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Accelerated Recovery after Cardiac Operations

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ABSTRACT

Background: The accelerated-recovery approach, involving early extubation, early mobility, decreased duration of intensive care unit stay, and decreased duration of hospitalization has recently become a controversial issue in cardiac surgery.

Methods: We investigated timing of extubation, length of intensive care unit stay, and duration of hospitalization in 225 consecutive cardiac surgery patients. Of the 225 patients, 139 were male and 86 were female; average age was 49.73 ± 16.95 years. Coronary artery bypass grafting was performed in 127 patients; 65 patients underwent aortic and/or mitral or pulmonary valvular operations; 5 patients underwent valvular plus coronary artery operations; and in 28 patients surgical interventions for congenital anomalies were carried out.

Results: The accelerated-recovery approach could be applied in 169 of the 225 cases (75.11%). Accelerated-recovery patients were extubated after an average of 3.97 ± 1.59 hours, and the average duration of stay in the intensive care unit was 20.93 ± 2.44 hours for these patients. Patients were discharged if they met all of the following criteria: hemodynamic stability, cooperativeness, ability to initiate walking exercises within wards, lack of pathology in laboratory investigations, and psychological readiness for discharge. Mean duration of hospitalization for accelerated-recovery patients was 4.24 ± 0.75 days. Two patients (1.18%) who were extubated within the first 6 hours required reintubation. Four patients (2.36%) who were sent to the wards returned to intensive care unit due to various reasons and 6 (3.55%) of the discharged patients were rehospitalized.

Conclusions: Approaches for decreasing duration of intubation, intensive care unit stay and hospitalization may be applied in elective and uncomplicated cardiac surgical interventions with short duration of aortic cross-clamping and cardiopulmonary bypass, without risking patients. Frequencies of reintubation, return to intensive care unit, and rehospitalization are quite low with this approach.

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INTRODUCTION

The accelerated-recovery approach is a current controversial issue. Recently, many developments have occurred in anesthesia management, surgical technique, and postoperative management. Adoption of the accelerated-recovery approach involves issues of preoperative education of the patient and the patient's family, anesthesia management, operative intervention, early extubation (within 6 hours postoperatively), decreased length of stay in an intensive care unit (ICU) by discharging the patient to a ward within the first 24 hours, early mobility, discharge from the hospital within the first 5 days, and maintenence of communication with the patient after discharge from the hospital [Engelman 1994, Krohn 1990, Wilmore 2000].

Krohn and colleagues [1990] first addressed this subject, publishing "Rapid Sustained Recovery after Cardiac Operations" in August 1990. The approach was first applied at Hartford Hospital, then at Baystate Medical Center [Engelman 1994].

In adopting an accelerated-recovery approach for our cardiac surgery patients, we did not apply a specific protocol (also called "fast-track protocol" in the literature). We aimed to investigate and discuss the feasibility of extubation within 6 postoperative hours, discharge from ICU within 24 hours, and discharge from the hospital within 5 days, by using routine anesthesia, surgery, and postoperation management.

MATERIALS AND METHODS

An accelerated-recovery approach that included shorter duration of intubation, ICU stay, and hospital stay was used in treatment of 225 consecutive cardiac surgery patients who underwent surgery performed by the same surgical team. No preoperative excluding criteria were applied; all cases, including elective, urgent, emergency, and redo surgeries, were included. Patient and the family were informed preoperatively and they were prepared for the application. Of 225 cases, 139 were male and 86 were female; average age was 49.73 ± 16.95 years.

Surgical interventions included coronary artery bypass grafting (CABG) (127 patients), aortic and/or mitral or pulmonary valvular operations (65 patients), valvular plus coronary operations (5 patients), and operations for congenital anomalies (28 patients) (Table 1, Figure ◎). Operations were classified as elective, urgent, and emergency according to

Table 1. Distribution of Accelerated-Recovery Patients (N = 169)*

Type of Operation	n	%
Coronary artery bypass grafting operations	**99**	**58.23**
CABG×1		
CPB	19	11.17
Beating-heart	40	23.53
CABG×2		
CPB	28	16.47
Beating-heart	1	0.59
CABG×3		
CPB	11	6.47
Valvular operations	**43**	**25.3**
AVR	5	2.94
AVR plus ascending aortoplasty	3	1.76
AVR plus MVR	2	1.18
AVR plus OMC→MVR	1	0.59
MVR	7	4.12
OMC	15	8.82
OMC→MVR	1	0.59
OMC plus AVR	5	2.94
Mitral valve posterior leaflet quadrangular resection	1	0.59
Mitral valve posterior leaflet quadrangular resection plus ring annuloplasty	1	0.59
Pulmonary valvotomy	2	1.18
Valvular plus coronary operations	**3**	**1.76**
Mitral valve repair plus CABG	3	1.76
Correction of congenital defects	**24**	**14.12**
Atrial septal defect	16	9.41
Ventricular septal defect	6	3.53
Ventricular septal defect plus AVR	1	0.59
Ventricular septal defect plus MSA	1	0.59

*CABG indicates coronary artery bypass grafting; CPB, cardiopulmonary bypass; AVR, aortic valve replacement; MVR, mitral valve replacement; OMC, open mitral comissurotomy; MSA, membranous septum aneurysm.

their priority (Table 2). In 57 (44.88%) of patients who had CABG, interventions were performed on a beating heart, whereas in the remaining 70 patients (55.12%) cardiopulmonary bypass (CPB) was used.

Anesthesia Management

The same anesthesia team performed the preoperative evaluation of patients for anesthesia management, and standard anesthesia regimens were used for pediatric and adult patients. All adult patients received midazolam (Dormicum) 0.05-0.1 mg/kg intramuscularly (IM) and scopolamine 0.006 mg/kg IM for premedication and they received fentanyl 10 μg/kg intravenously (IV), propofol (Diprivan) 2 mg/kg IV and pancuronium bromide (Pavulon) 0.1 mg/kg IV for induction of anesthesia. For maintenance, they received 2-5 μg/kg per hour fentanyl and 1.5-2 mg/kg per hour propofol (Diprivan) infusions and when necessary 0.05 mg/kg IV bolus pancuronium bromide (Pavulon). Sevoflurane (Sevorane) %1.5-3 V was preferred for maintenance. In pediatric patients, we used ketamine (Ketalar) 7-10 mg/kg IV and atropine sulfate (Atropine) 0.02 mg/kg IM for premedication, and thiopental (Pentothal) 3-5 mg/kg IV and pancuronium bromide (Pavulon) 0.1 mg/kg IV for induction.

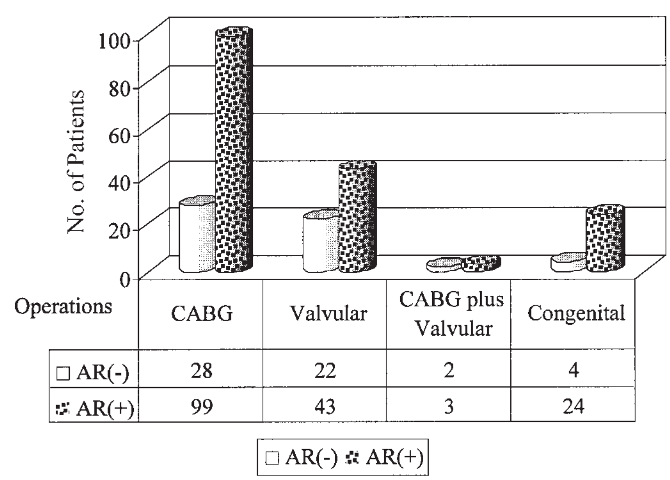
Operative Technique

Nonpulsatile bypass and a Dideco membrane oxygenator were used in all operations (SpA, Mirandola, Italy). Mild hypothermia, antegrade blood cardioplegia, and external cold application were used. The left internal thoracic artery was routinely used for the bypass of left anterior descending artery, and the saphenous vein was used for other coronary arteries.

Accelerated-Recovery Management

To prevent tissue edema and provide early extubation, perioperative fluid restriction was done so as to provide a balanced or almost balanced fluid intake-output. Hemodynamically stable and awakened patients with normal body temperature, with sufficient oxygenation and spontaneous respiration, and without hemorrhage were extubated within the first 6 postoperative hours (mean, 3.97 ± 1.59 hours). Digitalization was done when necessary (in patients with a left ventricle ejection fraction [EF] <30%, with atrial extrasystoles, and in patients in whom atrial fibrillation developed); and beta-blockers were continued in patients who had been using these agents preoperatively. Besides replacements for electrolyte imbalances, pre-, peri- and postoperative routine prophylactic (for the prophylaxis of atrial fibrillation) magnesium sulfate infusions were also given.

Patients were followed by the team who had cared for them in the ICU. Patient-controlled analgesia (PCA) was used when postoperative analgesia was required, as follows: tramadol (Contramal), 50-mg loading dose, 0.07 mg/kg per hour infusion rate, 10-mg IV bolus dose and a following 20 minutes of locking; this dosing was continued for 24 hours.



Graphic representation of accelerated-recovery (AR) patients and patients in whom it could not be applied, compared by types of surgery. CABG indicates coronary artery bypass grafting.

Table 2. Degree of Priority for Operations*

Operations (N = 225)	Elective (n = 181)	Urgent (n = 38)	Emergency (n = 6)
CABG (n = 127)	90 (70.87%)	31 (24.40%)	6 (4.73%)
Valvular (n = 65)	59 (90.77%)	6 (9.23%)	—
Valvular plus coronary (n = 5)	4 (80%)	1 (20%)	—
Congenital (n = 28)	28 (100%)	—	—

*CABG indicates coronary artery bypass grafting.

Following initiation of oral intake, patients received ketoprofen (one oral profenid 200-mg retard tablet per day) until discharge from the hospital. Pediatric patients received paracetamol as suppository (Paranox) in ICU and as paracetamol syrup after initiation of oral intake. In ICU, in order to prevent harmful effects of hypothermia, body temperature of patients was kept around 37°C and a blanket with electrical heater was used when necessary.

Patients were sent from ICU to the wards within the first 24 hours (mean, 20.93 ± 2.44 hours). Opportunities for early mobility and physical activity were provided. Sorbitol, tween 80, glycerin and sodium citrate combination were used for intestinal regulation. Ranitidine (Ulcuran) was used to decrease gastric acidity. Perioperative or postoperative corticosteroid was used when necessary (eg, in cases with long duration of CPB, myocardial edema, and increased pulmonary interstitial fluid). It was administered as 1 perioperative or postoperative dose of 250 mg once daily methylprednisolone (Prednol-L).

A patient with normal sinus rhythm and good oral intake and exercise capacity, with hematocrit >25% mg/dL, and without any surgical wound problem and who were afebrile (<37.5°C) was discharged from the hospital if the patient, the patient's family, and the doctor agreed on early discharge, if the residence of the patient was close to the hospital, and if a close communication with the patient was possible.

Statistical Analysis

Computerized statistical analyses were performed using SPSS 10.0 (SPSS, Chicago, IL, USA) statistical software. Data are expressed as means ± standard deviation. A *P* value of less than .05 was considered of statistical significance. The independent-samples *t* test, Pearson's chi-square test, the Fisher exact test, one-way analysis of variance (ANOVA), Levene's f test, post hoc multiple comparisons, Tukey's honestly significant differences test, and binary logistic regression analysis were used in the statistical evaluation of data.

For patients who underwent CPB, differences in durations of aortic cross-clamping (CC) and CPB between the accelerated-recovery group and the remaining patients were evaluated using the independent-samples *t* test based on the comparison of 2 independent group means. Levene's f test was done to test the homogeneity of variances of 2 groups. Group variances were found to be homogenous according to the f test. For the difference between mean durations of aortic CC, f: 0.067 significance (sig): 0.796, *t* test for equality of means *P* = .016, 95% confidence interval of the difference (CID), lower (l): 2.64 upper (u): 25.26 values were found with independent-samples *t* test. For the difference between mean durations of CPB, f: 0.186 sig: 0.667, *t* test for equality of means *P* = .038, 95% CID, l: 0.83 u: 29.74 values were found with independent-samples t test. As 95% CID did not include zero value in either calculation, the differences were considered to be significant.

For the effect of different operations in cases with long duration of hospitalization and for which the accelerated-recovery approach could not be adopted, Pearson's chi-square test based on the comparison of more than 2 independent group ratios was used. In cases for which the accelerated-recovery approach could not be used, a *P* value of .131 (2-sided) was obtained when all reasons of failure including social reasons were considered, whereas when only medical reasons were taken into account, and social reasons were excluded, a *P* value of .150 (2-sided) was found.

Individual operations were compared with each other by using the Fisher exact test, and inability to adopt the accelerated-recovery approach did not differ in terms of operation type. For patients for whom the accelerated-recovery approach was not adopted, because of an extended hospitalization, and in whom different operations were performed, mean durations of hospitalization were compared by the one-way analysis of variance method. By the use of post hoc multiple comparisons, Tukey's honestly significant differences test, variance equalities within operation groups were investigated and extended duration of hospitalization was not affected by operation type (*P* = .173).

Rate of return to ICU unit for patients younger than and older than 70 years of age was investigated by using the Fisher exact test based on comparison of independent group ratios (1 cells [25.0%] have expected count less than 5. The minimum expected count is 0.67) and no significant increase in return to ICU for patients older than 70 years of age (*P* = .508 [2-sided]). For determination of the significance of risk factors related to an ICU stay of more than 1 day, a binary logistic regression analysis was the preferred regression model, because of the nominal characteristics of the dependent variable "extended ICU stay." Independent variables were duration of aortic CC, duration of CPB, advanced age, respiratory complications, extended inotropic support, and increased blood and blood product transfusion.

RESULTS

Patients were extubated after an average of 3.97 ± 1.59 hours postoperatively. Two patients who were extubated after 2 and 4 hours postoperatively in ICU (one had undergone CABG and the other had undergone mitral valve replacement [MVR]) were reintubated at postoperative +3 and +20 hours, respectively. However, the first patient was extubated within the first 6 postoperative hours and was sent to the wards within 24 hours. For the latter, the accelerated-recovery approach could not be applied due to failure of reextubation. For accelerated-recovery patients, rate of freedom from intubation was 98.82%. Because only 2 patients required

Table 3. Distribution of Operations without Accelerated-Recovery Approach (N = 56)*

Operations	n	%	*P*†
Coronary artery bypass grafting operations	**28**	**50**	$P_{general}$ = .280 (n = 28) $P_{medical}$ = .062 (n = 5)
CABG×1			
CPB	3	5.36	
Beating-heart	13	23.21	
CABG×2			
CPB	6	10.71	
Beating-heart	3	5.35	
CABG×3			
CPB	2	3.58	
CABG×4			
CPB	1	1.79	
Valvular operations	**22**	**39.28**	$P_{general}$ = .061 (n = 22) $P_{medical}$ = .141 (n = 7)
AVR	5	8.92	
AVR plus supracoronary graft	1	1.79	
AVR plus MVR	3	5.35	
MVR	6	10.71	
OMC	4	7.14	
OMC plus AVR	3	5.36	
Valvular plus coronary operations	**2**	**3.57**	$P_{general}$ = .600 (n = 2) $P_{medical}$ = .306 (n = 1)
AVR plus CABG	1	1.79	
Mitral valve repair plus CABG	1	1.79	
Correction of congenital operations	**4**	**7.15**	$P_{general}$ = .242 (n = 4) $P_{medical}$ = .709 (n = 3)
Redo atrial septal defect plus PPVCA	1	1.79	
Atrial septal defect plus mitral valve repair→MVR	1	1.79	
Ventricular septal defect	1	1.79	
Pulmonary stenosis	1	1.79	

*CABG indicates coronary artery bypass grafting; CPB, cardiopulmonary bypass; AVR, aortic valve replacement; MVR, mitral valve replacement; OMC, open mitral comissurotomy; PPVCA, partial pulmonary venous connection anomaly.

†$P < .05$ is significant.

reintubation and in one of them the accelerated-recovery approach could not be applied, no statistical analysis for the determination of significance of risk factors leading to reintubation was performed.

Patients without any hemodynamic or laboratory abnormality were sent to the wards within 24 hours (mean, 20.93 ± 2.44 hours). Of 221 surviving patients, 9 stayed in ICU more than one day (4.07%), for the following reasons: inotropic support (4 patients), late extubation and respiratory problems (3 patients), arrhythmia (1 patient), and complete atrioventricular block (1 patient). Use of blood and blood products (2.84 ± 1.32 units: $P = .374_{nonsignificant[ns]}$), advanced age ($P = .953_{ns}$), duration of CPB ($P = .312_{ns}$), and duration of aortic CC ($P = .210_{ns}$) did not have any significant effect on duration of ICU stay; however, this duration was significantly increased by chronic obstructive pulmonary disease (odds ratio [OR] = 3.191, 95% CI: lower [l] = 1.268; upper [u] = 8.029; $P = .014$, binary logistic regression analysis) and inotropic support (OR = 5.684, 95% CI: l = 2.404; u = 13.437; $P < .001$; binary logistic regression analysis).

Four (2.36%) of 169 patients who were sent to wards in the first day returned to the ICU for various reasons: dyspnea (1 patient, CABG), atrial fibrillation (1 patient, CABG), pneumonia (1 patient, aortic valve replacement [AVR] plus MVR) and pneumothorax (1 patient, CABG). Rate of freedom from ICU return was 97.64% for patients who were sent to the wards within the first day.

Accelerated-recovery patients were discharged after an average of 4.24 ± 0.75 days. Rehospitalization rate was 3.55% (6 patients) for accelerated-recovery patients. Reasons for readmission to the hospital were gastrointestinal bleeding (1 patient, MVR), abdominal distention (1 patient, beating-heart CABG), sternal instability accompanied by cutaneous and subcutaneous infection (1 patient, CABG), endocarditis and ventricular failure (1 patient, AVR plus MVR), low cardiac output (1 patient, MVR) and atrial fibrillation (1 patient, CABG). Freedom from rehospitalization was 96.45% for accelerated-recovery patients. When reasons for return to ICU and rehospitalization were considered, no statistical analysis for the determination of risk factors was performed, because each patient had individual risk factors for these conditions.

The accelerated-recovery approach could be used in 75.11% of cases. It could not be adopted in 56 patients because of social factors, morbidity, and mortality (Table 3). Specific reasons for inability to apply an accelerated-recovery approach were as follows: social factors (ie, psychologically

Table 4. Reasons for Failure of Accelerated-Recovery Approach (N = 56)

Reasons	n	%
Social reasons	38	67.85
Arrhythmia		
Atrial fibrillation	3	5.36
Ventricular fibrillation	2	3.57
Need for inotropic support	3	5.36
Late extubation	2	3.57
Cardiac failure	2	3.57
Valve repair failure	1	1.79
Dyspnea	3	5.36
Anemia	2	3.57

unprepared patient, weekend day of discharge resulting in the discharge procedure not being completed, distant patient residence) (38 patients, 67.85%); arrhythmia (5 patients, 8.92%); need for inotropic support (3 patients, 5.36%); late extubation (2 patients, 3.57%); cardiac failure (2 patients, 3.57%); valve repair failure (1 patient, 1.79%); dyspnea (3 patients, 5.36%); and anemia (2 patients, 3.57%) (Table 4).

The effect of operation type on the failure of the accelerated-recovery approach was investigated, considering all causes (including social reasons) of failure and medical causes (excluding social reasons) of failure. Statistical significance was classified as $P_{general}$ and $P_{medical}$ and they were as follows for different operation types. CABG: $P_{general}$ = .280 (28 patients), $P_{medical}$ = .062 (5 patients); valvular operations: $P_{general}$ = .061 (22 patients), $P_{medical}$ = .141 (7 patients); valvular plus coronary operations: $P_{general}$ = .600 (2 patients), $P_{medical}$ = .306 (1 patient); and congenital operations $P_{general}$ = .242 (4 patients), $P_{medical}$ = .709 (3 patients) (the Fisher exact test).

For operations in which the accelerated-recovery approach could not be applied, extended duration of hospitalization was not affected by one or more operation type (*P* = .173, one-way analysis of variance; post hoc multiple comparisons, Tukey's honestly significant differences test).

In cases of cardiopulmonary bypass, mean durations of aortic CC and CPB were 55.53 ± 30.08 minutes and 88.19 ± 38.09 minutes, respectively, for accelerated-recovery patients, whereas these values were 69.48 ± 30.54 minutes and 103.48 ± 39.54 minutes, respectively, for patients ineligible for accelerated recovery. Durations of aortic CC and CPB were significantly higher in the non–accelerated-recovery group (for duration of aortic CC, *P* = .016; for duration of CPB, *P* = .038; CI, 95%, independent-samples t test].

Rate of return to the ICU (6.25%) was not found to be significantly higher for patients older than 70 years (*P* = .508, the Fisher exact test, 2-sided). Only one patient returned to the ICU due to dyspnea in this age group.

Early mortality was 1.77% (4 patients). One of 2 patients who had CABG underwent the operation by CPB and could not awaken properly during postoperative period. He became dependent on a respirator and died of adult respiratory distress syndrome (ARDS). The other CABG patient underwent beating-heart surgery and developed ventricular fibrillation at the fourth hour; he was resuscitated by internal cardiac massage in ICU. CPB was resumed and because left ventricle lateral wall contractions were not adequate, an additional bypass was done to the diagonal coronary artery that had a noncritical stenosis (angiographically) preoperatively. However, the patient died on the second day postoperation due to low cardiac output. A patient who had AVR and MVR could not be weaned from the respirator postoperatively; low cardiac output developed and the patient died due to ARDS and sepsis. A patient with MVR could not awaken and died due to dependency on respirator and sepsis.

Midterm mortality was 0.90% (2 patients). One of the 2 patients who died during midterm died 2 months following discharge because of endocarditis and ventricular failure (AVR and MVR). The other underwent beating-heart surgery; his EF was <30% and pulmonary artery pressure was 70-26 mm Hg. This patient died of low cardiac output after one month.

DISCUSSION

Studies for decreasing the duration of intubation, ICU stay, and hospital stay were initiated by B. Krohn and colleagues in 1990 at Los Angeles Good Samaritan Hospital [Krohn 1990]. In this approach, a patient and the patient's family are preoperatively informed about the accelerated-recovery application and they are allowed to prepare themselves. Patients are extubated in ICU within the first 6 hours and they are sent to the wards within the first 24 hours. Early mobility and physical activity are ensured. For intestinal regulation, metoclopramide HCl docusate sodium tid is recommended, and for decreasing gastric acidity, ranitidine is recommended [London 1998, Quigley 1997]. We used sorbitol, tween 80, glycerin and sodium citrate combination for intestinal regulation.

Corticosteroids are administered preoperatively and postoperatively for inhibition of inflammatory response and complement activation that are caused by CPB. Corticosteroids prevent complement activation during CPB, provide membrane stabilization, and contribute to myocardial protection [Engelman 1994]. We did not use corticosteroids routinely in all our study patients; instead, we used them when necessary (in cases of extended duration of CPB perfusion, myocardial edema, and increase in interstitial fluid).

Postoperative pain should be controlled by medications in the accelerated-recovery approach [Engelman 1994, London 1997]. According to pain management protocol of our center, adult patients are given tramadol (Contromal) via PCA in ICU and it is continued until oral intake is resumed. Then oral medication is given and ketoprofen (one oral profenid 200 mg retard tablet per day) is given until the patient is discharged from the hospital. Paracetamol is used for analgesia in pediatric age group.

Discharge takes place within 5 days if the patient is afebrile (<37.5°C), has sinus rhythm, lives close to the hospital, has no wound problem, and has a hematocrit of >25% mg/dL; if there is agreement between patient, family, and physician about early discharge; and a close dialogue with the patient is possible after discharge [Quigley 1997]. This approach decreases duration of hospitalization, morbidity and costs [Cheng 1998c].

Benefits of early extubation and early discharge from ICU within the first 24 hours include decreased morbidity, provision of early mobility, protection against infections that are due to extended duration of intubation, prevention of complications such as agitation and hypoxia that are due to increased duration of ICU stay, and prevention of complications due to immobilization such as venous thrombosis and pulmonary emboli [Engelman 1994, Oxelbark 2001]. Early mobility, strengthening of respiratory muscles, and pulmonary physiotherapy, which are provided by early discharge from the ICU to a ward, prevent atelectasis, dyspnea, and possible reintubation [Cheng 1998b, London 1998].

Nine of our patients (4.07%) stayed in the ICU for more than 1 day. Factors causing this extended stay were inotropic support, late extubation and respiratory problems, arrhythmia, and complete atrioventricular block. Amount of blood and blood product transfusion, advanced age, duration of CPB, and duration of aortic CC did not significantly increase the length of ICU stay; however, the ICU stay was found to be increased by inotropic support and chronic obstructive pulmonary disease.

Recently, use of high-dose opiods to prevent postoperative respiratory depression and to provide early extubation in open heart surgery has been decreasing, replaced by a "balanced anesthesia technique" involving combination of short-acting opiods with short-acting hypnotics. Although many agents are used for this purpose, propofol combined with low-dose fentanyl or remifentanil (Ultiva) is frequently used [Cheng 2001, Hickey 1995]. As a routine anesthesia technique in our center, we use a combination of propofol (Diprivan) and low-dose fentanyl.

As a benefit of early extubation, negative circulatory effects of positive pressure ventilation and positive end-expiratory pressure, and resulting insufficient perfusion of organs (myocardial and renal perfusions) are prevented. Extended duration of intubation increases duration of stay in the ICU. Intubated patients who are unable to establish verbal communication are anxious. Early extubation enables early communication and mobilility, and the likelihood of reintubation decreases [Cheng 1998b, Cheng 2001, Cheng 1998a), Hickey 1995, Royston 1998, Silbert 1998].

Engelman and colleagues [1996] reported that a protocol called "fast track," which resembles our accelerated-recovery application, did not increase early or late mortality and there was no difference between this group and non–fast-track group in terms of readmission to the hospital. Lahey and colleagues [1998] reported that the readmission rate of patients who were discharged after the seventh day was higher than that for patients who were discharged on the fourth, fifth, and sixth postoperative days. Engelman and colleagues [1994] found readmission rates for a fast-track group and a non–fast-track group to be 8.3% and 7.1%, respectively. Our results are similar this earlier data. In cases with early extubation and decreased ICU and hospital duration, rates of reintubation, return to ICU and rehospitalization were 1.18%, 2.36% and 3.55%, respectively, rates that are within acceptable limits. In our accelerated-recovery patients, therefore, freedom from reintubation, return to ICU, and rehospitalization were 98.82%, 97.64% and 96.65%, respectively.

When we compared cases with and without an accelerated-recovery approach in terms of type of the operation performed, no significant difference was found. In CPB cases, however, extended duration of aortic CC and CPB had significant negative impact on the abililty to apply an accelerated-recovery approach.

This accelerated-recovery approach may be applied to congenital heart disease cases and elderly patients (older than 70 years) [Engelman 1997, Lee 1999, Marianeschi 2000]. For elderly patients, Engelman and colleagues [1997] recommend to keep aortic CC time under 45 minutes and CPB time under 75 minutes and to avoid unnecessary revascularizations. We applied this accelerated-recovery approach in 24 (85.71%) of our 28 congenital surgery cases and in 16 patients over 70 years of age. No return to ICU or rehospitalization was necessary in congenital cases. One (6.25%) of patients above 70 years of age returned to ICU due to dyspnea, and no rehospitalization was seen in this group. Therefore, age greater than 70 years was not found to be a risk factor for return to ICU.

There are published data stating that the accelerated-recovery approach may be applied in complicated cases without any distinction [Engelman 1996, Serna 1998]. Our study also included high-risk patients with cardiac pathology. These included a patient who developed dissection of the left anterior descending coronary artery following transluminal coronary angioplasty and 7 patients with EF below 30%. None of these patients returned to ICU. However, a patient with low EF died 1 month after discharge from the hospital because of low cardiac output.

There are articles in the literature suggesting that most frequently encountered factors related to the extended duration of hospitalization following successful cardiac operations were noncardiac factors and there is emphasis that extended duration of initial hospitalization cannot prevent rehospitalization [Engelman 1996, Krohn 1990]. In our study factors extending the duration of hospitalization were social factors (67.85%), arrhythmia (8.92%), need for inotropic support (5.08%), late extubation (3.39%), cardiac failure (3.39%), valve repair failure (1.69%), dyspnea (5.08%) and anemia (3.39%) (Table 4). Causes for rehospitalization were gastrointestinal bleeding, abdominal distention, sternal instability, late tamponade and endocarditis, right heart failure, and atrial fibrillation.

The accelerated-recovery approach also has a cost-decreasing effect in cardiac surgery. But it must not cause a shift of costs to another hospital [Lahey 1998]. Therefore patients should be closely followed after discharge and whether they are hospitalized in another institution should be investigated. The accelerated-recovery approach should not be adopted for patients who have a likelihood of rehospitalization.

CONCLUSION

Based on our findings and the current literature data, we suggest that an accelerated-recovery approach that involves stages of decreasing the durations of intubation, intensive care unit stay, and hospitalization may be successfully applied in uncomplicated and elective cardiac surgery cases with short durations of aortic cross-clamping and cardiopulmonary bypass. Furthermore, we believe that this approach may be adopted without necessity for a special protocol, by applying current routine anesthesia, surgery, and postoperation management methods.

This approach avoids possible hospital complications and allows resumption of a patient's physiological and social conditions as soon as possible. Early extubation and early discharge from intensive care and from the hospital do not increase morbidity and mortality. Reintubation, return to the intensive care unit, and rehospitalization rates are quite low.

Although cost is an important issue, economic concerns should not solely determine whether this approach is to be applied. Early extubation and discharge (from intensive care unit and from the hospital) should not be the only aim. Physiological status of the patient should determine the management.

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