Reoperation after colorectal surgery is an independent predictor of the 1-year mortality rate

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ORIGINAL CONTRIBUTION

Reoperation After Colorectal Surgery Is an Independent Predictor of the 1-Year Mortality Rate

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BACKGROUND: Comparative evaluation of surgical quality among hospitals must improve outcome and efficiency, and reduce medical costs. Reoperation after colorectal surgery is a consequence of surgical complications and therefore considered a quality-of-care indicator. With respect to the mortality rate, the 1-year mortality may be a more meaningful figure than in-hospital mortality, because it also reflects the impact of surgical complications beyond discharge.

OBJECTIVE: The aim of our study was to evaluate the 1-year mortality after colorectal surgery and to identify predicting factors.

DESIGN: This study was a retrospective analysis from our colorectal surgery database.

PATIENTS: All patients who underwent elective colorectal surgery from 2005 to 2008 were included.

MAIN OUTCOME MEASURES: Both univariate and multivariate analysis were performed to identify predicting factors. The following variables were analyzed: age, operative risk according to the ASA class, Charlson-Age Comorbidity Index, indication for and type of resection, primary anastomosis, tumor staging, anastomotic leakage, and reoperation.

RESULTS: For 743 consecutive patients, the 1-year mortality rate was 6.9%. Patients were operated on mainly because of colorectal cancer (n = 537; 72%). The rate of reoperation and in-hospital mortality was 12.8% and 2.4%. Univariate survival analysis demonstrated that ASA class, age, Charlson-Age Comorbidity Index, reoperation, and stage of disease were independent predictors of 1-year mortality. Multivariate analysis showed that ASA class ($P = .020$; HR 1.69), age ($P = .015$; HR 2.08) and reoperation ($P = .001$; HR 2.72) are directly correlated with 1-year mortality.

LIMITATIONS: Both patients with benign diseases and colorectal cancer are included. Furthermore, no clear guidelines on whether to perform a reoperation were available.

CONCLUSION: One-year mortality after colorectal surgery is independently predicted by ASA class, age, and reoperation. Our results underline the value of the 1-year mortality rate and the reoperation rate as parameters for quality assessment in colorectal surgery.

KEY WORDS: Colorectal surgery; Reoperation; 1-year mortality; Quality assessment.

With increasing recognition that surgical outcomes can vary widely, patients, regulators, and administrators are seeking ways to collect reliable information to assess the quality of health care providers. When adjusted for patient risk, comparative evaluation of surgical quality among hospitals has been shown to improve outcomes, improve efficiency, and reduce medical costs.[1]

With regard to colorectal surgery, considerable hospital-to-hospital variability has been demonstrated in surgical outcomes. In general, measures of hospital morbidity, in-hospital or 30-day mortality, and length of stay have been the primary end points of assessing surgical quality. Unfortunately, these measures have major flaws that limit their usefulness.[2] An alternative measure is the reoperation rate, which may be considered an indicator of surgical complications and therefore of surgical quality. Although the reoperation rate has recently been adopted by regulators

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in the Netherlands for surgical quality assessment, comparison is not meaningful unless outcome data are adjusted for the hospital patient risk profile.

With respect to mortality, the 1-year mortality rate may be a more reliable indicator for surgical quality than the in-hospital or 30-day mortality, because the impact of serious surgical complications may extend beyond 30 days or the (primary) hospital admission. This has recently been demonstrated by Jamieson et al[3] for esophageal resection and may also hold true for other major surgical procedures.

To date, no studies on the 1-year mortality rate in relation to the quality of colorectal surgery have been reported. Therefore, the aim of our study was to evaluate the 1-year mortality rate after elective colorectal surgery and to identify its predicting factors.

MATERIALS AND METHODS

From January 2005 to August 2008, 743 consecutive patients underwent elective colorectal surgery in the Isala Clinics, a large teaching hospital in the Netherlands. Patient data and surgery-related characteristics were prospectively collected in the colorectal surgery database. Our database was approved by the medical ethics committee of our hospital.

The following variables were analyzed: sex, age, operative risk according to the ASA class, Charlson-Age Comorbidity Index (CACI),[4] indication for resection, type of resection, primary anastomosis, pathological staging according to the TNM (American Joint Cancer Committee/International Union Against Cancer) classification,[5] anastomotic leakage, reoperation, and in-hospital mortality. The "standard" definition of anastomotic leakage according to the United Kingdom Surgical Infection Study Group was used.[6] Type of resection was subdivided in 4 types: right colectomy (including ileocecal and transverse colonic resection), left colectomy (including sigmoid resection), rectal resection (all rectal procedures below 15 cm from the anal verge), and subtotal colectomy. Reoperation, within 30 days after the initial operation, was defined as an unplanned procedure in the operating room and did not include interventional radiological procedures.

The in-hospital, 30-day, and 1-year mortality was recorded during follow-up for all patients. To determine independent prognostic factors for 1-year mortality, an univariate survival analysis was performed using the Kaplan-Meier method. A log-rank test was used to determine statistical significance. Subsequently, we performed a stepwise multivariate analysis of survival using a Cox proportional hazards model. The following factors were entered as independent variables: age, ASA class, CACI, primary anastomosis, type of resection, tumor staging, anastomotic leakage, and reoperation. All *P* values were 2-tailed and significance was considered as a *P* value of less than .05. Statistical analyses were executed with the statistical software package SPSS, Version 18.0 (SPSS Inc., Chicago, IL).

TABLE 1. Baseline characteristics of 743 patients

Characteristics	*Number (%)*
Sex	
Male	390 (52.5)
Female	353 (47.5)
Age (years)[a]	66.6 (14.2)
ASA class	
I	208 (28.0)
II	366 (49.3)
III	169 (22.7)
Charlson Age Comorbidity Index	
0–4	468 (63.0)
≥ 5	275 (37.0)
Indication for surgery	
Colorectal cancer	537 (72.3)
Adenoma	64 (8.6)
Diverticulitis	63 (8.5)
Inflammatory bowel disease	48 (6.5)
Other	31 (4.2)
Pathology	
Benign disease	204 (27.4)
Stage[b] I	123 (16.6)
Stage II	189 (25.4)
Stage III	181 (24.4)
Stage IV	46 (6.2)

[a]Mean (SD).
[b]Staging based on the TNM classification of the American Joint Committee on Cancer and International Union Against Cancer.

RESULTS

In this study, 743 patients with a mean age of 67 years underwent an elective colorectal resection. Patients were mainly operated on for colorectal cancer (72%), and a minority of patients (28%) had benign disease. Nearly 50% of the patients with cancer were TNM stage II and III (Table 1). Right colectomy (32%), left colectomy (35%), and rectal resection (28%) were almost equally distributed in our study group; subtotal colectomy was performed in a minority of cases (5%). In 611 patients (82%), a primary anastomosis was constructed, resulting in an overall anastomotic leakage rate of 8.8% (Table 2). The rate of reoperation for the whole group was 12.8%. The most frequent indication for reoperation was anastomotic leakage, followed by wound dehiscence and abdominal abscess (Table 3). The overall in-hospital mortality and the 30-day mortality for the whole study group was 2.4%, and the 1-year mortality rate was 6.9%.

Univariate survival analysis, including in-hospital mortality, revealed that ASA class, age, CACI, reoperation and stage of disease were independent predictors of 1-year mortality. Multivariate analysis showed that the patient-related factors as ASA class ($P = .020$; HR 1.69), age ($P = .015$; HR 2.08), and reoperation ($P = .001$; HR 2.72) had a significant impact on 1-year mortality (Table 4).

TABLE 2. Surgery-related characteristics

Characteristics	*Number (%)*
Type of resection	
Right colectomy	240 (32.3)
Left colectomy	258 (34.7)
Rectal resection	207 (27.9)
Subtotal colectomy	38 (5.1)
Conduit	
Primary anastomosis	611 (82.2)
No continuity	132 (17.8)
Anastomotic leakage (n = 611)	
Yes	54 (8.8)
No	557 (91.2)
Reoperation	
Yes	93 (12.5)
No	650 (87.5)
In-hospital mortality	
Yes	18 (2.4)
No	725 (97.6)

DISCUSSION

In this study we show by multivariate analysis that the 1-year mortality rate after elective colorectal surgery is independently predicted by ASA classification, age, and reoperation rate. Whereas this result may be expected for ASA class and age, a direct correlation of the 1-year mortality rate with the reoperation rate after colorectal surgery has not been shown before.

Our data show a 1-year mortality rate of 6.9%, an in-hospital mortality rate of 2.4%, and a reoperation rate of 12.8%, which are all in line with the current literature (1.8%–14%).[7,8] The wide range in reported reoperation rates can be largely attributed to differences in definition and indication for reoperation.

Reoperations are generally undertaken for surgery-related complications, such as anastomotic leakage, wound infection, and bleeding.[9] For this reason, Birkmeyer et al[9] proposed that the reoperation rate may be used for monitoring surgical quality across hospitals and for identifying opportunities for quality improvement. In colorectal surgery, reoperation as an indicator of surgical quality was reported by Morris et al.[2] In that study, postoperative complications requiring reoperation were associated with increased hospital mortality and prolonged length of stay.

TABLE 3. Reasons for reoperation in 93 patients

Reason	*Number (%)*
Anastomotic leakage	49 (52.7)
Wound dehiscence	11 (11.8)
Abdominal abscess	7 (7.5)
Negative relaparotomy	6 (6.5)
Stoma revision	5 (5.4)
Bowel ischemia	4 (4.3)
Rebleeding	3 (3.2)
Small-bowel obstruction	2 (2.2)
Other	6 (6.5)

TABLE 4. Univariate and multivariate analysis of the 1-year mortality rate

	P		
Characteristics	*Univariate*	*Multivariate*	*HR (95% CI)*
ASA class	<.005	.020	1.69 (1.09–2.62)
Age	<.005	.015	2.08 (1.15–3.75)
CACI	.014	.693	—
Type of operation	.430	.421	—
Conduit	.431	.527	—
Anastomotic leakage	.052	.693	—
Reoperation	<.005	.001	2.72 (1.49–5.00)
Stage of disease	<.005	.134	—

CACI = Charlson Age Comorbidity Index.

In the Netherlands, the reoperation rate within 30-day after colorectal surgery has recently been adopted by the National Health Care Inspectorate as an indicator of quality of hospital care.[10] In the United States, however, this is not the case for 3 reasons. First, the wide range of reoperation rates between hospitals demonstrates the complexity of this parameter and it would be difficult to establish what reoperation rates would be "acceptable."[11] Second, a reliable and uniform prospective registration of reoperations is needed before the unplanned reoperation rate can be used as indicator of the quality of care.[7,8] Finally, reoperation rates could be easily confounded by differences in patient case mix across hospitals. For a meaningful comparison, a careful patient risk adjustment is therefore essential.[7,9] For this purpose, several risk-scoring systems aiming to predict mortality and morbidity can be used, such as the POSSUM scoring system (Physiological and Operative Severity Score for the enumeration of Mortality and Morbidity), the ASA class, and Acute Physiology And Chronic Health Evaluation scores.[7] Currently, the POSSUM score is considered the most reliable.[12,13] With the use of this score, a risk-adjusted comparative audit of colorectal resection between surgical units and individual surgeons has been reported.[14] The CACI is recently validated as a promising tool to predict 1-year mortality after major colorectal surgery and should therfore be adopted in colorectal surgery audit.[15,16] It is a well-recognized comorbidity classification tool that is simple to apply. However, in our study, the CACI was not an independent prognostic factor in multvariate analysis. Our data strongly support the value of the reoperation rate as an indicator of surgical quality in colorectal surgery, because it is directly correlated with the 1-year mortality rate.

There are some limitations to this study. First, there were no clear guidelines in our department on when to perform a reoperation. Additional investigations (imaging) combined with the patient's clinical condition mandated the reoperation in most cases, but sometimes only the clinical condition was considered in this decision.

To standardize this aspect of perioperative care, we propose the routine use of CT scanning to have a better selection of patients for relaparotomy leading to a reduction in the number of negative relaparotomies.[17] Another potential benefit of additional CT imaging may be a more important role for minimally invasive radiological procedures in the management of complications, such as percutaneous drainage of pelvic abscesses. When done successfully, this may lower the morbidity and mortality rates in comparison with surgical interventions. Second, our multivariate analysis did not show any influence of tumor staging on 1-year mortality. This may be explained by the fact that, in recent years, there are fewer colorectal cancer-related deaths of stage II and III patients at 1 year after surgery because of improved systemic chemotherapy regimens. This implies that the 1-year mortality is more likely to be surgery related, which is also supported by the fact that 27.4% of our series patients were operated on for benign disease. The exact causes of death during 1-year follow-up after discharge from hospital were unknown or could not be determined in most patients. Therefore, a direct correlation between death during follow-up and surgical complications cannot be formally established in the current study, but it is very likely given our multivariate analysis results.

Comparison of surgical outcome of colorectal resection between hospitals will become more important in the future for all stakeholders, because it may lead to improved outcomes, improved efficiency, and reduced medical costs.[1,8,18] In this respect, our findings have 2 important implications. At first, the 1-year mortality rate may be a valuable indicator of surgical quality of colorectal surgery, because it is directly correlated with the reoperation rate. The 1-year mortality rate (6.9%) may be a better outcome indicator than the 30-day or in-hospital mortality rate (2.4%), because the impact of surgery-related complications and of reoperation may extend well beyond 30 days or the initial hospital admission. As intensive care units become increasingly capable of supporting critically ill patients, a further decline of the 30-day or in-hospital mortality rate can be anticipated. The true consequences of major complications may therefore not be fully expressed in the 30-day mortality rate, but are likely to impact on the 1-year mortality. This concept was first suggested by Jamieson et al[3] for esophagectomy and is supported by the present study for colorectal surgery.

Furthermore, our data support the value of the reoperation rate as a quality indicator for colorectal surgery, because it independently predicts the 1-year mortality rate, which is generally higher than the 30-day or in-hospital mortality. Provided that clear definitions, reliable standardized prospective data collection, and careful patient risk adjustment are established, this indicator is a valuable tool for the assessment of surgical quality in colorectal surgery.

CONCLUSION

The reoperation rate after colorectal surgery is an independent predictor of the 1-year mortality. For quality assessment, both the reoperation rate and the 1-year mortality are valuable indicators in colorectal surgery, provided that reliable data collection and careful patient risk adjustment are established. These findings may facilitate the development of quality assessment strategies that may eventually lead to the improvement of patient outcomes, efficiency, and reduction of medical costs.

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