down into several components including:

- Admission to hospital on the morning of surgery [1].
- Reduced postoperative ventilation time [2].
- Same-day discharge from the cardiac intensive care unit (CICU) to the high dependency unit (HDU) on the cardiology ward.
- Early de-intensification (optimal analgesia, early liberalisation from fluids and early mobilisation) [3].
- Earlier discharge from hospital [4].

It is not synonymous with immediate postoperative tracheal extubation, which may be used in other contexts [5–8], although patients have at most a very brief period of mechanical ventilation.

In January 2006, the Great Ormond Street Hospital (GOSH) introduced a fast-track cardiac surgery programme incorporating the criteria listed above. Children are selected for the programme after discussion at the weekly Joint Cardiac multidisciplinary meeting where all referrals are presented and plans made for their individual care. To be eligible for the fast-track programme, children had to be over 6 months of age or weigh more than 10 kg, require uncomplicated open-heart surgery and be otherwise healthy. Exclusion criteria included small infants who are more likely to experience postoperative extubation failure [9], complex open-heart surgery where the postoperative period carries a higher risk of mortality and morbidity [10], requirement for post-procedural inotropic or vasodilator [11] and children with comorbid conditions associated with a greater likelihood of respiratory support [12]. Criteria for discharge to HDU are: stable and unsupported cardiac-pulmonary status, no evidence of postoperative bleeding and a fully conscious and comfortable patient. Any patient who required ongoing
respiratory assistance, cardiovascular support drugs, fluid boluses or close monitoring with one-to-one level nursing was considered unfit for fast track and kept in the ICU overnight.

2. Aims

The aims of this study were:

- To audit the fast-track cardiac surgery programme at GOSH.
- To ascertain the proportion of children who fast tracked successfully (i.e., were discharged from the CICU to the HDU area of the cardiology ward on the day of surgery) and to look for any factors that were linked with success or failure.
- To describe the overall length of hospital stay for patients in the fast-track programme and investigate factors linked with this outcome measure.

3. Methods

The study was registered with and approved by the Research and Development Office at the Institute of Child Health London.

A review of the fast-track database (Microsoft Excel spreadsheet) was performed. The Advanced Nurse Practitioner (ANP) in charge of the programme compiled data prospectively. The cases were numbered to allow analysis of whether position in the case series was related to either successful fast tracking or hospital length of stay.

Four demographic variables were reviewed:

- Age
- Weight in kg
- Operative procedure performed, which was categorised into:
  - (A) Atrial septal defect closure (ASD),
  - (B) Ventricular septal defect closure (VSD),
  - (C) Right ventricular outflow tract surgery (RVOT), consisting of relief of right ventricular outflow tract obstruction and placement of right ventricle to pulmonary artery conduit.
  - (D) Left ventricular outflow tract surgery (LVOT), consisting of resection of sub-aortic obstruction.
  - (E) Other procedures (Other), including mitral valve surgery and Warden procedure.
- Time of day of surgery: morning or afternoon case

The outcome measures were:

1. Fitness to fast track: whether or not the patient was clinically fit for discharge from the ICU on the day of surgery.
2. Overall length of hospital stay.

Any reason for failure to fast track and all patient complications were noted.

Data were analysed using the STATA 9 statistics package. For statistical analysis, the ASD closure group was considered the reference category as these patients had the greatest chance of successful fast tracking and the shortest length of hospital stay. To evaluate the effect of the operative procedure on outcome, each of the other four operative procedure categories were compared with the ASD group. Potential risk factors for failure to fast track were each investigated using univariate logistic regression analysis, generating the odds ratio for failure. Multiple logistic regression models were performed in order to ascertain the independent associations of the factors considered. The factors potentially linked to hospital length of stay were investigated using univariate linear regression analysis, generating a regression coefficient for length of hospitalisation for each factor. Factors were further explored with multiple regression models in order to ascertain the independent associations of the factors considered.

4. Results

A total of 194 patients were enrolled in the fast-track programme during the period of review from 1 January 2006 to 1 July 2008; this equates to around six patients per month. The largest group was ASD closure ($N = 84$), followed by VSD ($N = 60$), RVOTO ($N = 14$), LVOTO ($N = 11$) and others ($N = 25$). The mean age was 6.0 years with standard deviation (SD) 4.9 and mean weight was 22.7 (SD 17.6) kg. The cohort included 62 who were extubated on the operating table and 132 who were extubated in the ICU after a mean of 2.9 h (SD 4.5 h).

Of the 194 patients, 116 (60%) fast tracked successfully and 37 patients (19%) stayed overnight in CICU for logistical reasons such as lack of HDU beds or nursing staff issues. Therefore, overall, 153 patients (79%) were deemed clinically fit to fast track, and 41 patients (21%) were unfit since they stayed overnight in CICU for clinical reasons. These were mainly respiratory complications including re-intubation and postoperative stridor ($N = 12$), cardiovascular instability requiring inotropes or vasodilators ($N = 10$) or problems with bleeding/coagulation ($N = 6$). Table 1 shows the results of logistic regression to evaluate factors...
potentially associated with fitness to fast track. From Table 1, it can be seen that VSD ($P = 0.01$) patients were more likely to fail in comparison with the reference category ASD. Predictably, afternoon cases were more likely to fail than morning cases ($P = 0.03$). These three variables remained statistically significant when combined together in a multiple logistic regression model: VSD ($P = 0.02$), LVOTO ($P = 0.01$) and afternoon case ($P = 0.03$). No evidence was found for an association between either weight or age and fitness to fast track.

Length of hospital stay for the 194 patients ranged from 2 to 11 days, with mean 3.09 (SD 1.39) days. Seventy-one (37%) patients stayed 2 days, 107 (55%) stayed 3–4 days and 16 (9%) stayed 5–11 days. The length of hospitalisation did not vary greatly between the operative procedures: ASD 2.86 (SD 0.96) days, VSD 3.17 (SD 1.26) days, LVOTO 3.21 (SD 1.19) days, RVOTO 2.91 (SD 0.91) days and Others 3.8 (SD 2.55) days. We chose to present the multiple regression model of length of hospital stay in Table 2, where all the regression coefficients are adjusted for the other factors considered. The most notable finding was that the length of hospital stay decreased as the case number in the series increased, as the team involved in patient care became more familiar with the fast-track process ($P < 0.01$). There was some evidence that patients in the group of ‘Other’ procedures had longer hospital stays ($P = 0.02$), but given that the mean difference to the ASD category was less than 1 day, this was not a clinically meaningful margin. Given that adjusted regression coefficients are presented, it can be said that length of hospital stay fell with increased experience over time after adjustment for case mix in terms of operative procedure, age and weight. The graph in Fig. 1 demonstrates the increase in patients staying in hospital for 2 days, with a corresponding reduction in the numbers staying longer from 2006 to 2008, in keeping with the length of stay results demonstrated in Table 2.

5. Discussion

Our study shows that it is feasible to run an effective fast-track programme for uncomplicated open-heart procedures in children aged over 6 months at a UK centre. Approximately six out of 40 bypass operations per month were deemed suitable for inclusion based on pre-agreed criteria and selection at a multidisciplinary meeting. Of the 194 children enrolled in the first 2.5 years of the programme, 79% were fit to fast track out of the ICU on the day of their surgery. The likelihood of individual fitness was related to the operative procedure performed: ASD closure and RVOT surgery patients were more likely to fast track than VSD closure, LVOT and Other groups. The time of day that the surgery was performed was also a factor, therefore fast-track cases should be performed in the morning to maximise the likelihood of success. The patient’s age and weight were not linked to successful fast tracking; however, these are currently the selection criteria used for entry into the fast-track programme, with exclusion of smaller infants. As reported elsewhere [12,13], there was some indication of variation in hospital stay based on operative procedure, but the small difference observed of less than 1 day between groups was not considered clinically important in this series. The overall length of hospital stay significantly reduced since the programme began in 2006. This is attributed to greater experience and familiarity with the fast-track process with time, leading to more prompt de-intensification, mobilisation and discharge from hospital. Failure to fast track successfully did not impact on the overall length of hospital stay, and there appeared to be a good recovery even in the small number of children who suffered minor setbacks. There were no major complications or adverse events in the case series.

The aims of a fast-track programme are the simplification of postoperative care [1,3] and, it is hoped, an increase in patient and parent satisfaction. There are also theoretical economic considerations in terms of more cost-efficient care [4], associated with reduced consumption of intensive care and hospital resources. Any new programme should ensure that the practice is safe, with no increased risk to patients, hence the need for a multidisciplinary audit. Our programme was introduced with inputs from anaesthesia, cardiology, cardiac surgery, cardiac intensive care and nursing specialists. This group developed a pre-agreed protocol or patient pathway [2] for: patient inclusion, anaesthesia, analgesia, patient monitoring, family communication and de-intensification. An ANP who is essential for provision of consistent safe and effective care has led the programme from the
outset. The development of a high dependency or step-down area in the cardiology ward was also integral to the safety and effectiveness of the protocol. Prospective data collection on every patient is part of our routine practice. This includes the data presented here as well as blood gases, complications and all relevant times and dates. Based on this current audit study, we are satisfied with our current protocols but now plan to undertake an audit of parent and patient satisfaction with the process.

Fast-track surgery is not a new concept; it was common practice in the UK in the 1960s and 1970s due to the older patient population, limited drug availability and inferior ventilator technology of the time. For similar reasons, fast-track practices remain a mainstay of treatment for congenital heart surgery in the developing world [6,14,15]. As the complexity of case mix and available technology have evolved in the 1990s and beyond, prolonged postoperative ventilation has become more common after open-heart surgery [12]. Over the past few years there has been a change in surgical management techniques for certain congenital heart defects, moving away from initial palliation with delayed repair towards early primary repair [16,17]. When more complex repairs are undertaken, in particular for smaller infants, there is a greater likelihood of a transient reduction in cardiac output in the postoperative period, necessitating the use of inotropes and vasodilators [11] and more prolonged stay in intensive care [13]. Small infants undergoing open-heart surgery may be suitable for early extubation [8], but these patients were excluded from the fast-track programme and kept in intensive care overnight for cardio-vascular monitoring and pharmacologic support as required. As we and others [1] have shown, this is infrequently necessary for straightforward surgery in fit, larger children such as those included in our cohort.

In terms of study limitations, we have not presented the impact of the fast-track programme on the remainder of our cardiac surgical workload. The data required for such an analysis are beyond the scope of this audit; however, we have not noted any reduction in overall case volume or obvious adverse knock on effect. The data presented here only relate to those children who fulfilled inclusion exclusion criteria for fast tracking, and this may have introduced some selection bias into the analysis. We are unable to present any control group data, since none exists. Since the patients were included based on a predefined protocol, it may be the case that a wider group of procedures might be suitable for inclusion in the fast-track programme in the future. We also speculate that more extended use of the high-dependency unit may be an area for development. As stated, an important current goal is the audit of parent and patient views on this process: these data are currently unavailable.

6. Conclusions

To date, the fast-track cardiac surgery programme at GOSH has been a success since its introduction in January 2006. Its main aims have been achieved, namely the majority of patients in the programme have fast tracked successfully and been discharged from ICU on the day of surgery, and the overall length of hospital stay has been reduced. These data can now be used to aid careful assessment of cases on an individual basis to enable realistic preparation of the patient, parents and staff involved in the care of each child.

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References