Cell Biochem Biophys (2011) 61:413–419
DOI 10.1007/s12013-011-9203-7

TRANSLATIONAL BIOMEDICAL RESEARCH

Implementation of a Fast-Track Clinical Pathway Decreases Postoperative Length of Stay and Hospital Charges for Liver Resection

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Published online: 10 May 2011

Abstract A fast-track clinical pathway is designed to streamline patient care delivery and maximize cost effectiveness. It has decreased postoperative length of stay (LOS) and hospital charges for many surgical procedures. However, data on clinical pathways after liver surgery are sparse. This study examined whether use of a fast-track clinical pathway for patients undergoing elective liver resection affected postoperative LOS and hospital charges. A fast-track clinical pathway was developed and implemented by a multidisciplinary team for patients undergoing liver resection. Between July, 2007 and May, 2008, a total of 117 patients underwent elective liver resection: the fast-track clinical pathway (education of patients and families, earlier oral feeding, earlier discontinuation of intravenous fluid, no drains or nasogastric tubes, early ambulation, use of a urinary catheter for less than 24 h and planned discharge 6 days after surgery) was studied prospectively in 56 patients (postpathway group). These patients were compared with the remainder who had usual care (prepathway group). Outcome measures were postoperative LOS, perioperative hospital charges, intraoperative and postoperative complications, mortality, and readmission rate. Among all patients, 69 (59%) had complicating diseases and/or a history of surgery and 24 patients belonged to American Society of Anesthesiologists grade III–IV. Compared with the prepathway group, the postpathway group had a significantly shorter postoperative LOS (7 vs. 11 days, $P < 0.01$). The average perioperative hospital charges were RMB 26,626 for patients in the prepathway group and only RMB 21,004 for those in the postpathway group ($P < 0.05$), with no differences in intraoperative and postoperative complications ($P = 0.814$), mortality ($P = 0.606$), and readmission rate ($P = 0.424$). Implementation of the fast-track clinical pathway is an effective and safe method for reducing postoperative LOS and hospital charges for high-risk patients undergoing elective liver resection. The result supports the further development of fast-track clinical pathways for liver surgical procedures.

Keywords Liver resection · Clinical pathway · Perioperative care

Introduction

A fast-track clinical pathway consists of optimal sequencing and timing of interventions by physicians, nurses, and other staff for a particular diagnosis or procedure [1]. It was originally adapted from engineering fields, where it was used to increase efficiency and provide a timeline for job completion. A fast-track clinical pathway is developed and implemented by a multidisciplinary team to streamline patient care delivery and maximize effectiveness while minimizing cost. Contemporary socioeconomic pressures for more cost-efficient delivery of medical care are strong motivating forces for the development of a fast-track clinical pathway. To date, some studies have found that the fast-track clinical pathways can lead to a decrease in postoperative length of stay (LOS) and hospital charges, such as in colorectal [2, 3], vascular [4, 5], obstetric [6],

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urologic [7, 8], and pediatric procedures [9]. However, its role in hepatic surgery is still controversial.

Liver resection is a common abdominal operation with high risk of postoperative morbidity and mortality [10–13]. Data on the implementation of a fast-track clinical pathway in liver surgery are sparse [14, 15]. We hypothesized that such a fast-track clinical pathway for patients undergoing elective liver resection could help decrease postoperative LOS and hospital charges without increasing intraoperative and postoperative complications, mortality, and readmission rate.

Methods

Patients

Between July 2007 and May 2008, a total of 117 patients underwent elective liver resection in a teaching hospital of a medical university with a high-volume hepatic surgery unit. The fast-track clinical pathway was introduced by a multidisciplinary team to serve the patients on 1 January 2008. Fifty-six patients were treated according to the fast-track clinical pathway (postpathway group) and were compared with the 61 patients who had been treated according to the previous traditional pathway (prepathway group). Before surgery, all patients received antithrombotic prophylaxis subcutaneously and were given intravenous antibiotics. Liver resection was performed by the same liver surgeons in both groups. The patients had an extended right subcostal incision or bilateral subcostal incision, and the types of liver resection, according to the Brisbane 2000 terminology [16], are shown in Table 1. Following the operation, patients were not sent routinely to the intensive care unit (ICU) but were monitored overnight in the recovery room and then transferred to the ward, provided they were clinically stable. Patients with both malignant and benign disease were included in this analysis and excluded if they underwent hepaticojejunostomy, or choledochotomy and placement of a T-tube simultaneously.

Clinical Pathway

The multidisciplinary team that developed the fast-track clinical pathway included surgeons, nursing staff, physical therapists, and operating room personnel. All aspects of patient care were analyzed to streamline interventions for fast tracking, including the preoperative evaluation, education of patients and families, earlier oral feeding, earlier discontinuation of intravenous fluid, no drains or nasogastric tubes, early ambulation, use of a urinary catheter for less than 24 h and planned discharge 6 days after surgery, and were outlined for each day (Table 2). Epidural analgesia had been performed routinely in the authors' department since 2001, and no modification of the epidural regimen was introduced during the study period.

The fast-track clinical pathway was implemented for the patients at the time a decision was made for surgery. The preoperative evaluation was performed the day before surgery and included medical history, physical examination, and imaging studies, including abdominal ultrasound, computed tomography, magnetic resonance cholangiopancreatography, and triphasic liver computed tomography scan, blood analysis (complete blood count with platelets, electrolyte, serum creatinine, coagulation studies, and liver function tests), and an anesthesiology consultation. The preoperative education of patients and families was then conducted using a patient-friendly version of the clinical pathway to help them to understand general pathway goals and expectations. Intravenous fluid was administrated during the operation and discontinued on postoperative day 3 unless there was a medical reason to do otherwise, compared with discontinuation on day 5 in the previous traditional pathway. Patients were actively encouraged to exercise on bed 6 h after the operation and stand or walk out of bed at least 2 h on day 1 after surgery and gradually increase the workout. However, in the traditional pathway patients had to stay in bed 2–3 days after the operation. Oral intake of fluids was started after 6 h postoperatively, aiming for at least 600 ml of oral intake on the day of surgery. Preprinted discharge instructions were distributed to allow time for patients and their families to review and

Table 1 Types of liver resection

	Prepathway $n = 61$ n (%)	Postpathway $n = 56$ n (%)	P*
Non-anatomical resection	9(14.8)	7(12.5)	0.723
Segmentectomy	14(23.0)	13(23.2)	0.973
Bisegmentectomy	17(27.9)	17(30.4)	0.767
Hemihepatectomy	11(18.0)	9(16.1)	0.778
Extended hemihepatectomy	5(8.2)	4(7.1)	1.000†
Centralresection/trisegmentectomy	5(8.2)	6(10.7)	0.641

* χ^2 test, except † Fisher's exact test

Table 2 Fast-track critical pathway for liver resection

Before surgery	Preoperative evaluation
	Education of patients and families
	No preanaesthetic medication
	No bowel preparation
Day of surgery	Carbohydrate drinks up to 2 h before surgery
	Placement of thoracic epidural catheter (T7–T9 level) with continuous infusion of bupivacaine 0.125% with fentanyl l–2 μg/ml at a rate of 4–6 ml/h until day 3, plus intravenous paracetamol or NSAIDs
	No routine nasogastric drainage and drainage of the peritoneal cavity
	No sent routinely to the intensive care unit
	Physical therapy twice
	Restart oral feeding of liquid diet 6 h after surgery
Postoperative day 1	Out of bed ambulation, mobilized <2 h
	Physical therapy four times per day
	Reduction of intravenous fluids
	Patient drinks at least 1.0 l liquid diet
	Urinary bladder catheter in the morning
Postoperative day 2	Mobilization four times a day, <4 h
	Patient drinks at least 1.5 l liquid diet
	Reduction of intravenous fluids
Postoperative day 3	Mobilization four times a day, <6 h
	Patient drinks at least 2.0 l light diet
	Continuous reduction of intravenous fluids
	Epidural catheter removed in the morning, NSAIDs started or continue
Postoperative day 4	Switch all medications to oral route
	Discontinuation of intravenous fluids
	Semiliquid diet of at least 1.5 l
	Mobilization of four times per day, >6 h
Postoperative day 5	Mobilization a minimum of four times per day, >6 h
	Normal oral intake
	Distribute preprinted discharge instructions
Postoperative day 6	Full mobilization
	Discharge home
	Outpatient appointment made on postoperative day 10, 15, and 30

NSAID non-steroidal anti-inflammatory drug

formulate questions before discharge on postoperative day 5. Arrangements for discharge were made on postoperative days 6, provided that all organ functions had returned to normal and pain could be managed with oral analgesics. The patients were seen in the outpatient clinic for removal of stitches and information about histology on days 10 and 15, and a final postoperative checkup was scheduled on day 30 (Table 2).

Outcomes

Data were obtained from retrospective chart reviews for patients treated before implementation of the clinical pathway and from a prospective clinical database for patients treated after implementation. About 1 month after the patient was discharged from hospital, the administration center provided the individual's perioperative charges, postoperative LOS, complications, mortality, and readmission data. Outcome measures were postoperative complications (in-hospital and within 30 days of discharge), mortality (in-hospital death, irrespective of duration of stay, or death occurring within 30 days of discharge), average postoperative LOS (including readmission), readmission rate (within 30 days of discharge), and average perioperative hospital charges. Complications were classified as general and surgical complications. General complications included pneumonia, wound infection, urinary tract infection, delayed gastric emptying, postoperative ileus (defined as abdominal distension, colicky pain, absence of passage of flatus, and nausea/vomiting), deep venous thrombosis/pulmonary embolism, myocardial infarction, renal failure, and liver failure. Surgical complications included the following events requiring intervention/reoperation: bile leak with sepsis, upper gastrointestinal bleeding, intra-abdominal abscess, a large quantity of pleural effusion, and fascial dehiscence. The severity of complications was according to a validated complication classification [17]. Postoperative LOS was determined by calculating the difference in calendar days between the day of the operation and discharge, including readmissions. The total perioperative hospital charges were categorized into four categories, included charges for operation and anesthesia, auxiliary examination (including laboratory and radiology), drugs, and other.

Statistical Analysis

Results were analyzed using SPSS version 16.0 for Windows (SPSS, Chicago, IL, USA). For discrete variables, absolute and relative frequencies are given. For other variables, median values and range are presented. LOS and perioperative hospital charges were analyzed using the Mann–Whitney *U* test. Morbidity and mortality rates were analyzed using the χ^2 test or Fisher's exact test. Differences were considered significant at $P = 0.05$ or less.

Results

Clinical data are shown in Table 3, and there were no statistically significant differences between the two groups, including duration of surgery and operation blood loss. In this study, it is important to note that the patients consisted of high-risk groups with lower than normal body mass index, 69 patients having complicating diseases and/or a history of surgery, and 24 patients belonging to American Society of Anesthesiologists (ASA) grade III–IV. Some 50 patients had co-morbidities, and the main complicating diseases were cholangitis as a result of cholelithiasis which is especially prevalent in the southeast coast of China. Only 48 patients had no complicating disease nor a history of surgery.

The fast-track clinical pathways were generally well tolerated. Two patients in the postpathway group and one patient in the prepathway group developed postoperative ileus and required insertion of a nasogastric tube, and this was resolved within 4, 5, or 7 days by restricting intake. One patient in the postpathway group had an intra-abdominal drain inserted because of bile leak with sepsis, and one patient in the prepathway group had an intra-abdominal drain because of an intra-abdominal abscess. One patient in the prepathway group required insertion of a closed thoracic drainage tube as a result of a large quantity of pleural effusion. Three patients had signs of intra-abdominal bleeding, and diagnostic laparoscopies demonstrated intra-abdominal haematoma with active bleeding in two patients and requiring reoperation for hemostasis (one in each group), while the third patient, in the prepathway group, showed intra-abdominal haematoma without any obvious source of active bleeding and was treated conservatively treatment under close observation. Eleven of 56 patients in the postpathway group (20%) were sent to the ICU, significantly fewer than in the prepathway group (87%) ($P < 0.001$).

A common criticism of a fast-track clinical pathways is the potential for a negative impact on patient care. We

Table 3 Demographics and perioperative factors of patients undergoing liver resection in both groups

	Prepathway $n = 61$	Postpathway $n = 56$	P*
Age (years)	55(22–81)	57(23–73)	0.194
Sex ratio (M:F)	34:27	31:25	0.967
Body mass index	18(14–27)	17(14–28)	0.379
ASA			0.690
I and II	50	43	
III	10	11	
IV	1	2	
Complicating diseases			
Treated for cholangitis	13	11	0.469
Treated for pancreatitis	5	4	0.723
Treated for diabetes mellitus	3	3	0.719†
Treated for pulmonary disease	4	2	1.000†
Treated for liver abscess	2	2	1.000†
Treated for cardiovascular disease	1	0	1.000†
History of surgery	11	10	0.649
Median duration of surgery (m)	125 (81–187)	110(60–160)	0.451
Median operative blood loss (ml)	850 (0–2300)	760 (0–2100)	0.558
No. of patients transfused	25	21	0.659
Median volume transfused (ml)	600(200–1800)	550(400–1600)	0.410

ASA American Society of Anesthesiologists

Values are median (interquartile range)

* χ^2 test, except † Fisher's exact test

Table 4 Postoperative course in patients undergoing liver resection in both groups

	Prepathway $n = 61$ n (%)	Postpathway $n = 56$ n (%)	P*
Total complications[a]	27(44.3)	26(46.4)	0.814
General complications	21	15	0.371
Surgical complications	6	11	0.133
Patients with a complication[b]	23(37.7)	21(37.5)	0.982
Grade I	11	8	
Grade II	9	10	
Grade IIIa	1	1	
Grade IIIb	0	1	
Grade IVa	1	0	
Grade IVb	0	0	
Grade V	1	1	
Mortality	1(1.6)	1(1.8)	0.706[†]
Readmissions	2(3.3)	4(7.1)	0.424[†]

* χ^2 test, except † Fisher's exact test

[a] More than one complication was counted per patient

[b] Severity of complications classification (17), counting the severest complication per patient

attempted to assess possible increases in complications, especially in the associated areas. However, there was no statistically significant difference in our measures of morbidity and mortality between the two groups. Using a standard classification of complications by severity, there was also no a trend toward more severe complications in the postpathway group compared with the prepathway group (Table 4). One patient died in the postpathway group (a result of liver failure following an extended right hepatectomy in unsuspected alcoholic liver disease with death on day 20) and one patient in the prepathway group (myocardial infarction and cardiovascular failure with death on day 2). No significant difference in the re-admission rate (four in the postpathway group vs. 2 in the prepathway group) was observed between the groups in the 30 days after surgery. Four patients were readmitted for a median of 9 days (range 1–25 days) in the postpathway group, one for wound infection (6 days), one for deep vein thrombosis (4 days), one for intra-abdominal bleeding (6 days), and one for bile leak with sepsis (25 days). In the prepathway group, two patients were readmitted for 5 and 21 days, one for wound rupture and one for intra-abdominal abscess.

Data concerning postoperative LOS are presented in Fig. 1 and show that postoperative LOS was significantly shortened by implementation of the fast-track clinical pathway. Before implementation, the median postoperative LOS was 11 (range 4–37) days. Implementation of the pathway resulted in a reduction of LOS to 7 (range 3–26) days ($P < 0.01$). Perioperative hospital charges are presented in Fig. 2. The mean charges per perioperative hospital stay were RMB 21,004 for the postpathway group significantly less than the RMB 26,626 for the prepathway group ($P < 0.05$). The distribution of perioperative hospital charges in the four categories was analyzed, including surgery and anesthesia, drugs, auxiliary examination, and other.

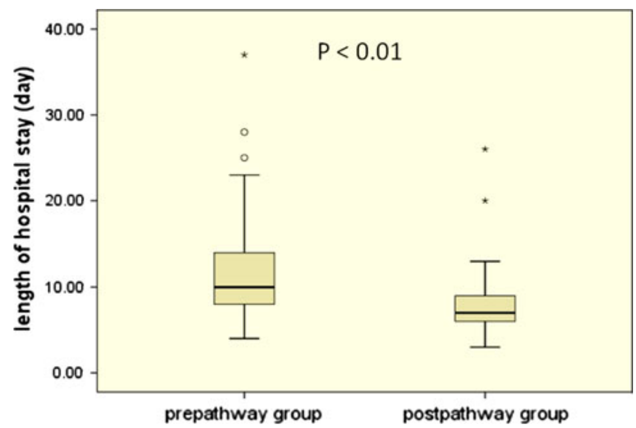

Fig. 1 Total postoperative length of hospital stay including readmissions, in the postpathway group and the prepathway group. *Horizontal lines* within boxes, *boxes*, and *error bars* represent median, interquartile range, and total range, respectively. $P < 0.01$ (Mann–Whitney U test)

The charges for other items decreased more significantly in the postpathway group as compared to the prepathway group ($P < 0.01$), and there were also significant decrease in drugs ($P < 0.05$) and auxiliary examinations ($P < 0.05$), but no difference for surgery and anesthesia ($P = 0.550$).

Discussion

We developed and implemented a fast-track clinical pathway by a multidisciplinary team to detail and direct optimal daily treatment and recovery goals for patients undergoing hepatic liver resection. Our goal in developing a high-quality, cost-effective health care for these patients was to eliminate unnecessary expenses while continuing to provide treatments or services considered important or

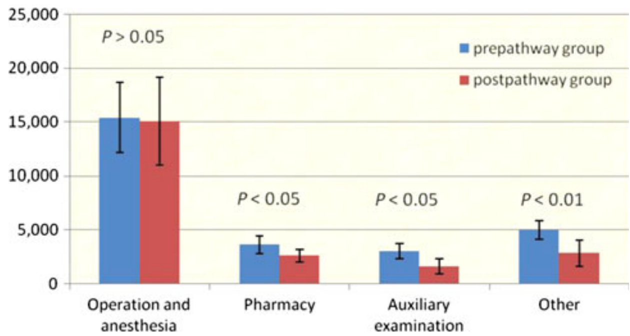

Fig. 2 Comparison of charges (in RMB) of four categories in two groups. In 2008, 6.9 RMB were equal to $1 US (Mann–Whitney *U* test)

essential, and to achieve an optimal outcome. In the current study, we confirmed that implementation of the clinical pathway significantly decreased postoperative LOS and perioperative hospital charges. More importantly, the decrease in LOS and charges was not achieved at the expense of increased postoperative complications or readmission rates in the postpathway group.

Perioperative intervention improvements that can be linked to pathway implementation are concerned with postoperative LOS. Multiple factors contributed to the reduction in LOS, including altering patients' expectations, preoperative education of hospital health-care providers, earlier mobilization and return of normal oral intake, and earlier discontinuation of intravenous fluid. Although average postoperative LOS (including readmissions) was reduced significantly from 11 to 7 days, the LOS was longer than others reported in the literature [14, 15]. The main reason was the high-risk nature of the patients in our study: among the 117 patients studied, more than half had complicating diseases and/or a history of surgery, and one-fifth belonged to ASA III–IV. Van Dam et al. reported that among 161 patients where median LOS was reduced to 6 days on implementation of multimodal enhanced recovery after surgery, only 30 belonged to ASA III, and none had a history of surgery [15]. Another study reported that median LOS was 4 days when a "fast-track" protocol was employed, but only one patient belonged to ASA III [14]. The reduction in length of postoperative hospital stay correlated directly with a significant reduction in total hospital charges [2, 18].

Perioperative hospital charges decreased significantly after implementation of the fast-track clinical pathway. These savings were achieved by fulfilling the pathway goals of reducing the variations in the fast-track clinical pathway and optimizing resource utilization. Analysis of the cost data by delivery system illustrated that the savings occurred in all components and resulted from an aggregation of multiple small cost-saving strategies, including the preoperative evaluation, education of patients and families, reduction in postoperative intensive care stay, earlier ambulation, and earlier discontinuation of intravenous fluid. However, surgical and anesthesia' charges in the postpathway group were not significantly lower than those in the prepathway group. The reason was that no modification of the operation and intraoperative anesthesia regimen was introduced during the study period. On the other hand, this was an indication that successful implementation of the clinical pathway for high-risk patients undergoing elective liver resection was a multifaceted and complex task. The multidisciplinary team and administrators understood and supported the pathway initiative and interdisciplinary cooperation, which was responsible for successful implementation of the fast-track clinical pathway [19]. In our department, we developed numerous formal educational sessions on the fast-track clinical pathway for every members of the multidisciplinary team before implementation, and all elements were discussed by the team. The team members met regularly to develop the pathway until it was completed, and after implementation, they continued to meet to discuss interventions so that the pathway could be continuously improved.

Care quality improvement is a major goal in the implementation of a fast-track clinical pathway. It is a never-ending process; no matter how good you are, you can always improve [20]. The members of the team provided information that was used for mapping outcomes on the timeline and for coordinating events to maximize efficiency. Every member voiced concerns as to how the pathway could be effectively accomplished and took an active part in the meetings to discuss variations. The pathway outlined specific deadlines for reaching both educational goals and medical outcomes.

Conclusions

In the present study, we confirmed that implementation of a fast-track clinical pathway in patients undergoing elective liver resection could improve hepatic surgical procedures by monitoring and improving quality of care. Reducing the postoperative ICU stay, early oral feeding and ambulation, earlier discontinuation of intravenous fluid, no drains or nasogastric tubes, and early removal of urinary catheters are effective and safe in reducing postoperative LOS and hospital charges for high-risk patients undergoing elective liver resection. However, in order to continuously improve health care, the results should be monitored carefully with repeated education and cooperation of all members of the multidisciplinary team involved in the clinical pathway. The study supports further development of clinical pathways for liver surgical procedures.

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