Original Article

The Reduction in Hospital Stay and Costs in the Care of Patients with Congenital Heart Diseases Undergoing Fast-Track Cardiac Surgery

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Objective

To assess the care provided to patients with congenital heart diseases and ischemic heart diseases undergoing cardiac surgery according to the fast-track recovery protocol compared with those undergoing the conventional procedure.

Methods

The transfer of patients from one hospital unit to another was assessed for 175 patients, 107 (61%) men and 68 (39%) women, with ages ranging from 0.3 to 81 years.

Results

The discharge rate from the different hospital units per unit of time of the patients with congenital heart diseases treated according to the fast-track recovery protocol compared with that of patients conventionally treated was as follows: a) 11.3 times faster than the discharge rate of patients treated according to the conventional protocol, in regard to the time spent in the operating room; b) 6.3 times faster in regard to the duration of the surgical intervention; c) 6.8 times faster in regard to the duration of anesthesia; d) 1.5 times faster in regard to the duration of perfusion; e) 2.8 times faster in regard to the stay in the postoperative recovery I unit; f) 6.7 times faster in regard to hospital stay (time period between hospital admission and hospital discharge); g) 2.8 times faster in regard to the stay in the preoperative unit; h) 2.1 times faster in regard to the stay in the admission unit after discharge from postoperative recovery; i) associated with reduced costs. The difference was not significant for patients with ischemic heart disease.

Conclusion

A reduction in the length of hospital stay and costs for the care of patients undergoing cardiac surgery according to the fast-track protocol was observed.

Key words

cost-benefit ratio, cardiac surgery, congenital heart diseases, treatment

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Cardiac surgical interventions are part of the current therapy for heart diseases, are a significant source of demand for economic and technical resources, and have the greatest economic impact on the hospitalizations authorized by the Brazilian Public Health System (Sistema Único de Saúde - SUS). In the year 2000, 2,398,344 hospital admissions were authorized by the SUS in the state of São Paulo, comprising a cost of R$ 1.2 billion. Among the hospitalizations due to surgical procedures of greatest economic impact, the following stood out: 6,785 (0.28%) myocardial revascularizations using extracorporeal circulation, at a cost of R$ 37.1 million (3.15%); and 1,689 (0.07%) surgical corrections for congenital heart diseases, at a cost of R$ 12.5 million (1.07%)[1]. An unsatisfied demand is believed to exist.

The technology involved in the diagnosis and surgical treatment of cardiovascular diseases is expensive. In 1999, the SUS spent R$ 763 million with 1.1 million hospitalizations due to diseases of the circulatory system, and, from January to March 2000, the SUS spent R$ 3.6 million with 1.4 million cardiologic medical visits[1]. The increase in costs is also evident in the accounting records of the hospital where this study was carried out: from 1995 to 2000, it increased from R$ 88.6 million to R$ 153.1 million[2].

Increases in the cost of health care[3] caused the implementation of studies on management of the health care system in regard to the finite nature of financial resources[4-7]. For some authors[8], the increase in costs was even considered a threat to the future of cardiac medical practice, if not managed properly. The increase in costs has led medical and hospital care providers of different countries, such as Germany[9], Switzerland[10], United States[10-15], Australia[14,15], and Canada[16], to assess alternative management strategies for these services, assuring access to services, the quality of services, and affordable costs. This change in scenario resulted in new strategies to reconcile customer satisfaction, organizational survival, and positive financial results[12]. The reduction in the needs of patients with health insurance, the reduction in payments for the services provided, the increase in competition, and the constant need for technological improvements caused hospitals to reexamine the processes used to manage expenses and resources to satisfy the demands imposed by scientific progress and to maintain activities related to that progress.

Surgeries account for 60% of the hospitalizations at the facility where this study was conducted. These surgeries are expensive, complex procedures, and the hospital services required by such procedures are expensive also. This demand and its complexity create the need for short, medium, and long-term planning that involve different segments, and, in some circumstances, may require waiting lists, as also observed in other countries, such as England[7] and Canada[2].

In the cardiovascular surgery programs, 38.9% to 45% of the expenditures occur in the operating room[16], and 71.8% to 80%[7] of the total occur in the first 36-48 postoperative hours, which includes the intensive care unit (ICU). The remaining costs between 15% and 21.3% occur in the wards, and between 5% and 6.9% in the outpatient care units. In the hospital studied, the expenditures had the following distribution: approximately 61% in the ICU and operating room and 39% in the wards. More recently, cardiovascular surgery programs have been proposed to optimize costs with no sacrifice in quality[20].

The concept of fast-track cardiac surgery appeared in the beginning of the 1990s. The principles of the protocol adopted were as follows: 1) intense education in preoperative care, aiming at not delaying hospital discharge; 2) extubation as soon as possible; 3) administration of anti-inflammatory medications as required; 4) prophylactic medication for supraventricular arrhythmias and gastrointestinal complications; 5) the patient should become ambulatory as soon as possible; 6) careful administration of fluid volume; 7) hospital discharge expected to occur between the third and fifth postoperative days[10,21]. The articulated combination of these principles reduced the response to stress, to organic dysfunction, and the time for the complete recovery of the patient, resulting in a reduction in hospital costs.

Other experiences have also been successful in more than 2000 cases of cardiovascular surgeries in adults, with good medical results, satisfaction of the patient, shorter hospital stay, and a reduction in costs[9,16,19,22]. The results were similar in pediatric cardiovascular surgeries[10,23].

A pilot study was developed based on the fast-track cardiac surgery protocol, allowing the anticipation of the need for a more detailed study of the process, from its medical-scientific foundation to the understanding of its organizational implications.

This study was carried out to assess the fast-track cardiac surgery protocol in Brazil, to analyze the organizational aspects of the different segments participating in the patient's treatment, and to contribute to the continuous improvement in organizational culture.

Methods

This study comprised patients undergoing cardiovascular surgery according to the fast-track recovery protocol and the conventional protocol from February 2000 to May 2001. The project was approved by the hospital's committee on ethics for the analysis of research projects.

The fast-track protocol provided specific management to assure an articulated flow with no delays in the medical and administrative procedures necessary for the best evolution of the process. The fast-track protocol comprised the prehospital and in-hospital phases. The prehospital phase included: a) outpatient care medical visit with the patient and his family and the members of the health care team. The outpatient care medical visits had the following objectives: to acquaint the patient and his family with the members of the team, such as the clinician, surgeon, anesthetist, nurse, social assistant, physical therapist, and, occasionally, the psychologist; b) prescheduling of the surgery before the last medical visit prior to hospitalization; c) adjustment of the arrangements for the hospitalization on the day before surgery, approximately 12 hours before; d) information to and preparation of the patient for early postoperative mobilization; e) preparation of the family to receive the patient at home after hospital discharge on the fourth postoperative day; f) in case of any problem and delay in hospital admission, the patients and family should give notice to the clinician and his team to receive the necessary care and orientation to plan the delay of surgery, allowing another patient to benefit from the delay; g) the release of the authorization for hospital admission, registering it on a waiting list, and its strict management by the support unit for the patient hospitalized or in the emergency unit; and, finally, h) the summoning of the patient.

The in-hospital phase comprised the following stages: A) at the admission unit - which is a continuation of patient-team interaction, with clinical medical visit, preanesthetic visit, and nurse visit, with professionals already known by the patient from the outpatient care visits prior to hospitalization, except for the nurse; addition of a new nurse professional could occur, if required; B) in the operating room - a) surgery performed by the surgeon and first attending physician participating in the fast-track protocol; b) anesthetic care to enable orotracheal extubation as early as possible; C) in the postoperative recovery unit - a) orotracheal extubation as soon as possible; b) efficient analgesia to enhance breathing and postoperative physical therapy; c) discharge from the postoperative recovery unit to the admission unit, as soon as the clinical conditions of the patient allow, without having to wait for a routine hour of transfer.

The conventional protocol was performed according to the usual hospital routine and comprised the prehospital and in-hospital phases.

The prehospital phase consisted of the following: a) outpatient care visit exclusively with the clinician; b) visit with the nurse after the medical visit for instructing the patient or his caretaker, or both, about the routine and preparation for the tests to be performed; c) once the diagnostic process was concluded, the clinician released the authorization for hospital admission and registered it on a waiting list; d) visit with the nurse after the medical visit for orientation about the summoning to hospitalization; e) summoning of the patient based on the management of vacant hospital beds and concomitant scheduling of the surgical program, coordinated by the support unit for patients hospitalized or in the emergency unit.

The in-hospital phase consisted of the following: A) in the admission unit: a) review of the clinical conditions and diagnostic examinations by the medical and nurse team acting in the admission unit; b) correction or inclusion of the patient in the surgical program; B) in the operating room – surgery performed by the team scheduled by the surgical programming unit; C) in the postoperative recovery unit: a) recovery in the postoperative routine recovery unit I or II; b) transfer to the admission unit according to a routine of pre-established times.

The diagnoses adopted were established by the medical team according to ICD-10.

The examinations and procedures performed on the patients with congenital and ischemic heart diseases in the pre, trans, and postoperative phases in the 2 protocols were considered for billing purposes. The medications and special materials (ortheses and prostheses) used were accounted for according to the total length of hospital stay. For billing purposes, the values adopted for the procedures and examinations were those from the table provided by the Brazilian Medical Association - 1990; for the special materials, the values adopted were those of the SUS; and for medications, the values adopted were those of the Brasíndice 2002.

All patients participating in the fast-track recovery and conventional protocols with the following characteristics were included in the study: a) first surgical intervention; b) no clinical or laboratory evidence of ventricular dysfunction; c) noncomplex congenital acyanotic heart diseases and ischemic heart diseases; d) at least 2 outpatient medical visits before hospitalization. The following patients were excluded from the study: a) patients who had undergone previous cardiac surgery; b) patients with complex congenital heart diseases; and c) patients who had undergone emergency heart surgery.

The study comprised 622 patients undergoing cardiovascular surgical intervention, of whom 203 (32.6%) were operated on according to the fast-track protocol, and 419 (67.4%) were operated on according to the conventional protocol. In the fast-track protocol, 107 patients were considered eligible for the study: 56 (52%) patients with congenital heart diseases and 51 (48%) patients with ischemic heart diseases. In the conventional protocol, 68 patients were considered eligible for the study: 26 (38%) patients had congenital heart diseases and 42 (62%) had ischemic heart diseases.

Table I shows the patients' ages. The age of patients with congenital heart diseases in the fast-track protocol ranged from 1.0 to 38 (± 10.8) years, and the age of those in the conventional protocol ranged from 0.3 to 60 (± 16.0) years. In regard to patients with ischemic heart diseases, the age of those in the fast-track protocol ranged from 38.0 to 79.0 (± 8.8) years, and the age of those in the conventional protocol ranged from 18.0 to 81.0 (± 12.3) years.

The distribution regarding sex in each medical care protocol according to the diagnosis is shown in table II. Of the 107 (61.1%) men, 37 (34.6%) had congenital heart disease and 70 (65.4 %) had ischemic heart disease. Of the 68 (38.9%) women, 45 (66.2%) had congenital heart diseases, and 23 (33.8%) had ischemic heart diseases.

Table I - Distribution of the frequencies according to age (in years) in patients with congenital and ischemic heart diseases in the 2 protocols

Age	Protocol			
	Congenital		Ischemic	
	Fast-track	Conventional	Fast-track	Conventional
N	56	26	51	42
Mean	11.9	10.0	60.0	59.4
Standard deviation	10.8	16.0	8.8	12.3
Minimum	1.0	0.3	38.0	18.0
Median	10.0	4.0	60.0	59.0
Maximum	38.0	60.0	79.0	81.0

Table II - Distribution according to sex for patients in the 2 protocols

Heart disease	Protocol	Sex			
		Male	%	Female	%
Congenital	Fast-track	28	50	28	50
	Conventional	9	65	17	35
Ischemic	Fast-track	41	80	10	20
	Conventional	29	69	13	31
Total		107	61	68	39

The weight of patients with congenital heart diseases in the fast-track recovery protocol ranged from 4.5 to 77 (mean of 32) kg, and their body mass index ranged from 6.3 to 44.4 (mean of 18.4) kg/m^2; the weight of patients with congenital heart diseases in the conventional protocol ranged from 2.5 to 75 (mean of 19.8) kg, and their body mass index ranged from 11.1 to 28.2 (mean of 16.2) kg/m^2. The weight of patients with ischemic heart diseases in the fast-track recovery protocol ranged from 44 to 104 (mean of 72.7) kg, and their body mass index ranged from 19.6 to 37.1 (mean of 26.5) kg/m^2. The weight of patients with ischemic heart diseases in the conventional protocol ranged from 44 to 100 (mean of 72.4) kg, and their body mass index ranged from 17.6 to 35.2 (mean of 26.9) kg/m^2.

The diagnoses of the patients with congenital heart diseases in the fast-track recovery protocol were as follows: atrial septal defect in 37 (66%) patients, persistent ductus arteriosus in 14 (25%), and ventricular septal defect in 5 (9%). The diagnoses of those in the conventional protocol were as follows: atrial septal defect in 12 (46%) patients, ventricular septal defect in 9 (35%), and persistent ductus arteriosus in 5 (19%). On the other hand, the diagnoses of the patients with ischemic heart disease in the fast-track recovery protocol were as follows: chronic coronary heart disease in 36 (55.5%) patients, and acute coronary heart disease in 12 (18.5%). Fifteen (23%) patients had already experienced previous myocardial infarction. Glycemia ranged from 83 to 336 (mean of 137.1) mg/dL, and creatinine values ranged from 0.7 to 1.8 (mean of 1.1) mg/dL. The diagnoses of the patients in the conventional protocol were as follows: chronic coronary heart disease in 39 (75%) patients and acute coronary heart disease in 3 (6%). Glycemia ranged from 74 to 446 (mean of 141) mg/dL, and creatinine values ranged from 0.7 to 10.6 (mean of 1.3) mg/dL. Eight (15%) patients had experienced myocardial infarction.

To assess the transfer of patients from one hospital unit to another, the following parameters were studied: age; sex; weight; body mass index; height; fast-track recovery and conventional protocols; type of heart disease; in-hospital evolution; postoperative infection; infection after hospital discharge; readmission; time elapsed between admission and surgery; length of stay in the operating room; duration of surgery; duration of anesthesia; duration of the perfusion procedure; length of stay in the postoperative recovery unit; length of postoperative hospitalization; length of hospital stay; and billing of examinations, procedures of the entire health team involved, special materials, and medications during hospitalization.

The descriptive analysis was performed using the minimum and maximum values, median, mean, and standard deviation. The length of stay of patients in the different hospital units was estimated with the probability of survival by using the Kaplan Meier method,

in which discharge from a hospital unit (representing the transfer of the patient to another unit) was considered an event, and death was considered the censored data. The comparisons between the stays in the different units studied in both protocols were performed with the Log-Rank and Breslow tests[24]. Then, the Cox proportional hazards regression model was used[24]. Finally, the 1-way analysis of variance (ANOVA) was used to compare the procedures and examinations performed, the consumption of medications, and the use of special materials in the pre-, trans-, and postoperative phases. The value of $P < 0.05$ was considered significant.

Results

The following procedures were performed in the patients with congenital heart diseases: section and suture of persistent ductus arteriosus, ventricular septoplasty, atrial septoplasty. Of the 56 patients in the fast-track protocol, 14 (25%) corrections of persistent ductus arteriosus were performed without extracorporeal circulation, and of the 26 patients in the conventional protocol, 5 (19%) corrections of persistent ductus arteriosus were performed without extracorporeal circulation.

The patients with ischemic heart disease underwent myocardial revascularization as follows: 51 patients in the fast-track protocol, 6 (12%) of whom had no extracorporeal circulation; and 42 patients in the conventional protocol, 8 (19%) of whom had no extracorporeal circulation.

Postoperative infection occurred in 6 (3.9%) patients. In patients with congenital heart diseases, postoperative infection occurred in 1 (4.3%) patient in the conventional protocol, and no infection was observed in those in the fast-track protocol. Postoperative infection was observed in 5 patients with ischemic heart disease, 2 (4.5%) in the fast-track protocol and 3 (7.1%) in the conventional protocol. Records of 4 patients in the conventional protocol were not recovered, 2 with congenital heart diseases and 2 with ischemic heart diseases. Among the patients with ischemic heart diseases in the fast-track protocol, 2 (4.1%) died in the hospital. Evolution after hospital discharge was followed up in the period studied through an active search of hospital records.

Infection after hospital discharge was diagnosed in 18 (10.3%) patients as follows: 2 (7.7%) had congenital heart diseases and were in the conventional protocol, 7 (13.7%) had ischemic heart diseases and were in the fast-track protocol, and 9 (21.4%) had ischemic heart diseases and were in the conventional protocol. No infection was observed in patients with congenital heart diseases in the fast-track recovery protocol.

Ten (6.0%) patients were rehospitalized, 1 (4.3%) of whom had congenital heart disease and was in the conventional protocol. No rehospitalization was observed in patients with congenital heart disease in the fast-track protocol. Of the patients with ischemic heart disease, 3 (6.7%) rehospitalizations were observed in patients in the fast-track protocol and 6 (14.3%) rehospitalizations were observed in patients in the conventional protocol. The records of 6 patients in the fast-track protocol and of 3 patients in the conventional protocol were not recovered.

The length of hospital stay in the different hospital units for patients with congenital heart diseases is shown in tables III and IV and the comparison of the Kaplan Meier curves is shown in figure 1 (length of preoperative hospitalization) and figure 2 (length of hospital stay).

The length of stay in the different hospital units for patients with ischemic heart diseases is shown in tables V and VI and the comparison of the Kaplan Meier curves is shown in figure 3 (preoperative hospitalization) and figure 4 (length of hospital stay).

The billing values observed in the pre, trans, and postoperative phases based on the records of the examinations, procedures, special materials used, and medications administered are shown in tables VII and VIII.

The multivariate analysis of the transfer of patients with congenital heart diseases from one hospital unit to another estimated by the relative risks of discharge from these units is shown in table IX.

The relative risk of stay in the preoperative unit was 2.8, ie, the discharge rate per unit of time for patients with congenital heart disease in the fast-track protocol was 2.8 (95% CI = 2.1; 4.0) times greater than the discharge rate of patients in the conventional protocol.

The relative risk of the duration of the surgical procedure was 6.3, ie, the discharge rate per unit of time for patients with congenital heart disease in the fast-track protocol was 6.3 (95% CI = 3.6; 11.0) times greater than the discharge rate of patients in the conventional protocol.

The difference in the transfer of patients with ischemic heart diseases from one hospital unit to another was not statistically significant between the fast-track and conventional protocols.

Discussion

The patients' ages ranged from 3 months to 81 years, showing the feasibility of the fast-track protocol for adults and children[5,11,22,25,26]. Patients with less complex heart diseases were studied, and this was observed in other reports in the literature, which included

Table III - Length of stay in the different hospital units for patients with congenital heart disease in the 2 protocols

Unit	Fast-track protocol				Conventional protocol			
	Min	Max	Mean	sd	Min	Max	Mean	sd
Preoperative hospitalization (days)	1	1	1	1	1	26	6.6	7.4
Stay in the operating room (hours)	1.9	4.8	3.3	0.6	2.8	6.8	5	1.1
Duration of surgery (hours)	1.1	3.8	2.1	0.7	1.3	5.5	3.4	1.1
Duration of anesthesia (hours)	1.8	5	3.2	0.6	2.5	6.5	4.7	1.1
Duration of perfusion (hours)	-	2	0.6	0.5	-	1.9	0.9	0.6
Stay in REC I (hours)	24	57.2	30.5	8.4	6.2	125.3	47.3	33.4
Hospital stay after discharge from REC (days)	2	8	3.4	1.3	2	13	5	2.4
Length of hospital stay (days)	4	10	5.5	1.3	4	38	13.5	8.7

sd: standard deviation; REC: recovery

Table IV - Descriptive levels of the Log-Rank and Breslow tests for comparison of the patients with congenital heart disease treated according to the 2 protocols regarding length of stay/duration

Variable	Descriptive level	
	Log-Rank	Breslow
Length of hospital stay	< 0.0001	< 0.0001
Time interval between admission and surgery	< 0.0001	< 0.0001
Time interval between discharge from REC and hospital discharge	0.0002	0.0001
Stay in the operating room	< 0.0001	< 0.0001
Duration of surgery	< 0.0001	0.0001
Duration of anesthesia	< 0.0001	< 0.0001
Duration of perfusion	0.0315	0.0573
Length of stay in REC I	< 0.0001	0.0002

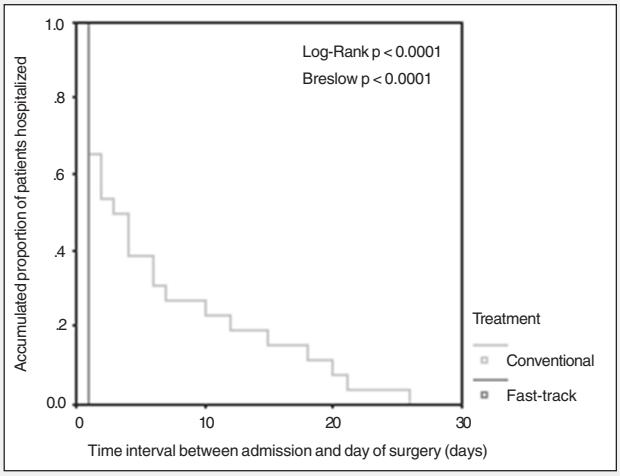

Fig. 1 - Comparison between the admission date and surgery date of patients with congenital heart diseases treated according to the fast-track and conventional protocols.

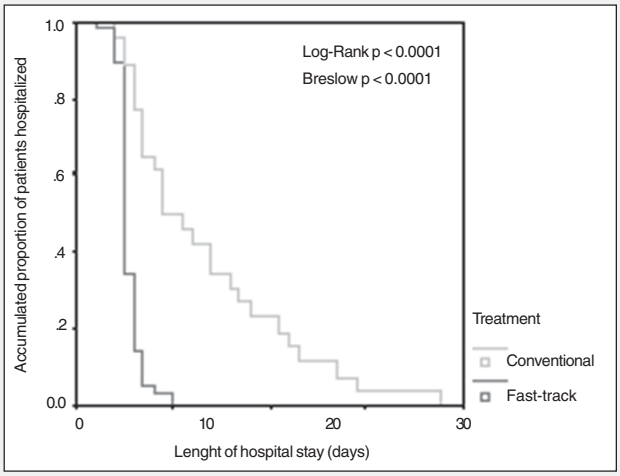

Fig. 2 - Comparison of the length of hospital stay (days) for patients with congenital heart diseases treated according to the fast-track and conventional protocols.

patients with a nosological profile comparable to that in this study[11,26]. However, the same protocol was used for patients with more complex diseases, such as tetralogy of Fallot and transposition of the great arteries[11]. It is worth emphasizing that the fast-track protocol has also been adopted for diseases of other organs and systems[27]. Therefore, it is an initiative especially developed for cardiac surgical interventions and useful for patients with other diseases.

The frequency of postoperative infection was lower in the fast-track protocol (3.6%), similarly to that reported in other experiences[13,26].

Two patients with ischemic heart disease in the fast-track protocol died. Although the number is not statistically significant, other studies did not report statistically different mortality for patients in the fast-track protocol[22,26]. The same was observed in regard to the incidence of infection after hospital discharge[5,9,20,26].

Of 10 rehospitalizations, 9 occurred in patients with ischemic heart disease, 3 of whom were in the fast-track protocol and 6 of whom were in the conventional protocol. The rehospitalization rate ranged from 2% to 20.9% of those reported in the literature[5,9,13,20].

Therefore, the examination of the demographic and clinical characteristics of the patients in this study showed that the fast-track protocol had a satisfactory margin of safety, being comparable to that of the conventional protocol.

Although this study provided the opportunity to evaluate both protocols concomitantly, the allocation of patients into the protocols was not randomized, but this restriction has also been reported in other studies[5,11,13]. Other studies[11,13] reported in the literature changed the hospital routine, and comparisons were performed in regard to the experience prior to change.

The length of stay in the different hospital units was shorter in the fast-track protocol, in accordance with that reported in the literature[11]. However, the different authors who studied this issue focused more frequently on the length of hospital stay, the stay in the ICU, the length of postoperative hospitalization, and the duration of orotracheal intubation[11,13,16,23,27,28]. The other time intervals analyzed in this study, such as the length of preoperative hospitalization, which has psychological and clinical implications, even an effect on the skin bacterial flora, had not been previously assessed[29]. This also influences cost, because many forms of hospital payment are based on the diagnosis and not on the length of hospital stay.

The mean hospital stay was shorter for the patients in the fast-track recovery protocol, which was evident in the multivariate analysis for patients with congenital heart diseases. For patients with ischemic heart diseases, this difference may be suggested based on the univariate analysis, but, perhaps due to the size of the sample or other confounding factors, it was not evident in multivariate analysis. In another published study[11], the mean length of hospital stay for patients operated on for atrial septal defect decreased from 5 to 4 days after implementation of the program. For patients operated on who had ventricular septal defect, the length of hospital stay decreased from 6 to 5 days. And no significant change was observed in patients operated on who had persistent ductus arteriosus. For more complex heart diseases, such as tetralogy of Fallot and transposition of the great arteries, the length of hospital stay decreased from 10 to 8 days and from 15.5 to 13 days, respectively. Therefore, both in our study and others, a decrease in the length of hospital stay was observed with the fast-track protocol.

After multivariate analysis, a shorter length of stay in the postoperative ICU was observed for patients with congenital heart disease in the fast-track protocol, and, for patients with ischemic heart disease, the difference was shown only with univariate analysis. In other studies, the longer length of stay in the ICU and longer time for orotracheal intubation were predictive of longer hospitalization. The implementation of the protocol reduced the length of stay in the ICU by 1 day for patients with atrial septal defect, ventricular septal defect, and persistent ductus arteriosus[11]. However,

Table V - Length of stay in the different hospital units for patients with ischemic heart diseases in the 2 protocols

Unit	Fast-track protocol				Conventional protocol			
	Min	Max	Mean	sd	Min	Max	Mean	sd
Preoperative hospitalization (days)	1	24	2.5	4.4	1	27	8.3	5.5
Length of stay in the operating room (hours)	8	17.6	12.9	3.7	4.5	14.2	6.9	1.7
Duration of surgery (hours)	2.3	7.4	4.7	1.3	2.9	12.8	5	1.7
Duration of anesthesia (hours)	2	9	6.1	1.2	4	13.8	6.5	1.9
Duration of perfusion (hours)	-	2.8	1.4	0.6	-	3	1.4	0.9
Length of stay in REC I (hours)	3	24	9	4.5	14.9	192.8	48.5	33.4
Length of stay in REC II (hours)	13	258	36	47	7	193	46	39
Length of stay in the hospital after discharge from REC (days)	5	47	5.1	6.5	3	46	8.7	7.8
Length of hospital stay (days)	6	53	10.6	8.7	8	57	20.1	9.7

Sd - standard deviation

Table VI - Descriptive levels of the Log-Rank and Breslow tests for comparison of the patients with ischemic heart diseases treated according to the 2 protocols regarding length of stay/duration

Variable	Descriptive level	
	Log-Rank	Breslow
Length of hospital stay	< 0.0001	< 0.0001
Time interval between admission and surgery	< 0.0001	< 0.0001
Time interval between discharge from REC and hospital discharge	0.0002	0.0001
Stay in the operating room	0.5682	0.9843
Duration of surgery	0.4871	0.9318
Duration of anesthesia	0.3402	0.6671
Duration of perfusion	0.3127	0.9125
Length of stay in REC I	< 0.0001	< 0.0001
Length of stay in REC II	0.3312	0.2653

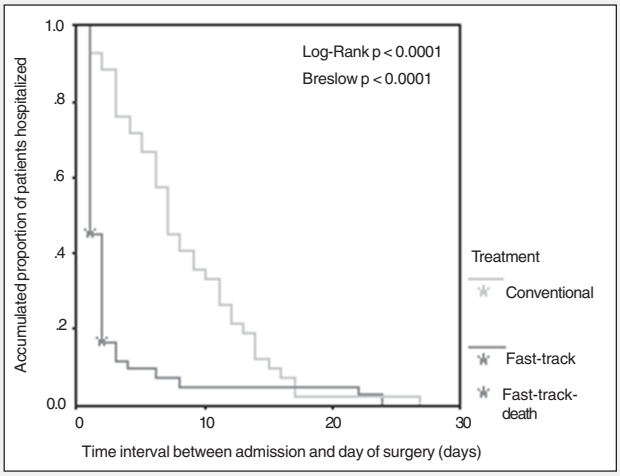

Fig. 3 - Comparison between the admission date and surgery date of patients with ischemic heart diseases treated according to the fast-track and conventional protocols.

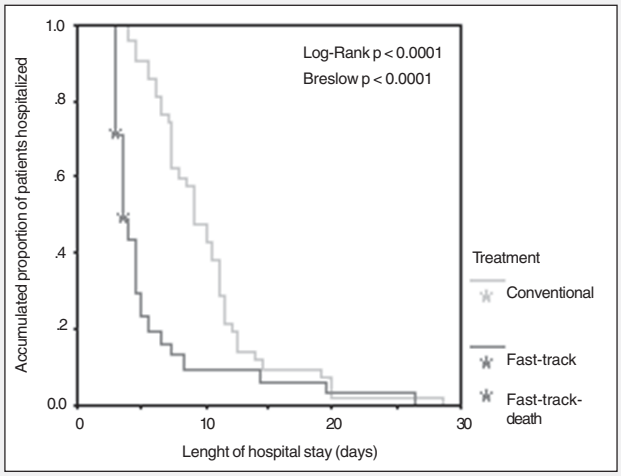

Fig. 4 - Comparison of the length of hospital stay (days) for patients with ischemic heart diseases treated according to the fast-track and conventional protocols.

for other authors, the reduction in the time of orotracheal intubation was not considered significant enough to reduce the length of hospital stay. It was even suggested that 1 more night in the ICU might contribute to greater safety on hospital discharge[22]. The numbers found in the study by Walji et al[22] are worth noting: for the 144 (56%) patients undergoing minimally invasive techniques, the mean length of stay in the ICU after surgery was 4.3 ± 6.3 days, as compared with 5.4 ± 5.9 days for the other patients. After 1 year, the percentage of patients discharged between the first and the fourth postoperative days was 70%[22].

In another study[26], 135 (48%) patients in the fast-track protocol were discharged between the third and the fifth postoperative days, while 74 (26%) in the routine protocol were discharged in the same time period. The stay in the ICU for patients with ischemic heart disease in the fast-track protocol was 9 ± 4.5 hours, and, in the conventional protocol, it was 48.5 ± 33.4 hours. In another study[20], a reduction by 1.2 days in the length of stay in the ICU after surgery was observed for patients with ischemic heart disease operated on as a result of the application of the fast-track protocol.

The length of stay in the operating room, the duration of the surgery, the duration of the anesthesia, and the duration of perfusion were shorter for the patients with congenital heart diseases in the fast-track protocol. The different studies published in the literature did not analyze these data carefully[5,11,23,25,26,30], hindering a comparison.

For patients with ischemic heart disease, no statistically significant difference in time was observed between the 2 protocols.

Due to operational reasons, we chose to assess the billing system for the procedures and examinations performed in the pre, post, and transoperative periods. The special materials (ortheses, prostheses) and the medications were accounted for considering the total length of hospital stay.

The unitary value billed per patient with congenital heart disease operated on in the fast-track protocol was 29.5% lower than that for the patient operated on in the conventional protocol. The greatest difference is noted in the period corresponding to the stay in the operating room and in the postoperative ICU

Table VII - Billing in *reais* of hospitalization in the 2 protocols for the care of patients with congenital heart disease

Hospitalization phase	Fast-track (N = 56) Total	Fast-track (N = 56) Unitary value	Conventional (N =26) Total	Conventional (N =26) Unitary value	P (ANOVA)
Preoperative					
Examinations	224.00	4.00	1,818.86	69.65	0.018
Procedures	6,682.58	119.33	1,760.92	67.73	0.016
Transoperative					
Examinations	8,306.10	148.32	4,961.32	190.82	0.04
Procedures	38,639.52	689.99	44,781.21	1,722.35	0.965
Postoperative					
Examinations	8,010.97	143.05	4,890.00	188.01	0.04
Procedures	18,106.31	323.33	8,116.72	312.18	0.032
Materials and medications					
Special materials	40,919.75	730.71	20,117.30	773.74	0.677
Medications	39,121.53	698.60	18,798.40	732.02	0.199

Table VIII - Billing in *reais* of hospitalization in the 2 protocols for the care of patients with ischemic heart diseases

Hospitalization phase	Fast-track (N = 51) Total	Fast-track (N = 51) Unitary value	Conventional (N =42) Total	Conventional (N =42) Unitary value	P (ANOVA)
Preoperative					
Examinations	5,031.40	98.65	50,188.56	1,194.97	0.446
Procedures	5,602.40	109.85	18,308.45	435.92	0.237
Transoperative					
Examinations	29,285.86	574.23	26,750.94	636.93	0.853
Procedures	131,265.03	2,573.82	91,157.58	2,170.42	0.188
Postoperative					
Examinations	13,060.96	256.10	17,729.31	422.13	0.989
Procedures	22,658.60	444.29	21,142.29	503.39	0.741
Materials and medications					
Special materials	66,814.10	1,310.08	40,806.14	971.58	0.044
Medications	71,069.50	1,393.52	68,317.85	1,626.62	0.795

Table IX - Relative risks of discharge of patients with congenital heart diseases in their different stages of hospitalization in the 2 protocols

Variable	Relative risk	Confidence interval (95%)
Length of stay in the different hospital units		
Postoperative recovery	2.8	1.7 – 4.6
Postoperative hospitalization	2.1	1.5 – 2.8
until discharge from the hospital		
Admission	6.7	3.9 –11.5
Duration of the procedure		
Surgery	6.3	3.6 –11.0
Anesthesia	6.8	4.0 –11.7
Perfusion	1.5	1.1 – 2.0

(128.2%), followed by that in the preoperative unit (11.3%) and in the postoperative unit (7.2%). However, the *p* values obtained with the analysis of variance of the means of billing suggest lower expenses in the examinations and procedures performed in the preoperative phase, examinations in the transoperative phase, and examinations and procedures performed in the postoperative phase. No statistically significant difference was observed for the billing of special materials and medications used.

In regard to patients with ischemic heart disease, the unitary value billed was 16.1% lower for patients in the fast-track protocol. However, the *p* value obtained with analysis of variance of the means of billing showed a lower statistical significance in the special materials used for patients in the conventional protocol, suggesting lower costs in this billing item.

Although the data have not reached statistical significance in all variables studied, it is possible to formulate the hypothesis that the findings have practical importance, considering the lower absolute values of billing of the materials, medications, and special materials used in the different healthcare facilities occupied by the patients in the fast-track protocol.

We emphasize that the financing practice of SUS is performed by billing per diagnosis, not taking into consideration the examinations and the procedures performed during hospitalization. Thus, while the examinations and procedures performed during the hospitalization cannot be billed for individually, a series of them, such as hemodynamic studies, ultrasonography, graphic and nuclear medicine methods, when performed in the prehospital phase, may be billed to SUS. Therefore, the fast-track protocol, in addition to allowing reimbursement for expenses incurred in the outpatient care unit, exempts the hospital from expenses not totally reimbursed in the in-hospital phase.

Different experiences published showed a reduction in costs with the adoption of the fast-track protocol. Therefore, a mean reduction in costs by US$ 4,000 per patient (from US$ 27,761 to US$ 23,772) was observed during hospitalization [24]. The reductions in costs were as follows: 26% in surgeries for the correction of atrial septum; 28% in the surgical correction of ventricular septum; 29% in the correction of persistent ductus arteriosus; 26% in the correction of tetralogy of Fallot; and 16% in the correction of transposition of the great arteries[21]. This study also correlated costs with early extubation and shorter hospitalization, and also established a significant correlation with fewer days spent in the ICU[21]. Another study[20] reported a decrease by US$ 1,004 and US$ 1,667 in patients with ischemic heart disease and valvular heart disease operated on, respectively. The increase in costs due to the increment of anesthetic and anti-inflammatory drugs was offset by the reduction in the stay in the postoperative intensive care unit.

The major predictors of costs in cardiovascular surgery were identified as length of hospital stay, length of stay in the ICU, length of stay in the operating room, and patient's age[16]. Another study[4], however, did not identify preoperative predictive factors, and concluded that the most significant predictors were postoperative complications, respiratory failure, left ventricular failure, and mortality. That study also reported that costs were directly related to the length of stay in the ICU and the presence of postoperative complications. The greatest direct costs in the ICU were as follows: nurse team, 45% to 50%; support services, 22% to 25%; supplies and equipment, 15% to 20%; and medications, 4% to 13%, thus the effort to obtain extubation as soon as possible, so that the patient can continue his recovery in a hospital unit with less expensive resources installed[16].

The reduction in the length of preoperative hospitalization by 1 or 2 days, aiming at hospitalization on the same day of surgery, reduced the costs in surgeries of patients with ischemic heart disease by 2% to 3%[16]. On the other hand, the study of readmissions after cardiovascular surgery discusses whether the fast-track protocol for cardiovascular surgery results in cost savings or cost shifting, because, after 527 surgeries, 110 (20.9%) readmissions occurred, 49% at hospitals other than that where the surgery was performed, which has great economic significance, mainly for the hospital receiving these patients[5].

The study had a prospective historic character: the sample size was limited not only due to the strict criteria of inclusion, but also due to the interruption in the program, with the consequent reduction in the number of patients eligible for this analysis. In addition, some relevant time intervals, such as the duration of orotracheal intubation, one of the predictive factors of the length of hospital stay and hospital costs, could not be assessed[11]. The costs of the prehospital phase also could not be assessed separately.

Although some manifestations of greater trust in the health care team that implemented the fast-track protocol were observed in the patients and their families in the prehospital phase, customer satisfaction was not assessed in this study.

In conclusion, the organizational coupling of initiatives and technical competences showed that the fast-track protocol is feasible and may contribute both to approaching the patients and to greater operational efficiency of the hospital and the medical services involved. The incorporation of these objectives into the organizational culture may also contribute to improve the satisfaction of customers and care providers, in addition to more precisely allocating the use of hospital medical resources. Thus, both in our study, which suggested fewer expenditures based on the billing data, and in data published in the literature, the health care provided according to the fast-track protocol resulted in lower costs for the system financing the program.

More specifically, the patients with congenital heart diseases had a shorter length of stay in the different medical and hospital units in the pre, trans, and postoperative phases, when the fast-track protocol was used, allowing lower expenditures during those phases.

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