

Postoperative Complications: Looking Forward to a Safer Future

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Abstract

Colorectal surgery patients frequently suffer from postoperative complications. Patients with complications have been shown to be at higher risk for mortality, poor oncologic outcomes, additional complications, and worse quality of life. Complications are increasingly recognized as markers of quality of care with more use of risk-adjusted national surgical databases and increasing transparency in health care. Quality improvement work in colorectal surgery has identified methods to decrease complication rates and improve outcomes in this patient population. Future work will continue to identify best practices and standardized ways to measure quality of care.

Keywords

- ▶ postoperative complications
- ▶ surgical quality
- ▶ prehabilitation

Colorectal surgery is associated with a high risk of morbidity and mortality in comparison to other general surgery subspecialties. Overall mortality rates following colorectal surgery range from 1 to 16.4%,^{1–4} with morbidity rates as high as 35%.^{1,2,5} Furthermore, following colorectal surgery, patients require the need for a second operation 2 to 5.8% of the time.⁶ The significant postoperative morbidity in this patient population has been extensively researched in an effort to identify areas for quality improvement and is increasingly being targeted by payers who are withholding payments for preventable complications.⁷ In addition, there has been a growing emphasis on transparent reporting of clinical outcomes and a search for specialty-specific quality metrics to objectively compare surgical quality across hospitals.

Postoperative Complications

Postoperative complications occur in up to one-third of patients undergoing colorectal procedures.¹ Longo et al² identified a complication rate of 28% in patients who underwent colectomy for colon cancer in the National Veterans Affairs Surgical Quality Improvement Program database. A similar complication rate (27%) occurred in an analysis of more than 600 patients with ulcerative colitis who had colectomy.⁵ The most common complications following colorectal resection are infectious, wound infection or organ

space infection, and gastrointestinal (GI) motility complications, including ileus and bowel obstruction.

Wound complications, such as infection, hematoma, and dehiscence are common after colorectal surgery, occurring in up to 13% of patients.^{1,8} An analysis of SEER (Surveillance, Epidemiology, and End Results Program) Medicare patients with colorectal cancer who required reoperation after initial resection found that wound complications accounted for 21% of reoperative cases.¹ Anastomotic leak or organ space infection occurs at a similar rate of 3 to 10% and is responsible for 32% of reoperations in colorectal cancer patients.^{1,8–15}

Although definitions of ileus and partial small bowel obstruction vary widely in the literature, these disorders are recognized as a significant source of postoperative morbidity in colorectal surgery patients. Definitions vary in which signs and symptoms are included (abdominal distension, lack of bowel sounds, nausea, vomiting, lack of flatus, and/or bowel movements) and duration of ileus after surgery (24 hours–5 days). Prolonged ileus after colorectal surgery is reported to range from 5.3 to 24%.^{1,2,16–18} Asgeirsson et al¹⁷ reported the highest postoperative ileus rate of 24% using the definition of > 3 episodes of emesis with return to NPO (nothing by mouth) status and/or reinsertion of a nasogastric tube. The study also outlined significantly higher total 30-day episode of care costs for colectomy in patients with ileus (\$16,600 vs. \$8,300, $p < 0.05$).

Although a major cause of morbidity in colorectal surgery patients is directly related to bowel resection (infection, GI dysmotility), these patients are as susceptible as all surgery patients to other postoperative complications. Up to 11% of patients suffer cardiorespiratory complications, 5% have postoperative hemorrhage, urinary complications occur in 8%, and venous thrombosis occurs approximately 1% of the time.¹ A more specific breakdown of pulmonary complications in colectomy patients from the National Veterans Affairs Surgical Quality Improvement Program database found pneumonia occurred in 6.2% of patients and failure to wean from the ventilator occurred in 5.7%.²

Risk Factors for Complications

Multiple studies have evaluated predictors of overall morbidity following colorectal surgery. Patient factors predicting postoperative complications include older age, comorbidity (specifically neurologic or cardiorespiratory comorbidity), and low preoperative albumin.^{1,5} Operative variables found to predict morbidity included emergent operation, longer operative time (> 120 minutes), and peritoneal contamination.^{1,5}

Others have identified similar risk factors for development of anastomotic leak after colorectal resection. In addition to the risk factors listed earlier, operative length, intraoperative blood loss (> 200 or > 300 mL), need for intraoperative transfusion, and dirty case classification have been found to predict anastomotic leak.^{8–10} Patient characteristics found to specifically predict anastomotic leak included male gender, higher ASA (American Society of Anesthesiologists) classification, preoperative radiation, and postoperative hyperglycemia.^{8,14} An analysis of GI anastomotic leak anywhere in the GI tract demonstrated congestive heart failure (CHD) ($p = 0.007$), peripheral vascular disease (PVD) ($p = 0.048$), alcohol abuse ($p = 0.002$), steroid use ($p = 0.027$), weight loss ($p = 0.011$), and abnormal sodium ($p = 0.002$) to predict anastomotic failure.¹²

Patient characteristics found to be independent predictors of slow return of bowel function include older age, male gender, and chronic narcotic pain medication use.^{16,18} Comorbidities found to correlate with slow return of bowel function include low preoperative serum albumin, peripheral vascular disease, and respiratory comorbidities. Urgent operation, history of previous abdominal operation, prolonged operative time (> 3 hours), new stoma, and need for perioperative transfusion were operative factors found to be predictive of postoperative ileus in colorectal surgery patients.^{16,18}

Both length of stay and postoperative readmissions have been used as markers of quality of care in recent years and preventable readmissions are increasingly tied to reimbursement.^{19,20} In colorectal surgery patients, distal anastomosis, benign pathology, open technique, older age, comorbidity, social deprivation, and low provider volume have been found to be risk factors for prolonged length of stay.²¹ In addition, new stoma, proctectomy, and surgical site infection (SSI) have been found to correlate with hospital readmission.²² Specifically, colon cancer patients who undergo colectomy are at increased risk for readmission if they have more comorbid-

ities (Charlson ≥ 3), male gender, and emergent admission. Furthermore, in this patient population perioperative transfusion, new ostomy, prolonged length of stay, and discharge to nursing home have been found to be predictive of postdischarge readmission.^{23,24}

This type of aggressive thin slicing of patient factors that contribute to short-term outcomes has led to the development of many predictive models. Perhaps one of the most widely acknowledged predictive calculators has been developed by the American College of Surgeons (ACS).^{25,26} This tool uses procedure-specific information to provide an accurate prediction both of risk for various complications as well as hospital length of stay. Importantly, the ACS National Quality Improvement Project (ACS NSQIP) calculator provides risk stratification which allows the patient to see their risk in the context of other more average risk patients. These types of tools allow surgeons to not only anticipate various complications but to guide patient counseling on expected outcomes. This type of informed consent allows surgeons to consider the outcomes that are most important to patients so they can make decisions that align with their goals of life.^{27,28}

Multiple Complications

In colorectal surgery patients, the development of multiple complications has been found to be associated with worse postoperative outcomes including prolonged length of hospital stay (risk ratio [RR]: 2.8, 95% confidence interval [CI]: 2.3–3.2) and postoperative mortality (RR: 7.2, 95% CI: 5.1–9.7).⁶ A study of patients who underwent nonemergent colectomy and developed postoperative ileus were significantly more likely to suffer other postoperative complications (50 vs. 21%, $p < 0.001$) compared with patients who did not develop ileus.³ In another study, patients who underwent colorectal surgery and developed postoperative ileus were more likely to also develop deep vein thrombosis after surgery as compared with patients who did not develop ileus (7.1 vs. 1.1%, $p = 0.026$).¹⁶ More work is needed to further elucidate which complications are occurring in patients with multiple complications and to determine what can be done to stop the cascade of complications in patients at risk for developing multiple complications.

Outcomes after Complications

As emphasis on quality of care expands, it is becoming increasingly evident that we must be able to accurately measure relevant outcomes. Not only do we have to be able to measure those outcomes related to safety and effectiveness but also we must accurately measure outcomes reflecting efficiency of care delivery, the equitable delivery of care, timeliness of care delivery, and finally our delivery of patient centered care. Our current tools to measure these pillars of quality are somewhat limited and historically inaccurate. In fact, the most widely accepted measures of safety of care are known to be inaccurate as they rely on accurate coding by the physicians.^{29–31} Despite the known inaccuracy, these results are reported in a transparent fashion on a national scale.

Furthermore, many of these outcomes reported are not felt to be relevant to a surgical practice. However, we do have available to several measures that are relevant and may reflect the system responsible for the delivery of patient care. These measures include readmission after discharge, mortality after a major postoperative complication (so-called failure to rescue), quality of life, and long-term implications on oncologic outcomes.

Failure to Rescue/Mortality

Although postoperative mortality has traditionally been used as a marker of quality of surgical care, recently failure to rescue or death following a major postoperative complication has been increasing favored as a quality indicator. A Dutch study assessed failure to rescue after colorectal cancer surgery and found high hospital volume (> 200 patients/year), academic status, and high level of intensive care unit (ICU) facilities to be associated with low failure to rescue rates. Only high level of ICU facilities independently predicted low failure to rescue rates (odds ratio [OR]: 0.72, 95% CI: 0.65–0.88).⁴

The most common causes of mortality in a French study were septic shock, followed by terminal cancer, and cardiac failure.¹ Ho et al demonstrated that organ space, but not superficial SSI, tended to be associated with mortality in patients who underwent colorectal surgery, where mortality rates were 1.4% without SSI, 1.2% with superficial SSI, and 6.3% with organ space infection ($p = 0.813$).⁸ An analysis of 32,000 patients from the ACS NSQIP database found that mortality was four times more common in colectomy patients who developed postoperative ileus as in patients without ileus (4 vs. 1%, $p < 0.001$).³ A veterans administration study found high (> 50%) failure to rescue rates in patients who had colectomy for colon cancer with the following complications: coma, cardiac arrest, failure of vascular graft prosthesis, renal failure, pulmonary embolism, and progressive renal insufficiency.²

Others have specifically assessed failure to rescue following anastomotic leak or mortality after need for postoperative reoperation. One study assessed patients who had any GI anastomosis (colorectal, esophageal, pancreatic, small bowel) and found that patients who suffered postoperative anastomotic leak also had higher 30-day mortality (8.4 vs. 2.5%, $p < 0.0001$) and long-term mortality (36.4 vs. 20.0, $p < 0.0001$) than patients without leak.¹² Another study in patients with colonic resection similarly demonstrated higher mortality (16.4 vs. 3.1%, $p < 0.001$) in patients with anastomotic leak compared with patients without leak. Predictors of death after anastomotic leak included older age, higher ASA classification, high Charlson score, and emergency surgery.¹⁴ Colorectal cancer patients in the SEER database were found to have higher early mortality (RR: 2.4) if they required reoperation following a colorectal procedure.⁶

Oncologic Outcomes

As many colorectal patients are undergoing resection for malignancy, long-term oncologic outcomes are extremely important measures of surgical success in this patient population. Multiple studies have evaluated the association among

postoperative complications, timing of chemotherapy, and cancer outcomes in colorectal surgery patients. In a large SEER Medicare study,³² patients with stage III colorectal cancer who developed complications were much more likely to have adjuvant chemotherapy omitted (46 vs. 31%, $p < 0.0001$) compared with patients who did not develop complications. Complications remained an independent predictor of chemotherapy omission on multivariable analysis (OR: 1.76, 95% CI: 1.59–1.95). Complications were also found to correlate with delays in chemotherapy ($p < 0.0001$) and patients with multiple complications had increased RRs for delayed therapy ($p < 0.0001$). A review of a rectal cancer database at a single academic center identified an association between postoperative complications and chemotherapy delays > 8 weeks after surgery. Furthermore, patients who received chemotherapy later were found to have worse local and distant recurrence as well as worse overall survival as compared with patients who received chemotherapy in the first 2 months after surgery.³³ Others have described similar findings of worse overall mortality in patients who did not receive adjuvant chemotherapy within 8, 12, or 16 weeks of surgery.^{34,35}

Anastomotic leak following colorectal anastomosis is a relatively common complication and researchers have evaluated the relationship between leak and oncologic outcomes. A study of 1,181 rectal cancer patients demonstrated no relationship between anastomotic leak and local recurrence ($p = 0.669$), overall recurrence ($p = 0.606$), overall survival ($p = 0.648$), or cancer related survival ($p = 0.421$).¹³ Alternatively, a meta-analysis evaluating risk of cancer recurrence and mortality found increased rates of local recurrence (OR: 2.9, $p < 0.001$) and cancer-specific mortality (OR: 1.75, $p = 0.0001$) in colorectal cancer patients who suffered anastomotic leak, while the relationship between anastomotic leak and distant recurrence (OR: 1.38, $p = 0.083$) was not statistically significant.

Readmissions

Preventable hospital readmissions have increasingly been targeted as markers of quality of care, as they are costly, affect patient satisfaction, correspond with worse outcomes, and have also recently been tied to hospital reimbursement. As readmission following colorectal surgery is relatively common, identifying risk factors for readmissions and developing programs to prevent postoperative readmissions has been a popular area of research and quality improvement work. Not surprisingly, postoperative complications are a common cause for readmission in this patient population, and therefore, early identification and treatment of these complications as an outpatient are key to preventing readmission in these patients.³⁶

An analysis of patients who underwent colectomy for colon cancer in the SEER Medicare database demonstrated an 11% readmission rate within 30 days. Patients who were readmitted were also found to have higher likelihood of 1 year mortality (16 vs. 7%, $p < 0.0001$).²⁴ A study of > 10,000 patients who underwent colorectal surgery demonstrated a similar 30-day readmission rate of 11.4% and 90-day readmission rate of 23.3%.²² Patients with ulcerative colitis who underwent restorative proctocolectomy

were found to be readmitted at a rate of 18% within 30 days of discharge and 23% within 90 days. Patients who had rectal resections were more likely to be readmitted than patients who had colon resections (9.4 vs. 7.6%, $p < 0.001$).²¹ This likely reflects complications following new stoma formation at the time of surgery. In patients who underwent colorectal resections and diverting ileostomy, the 60-day readmission rate was 16.9%.³⁷

The complications most commonly associated with prolonged length of stay, postoperative readmission, and higher costs include GI motility complications, dehydration, and anastomotic leak.^{24,38} Patients with GI anastomosis and anastomotic leak had a significantly longer length of stay (13 vs. 5 days, $p < 0.0001$) compared with patients without leak. Anastomotic leak also correlated with higher costs (\$1,694 vs. \$945, $p < 0.0001$).¹² Postoperative readmissions have been found to be almost twice as common in patients who have an ileus after colectomy compared with patients who do not have ileus (17 vs. 9%, $p < 0.001$).³ Furthermore, postoperative ileus has been demonstrated to be associated with significantly higher cost during the index hospitalization (\$16,612 vs. \$8,316, $p < 0.05$) in comparison to patients who do not develop ileus.¹⁷ In patients with diverting ostomy, up to 43% of patients who were readmitted required admission for dehydration.³⁷

Quality of Life

Complications following colorectal surgery can range from minor complications with minimal impact on length of stay and long-term outcomes to severe complications requiring intensive care stays, reoperation, or discharge to higher level of care. Not surprisingly, these complications have a profound effect on patients' quality of life. Patients who had anastomotic leak following low anterior resection reported worse health-related quality of life at 1 year after surgery including worse physical function ($p = 0.04$), emotional function ($p = 0.003$), and social function ($p = 0.009$) as compared with patients who had an uncomplicated postoperative course. Patients with leak also reported worse gastrointestinal quality of life index global ($p = 0.005$) and emotional function scores ($p = 0.007$).³⁹

A study of colorectal patients who had complications requiring surgical intervention found that patients with complications were less satisfied with their physicians. Patients judged their satisfaction with the quality of care and the following physician areas: interpersonal skills, technical skills, information provision, and availability to be worse than in patients without such complications. The presence of postoperative anastomotic leak was an independent predictor of quality of life.⁴⁰ Another group demonstrated worse quality of life scores up to 36 months after surgery in patients with complications. Specifically, physical and social function, role functioning, body image, mobility, self-care, and pain scores were significantly worse at 36 months in patients with postoperative complications.⁴¹

Quality Improvement

Surgical Quality

With an increasing emphasis on postoperative outcomes and transparency around the quality of care, we provide surgical

patients, as there are many opinions about what markers should be used to define high-quality surgical care. Some have made the argument that unplanned procedural intervention following colorectal cancer surgery should be a marker of surgical quality. One SEER Medicare study found 5.8% of patients to require postoperative procedures and interventions correlated with early mortality (RR: 2.4, 95% CI: 2.1–2.9) and prolonged hospitalization (RR: 2.2, 95% CI: 2.1–2.4).⁶ Others have proposed a similar metric, mortality after major complication, or failure to rescue. However, Billeter et al³¹ found little variation in risk-adjusted hospital mortality rates and therefore concluded that failure to rescue would be a poor differentiating quality metric. Almoudaris et al³⁰ found some correlations between failure to rescue and need for reoperation; however, the authors did not find high mortality to correlate with other performance measures. Others have sought to identify patient expectations and patient reported outcomes as quality markers in colorectal surgery. One study assessed patients' expectations of postsurgery bowel function and found patients are most interested in information sources, personal attitudes, and expected outcomes.⁴²

Many studies have attempted to intervene to decrease complications and improve outcomes in colorectal surgery patients. Successful work has focused on improving patients' physical function, standardizing care, preventing complications, and when complications occur identifying complications early and intervening to prevent other poor postoperative outcomes, such as readmission and mortality.

Prehabilitation

Preoperative fatigue and poor physical function have been found to be associated with postoperative complications.⁴³ Some work has been done in elderly colorectal surgery patients to determine if patient's functional capacity can be optimized preoperatively in an effort to improve outcomes in this at-risk patient population. The results of one randomized controlled trial demonstrated that 33% of colorectal surgery patients who underwent prehabilitation improved their physical function, mental health, vitality, self-perceived health, and peak exercise capacity. Patients who deteriorated during prehabilitation had more complications, reoperations, and increased need for ICU care.⁴⁴ This study highlights the need to not only assess the baseline medical and functional status of patients to accurately counsel patients about risks of surgery and expected outcomes but also demonstrates that an intensive walking and breathing exercise program can improve some patients' functional status and decrease the risk of postoperative complications.

Perioperative Protocols

Others have demonstrated improved outcomes with the protocolization of perioperative patient care. Enhanced recovery after surgery (ERAS) or fast track programs have become prevalent in colorectal surgery around the country and internationally. These programs combine utilization of a multidisciplinary team, protocolization of preoperative, intraoperative, and postoperative management, and an emphasis on patient education and expectation setting. A meta-

analysis of enhanced recovery programs found reduced length of hospital stay ($p < 0.00001$) and total complication rate ($p = 0.0006$) in ERAS patients.⁴⁵ ERAS protocols have repeatedly been shown to reduce length of stay^{46–49} and hasten return of bowel function^{48,50} without influencing complication or readmission rates.^{49,51}

Similar work has been done in the area of postoperative infections. SSIs are prevalent following colorectal surgery and are also a common cause of postoperative readmission.⁵² SSI reduction bundles focus on prevention of SSI preoperatively, in the operating room, and postoperatively and include measures such as patient preparation in the OR, administration of antibiotics, closing protocols for fascial closure, aggressive postoperative treatment of hyperglycemia, and patient education. Implementation of a SSI bundle at the Mayo Clinic resulted in a decrease in overall SSI rates (9.8–4.0%, $p < 0.05$) and superficial SSI rates (4.9–1.5%, $p < 0.05$).⁵³ As more is known about predictors of good postoperative outcomes, we can standardize perioperative care to reflect best practices both for specific postoperative complications and for overall perioperative patient care.

Discharge Process/Readmission Prevention

The need for postoperative readmission is common in colorectal surgery patients and as hospitals are increasingly penalized for preventable readmissions, there has been a recent focus on preventing readmissions after surgery. An expert consensus on warning signs for deterioration of patient condition after colorectal surgery identified 10 symptoms; patients should watch for and call their surgeon if they develop. Symptoms included wound symptoms (drainage, opening, and erythema), abdominal symptoms (lack of bowel movement, pain, vomiting, and change in ostomy output), fever, shortness of breath, or chest pain.⁵⁴ One study assessed the utility of five nurse phone calls over the 6 months after discharge in Australia. Although improvements did not reach statistical significance, there were clinically significant improvements in emergency department utilization (21 vs. 33%, $p = 0.23$), hospital readmission (37 vs. 47%, $p = 0.37$), and health care quality of life scores (106.0 vs. 98.6, $p = 0.19$).⁵⁵ A study of medical and surgical patients ≥ 65 years old implemented a comprehensive discharge plan and home follow-up protocol using advance practice nurses. The intervention group had lower readmission rates (20.3 vs. 37.1%, $p < 0.001$), less incidence of multiple readmissions (6.2 vs. 14.5%, $p = 0.01$), and less hospital days per patient (1.53 vs. 4.09, $p < 0.001$). Long-term follow-up at 6 months demonstrated decreased total Medicare reimbursements in the intervention group (\$0.6 vs. \$1.2 million, $p < 0.001$) as compared with the control group.⁵⁶ These improvements in readmission rates likely reflect the early detection and treatment of postoperative complications and demonstrate the importance of patient education and early postoperative clinic follow-up.

Conclusion

In summary, postoperative morbidity is common in colorectal surgery patients with up to one-third of patients suffering

complications. Complications have been demonstrated to be associated with poor long-term outcomes and also have been shown to affect long-term quality of life. As more national, risk-adjusted datasets are collected and as more metrics of quality of care are reported publicly, postoperative complications are increasingly recognized as markers of quality of care in colorectal surgery. In addition to risk-adjusted patient outcomes, a combination of performance metrics including measuring the use of evidence-based practices and confirmation of the delivery of patient centered care will be necessary to truly capture the quality and safety of patient care. Although much work has been done to decrease postoperative complications and improve outcomes in colorectal surgery patients, more work is needed to identify best practices and standardize perioperative care.

Conflict of Interest

The authors have no conflict of interest to declare.

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