The critically ill patient after hepatobiliary surgery

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Background: We analyzed the causes and results of utilization of critical care services in the special care unit in patients after surgical procedures performed by the hepatobiliary surgical service during a 23-month period.

Results: Thirty-two of 537 patients (6.0%) required postoperative admission to the special care unit. Twenty-one patients were admitted directly from operating room or from recovery room because of inability to wean from ventilator ($n=10$), hypovolemic shock ($n=4$), myocardial ischemia or infarction ($n=2$), sepsis ($n=2$), upper gastrointestinal bleeding ($n=2$), and acute renal failure ($n=1$). Eleven postoperative patients were admitted from floor care for respiratory failure ($n=4$), cardiac dysrhythmia or infarction ($n=4$), sepsis ($n=2$), and upper gastrointestinal bleeding ($n=1$). Thirty-eight per cent of patients ($n=12$) admitted to the special care unit after surgery died. By multivariate analysis, total postoperative stay in the special care unit that was greater than median total duration of stay of 4.5 days was the only independent predictor of mortality ($P=0.041$).

Conclusions: Respiratory failure was the predominant component of all complications after hepatobiliary surgery. No clinically useful predictors of eventual outcome could be identified.

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Keywords: critical care, hepatobiliary surgery, morbidity, mortality, pancreatic surgery

Received: 14 April 1999
Revisions requested: 2 July 1999
Revisions received: 22 September 1999
Accepted: 23 September 1999
Published: 13 October 1999

Crit Care 1999, **3**:139–144

The original version of this paper is the electronic version which can be seen on the Internet (http://ccforum.com). The electronic version may contain additional information to that appearing in the paper version.

Print ISSN 1364-8535 Online ISSN 1466-609X

Introduction

Postoperative morbidity and mortality after hepatobiliary operations, especially in cancer patients, has traditionally been perceived as being high. Prior reports, however, have failed to identify a predominant class of complications, such that interventions could be undertaken that might be able to reduce the incidence of these complications. Prior reports have focused on subgroups of operations within the family of all hepatobiliary procedures, such as hepatic resection [1–5], proximal bile duct resection [6,7], pancreatic resection [8,9], and biliary–enteric bypass [10]. There are no prior reports on the utilization and outcomes of critical care services required in the management of all patients who experience complications after hepatobiliary surgery at a single institution. This paper reviews the complications leading to the utilization of critical care services after all hepatobiliary procedures performed over a 23-month period by a team of specialized surgeons, nurses, anesthesiologists, and internists who comprise the Hepatobiliary Disease Management Team of the Memorial Sloan-Kettering Cancer Center.

Materials and methods

Between February 2, 1994 and December 28, 1995, all patients admitted to the Hepatobiliary Surgical Service at Memorial Sloan-Kettering Cancer Center were identified from the institutional database and the hepatobiliary database. For these patients, the following variables were collected from the Institutional Database: admitting diagnosis, operative procedure(s) performed, whether admission to

SCU = special care unit; PACU = postanesthesia care unit.

the special care unit (SCU) was required, and outcome. For all patients undergoing hepatobiliary surgical procedures and admitted to the SCU during their hospital course, multiple preoperative, intraoperative, and postoperative variables were collected by retrospective chart review.

Patients undergoing hepatic, biliary, or pancreatic resection by the Hepatobiliary Surgical Service are routinely monitored during emergence from anesthesia in the postanesthesia care unit (PACU) for the first postoperative night, and, if stable the following morning, are transferred to floor care for further postoperative care. In this study, time in the PACU was not counted as utilization of the critical care services. Total duration of SCU stay was defined as the total number of days (consecutive or nonconsecutive) spent in the SCU during a hospital admission. Postoperative death was defined as death within 30 days postoperatively or before discharge from the hospital.

Statistical analysis

Results are expressed as the means ± standard deviation, median (range), or as the number and percentage of the total number of patients for categoric variables. One-way analysis of variance was used for comparison of all continuous variables. Pearson's χ^2 analysis or Fisher's exact test, when appropriate, were used for univariate comparisons for all categoric variables analyzed. When multiple categoric variables were determined to be statistically significant by univariate analysis, they were then entered into a logistic regression model for multivariate analysis to determine independent predictors of outcome. The software program SPSS for Windows (version 8.0; SPSS Incorporated, Chicago, Illinois, USA) was utilized for all statistical analyses. $P \leq 0.05$ was considered statistically significant.

Results

Study population

Between February 2, 1994 and December 28, 1995, 1048 patients were admitted to the Hepatobiliary Surgical Service (admitting physicians LHB and YF) at Memorial Sloan-Kettering Cancer Center. Of these, 32 out of 537 patients (6.0%) undergoing surgical treatment were admitted to the SCU, whereas four out of 511 patients (0.8%) who were receiving medical treatment only were admitted to the SCU. No single surgical procedure was associated with a higher frequency of SCU utilization than other procedures (data not shown).

Preoperative variables

The mean age of the 32 patients (22 males, 10 females) admitted to the SCU for postoperative care was 63.2 ± 12.2 years (median 66 years, range 30–84 years). The admitting diagnoses are summarized in Table 1. Eighteen patients had a history of cardiac disease, 10 were jaundiced in the preoperative period, 10 underwent preoperative biliary instrumentation, nine underwent preoperative biliary drainage, five had a history of cirrhosis and/or portal hypertension, four had a history of chronic obstructive pulmonary disease, and three had a history of viral hepatitis.

Table 1

Diagnoses of those 32 patients who required critical care services during postoperative care and number of deaths by diagnosis

Diagnosis	Diagnosis [% (*n*)]	Deaths (*n*)
Hepatocellular carcinoma	25 (8)	3
Pancreatic/peripancreatic malignancy	13 (4)	1
Colorectal hepatic metastases	9 (3)	1
Noncolorectal hepatic metastases	9 (3)	1
Cholangiocarcinoma	8 (3)	2
Benign biliary disease	6 (2)	0
Acute necrotizing pancreatitis	6 (2)	1
Polycystic disease of the liver	6 (2)	1
Bleeding peptic ulcer disease	6 (2)	1
Perforated peptic ulcer disease	3 (1)	1
Abdominal wall dehisence	3 (1)	0
Empyema	3 (1)	0

Mean preoperative laboratory values of those 32 patients admitted to the SCU for postoperative care were as follows: albumin 3.5 ± 0.7 g/dl (normal range 4.0–5.2 g/dl), prothrombin time 12.6 ± 1.1 s (normal range < 13.1 s), total bilirubin 3.5 ± 6.4 mg/dl (normal range 0–1.0 mg/dl), creatinine 1.1 ± 0.3 mg/dl (normal range 0.6–1.3 mg/dl), and white blood cell count 9228 ± 6452 cells/mm^3 (normal range 5000–10 000 cell/mm^3).

Operative variables

A summary of the operations performed on those 32 patients admitted postoperatively to the SCU is shown in Table 2. Twenty-six patients were operated upon electively and six patients emergently. Sixteen patients underwent resection of malignant disease with curative intent, six underwent treatment for benign disease, six had palliative operations, and four received treatment for complications of a surgical procedure performed during a previous hospital admission. Mean operating time was 232 ± 116 min (median 210 min, range 37–493 min), mean intraoperative blood loss was 2064 ± 2271 cm^3 (median 1100 cm^3, range 0–9000 cm^3), mean transfusion of red blood cells was 3.4 ± 4.7 units (median 2 units, range 0–18 units), and mean intraoperative fluid administration was 5369 ± 3922 cm^3 (median 4300 cm^3, range 400–20 600 cm^3). During their postoperative course, seven patients required second procedures (two drainage intraabdominal abscesses, two tracheostomies, one repair of bleeding peptic ulcer, one repair of postoperative intra-

Table 2

Type of operations performed on 32 patients admitted requiring critical care service during postoperative care and the number of postoperative deaths by type of operation

Type of operation	Type of operation [% (*n*)]	Deaths (*n*)
Hepatic resection	47 (15)	5
Biliary enteric bypass	13 (4)	2
Pancreatic resection	9 (3)	1
Peptic ulcer operation	9 (3)	2
Extrahepatic bile duct resection	6 (2)	0
Acute pancreatitis operation	6 (2)	1
Combined hepatic and pancreatic resection	3 (1)	1
Abdominal wall dehisence	3 (1)	0
Thoracotomy and decortication	3 (1)	0

Table 3

Postoperative complications in those 32 patients who required critical care services during postoperative care

Postoperative complications	Patients [*n* (%)]
Respiratory failure	16 (50)
Acute renal failure	9 (28)
Bacteremia	9 (28)
Pneumonia	8 (25)
Upper gastrointestinal bleeding 8 (25)	
Hepatic failure	5 (16)
Cardiac dysarrhythmias	5 (16)
Intraabdominal abscess	5 (16)
Urinary tract infection	4 (13)
Wound infection	3 (9)
Myocardial ischemia/infarction	3 (9)
Central line infection	2 (6)
Intra-abdominal bleeding	1 (3)
Empyema	1 (3)

abdominal bleed, one repeat pancreatic debridement), two patients required a third procedure (one repeat pancreatic debridement, one removal of intra-abdominal packing and closure of abdomen), and one patient required a fourth procedure (thoracotomy/decortication for empyema).

Postoperative variables and complications

The mean total stay in the SCU was 11.2 ± 17.6 days (median 4.5 days, range 1–78 days). The mean postoperative duration of hospital stay was 28.2 ± 36.3 days (median 15.5 days, range 4–177 days). Twenty-one patients were admitted to the SCU directly from the operating room, or the following morning from the PACU. The reason for admission to the SCU in these 21 patients was inability to wean from the ventilator ($n = 10$), hypovolemic shock ($n = 4$), myocardial ischemia/infarction ($n = 2$), ongoing septic shock ($n = 2$), ongoing upper gastrointestinal bleeding ($n = 2$), and acute renal failure ($n = 1$). Eleven patients were admitted to the SCU from floor care at a later time during their postoperative course. The reasons for admission to the SCU in these 11 patients were respiratory failure ($n = 4$), cardiac dysrhythmia/infarction ($n = 4$), septic shock ($n = 2$), and upper gastrointestinal bleeding ($n = 1$). Ten patients required readmission to the SCU after being transferred to floor care (five because of upper gastrointestinal bleeding, five because of respiratory failures), four patients required a third SCU admission (all because of respiratory failures), and two patients requiring a fourth SCU admission (both because of intra-abdominal abscesses/sepsis). A comprehensive list of all postoperative complications seen is shown in Table 3.

High and low postoperative laboratory values

Mean high and low postoperative laboratory values of the 32 patients admitted to the SCU in the postoperative period and the mean days on which they occurred were as follows: lowest albumin value 2.1 ± 0.4 g/dl on day 13 (± 25 days), highest prothrombin time 16.7 ± 3.0 s on day 13 (± 28 days), highest total bilirubin value 6.9 ± 6.3 mg/dl on day 15 (± 34 days), highest creatinine value of 1.9 ± 1.0 mg/dl on day 13 (± 17 days), and highest white blood cell count of 20 547 ± 8467 cells/mm^3 on day 9 (± 13 days).

Postoperative mortality

The overall postoperative mortality of all patients operated on by the Hepatobiliary Surgical Service was 3.2% (17 out of 537 patients). Twelve of the 32 patients (37.5%) admitted to the SCU during their postoperative course died, compared with five out of 505 (1.0%) patients never admitted to the SCU during their postoperative course ($P < 0.001$). Neither the preoperative diagnosis (Table 1) nor the operation performed (Table 2) appear to be associated with an increased risk of SCU death. At the time of death, eight out of the 12 patients (67%) had respiratory failure, five patients (42%) had hepatic failure, and three patients (25%) had acute renal failure. Additionally, five out of the 12 patients (42%) were septic, two patients (17%) had persistent coagulopathy and ongoing upper gastrointestinal bleeding, and two patients (17%) died of acute cardiopulmonary arrest of undetermined etiology. Overall, three out of the 12 patients (25%) had multiple organ system failure.

Mean total postoperative duration of stay in the SCU was significantly longer ($P = 0.035$) for nonsurvivors (20.0 ± 23.8 days) than for survivors (6.2 ± 10.2 days). Univariate

Table 4

Potential preoperative and intraoperative variables associated with postoperative mortality by univariate and multivariate analyses in those 32 patients who required critical care services during postoperative care

Variables	Univariate (*P*)	Multivariate (*P*)
Preoperative variables		
Age	0.999	–
Sex	0.119	–
History of cirrhosis/portal hypertesion	0.053	0.194
History of viral hepatitis	0.044	0.802
History of jaundice	0.703	–
History of cardiac disease	0.718	–
Diabetes mellitus	0.999	–
Chronic obstructive pulmonary disease	0.999	–
Preoperative biliary instrumentation	0.703	–
Preoperative biliary drainage	0.999	–
Diagnosis		
Hepatocellular carcinoma	0.999	–
Pancreatic/peripancreatic malignancy	0.999	–
Colorectal hepatic metastases	0.999	–
Noncolorectal hepatic metastases	0.999	–
Cholangiocarcinoma	0.540	–
Benign biliary disease	0.516	–
Polycystic disease of the liver	0.999	–
Other disease	0.999	–
Intraoperative variables		
Operative time	0.999	–
Blood loss	0.999	–
Intravenous fluids	0.999	–
Transfusion of red blood cells	0.724	–
Elective versus emergency case	0.647	–
Resected for cure versus palliation	0.999	–
Hepatic resection	0.726	–
Biliary enteric bypass	0.620	–
Pancreatic resection	0.999	–
Peptic ulcer operation	0.540	–
Extrahepatic bile duct resection	0.516	–
Combined hepatic/pancreatic resection	0.375	–
Other operations	0.999	–

analysis demonstrated that mortality was significantly increased for patients who had median total postoperative duration of stay in the SCU that was greater than the overall median duration of stay of 4.5 days ($P=0.009$) and for patients who had more than two SCU admissions during their hospitalization ($P=0.014$). However, multivariate analysis of these variables suggested that only a median total postoperative duration of stay in the SCU of greater than the median total duration of stay of 4.5 days was an independent predictor of postoperative mortality ($P=0.041$). Postoperative mortality did not depend on the total postoperative duration of stay, or on the number of times a patient was taken to the operating room.

Preoperative and intraoperative variables were analyzed (Table 4) as potential predictors of postoperative mortality among patients admitted to the SCU. A history of viral hepatitis ($P=0.044$) was determined to be significantly associated with postoperative mortality among patients admitted to the SCU by univariate analysis. By univariate analysis, the association of history of cirrhosis/portal hypertension with postoperative mortality was determined to approach statistical significance ($P=0.053$) among patients admitted to the SCU. Multivariate analysis of those two variables revealed that neither a history of viral hepatitis and a history of cirrhosis/portal hypertension was an independent predictor of postoperative mortality among patients admitted to the SCU.

Preoperative and postoperative laboratory values (mean ± standard deviation) in survivors ($n=20$) and nonsurvivors ($n=12$) were analyzed as potential predictors of postoperative mortality among patients admitted to the SCU (Table 5). In nonsurvivors preoperative prothrombin time was significantly higher, preoperative albumin was nearly significantly lower ($P=0.056$), postoperative prothrombin time was significantly higher ($P=0.021$), postoperative albumin levels were nearly significantly lower ($P=0.055$), and postoperative white blood cell count was significantly higher ($P=0.020$).

Postoperative variables were analyzed as potential predictors of postoperative mortality among patients admitted to the SCU (Table 6). By univariate analysis, a patient with postoperative pneumonia ($P=0.002$), hepatic failure ($P=0.004$), or respiratory failure ($P=0.009$) was statistically more likely to die than patients with other complications. However, multivariate analysis of these three postoperative complications failed to disclose any independent predictor of postoperative mortality.

Discussion

There is relatively incomplete information available within the literature as to the causes and outcomes of utilization of critical care services for patients undergoing hepatobiliary surgery. In the present paper, we have reviewed the Memorial Sloan-Kettering Cancer Center experience during the period of February 2, 1994 to December 28, 1995. Firstly, this study was initiated to help to determine the causes of major morbidity and mortality after hepatobiliary surgery, such that we might alter our patient care in order to avoid similar complications in the future. Secondly, this study was initiated to help to evaluate possible predictors of survival once a major complication had arisen, such that guidance could be given to clinicians caring for such patients in determining the likelihood of ultimate survival of such events.

Over a 23-month period, 6.0% of patients operated upon by the Hepatobiliary Surgical Service at Memorial Sloan-Kettering Cancer Center required critical care services. Information on similar critical care services utilized by comparable hepatobiliary services at other institutions is not available in the surgical literature; however, this

Table 5

Preoperative and postoperative laboratory values in surviving and nonsurviving patients requiring critical care services during postoperative care

Laboratory values	All patients ($n = 32$)	Survivors ($n = 20$)	Nonsurvivors ($n = 12$)	*P* value
Preoperative				
Albumin (g/dl)	3.5 ± 0.7	3.7 ± 0.7	3.2 ± 0.7	0.056
Prothrombin time (s)	12.6 ± 1.1	12.2 ± 0.9	13.1 ± 1.2	0.025
Total bilirubin (mg/dl)	3.5 ± 6.4	4.5 ± 7.6	1.8 ± 3.4	0.263
Creatinine (mg/dl)	1.1 ± 0.3	1.1 ± 0.3	1.0 ± 0.4	0.263
White blood cells (cells/mm^3)	9228 ± 6452	8005 ± 3384	11 267 ± 9501	0.170
Postoperative				
Albumin low (g/dl)	2.1 ± 0.4	2.2 ± 0.5	1.9 ± 0.4	0.055
Prothrombin time high (s)	16.7 ± 3.0	15.8 ± 2.6	18.3 ± 3.1	0.021
Total bilirubin high (mg/dl)	6.9 ± 6.3	6.9 ± 7.5	6.9 ± 3.6	0.998
Creatinine high (mg/dl)	1.9 ± 1.0	1.6 ± 0.8	2.2 ± 1.3	0.102
White blood cells high (cells/mm^3)	20 547 ± 8467	17 905 ± 6055	24 950 ± 10 240	0.020

Values are expressed as means ± standard deviation.

Table 6

Potential postoperative complications associated with postoperative mortality by univariate and multivariate analyses in those 32 patients who required critical care services during postoperative care

Postoperative complications	Univariate (*P*)	Multivariate (*P*)
Respiratory failure	0.009	0.093
Bacteremia	0.696	–
Pneumonia	0.002	0.239
Upper gastrointestinal bleeding	0.116	–
Acute renal failure	0.696	–
Hepatic failure	0.004	0.863
Cardiac dysarrhythmias	0.130	–
Intra-abdominal abscess	0.999	–
Wound infection	0.999	–
Urinary tract infection	0.136	–
Myocardial ischemia/infarction	0.274	–
Central line infection	0.999	–
Intra-abdominal bleeding	0.999	–
Empyema	0.375	–

appears to be an appropriate level of care, because the mortality of patients treated postoperatively with floor care alone was only 1% (five out of 505 patients). The fact that the mortality of hepatobiliary patients, once admitted to the SCU, was 37.5% (12 out of 32 patients) may be taken to suggest that patients might have been kept for inappropriately long periods on floor care before being admitted to a critical care setting, or that the problems that arose were poorly treated in the critical care setting, or that the problems that arose were beyond the ability of critical care medicine to salvage. The latter explanation seems to be the most probable.

The causes for admission to a critical care setting were varied. Three findings from the present results appear to be worth further discussing, however. First, more than 50% of the patients requiring a SCU admission suffered respiratory failure. It is possible that instituting an improved preoperative evaluation of pulmonary function, as well as instituting a pulmonary rehabilitation program, might help to reduce this excessive rate of respiratory failure. Second, the intraoperative blood loss among patients requiring a SCU admission was approximately 2000 cm^3 and the intraoperative blood transfusion requirement among patients requiring a SCU admission was 3.4 units of packed red blood cells. Both of these values are well above the median values of 645 cm^3 of intraoperative blood loss and less than one unit of packed red blood cells for intraoperative blood transfusion recorded for 496 patients undergoing hepatic resection at our own institution [11]. Third, 10 out of 32 patients requiring a SCU admission underwent preoperative biliary drainage procedures, which is above the rate for all patients undergoing hepatobiliary surgery. Our own institutional data have

shown that previously drained patients with tumors causing proximal or distal obstruction of the biliary tree who undergo surgical resection or surgical bypass suffer increased intraoperative blood loss [12], as well as increased postoperative infectious complications [13–16]. Those organisms responsible for the postoperative infectious complications were the same as those organisms isolated from intraoperative bile cultures [14,16–18]. This suggests that the potential benefit of preoperative drainage of the biliary tree before surgical resection is questionable and needs to be evaluated further.

On univariate analysis, we found an association of a history of viral hepatitis with postoperative mortality ($P = 0.044$) and a near association of a history of cirrhosis (with or without portal hypertension) with postoperative mortality ($P = 0.053$). These findings confirm the prior reports of Bozzetti *et al* [1] and Lehnert and Herfarth [19]. Likewise, we found that preoperative prothrombin time was significantly ($P = 0.025$) higher in the nonsurviving patients versus the surviving patients who required postoperative critical care utilization, and preoperative albumin was nearly significantly ($P = 0.056$) lower in the nonsurviving patients versus the surviving patients who required postoperative critical care utilization. These findings confirm the prior reports of Nagino *et al* [6], Su *et al* [7], and Lehnert and Herfarth [19]. Although these associations were not independent predictors of postoperative mortality on multivariate analysis, these associations suggest the importance of hepatic function and hepatic reserve in preoperative patient selection for hepatobiliary surgery, as has been previously established by the Child–Turcotte–Pugh grading system for severity of liver disease [20,21]. None of the thirty-two patients requiring postoperative SCU admission had ascites or were encephalopathic preoperatively. Therefore, preoperative prothrombin time and preoperative albumin, as well as a history of viral hepatitis and/or a history of cirrhosis with or without portal hypertension, may be taken to indicate a need for heightened alertness to the possibility of the need for critical care services after significant hepatobiliary surgery.

Once admitted to the critical care unit, postoperative mortality increased with increasing duration of stay, with patients whose SCU stays exceeded 4.5 days doing significantly worse. Beyond this association of survival and duration of SCU stay, we were unable to establish any distinct individual markers to help determine the appropriateness of continuing aggressive care of critically ill patients. However, if markers could be identified, then the determination of the time at which aggressive critical care becomes futile could be established. This would ultimately better assist the critical care staff in advising the patient or proxy as to when survival is unlikely, and all subsequent decisions about pursuing further aggressive interventions could be made with this in mind.

Acknowledgements

The authors gratefully acknowledge Ruth L Sun (Hepatobiliary Database Manager) and Frank M Lewis (Systems Development Data Administrator) for their assistance in identifying patients and collecting data from the hepatobiliary and institutional databases, respectively.

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