Ninety-Day and In-hospital Mortalities After Gastrointestinal and Hepatopancreatic Biliary Surgery—a Case Series Analysis

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Abstract
The aim was to do a retrospective analysis and audit of our 90-day and in-hospital mortalities after gastrointestinal and hepatopancreatic biliary surgery in our department and analyze factors predicting them. All patients who underwent gastrointestinal and hepatopancreatic biliary surgery in our department in the last 3 years were evaluated for 90-day postoperative and in-hospital mortalities and various factors affecting them. Categorical values were analyzed using the chi-square test or Fisher’s exact test wherever appropriate. Continuous variables were analyzed using the Student t-test for parametric data and Mann–Whitney U test for nonparametric data after skewness and kurtosis analysis. Multivariate analysis was done using logistic regression analysis. A p-value less than 0.05 was considered statistically significant. Statistical analysis was done using SPSS version 23(IBM). Four hundred and twelve patients underwent gastrointestinal and hepatobiliary surgery in the last 3 years at our institute. Two hundred and twenty-two patients underwent major gastrointestinal and hepatobiliary surgeries in the last 3 years at our institute. Ninety-day all-cause mortality after major surgery was 10.8%, all-cause in-hospital mortality was around 8.5% in major surgery. Ninety-day mortality in elective and emergency surgeries was 6.7% and 22.4%, respectively. In-hospital mortality in elective and emergency surgeries was 4.8% and 18.9%, respectively. There was no 90-day mortality after nonmajor surgery. On multivariate analysis, nontechnical complications and emergency surgery independently predicted 90-day mortality. On multivariate analysis, acute kidney injury, nontechnical complications, and emergency surgeries independently predicted in-hospital mortalities. Nontechnical complications and emergency surgeries are independently associated with 90-day mortality, and acute kidney injury, nontechnical complications, and emergency surgery independently predict in-hospital mortality.

Keywords Mortality · Gastrointestinal surgery · Hepatopancreatic biliary surgery · Hpb surgery

Introduction
Postoperative mortality is a very important criterion to determine the quality of care, and mortality rates play a very important role in the risk–benefit analysis of any surgical procedure [1]. Overall, postoperative mortality decreases after the improvement of perioperative practices. However, complex gastrointestinal and hepatobiliary surgeries still have a major share in postoperative morbidity and mortality [2].

Surgeons are sometimes not comfortable discussing their outcome data, and there is an increasing need for transparency in reporting surgical outcomes. A surgical mortality audit is an important tool to improve quality. There are some reports [3] that mortality audits improve surgical performances and make surgeons understand the role of better communication with the patients regarding real risk–benefit ratios and stop them from giving unrealistic hope to patients and their relatives.

This analysis aims to do a mortality audit of our data about in-hospital and 90-day mortality in gastrointestinal and hepatopancreatic biliary surgery. We also evaluated various factors responsible for mortality in major surgeries via univariate and multivariate analysis.
Patients and Methods

All patients who underwent gastrointestinal and hepatopancreatic biliary surgery in our department in the last 3 years were evaluated for 90-day postoperative and in-hospital mortalities and various factors affecting them. We evaluated various factors like age, sex, type of surgery, and emergency surgery. CDC grade of a wound, American society of anesthesiology grade, blood product used, operative time, technical or nontechnical complications, acute kidney injury, all types of leaks, bile leaks, anastomotic leaks, open or laparoscopic surgery, overall morbidity, and malignant diseases for their association with 90-day and in-hospital mortalities.

Statistical Analysis

Categorical values were analyzed using the chi-square test or Fisher’s exact test wherever appropriate. Continuous variables were analyzed using the Student \( t \)-test for parametric data and Mann–Whitney \( U \) test for nonparametric data after skewness and kurtosis analysis. Multivariate analysis was done using logistic regression analysis. A \( p \)-value less than 0.05 was considered statistically significant. Factors with \( p \) value of less than 0.05 were included in multivariate analysis. Statistical analysis was done using SPSS version 23 (IBM).

Definitions

Mortality

In-hospital mortality was defined as any mortality when a patient is admitted to the hospital. Nine-day mortality was defined as any cause of mortality in 90-day postoperative period. Ninety-day mortality included all the in-hospital mortalities.

Acute Kidney Injury

Acute kidney injury is defined according to acute kidney injury network classification [4, 5]. Any grade of acute kidney injury was considered significant.

Intraoperative Hypotension

Intraoperative hypotension was defined as systolic arterial pressure below 80 mmHg, a decrease in systolic arterial pressure by 20% below baseline, or vasopressor requirement [6].

Nontechnical and Technical complications

Nontechnical complications were defined as perioperative complications related to patients’ physiological health or comorbidities (e.g., acute kidney injury, ARDS, acute respiratory failure, and cardiac complications), rather than to surgical procedures or techniques.

Technical complications were defined as perioperative complications related to surgical procedures or techniques (e.g., bleeding, leaks, and sepsis). Any nontechnical complications arising after diagnoses of technical complications like bile leaks were considered technical complications. ARDS was defined according to the Berlin definition [7]. Acute myocardial infarction and postoperative left ventricular dysfunction were diagnosed as per cardiologists’ opinion based on cardiac markers, electrocardiogram, and echocardiography. Pulmonary embolism was confirmed using a contrast-enhanced CT scan.

Centre of Disease Control Grading

We also defined surgical wounds according to the Centre for Disease Control as clean (grade 1), clean-contaminated (grade 2), contaminated (grade 3), and dirty (grade 4).

Major and Nonmajor Surgery

We defined surgeries with literature-proven negligible mortality like laparoscopic cholecystectomy, all hernia surgeries, laparoscopic appendicectomies as nonmajor surgeries, and other surgeries as major surgeries. All emergency surgeries except for abovementioned surgeries were also defined as major surgeries. We defined any grade Clavien-Dindo classification as morbidity.

Results

Four hundred and twelve patients underwent gastrointestinal and hepatobiliary surgery in the last 3 years at our institute.

Ninety-Day and In-hospital Mortalities

Ninety-day all-cause mortality was 5.8%, and all-cause in-hospital mortality was around 4.6%. Ninety-day mortality in elective and emergency surgeries was 3.2% and 18%, respectively. In-hospital mortality in elective and emergency surgeries was 2.35% and 15.2%, respectively. As there were no mortalities in 190 nonmajor surgeries, we excluded them...
from univariate and multivariate analysis for factors affecting mortality.

Two hundred and twenty-two patients underwent major gastrointestinal and hepatobiliary surgery in the last 3 years at our institute. Ninety-day all-cause mortality after major surgery was 10.8%, while all-cause in-hospital mortality was around 8.5% in major surgery. Ninety-day mortality in elective and emergency surgeries was 6.7% and 22.4%, respectively. In-hospital mortality in elective and emergency surgeries was 4.8% and 18.9%, respectively. On multivariate analysis, nontechnical complications and emergency surgery independently predicted 90-day mortality.

A total of nineteen patients underwent upper gastrointestinal surgery (5 partial gastrectomy, 4 total gastrectomy, 3 transhiatal esophagectomy, 3 gastrojejunostomies, 4 Nissen fundoplication), 51 underwent small bowel surgeries, 233 patients underwent hepatopancreatic biliary surgery (143 cholecystectomies, 52 liver resections, 8 right trisegmentectomies, 3 left trisegmentectomies, 15 right hepatectomies, 7 left hepatectomies, 3 segmentectomies, 2 non-anatomic resections, 11 extended cholecystectomies with segment 4b5 3 choledochal cyst resections), 20 underwent liver transplantations, 18 underwent pancreatic resections (9 whipples, 5 distal pancreatectomies, 1 enucleation, 3 lateral pancreaticojejunostomy), 60 patients underwent colorectal surgeries (24 anterior resections, 5 abdominoperineal resections, 12 right hemicolecetomies, 11 left hemicolecetomies, 4 complex perianal fistulas, 4 stapler hemorrhoidectomies), and 47 underwent hernia surgeries (34 inguinal hernias, 12 ventral hernias, 1 lumbar hernia).

On univariate analysis, CDC grade of wound classification, intraoperative hypotension, acute kidney injury, morbidity after surgery, nontechnical complications, number of blood products used, American Society of Anesthesiology (ASA) grading, and bile leaks were associated with 90-day mortality.

On univariate analysis, CDC grade of wound classification, intraoperative hypotension, acute kidney injury, morbidity after surgery, nontechnical complications, number of blood products used, American Society of Anesthesiology grading, and emergency surgery were associated with in-hospital mortality.

On multivariate analysis, nontechnical complications and emergency surgery independently predicted 90-day mortality and acute kidney injury, nontechnical complications, and emergency surgeries independently predicted in-hospital mortalities. Multivariate analysis with odds ratio is described in Table 1.

### Discussion

Perioperative mortality is one of the most important problems the surgical community must face. Perioperative mortality ranges from 0.1% to as high as 27–30%, depending on the type of surgery [8, 9]. Gastrointestinal and hepatobiliary surgeries are technically demanding procedures and have among the highest perioperative mortality rates [10–12]. Another issue is surgeons rarely audit their mortality data scientifically and in-process rarely know what factors might be responsible for poor outcomes in their patients.

This study aimed to do a mortality audit for patients operated for major gastrointestinal and hepatobiliary surgeries in

### Table 1

Multivariate analysis for 90-day and in-hospital mortalities for all factors with p value less than 0.05 on univariate analysis after major gastrointestinal and hepatopancreatic biliary surgery by logistic regression analysis

| Factor                                              | Multivariate analysis in 90-day mortality (p values with odds ratio and 95% confidence intervals of factors with p value < 0.05) | Multivariate analysis in in-hospital mortality (p values with odds ratio and 95% confidence intervals of factors with p value < 0.05) |
|-----------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|
| Intra operative hypotension (n = 24)                | p = 0.182                                                                                                                  | p = 0.201                                                                                                                     |
| Acute kidney injury (n = 24)                        | p = 0.177                                                                                                                  | p = 0.031, odds ratio 7.15, 95% confidence interval 1.19–42.86                                                                 |
| Morbidity (any grade Clavien-Dindo classification complication) (n = 47) | p = 0.662                                                                                                                  | p = 0.614                                                                                                                     |
| Nontechnical complications (n = 33)                 | p < 0.0001, odds ratio: 24.42 (95% confidence interval, 4.61–129.23)                                                      | p < 0.0001, odds ratio 20.86, 95% confidence interval 4.93–88.27                                                             |
| Emergency surgery (n = 72)                          | p = 0.017, odds ratio: 9.015 (95% confidence interval, 1.48–54.88)                                                       | p = 0.030, odds ratio 5.88, (95% confidence interval 1.19–29.12)                                                            |
| Bile leak (n = 13)                                  | p = 0.322                                                                                                                  | p = 0.674                                                                                                                     |
| CDC grade of surgery                                | p = 0.520                                                                                                                  | p = 0.709                                                                                                                     |
| Blood product use                                   | p = 0.412                                                                                                                  | p = 0.661                                                                                                                     |
| ASA                                                 | p = 0.451                                                                                                                  |                                                                                                                                  |

All significant p values mentioned in boldface with odds ratios and 95% confidence intervals.
Our department and study factors responsible for 90-day and in-hospital mortalities.

Our elective 90-day and in-hospital mortality rates after elective and emergency major surgeries were around 6.7% and 4.8% respectively and 22.4% and 18.9% respectively, which is comparable to what Sørensen et al. [12] described in their study.

Our overall 90-day and in-hospital mortality rates for the entire cohort were 5.6% and 4.2% which were comparable to published literature [13].

We chose to study 90-day mortality instead of 30-day mortality as Mayo et al. [14] described 90-day mortality should be the standard criteria to describe perioperative mortality.

As we have described in results, various factors were associated with 90-day and in-hospital mortalities after major gastrointestinal and hepatobiliary surgeries, but on multivariate analysis of nontechnical complications, emergency surgery independently predicted both 90-day and in-hospital mortalities. Postoperative acute kidney injury was associated with in-hospital mortality independently; however, it was not associated with 90-day mortality after multivariate analysis which may imply that patients who recovered from postoperative acute kidney injury did well subsequently.

Ninety-day mortality and in-hospital mortality in major surgeries in our series were 6.7% and 4.8%, respectively. Heyer et al. [15] in their recently published study consisting of a large cohort of complex gastrointestinal surgeries showed textbook outcomes increasing over time; they showed 90-day mortality of around 9.2% in a cohort of more than 31,000 patients operated between 2014 and 2016. In our series complex, gastrointestinal surgery for malignancy showed similar results of 9.3% 90-day mortality and 5.3% in-hospital mortality. However, surgery for the malignant disease was not associated with 90-day or in-hospital mortality either in univariate or multivariate analysis in our cohort.

Type of surgery like liver resections or transplants, HPB surgery, upper gastrointestinal surgery, small intestinal surgeries, colorectal surgeries, hernia, and other surgeries were not associated with 90-day or in-hospital mortality. Colorectal surgery was not associated with 90-day mortality; it was associated with in-hospital mortality on univariate analysis but failed to show association on multivariate analysis.

Surgeons are always worried about the technical aspects of surgery, although very few studies have been carried out that looked at the impact of nontechnical complications on perioperative mortality. There are various perioperative complications, which are not related to surgical techniques and depend on many factors, such as patients’ preoperative conditions, perioperative course of anesthesia, and pathophysiologic response to surgical stress. These complications can include, but are not limited to, acute kidney injury, ARDS, postoperative delirium, myocardial infarction, and postoperative acute left ventricular dysfunction. These complications contribute significantly to overall mortality [16, 17].

In our series, nontechnical complications were independently associated with 90-day and in-hospital mortalities after major gastrointestinal and hepatopancreatic biliary surgery in multivariate logistic regression analysis, and their strength was very high with odds ratios of 20.86 and 7.15 respectively for 90-day and in-hospital mortalities, suggesting the need to concentrate on preoperative, intraoperative, and postoperative critical care management to prevent and treat such complications. Pre- and intraoperative factors like CDC grading of wound classification, American Society of Anesthesia Score, number of blood transfusions, and duration of surgery-predicted 90-day and in-hospital mortalities on univariate analysis failed to show independent association on multivariate analysis, and they might have some role to play in the development of nontechnical complications.

Technical complications like intraoperative bleeding, anastomotic leaks, or bile leaks have no association with in-hospital mortality. Bile leaks had an association with 90-day mortality on univariate analysis but had no independent association after multivariate analysis. It again showed the importance of perioperative critical care management to reduce mortality.

Emergency surgeries also predicted both 90-day and in-hospital mortalities independently.

In our analysis, there was no difference between mortality in open and laparoscopic surgeries.

There are certain limitations of this study; as a retrospective analysis, there can be inherent limitations of retrospective analysis like selection bias. We did not have all the details of small bowel surgeries. We did not have details for liver resection for cirrhotic or noncirrhotic. There can be other factors affecting mortality that could not be included in the analysis. The sample size was small as can be seen from the wider confidence interval. Our unit is predominantly hepatopancreatic biliary (HPB) surgery unit in this analysis. HPB surgeries outnumbered the other surgeries. The strength of the study is that it is one of the few studies showing strong strength of association with postoperative nontechnical complications with postoperative mortality.

In conclusion, nontechnical complications and emergency surgeries are independently associated with 90-day mortality, and acute kidney injury, nontechnical complications, and emergency surgery independently predict in-hospital mortality.

Declarations

Ethics Approval Done.
Conflict of Interest  The authors declare no competing interests.

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