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Original Research Article

Postoperative complications and mortality after major gastrointestinal surgery

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ARTICLE INFO

Article history:
Received 28 September 2013
Accepted 27 January 2014
Available online 27 June 2014

Keywords:
Major abdominal surgery
High-risk patients
Postoperative complications
Mortality

ABSTRACT

Background and objective: The incidence of postoperative complications and death is low in the general population, but a subgroup of high-risk patients can be identified amongst whom adverse postoperative outcomes occur more frequently. The present study was undertaken to describe the incidence of postoperative complications, length of stay, and mortality after major abdominal surgery for gastrointestinal, hepatobiliary and pancreatic malignancies and to identify the risk factors for impaired outcome.

Material and methods: Data of patients, operated on for gastro-intestinal malignancies during 2009–2010 were retrieved from the clinical database of Tartu University Hospital. Major outcome data included incidence of postoperative complications, hospital-, 30-day, 90-day and 1-year mortality, and length of ICU and hospital stay. High-risk patients were defined as patients with American Society of Anesthesiologists (ASA) physical status ≥3 and revised cardiac risk index (RCRI) ≥3. Multivariate analysis was used to determine the risk factors for postoperative mortality and morbidity.

Results: A total of 507 (259 men and 248 women, mean age 68.3 ± 11.3 years) were operated on for gastrointestinal, hepatobiliary, or pancreatic malignancies during 2009 and 2010 in Tartu University Hospital, Department of Surgical Oncology. 25% of the patients were classified as high risk patients. The lengths of intensive care and hospital stay were 4.4 ± 7 and 14.5 ± 10 days, respectively. The rate of postoperative complications was 33.5% in the total cohort, and 44% in high-risk patients. The most common complication was delirium, which occurred in 12.8% of patients. For patients without high risk (ASA < III; RCRI < 3) in-hospital, 30-, 90-day and 1-year mortality were 2%, 5%, 12.7% and 26.0%. Patients with ASA ≥ III and RCRI ≥ 3 had 2.3% in-hospital mortality, and at 30-, 90 days and 1 year the mortality was 8.5%, 17.8%, and

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Peer review under the responsibility of the Lithuanian University of Health Sciences.

Production and hosting by Elsevier

http://dx.doi.org/10.1016/j.medici.2014.06.002

42.2%, respectively ($P = 0.001$, $P < 0.0001$ and $P < 0.0001$ compared to the lower risk patients). On multivariate analysis, age above 70 years, ASA ≥ III, RCRI ≥ 3, duration of surgery >130 min, and positive fluid balance >1300 mL after the 1st postoperative day, were identified as independent risk factors for the development of complications.

Conclusion: The complication rate after major gastro-intestinal surgery is high. ASA physical status and revised cardiac risk index adequately reflect increased risk for postoperative complications and worse short and long-term outcome.

1. Introduction

Recent estimates indicate that millions of major surgical procedures are performed worldwide each year [1]. The high-risk non-cardiac surgical population represents a major global healthcare challenge [2–7]. The incidence of postoperative complications and death is low overall, but the sub-group of high-risk patients accounts for over 80% of postoperative deaths, even though these high-risk patients account for fewer than 15% of the in-patient procedures [4,6]. Advanced age, co-morbid disease, and major and urgent surgery are the key factors associated with increased risk [4,6,7]. Patients undergoing gastrointestinal surgery for malignancy are typical representatives of such high-risk patients. Despite strong evidence of their impact on poor surgical outcomes, our understanding of standards of postoperative care is limited. Neither short- nor long-term outcomes after major gastrointestinal surgery in Estonia have been reported. For a population of 1.3 million there exist two national tertiary care centres. The present retrospective study has been performed in one of these centres, Tartu University Hospital. The present study was undertaken first, to describe the incidence of postoperative complications, length of stay, and mortality after major abdominal surgery for gastrointestinal, hepatobiliary and pancreatic malignancies in our centre, and, second, to identify the risk factors for impaired outcome.

2. Material and methods

This study was approved by the Research Ethics Committee of the University of Tartu (protocol No. 204/T-6).

Records of patients who were operated on in Tartu University Hospital, Department of Surgical Oncology between January 1, 2009, and December 31, 2010, were retrieved from the hospital clinical database and retrospectively reviewed. Patients' demographics, underlying diagnoses, main perioperative and intensive care data were extracted and analyzed. ASA physical status score [8] and revised cardiac risk index (RCRI) [9] were documented for assessment of risk associated with concomitant diseases. High risk patients were defined as patients with American Society of Anesthesiologists (ASA) physical status ≥3 and revised cardiac risk index (RCRI) ≥3. Postoperative complications were retrospectively documented using the definitions in Table 1. Duration of intensive care unit

Table 1 – Definition of complications.

Infection	Pneumonia – confirmed chest X-ray, marked in case history Abdominal – confirmed abdominal computed tomography, marked in case history Urinary tract – clinical diagnosis, UTI marked in case history Wound – clinical diagnosis, marked in case history Septic shock – ACCP consensus criteria [10], marked in case history
Respiratory	Mechanical ventilation >24 h Reintubation regardless of the reason
Cardiovascular	Acute myocardial infarction – ECG signs of ischaemia, troponin $T > 0.03$ ng/mL; diagnosis marked in case history Cardiac arrest Cardiac arrhythmia – atrial fibrillation, ventricular fibrillation, marked in case history, use of iv antidysrhythmics (amiodarone ≥150 mg/day; metoprolol ≥5 mg; propafenone ≥70 mg)
Neurological	Transient confusion – needing intravenous therapy with haloperidol and/or clonidine, marked in case history Stroke – clinical diagnosis confirmed with computed tomography, marked in case history
Abdominal	Anastomotic leak – needing drainage or reoperation, marked in case history Ileus – requiring nasogastric aspiration or surgery, marked in case history
Renal	Urine output <0.5 mL/kg/h for more than 12 h or increased creatinine (2×) [11] Required dialysis for acute renal failure
Other	Postoperative massive haemorrhage – need for therapeutic endoscopy or re-operation, marked in case history Re-operation for other reasons than listed above

(ICU) and hospital stay as well as hospital mortality were documented from hospital records; 30-day, 90-day and 1-year mortality data from the national registry.

2.1. *Statistical analysis*

The Statistical Package for the Social Sciences (Version 18.0 SPSS Inc., Chicago, IL, USA) software was used for statistical analysis. Continuous variables are expressed as mean (standard deviation (SD)), and categorical data as number (%) of patients. The Kolmogorov–Smirnov test with Lillefors significance correction was used for normality control of the distribution of continuous variables. The unpaired *t* test for normally distributed variables and the Mann–Whitney *U* test for nonnormally distributed continuous variables were used for comparisons of two groups. The Chi-square test was used for categorical variables. Data are presented as means (SD) unless otherwise specified. The differing incidences of complications and mortality rates have been presented as odds ratios (OR) with 95% confidence intervals (CI). $P < 0.05$ was considered statistically significant. To determine the risk factors for postoperative complications we conducted multivariate analysis. The cut-off values were determined using reader operating characteristic (ROC) curve analysis.

3. Results

Five hundred and seven patients (259 men and 248 women, mean age 68.3 (SD, 11.3) years) were operated on for gastrointestinal, hepatobiliary or pancreatic malignancies during 2009 and 2010. The main location of operation was the lower gastrointestinal tract (in 50.3% of the cases), followed by the upper gastrointestinal tract (24.1%), the pancreas (7.3%) and the liver (4.3%). In 12.6% of the cases the surgery included more than one location (e.g., colectomy and liver resection). In 1.4% of the cases the malignant process was widespread and definitive surgery was not possible.

Some 89.5% of the operations were elective. The mean duration of surgery was 151 (SD, 66) min. General anaesthesia combined with epidural analgesia was used in a majority of cases (72%); in the remainder general anaesthesia alone was used. On average patients received 2677 (SD, 1274) mL intravenous fluids in the operating theatre. Fluids were given according to clinical judgement; no routine cardiac output monitoring or protocolised approach for haemodynamic management was applied in the operating theatre. 85.5% of patients were admitted to ICU for postoperative care. The mean ICU stay was 4.4 (SD, 7) days, after which they were transferred to a step-down unit in the surgical ward. The mean length of hospital stay was 14.5 (SD, 10) days.

At least one non-lethal postoperative complication occurred in 33.5% patients, while 15% had two or more complications. The most common complication was delirium, which occurred in 12.8% of patients. The most common infectious complications were pneumonia (6.1%), intra-abdominal infection (4.2%) and wound infection (4.2%). Septic shock developed in 4.1% of the patients. Other complications and their rates are depicted in Fig. 1. On multivariate analysis, age above 70 years, ASA ≥ III, RCRI ≥ 3, duration of surgery >130 min, and positive fluid balance >1300 mL on the first postoperative day, were identified as independent risk factors for development of complications (*P* values for all these risk factors were less than 0.05).

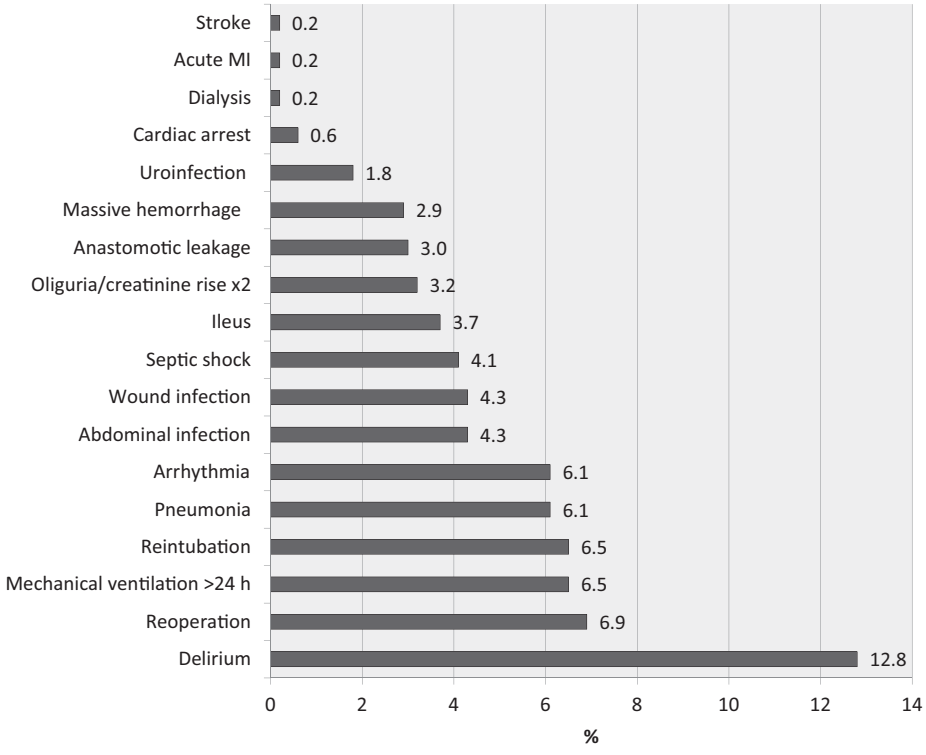

Fig. 1 – Frequency of postoperative complications.

Table 2 – Comparison between patients without and with complications.

	Patients without complications $n = 336$ (66.5%)	Patients with complications $n = 161$ (33.5%)	
Length of ICU stay, days, mean (SD)	2.8 (2.0)	7.8 (10.8)	$P < 0.0001$
Length of hospital stay, days, mean (SD)	11 (3.8)	24 (15.0)	$P < 0.0001$
In-hospital mortality n (%)	1 (0.3)	8 (5.0)	OR = 16.7 (95% CI 2.0–134.6)*
30-day mortality n (%)	11 (4.0)	13 (6.8)	OR = 2.4 (95% CI 1.1–5.7)*
90-day mortality n (%)	31 (9.2)	32 (20.0)	OR = 2.3 (95% CI 1.3–4.0)*
1-year mortality n (%)	94 (28.0)	59 (37.0)	OR = 1.5 (95% CI 0.95–2.1)

* $P < 0.05$.

The occurrence of any complication was associated with a worse outcome (Table 2) with odds ratios ranging from 1.5 to over 16 for mortality at different time points.

In-hospital, 30-, 90-day and 1-year mortalities for patients with ASA < III and RCRI < 3 were 2%, 5%, 12.7% and 26.0%. Patients with ASA ≥ III and RCRI ≥ 3 had 2.3% in-hospital mortality, and at 30 and 90 days and 1 year the mortality was 8.5%, 17.8% and 42.2%, respectively ($P = 0.001$, $P < 0.0001$ and $P < 0.0001$ compared to the lower risk patients) (Table 3). The cumulative survival for patients without high risk was significantly better than that of the patients at high risk ($P < 0.005$) (Fig. 2).

We performed subgroup analysis for two largest groups according to the site of surgery – upper and lower gastrointestinal surgery (24.1% and 50.3% of the cases, respectively). There was significantly higher in-hospital and 30-day mortality in those having upper gastrointestinal tract surgery, but no other significant differences were present (Table 4).

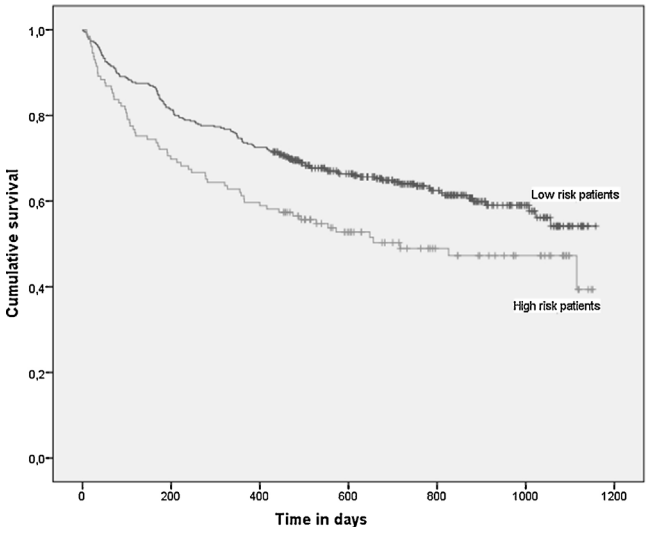

Fig. 2 – Kaplan–Meier curve for cumulative survival ($P < 0.005$).
Low risk patients – ASA < III and RCRI < 3, high risk patients – ASA ≥ III and RCRI ≥ 3.

4. Discussion

This study describes the outcome of patients operated on in one of Estonia's tertiary hospitals, which is responsible for approximately half of the operations performed nationally for gastrointestinal malignancy. With some limitations the results could be generalized for the entire country.

Reported mortality rates after major abdominal surgery can be as high as 17% [12], but are usually between 3% and 7% [13–15]. Compared to the literature, hospital mortality in our study group was relatively low at 2%; this may be explained by the policy of admitting the majority (85.5%) of the patients to the intensive care unit after surgery. This is consistent with the results of the recent EuSOS study, in which 73% of the deaths occurred among patients who were never admitted to ICU, and where postoperative mortality was lower in countries which have better provision of intensive care beds/better access to the ICU [14]. The Estonian data in the EuSOS study reflect patients recruited from 3 hospitals including our own, but with a different timeframe from the present study. The in-hospital mortality for Estonia in EuSOS was 1.5% [16]. The marginally higher mortality rate of 2% in the present study can be explained by the higher proportions of major surgery and comorbidity in our study group, and a consequent higher risk of postoperative complications.

The long-term survival of patients undergoing major abdominal surgery for malignancy is influenced by many factors (e.g., presence/development of postoperative complications, radical versus palliative surgery, comorbidity). Short- and long-term mortality is significantly higher among patients with postoperative complications, as established in the literature [3]. This is reconfirmed in our study, where patients with postoperative complications had significantly higher 30- and 90-day mortality rates compared to patients without complications.

A negative impact of higher ASA physical status score and revised cardiac risk index at the time of surgery on short-term mortality is well recognized [17]. In the present study we have shown that they are also accurate markers of adverse longer-term mortality. An ASA status ≥III and revised cardiac risk index ≥3 are statistically significant predictors of worse mortality at 90 days and at 1 year (Fig. 2).

Table 3 – Comparison between patients without and with high risk.

	Patients with ASA < III and RCRI < 3 (n = 377)	Patients with ASA ≥ III and RCRI ≥ 3 (n = 129)	
Patients with complications n (%)	126 (33.5%)	57 (44.0%)	P = 0.02
LOS ICU stay days, mean (SD)	3.5 (5.3)	6.0 (10.0)	P = 0.008
LOS days, mean (SD)	13.7 (8.9)	17.0 (13.6)	P = 0.012
In-hospital mortality n (%)	7 (2.0)	3 (2.3)	OR 1.0 (95% CI 0.96–1.03)
30-day mortality n (%)	14 (5.0)	11 (8.5)	OR 2.4 (95% CI 1.1–5.5)*
90-day mortality n (%)	41 (12.7)	23 (17.8)	OR 1.8 (95% CI 1.02–3.1)*
1-year mortality n (%)	100 (26.0)	54 (42.2)	OR 2.0 (95% CI 1.3–3.0)*

* $P < 0.05$.

Postoperative complications clearly have negative impacts on mortality and length of hospital stay, but their frequency, as reported on the literature, has great variability depending on the type of surgery (e.g., the postoperative complication rate of 51% after oesophageal resection [13]), and study design (e.g., reaching up to 70% in some prospective studies [18,19]). In our study at least one complication occurred in 33.5% of the patients. This relatively low frequency is likely to be due to the retrospective data collection of our study.

The most frequent postoperative complication in our study group was delirium, which occurred in 12.6% of the patients, as is typically described in the literature 10–15% [20,21], but the incidence can be as high as 52% after hip fracture and aortic surgery [22]. Postoperative delirium is defined as change in mental status characterized by reduced awareness of the environment and a disturbance in attention, and may be accompanied by other, more florid perceptual symptoms or cognitive symptoms including disorientation or temporary memory dysfunction [23]. Delirium might be hypoactive, hyperactive or a mixture of both forms. The first, hypoactive form, can be difficult to diagnose and recognize due to subtle symptoms including lethargy and inattentiveness. Development of postoperative delirium is associated with worse outcomes with regard to length of intensive care and hospital stay, higher mortality and health-care cost [24]. Risk factors for postoperative delirium are older age, emergency surgery, use of psychotropic drugs, greater comorbidity, cognitive, sensory and functional impairment [21,22].

Table 4 – Comparison between upper and lower gastrointestinal tract surgery.

	Upper GI tract	Lower GI tract	P
Total	122 (24.1)	255 (50.3)	
Pneumonia	9 (7.4)	15 (5.9)	0.3
Abdominal infection	5 (4.0)	10 (3.92)	0.4
Urinary infection	0 (0.0)	7 (2.7)	0.06
Wound infection	4 (3.2)	12 (4.75)	0.3
Septic shock	5 (4.0)	13 (5.0)	0.4
Mechanical ventilation >24 h	6 (4.9)	18 (7.0)	0.3
Reintubation	9 (7.4)	17 (6.6)	0.4
Acute myocardial infarction	1 (0.81)	0 (0.0)	0.3
Cardiac arrest	1 (0.81)	2 (0.78)	0.6
Cardiac arrhythmia	6 (4.9)	18 (7.0)	0.2
Delirium	13 (10.6)	33 (13.0)	0.3
Stroke	0 (0.0)	1 (0.4%)	0.6
Anastomotic leakage	1 (0.81)	11 (4.3)	0.06
Ileus	3 (2.45)	14 (5.5)	0.1
Oliguria	5 (4.0)	7 (2.74)	0.5
Dialysis	0 (0.0)	2 (0.78)	0.7
Massive bleeding	5 (4.0)	5 (1.96)	0.2
Reoperation	8 (6.5)	20 (7.8)	0.1
Complication rate	36 (29.5)	87 (34.0)	0.4
In-hospital mortality	7 (5.7)	2 (0.8)	0.006*
30-day mortality	12 (9.8)	9 (3.5)	0.015*
90-day mortality	19 (15.6)	27 (10.6)	0.1

Values are number (percentage).
* $P < 0.05$.

On multivariate analysis, age above 70 years, ASA ≥ III, RCRI ≥ 3, duration of surgery >130 min, and positive fluid balance >1300 mL after the 1st postoperative day, were identified as independent risk factors for the development of complications. The negative impact of volume overload is a well-recognized risk factor for postoperative complications [26]. The principle of adherence to zero fluid balance is increasingly established. In the present cohort we identified 1300 mL as a cut-off value related to morbidity.

There is no single measure or ''magic bullet'' to decrease the postoperative complication rate or mortality after surgery. A multimodal approach is evidently needed. Applying ERAS (Enhanced Recovery After Surgery) recommendations [27,28]; perioperative goal directed infusion therapy, and haemodynamic optimization [29,30], and improving access to the intensive care or high dependency unit [31] have all been shown to be of value. Our analysis demonstrates that the latter may be the most important as this is the only factor to have been consistently implemented in our patients during our recruitment period. Nonetheless we could demonstrate a creditably low mortality rate despite a high level of comorbidity.

5. Conclusions

The complication rate after major surgery for gastrointestinal, hepatobiliary and pancreatic malignancies is high. These postoperative complications significantly increase the hospital stay and mortality. ASA physical status and revised cardiac risk index adequately reflect the increased risk of postoperative complications, including mortality, and can be recommended as useful preoperative indices to identify high-risk patients.

Conflict of interest

The authors state no conflict of interest.

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