

◆ EDITORIAL VIEWS

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Fast Track Cardiac Surgery Pathways

Early Extubation, Process of Care, and Cost Containment

COST containment and efficient resource use have forced the pendulum back to the debate of early tracheal extubation in cardiac surgical patients and the evolution of value-based anesthesia care.^{1,2} The pressure to reduce costs resulted from market forces and health care reform in the 1990s. In this era of cost containment and physician report cards, we are held accountable for patients' outcome in terms of mortality, morbidity, quality of life, length of stay (LOS), and costs of care. Although it has recently been demonstrated that early tracheal extubation anesthesia is safe, cost beneficial, and can improve resource use in cardiac surgery,^{3,4} questions still remain regarding the significance of early extubation, the process of care on resource utilization, and costs of cardiac surgical care. In this issue of ANESTHESIOLOGY London *et al.* further our understanding by questioning "should we pre-select patients into fast track cardiac surgery? Or what are the predictive risk factors for early tracheal extubation?"⁵ Butterworth *et al.* addresses a controversial question: "can anesthetic agents facilitate early extubation and thus reduce intensive care unit and hospital length of stay?"⁶ The principal question is "cost containment in fast track cardiac surgery pathways: early extubation or process of care?"

This Editorial View accompanies the following articles: Butterworth J, James R, Prielipp RC, Cerese J, Livingston J, Burnett DA, and the CABG Clinical Benchmarking Data Base Participants: Do shorter-acting neuromuscular blocking drugs or opioids associate with reduced intensive care unit or hospital length of stay after coronary artery bypass grafting? ANESTHESIOLOGY 1998; 88:1437-46; and London MJ, Shroyer AL, Coll JR, MaWhinney S, Fullerton DA, Hammermeister KE, Grover FL: Early extubation following cardiac surgery in a veterans population. ANESTHESIOLOGY 1998; 88:1447-58.

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The Concepts

Before we examine these questions, there are a few terms that need to be clarified.

1. *Fast track cardiac anesthesia*: A perioperative anesthetic management that aims to facilitate tracheal extubation of patients within 1-6 h after cardiac surgery. Most centers consider fast track extubation up to 8-10 h postoperation.
2. *Fast track cardiac surgery or pathways*: A process of care, including multidisciplinary approach aimed to improve the efficiency of care in cardiac surgical patients. Early extubation anesthesia is a major key to the success of the fast track cardiac surgery pathways.

Clinical pathways were first applied to health care in the 1980s when prospective payment systems focused greater interest on potential methods to improve hospital efficiency. Clinical pathways are management plans that display goals for patients and provide the corresponding ideal sequence and timing of staff actions to achieve those goals with optimal efficiency. The general format of critical pathways outlines the suggested patient care process based on a time-task matrix, listing the components of care in one column and crossaligning these entries with columns pertaining to time. The lack of active involvement by physician-experts is a key reason for the failure of pathway programs.

Should We Pre-select Patients for Fast Track Cardiac Surgery Pathways?

Several studies have suggested that perioperative morbidity and mortality of cardiac surgical patients are strongly influenced by patients' preoperative severity of illness and postoperative complications.⁷⁻¹² Becker *et al.* found that the postoperative acute physiology score (APS) was the most powerful predictor of mortality.¹² They hypothesized that postoperative APS reflected the summation effects of surgical skill, anesthetic management, effectiveness of immediate postopera-

tive care, and the preoperative characteristics of the patient.¹² Although the literature has shown that intraoperative anesthetic management,^{13,14} duration of cardiopulmonary bypass and of aortic cross clamp,¹⁵ the individual anesthetist,¹⁶ and postoperative intensive care unit (ICU) management¹⁷ can all influence the outcome of patients, these factors have not been incorporated into any cardiac surgery risk predictive model. In an analysis of 885 consecutive coronary artery bypass graft (CABG) patients who underwent fast track cardiac anesthesia, 75% were found to be extubated within 10 h. Only age, intraoperative inotropic use and intra-aortic balloon pump (IABP), and postoperative rapid atrial arrhythmia were found to be independent predictors of failing to meet extubation criteria.¹⁸ Therefore preoperative risk factors other than age of patients are not major predictors when considered with the intraoperative and postoperative process of care variables for early extubation. Further, intraoperative and postoperative complications were shown to be major determinants of prolonged ICU LOS.¹⁹

London *et al.*⁵ investigated this important question of whether early extubation is a patient or hospital level variable process of care in fast track clinical pathways. Of the preoperative risk variables considered, only age and preoperative IABP were multivariately associated with time to extubation (Risk Model). In a Risk-Process Model, intraoperative clinical process variables were found to add significantly to the model performance. An adverse association with major inotropes use and platelet transfusion could be attributable to intraoperative hemodynamic instability, poor cardiac function, and coagulopathy from prolonged cardiopulmonary bypass duration. There was no surprise that prolonged intubation time was associated with increasing dosage of narcotics used. They confirm that intraoperative clinical process variables are more important factors in determining the timing of postoperative extubation than preoperative risk factors.

The strengths of the study by London *et al.*⁵ are (1) patient population managed by fast track clinical pathways, (2) inclusion of both CABG and valvular surgery, and (3) inclusion of intraoperative clinical process variables to preoperative risk factors. The limitations of this study are (1) retrospective data collection, (2) relatively small sample size, (3) almost only male gender population, (4) other compounding factors and temporally associated changes in process of care unrelated to the fast track pathways, (5) no inclusion of physician-specific factors, and (6) no use of a separate derivation and

validation data set or validation methodology. The work by London *et al.*⁵ supports our contention that we need not pre-select patients for fast track cardiac anesthesia, *i.e., every patient should be a candidate for early extubation.* It is the intraoperative and postoperative morbidity rates that ultimately determine the feasibility of early extubation and ICU LOS.

Is Fast Track Cardiac Anesthesia Safe?

Consistent with other fast track clinical pathways observational studies relative to a pre-fast track cohort,²⁰⁻²⁵ London *et al.*⁵ also did not detect any increase in postoperative morbidity and mortality rates. In a prospective randomized controlled trial, Cheng *et al.*³ recently demonstrated that early extubation did not increase postoperative cardiorespiratory, sympathoadrenal stress, morbidity, or mortality.

How Early Should Patients Be Extubated?

Although it is possible to extubate patients postoperatively on the operating table, the early risks of hypothermia, bleeding, and cardiorespiratory instability outweigh the potential cost-saving benefits and is not recommended by most centers.^{3,4,20,21} One must not forget the delay and the costs of operating room (OR) time to fully awaken and extubate patients in the OR. These patients should be assessed for extubation 1-6 h post-operation.

Do Short-acting Anesthetic Agents Facilitate Early Extubation, Thus Reducing ICU and Hospital LOS?

Butterworth *et al.*⁶ address an interesting question, namely the impact of more *versus* less expensive neuromuscular blocking agents or narcotics on critical care use and hospital LOS from a multicenter database. A total of 1,094 patients undergoing primary CABG surgery at 40 academic health centers were studied. There was marked and statistically significant variability by site in duration of intubation, ICU LOS after extubation, and postoperative LOS. The authors concluded that there was no difference between vecuronium and pancuronium in duration of intubation, and the use of shorter-acting opioid or neuromuscular blocking drugs had no association with ICU LOS after extubation or postoperative LOS.

The strengths of the study by Butterworth *et al.*⁶ are (1) relatively large sample size of primary CABG surgery, (2) multicenter design, and (3) use of several statistical models for analysis. The limitations of this study are (1) retrospective study design, (2) no standardization of procedures, extubation or LOS discharge criteria, or data collection among centers, all thus resulting in marked interhospital variation in outcome measurement, (3) no standardization of the anesthetic drugs dosage being used, timing for dosage, or total dosage for the operation, and (4) no standardization of physician practices in the drugs being examined. Despite these limitations, this study is consistent with the others observational studies^{20,22,23} as the method of delivering health care (process of care) could have a more significant impact on ICU and LOS than the choice of the drugs (early extubation) being used. This study supports our contention that *early tracheal extubation does not necessarily mean early ICU or hospital discharge.*

Cost Containment in Fast Track Cardiac Surgery Pathways: Early Extubation or Process of Care?

It has been shown that resource use measured as LOS and cost are strongly influenced by severity of illness of patients, postoperative complications,⁴ and efficiency of nursing unit^{26,27} and that there are variations in resource use among different institutions.^{6,28} London *et al.*⁵ identify an interesting point between early extubation and resource use: the time of ICU admission after surgery was significantly associated with prolonged intubation. There is a bimodal distribution with a nadir in the frequency of extubation occurring between 10 and 12 h postoperatively in their population. Also the relation between time to extubation and ICU LOS is not continuous in their center, given that transfer out of the ICU occurs at relatively set times of the day centered around nursing shift changes. Similarly Butterworth *et al.* recognize that when duration of intubation exceeded certain threshold values, it was associated with increased LOS measures.⁶ Therefore, *the process of postoperative care must be modified to complement early tracheal extubation for maximum cost efficiency.*

Intensive care unit LOS is a commonly used yardstick for indirect measurement of cost. However, decreased ICU LOS does not necessarily translate into cost savings

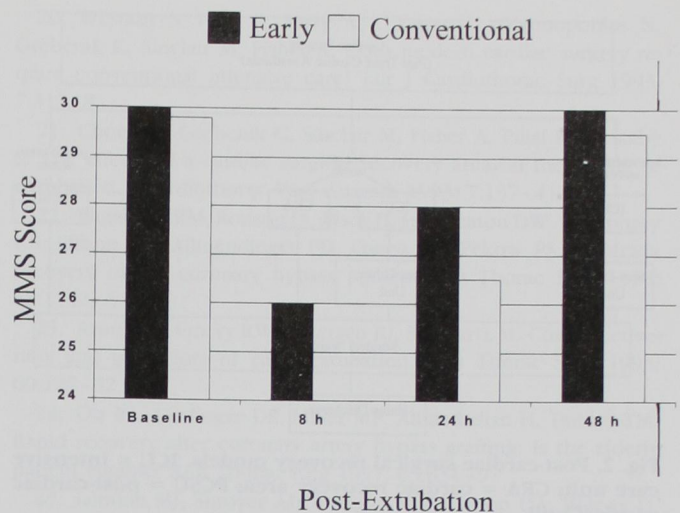


Fig. 1. Recovery of mini-mental state (MMS) score post-extubation between early extubation and conventional extubation CABG patients. Adapted from Cheng DCH, Karski J, Peniston C, Asokumar B, Raveendran G, Carroll J, Nierenberg H, Roger S, Mickle D, Tong J, Zelovitsky J, David T, Sandler A: Morbidity outcome in early versus conventional tracheal extubation after coronary artery bypass grafting: A prospective randomized controlled trial. *J Thorac Cardiovasc Surg* 1996; 112:755-64.

unless variable costs are proportionately reduced. It should be noted that the economic consequences of post-CABG complications are far more costly than an uncomplicated recovery.⁴ Early extubated patients recover to baseline performance in the mini-mental state (MMS) test 24 h before the conventional extubation group (fig. 1).³ This accelerated improvement in mental status allows earlier chest tube removal, mobilization, and oral intake of food, resulting in reduced ICU and hospital LOS. Therefore, *we must control sedation rather than allowing sedation to control us.*

Fast track cardiac anesthesia provides the opportunity for the paradigm shift in postoperative care of cardiac surgical patients. It will be necessary to enhance the efficiency of delivering the care process, change the process of care, or alter the structure environment (e.g., ICU). The concept of providing graded levels of care in post-cardiac surgical unit model can be categorized by patient flow and postoperative recovery (fig. 2).

1. *Conventional Model:* The conventional flow of patients from OR to ICU, then to a free standing unit and ward.
2. *Parallel Model:* A free-standing unit that directly admits postoperative cardiac patients and operates in parallel to an independent ICU.²⁰

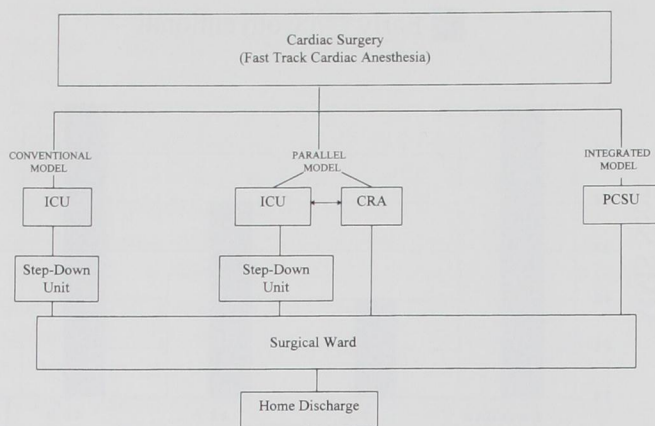


Fig. 2. Post-cardiac surgical recovery models. ICU = intensive care unit; CRA = cardiac recovery area; PCSU = post-cardiac surgical unit.

3. *Integrated Model:* A fully integrated post-cardiac surgical unit with ICU. Patients are admitted directly from OR and recover with flexible nursing ratio for different acuity level of care.^{3,4}

It should be emphasized that specific advantages of any one model of care for a specific institution or program may depend on the caseload, personnel, resources, or physical structure available.

Conclusions

This is an exciting era of evolution in cardiac surgical care. Fast track cardiac anesthesia grants a paradigm shift in postoperative care in fast track cardiac surgical pathways. An important challenge for anesthesiologists is to participate in the clinical pathways development and implementation so that the management protocols reflect our knowledge in perioperative care. Innovations should continue to focus on perioperative process of care to prevent or reduce morbidity and mortality, which will result in improvement of resource utilization and costs of care. We continue to require multicenter database benchmarking studies; although we must ensure standardization of definitions and appropriate perioperative and outcome variables collected. Clinical pathways emphasize efficiency of care, therefore it is important to monitor not only the hospital phase but also pre-hospital and post-hospital care for cost-effectiveness. Despite the limitations, this type of analysis and modeling is important to generate association, predictions, and further hypothesis. We must confirm out-

come studies with comprehensive validation methodology, although for defining causal relationship, therapeutic intervention, or changing clinical practice, the most powerful study design is still a prospective randomized, double-blinded controlled clinical trial.

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Laryngeal Reflexes

Exploring Terra Incognita

THE most honest of ancient cartographers referred to areas of the map beyond human knowledge as simply *terra incognita*. Despite their obvious clinical signifi-

cance,¹ reflexes that involve the function of the upper airway largely remain *terra incognita* for the anesthesiologist. Since the classic description of human laryngospasm by Fink in 1956,² the anesthesia literature has been largely barren of clinical investigation into this important topic. Basic information regarding each component of these reflexes, especially in anesthetized humans, is simply not available. There are several possible reasons for this ignorance, but many probably relate to the difficulty in assessing laryngeal function *in vivo*. In this issue of *ANESTHESIOLOGY*, Tagaito *et al.*³ introduce a technique that may prove useful to explore this unknown territory.

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