Predicting and Preventing Postoperative Outcomes

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Abstract

Keywords

- ▶ postoperative complication
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- ▶ colorectal surgery

Complications after colorectal surgery are common. Given the frequency of postoperative complications and their implications on quality of life, it is important to know how to predict and prevent the complications that we encounter. This article aims to provide ways to predict and prevent postoperative complications in colorectal surgery. Here, we review the predictive models, American College of Surgeons National Surgery Quality Improvement Program risk calculator and Physiological and Operative Severity Score for the enUmeration of Mortality and morbidity on their practicality and usefulness. Additionally, this review summarizes nonmodifiable and modifiable risk factors in colorectal surgery, which are important for surgeons to understand to minimize and attempt to avoid postoperative complications as well as providing ways to optimize patients preoperatively. Thus, this review will provide information to surgeons to predict and prevent postoperative complications, how to optimize patients preoperatively and ultimately to help reduce their occurrence.

What Are the Current Predictive Models of Postoperative Risks in Colorectal Surgery and Are They Useful or Practical?

Informed consent is an integral part of the preoperative conversation and something which provides the foundation on which surgeons and patients build mutual trust. However, this is often challenging, in that it is influenced by the clinical and subjective experience of the surgeon and various characteristics of the patient and procedure. Moreover, patients face their own challenges as their perspectives on informed consent are also influenced by multiple factors, which include age, sex, race, education level, native language, and socioeconomic status.¹ To that end, many surgeons now utilize a risk calculator to help provide patients with more objective data to help characterize and quantify their individual risk for developing postoperative complications. There are two main predictive models of postoperative risks in colorectal surgery: the American College of Surgeons (ACS) National Surgery Quality Improvement Program (NSQIP) risk calculator and Physiological and Operative Severity Score for the enUmeration of Mortality and morbidity (POSSUM), with

its variants. This section is aimed to provide an overview of both risk calculators regarding their practicality and usefulness, as well as additional methods to help assess the cognitive, physiologic, and psychosocial well-being of patients preoperatively to help maximize their likelihood of a successful postoperative recovery.

American College of Surgeons National Surgery Quality Improvement Program

NSQIP Risk Calculator

The ACS NSQIP risk calculator was developed to provide surgeons with a tool to estimate patient-specific postoperative complications to incorporate in shared decision-making processes and informed consent with patients, as well as allowing surgeons to plan ahead for potential complications.² The ACS NSQIP risk calculator uses 20 preoperative patient characteristics such as age, American Society of Anesthesiologists (ASA) class, body mass index (BMI), and medical comorbidities with planned procedures and Current Procedural Terminology (CPT) codes to predict 15 postoperative outcomes within 30 days following surgery.³

This tool uses procedure-specific information to provide an accurate prediction of risk both for various complications, as well as hospital length of stay. The ACS NSQIP calculator provides risk stratification that allows the patient to see their risk in the context of other more average-risk patients. This tool allows surgeons not only to anticipate various complications but also to guide patient counseling on expected outcomes. This helps surgeons to consider the outcomes that are most important to patients, so they can make decisions that align with their goals of life.^{4,5} ▶ **Table 1** lists 20 preoperative patient characteristics and 15 postoperative outcomes used in ACS risk calculator.

The ACS NSQIP risk calculator examined 1,414,006 patients over 1,557 unique CPT codes and demonstrated excellent performance in predicting mortality (c-statistic = 0.944, Brier score = 0.011 [where scores approaching 0 are better]) and morbidity (c-statistic = 0.816, Brier score = 0.069).² The ACS risk calculator was also found to be very accurate in predicting postoperative outcomes in elective colorectal surgery.² However, conversely, Lubitz et al found that in emergent colorectal surgery, the ACS risk calculator underestimated serious complications and length of stay and overestimated discharge to skilled nursing facility.¹ This was corroborated by Cologne et al's group in a high-volume minimally invasive colorectal surgery practice.⁶ Thus, the ACS risk calculator is a valuable tool for allowing more informed consent; however, too many factors exist that impact the outcomes that cannot be measured by any specific model. Risk prediction will always be dependent on the accuracy of the data entered into the model,

and can be improved with more accurate data input.⁷ Therefore, surgeons should utilize ACS risk calculator as a guide to help provide risk stratification to patients and support them to make informed consent.

Physiological and Operative Severity Score for the enUmeration of Mortality and morbidity

Prior to the development of the ACS risk calculator, POSSUM was used to assess morbidity and mortality rates in all surgical patients.⁸ This tool utilizes 12 physiological parameters and 6 operative measures for assessment to predict postoperative morbidity and mortality. However, Prytherch et al initially demonstrated overprediction of mortality by POSSUM by more than twofold on overall patients and more than sevenfold on the lowest risk patients.⁹ Subsequently, Portsmouth POSSUM (P-POSSUM) was developed to compensate for this overprediction. Utilizing a modified equation, they evaluated 10,000 patients with the same parameters as original POSSUM and demonstrated a more accurate prediction of overall mortality.^{9,10} Nevertheless, another study found that POSSUM and P-POSSUM still overpredicted 30-day postoperative mortality within colorectal surgery patients.¹¹ This led to the development of specialty-specific POSSUM. ColoRectal POSSUM (CR-POSSUM) simplified POSSUM and utilizes six physiological parameters and four operative measures for prediction of mortality.¹² ▶ **Table 2** lists the physiological parameters and operative measures for POSSUM.

The validity of both P-POSSUM and CR-POSSUM has been measured. However, the results from these data have been

Table 1 Preoperative patient characteristics used for ACS risk calculator and postoperative outcomes³

Preoperative patient characteristics	Postoperative outcomes
Age group (under 65 y, 65–74 y, 75–84 y, 85 y or older)	Serious complication (death, cardiac arrest, myocardial infarction, pneumonia, progressive renal insufficiency, acute renal failure, PE, DVT, return to the OR, deep incisional SSI, organ space SSI, systemic sepsis, unplanned intubation, UTI, wound disruption)
Sex (male, female)	Any complication (superficial incisional SSI, deep incisional SSI, organ space SSI, wound disruption, pneumonia, unplanned intubation, PE, ventilator > 48 h, progressive renal insufficiency, acute renal failure, UTI, stroke, cardiac arrest, myocardial infarction, DVT, systemic sepsis)
Functional status (independent, partially dependent, totally dependent within 30 d prior to surgery)	Pneumonia
Emergency case	Cardiac complication (cardiac arrest or MI)
American Society of Anesthesiologist class	SSI
Steroid use for chronic condition	UTI
Ascites within 30 d prior to surgery	VTE
Systemic sepsis within 48 h prior to surgery	Renal failure (progressive renal insufficiency or acute renal failure)
Ventilator dependence	Colon ileus (conditionally displayed based on the selected procedure)
Disseminated cancer	Colon anastomotic leak (conditionally displayed based on the selected procedure)
Diabetes	Readmission
Hypertension requiring medication	Return to OR
Congestive heart failure in 30 d prior to surgery	Death
Dyspnea (with moderate exertion, at rest)	Discharge to nursing or rehab facility
Current smoker within 1 y	Predicted length of hospital stay
History of severe COPD	
Dialysis	
Acute renal failure	
BMI (height and weight)	

Abbreviations: ACS, American College of Surgeons; BMI, body mass index; COPD, chronic obstructive pulmonary disease; DVT, deep vein thrombosis; MI, myocardial infarction; OR, operating room; PE, pulmonary embolism; SSI, surgical site infection; UTI, urinary tract infection; VTE, venous thromboembolism.

Table 2 Physiological parameters and operative measures used in POSSUMs

Physiological parameters	Operative measures
Age	Operative severity (minor, moderate, major, major +)
Cardiac signs	Multiple procedures
Respiratory signs	Total blood loss (mL)
Systolic blood pressure	Peritoneal soiling
Heart rate	Malignancy
Glasgow coma score	Mode of surgery (elective, urgent, emergency)
Hemoglobin	
White blood cell count	
Urea	
Sodium	
Potassium	
Electrocardiogram	

Abbreviation: POSSUM, Physiological and Operative Severity Score for the enUmeration of Mortality and morbidity.

Note: Bold indicates values used in CR-POSSUM.

inconsistent.^{8–10,13} Incongruous results from these studies indicate that accuracy of P-POSSUM and CR-POSSUM is variable between centers secondary to different populations, institutions, or health care systems.¹⁰ In general, both P-POSSUM and CR-POSSUM have been shown to be useful in predicting mortality.^{9,13} However, only the original POSSUM can accurately predict all-cause morbidity. This was demonstrated by Bromage and Cunliffe looking at colorectal cancer patients specifically.^{13,14} Nevertheless, POSSUM lacks the ability to predict any specific postoperative complications.¹⁴ Further research with meta-analysis of POSSUM validation over different populations will likely improve its accuracy.¹⁰

Patient comorbidity clearly impacts risk for postoperative complications.¹⁵ The NSQIP risk calculator as well as other models have shown the impact of these comorbidities regarding risk for postoperative complications.⁷ However, as patients with surgical problems age, it is important to recognize how frailty, cognitive impairment, and social support impact patient outcomes. These are largely neglected in current predictive nomograms, however, clearly impact postoperative outcomes. Cognitive impairment has been shown to correlate with discharge to a higher level of care within the older adult population, and has also been found to correlate with a higher risk for postoperative complications, longer length of stay, and higher 6-month mortality.^{16,17}

An additional consideration in the high-risk older adult population is frailty. This is defined as a syndrome characterized by age-related declines in functional reserves across an array of physiologic systems.¹⁸ Perhaps the best measurement, termed the frailty phenotype, is characterized by unintentional weight loss, decreased energy, and decreased activity and strength.¹⁸ This clearly impacts postoperative outcomes in the older adult population.^{19,20}

Another important factor which may impact recovery is the social structure of the patient. A group from Michigan examined the concept of social connectedness as it relates to

postoperative recovery and found that patients with more friends and family, as well as by the interaction within the network experienced less subjective pain, and less perceived unpleasantness from the pain as compared with those with less social connectedness.²¹

As we continue further to our field, we must work to more accurately counsel our patients on their perioperative risk. The ACS risk calculator and POSSUM score are both good risk stratification systems and predictive models that are readily available for surgeons to use for more precise preoperative risk assessment. Although these models seem to accurately predict postoperative complications, they have inherent limitations. Moreover, they depend on the accuracy of the data entered into the model. These models, together with assessment of cognitive impairment, frailty index, and a patient's social structure, may help surgeons more accurately counsel patients regarding their risk, as well as understand how to modify certain factors to improve surgical outcomes.

What Are the Preoperative Risk Factors for Morbidity and Mortality in Colorectal Surgery?

There are a myriad of patient-specific factors that predispose to an increased risk of perioperative complications. Known risk factors for colorectal surgery should be assessed and recognized preoperatively in an attempt to reduce postoperative complications and initiate individualized preoperative interventions and attempts at prehabilitation. There are modifiable and nonmodifiable preoperative risk factors affecting the outcomes in colorectal surgery.

Nonmodifiable Risk Factors

Certain risk factors specific to patients requiring a surgical procedure are sometimes not necessarily modifiable. These include a patient's age, gender, various medical comorbidities, prior abdominal surgery, and potential urgent or emergent nature of the procedure itself.

Age

It is well recognized that the risk profile of patients undergoing surgery often increases with increasing age. This can be somewhat quantified by the aforementioned frailty index, and often includes an inherent increase in comorbidities. Age is included as a risk factor in both the ACS NSQIP risk calculator and POSSUM. However, increasing age also encompasses nonquantifiable and potentially unidentified psychosocial risk factors which contribute to an increase in complications. In one study looking at geriatric patient populations (age: 70 and older) postoperative outcomes, they found that these geriatric patients demonstrated low mortality rates in elective and noncardiac surgery (3.7%).²² However, the rate of developing one or more postoperative complications was elevated at 21% when compared with a younger cohort.²² Younger patients (under the age of 59 years) demonstrated <1% postoperative mortality after elective colorectal surgery. However, this increased 3% points every 10 years.²³ They identified high ASA classification (III

or IV), emergency surgery, and intraoperative tachycardia as those factors associated with increased odds of developing postoperative complications in elderly patients.^{22,24}

Gender

The incidence of postoperative complications, specifically anastomotic leak, is increased in males undergoing colorectal surgery.²⁴ Kirchhoff et al found an incidence of anastomotic leak in males of 7.8% compared with 2.3% in their female counterparts ($p < 0.001$) in a consecutive series of 1,316 patients in a single institution on multivariate analysis.²⁵ In addition, another study demonstrated that male gender demonstrated an increased rate of anastomotic leak rate in low rectal anastomosis with an odds ratio (OR) of 3.5.²⁶ Moreover, a single-institution prospective study of 616 patients found that the significant independent predictors for anastomotic leak were anastomoses less than 10 cm from the anal verge, comorbidity index of 3 or more, high inferior mesenteric artery ligation, intraoperative complications, and being of the male sex.²⁷ Some have postulated that this may be secondary to the anatomical differences in male and female patients, which include their narrower pelvis, and likely more difficult dissection and anastomotic construction.^{24,27,28} Thus, being elderly and/or male gender, in general, both increase patient-specific risk of postoperative complications in colorectal surgery.

Prior Abdominal Surgery

Prior abdominal surgery complicates colorectal surgery by increasing the difficulty of the procedure secondary to abdominal and pelvic adhesions. This often increases the length of the procedure and reduces the likelihood of proceeding in a minimally invasive fashion. Franko et al demonstrated a higher rate of postoperative complications in patients who had previously undergone abdominal surgery when compared with those patients who had not been formerly operated on.²⁹ These complications included a higher rate of conversion to open from laparoscopic surgery (19.6 vs. 11.4%; $p < 0.001$; OR: 1.9), inevitable enterotomy (1.4 vs. 0.2%; $p = 0.04$; OR: 6.9), postoperative ileus (6.6 vs. 3.0%; $p = 0.012$; OR: 2.3), and reoperation (2.3 vs. 0.2%; $p = 0.006$; OR: 11.1). However, they did not find a significant difference in mortality rate.²⁹ Lipska et al studied 541 consecutive operations and demonstrated that prior abdominal surgery increased the risk of anastomotic leak with an OR of 2.4.²⁶ Their overall mortality rate was 3.7% and was higher in patients with anastomotic leak 14.3% ($p = 0.01$).²⁶ Thus, taking this information in aggregate, patients with prior abdominal surgery should be counseled on the increased risk of postoperative complications. Surgeons should similarly take this into consideration as it relates to their preoperative planning.

Medical Comorbidities and Health Status Prior to Surgery

The quantity and severity of a patient's preoperative medical comorbidities clearly heavily influence their risk of postoperative complications. Some of these comorbidities are somewhat

modifiable when planning elective colorectal procedures. In a Department of Veterans Affairs study on 5,853 patients undergoing colectomy for colon cancer, they identified specific preoperative risk factors that significantly increase the risk of 30-day all-cause mortality. Ascites, hypernatremia (Na > 145 mEq/L), DNR (Do Not Resuscitate) status prior to operation, ASA classification III and IV or V, and low serum albumin prior to operation all strongly predicted increases in postoperative 30-day mortality. In addition, one or more complications were observed in 28% of patients with these risk factors. Complications included postoperative ileus (7.5%), pneumonia (6.2%), failure to wean from the ventilator (5.7%), and urinary tract infection (5%).²⁸ Thus, as expected, medical comorbidities prior to surgery affect negatively on postoperative complications unless optimized prior to surgery.

Modifiable Risk Factors

In an attempt at reducing postoperative complications, there have been efforts at attempting to modify individual patient's risk factors in the elective setting so as to minimize their perioperative surgical risk profile. Certain risk factors can be influenced or intervened upon to benefit both the patient and surgeon prior to surgery.

Obesity

The literature on the effect of obesity associated with postoperative complications in colorectal surgery is inconsistent.^{30–34} However, it is well known that obesity contributes to multiple comorbidities and increases postoperative surgical complications, in general. Its impact regarding colorectal surgery is not an exception. The number of people classified as overweight (BMI = $25 < 30$ kg/m²) is at pandemic proportions. There are ~34% of adults and 15 to 20% of children and adolescents in the United States are obese (BMI > 30 kg/m²).³⁵ The prevalence of obesity is increasing and significantly influences overall survival of the general population.³⁵ Obesity affects colorectal surgery by longer operative times, prolonged hospital stay, higher intra- and postoperative complications (anastomotic leak, surgical site infection [SSI], stoma complications), and higher conversion rate from laparoscopic surgery to open surgery.³⁶ Some report SSI rate as high as 60% in obese patients.^{30,31,33} Additionally, patients with BMI more than 25 kg/m² have a higher risk for incisional hernias.^{24,32} However, sometimes BMI alone does not tell the whole story. Waist circumference and waist/hip ratio (WHR) has been evaluated to determine whether body fat distribution affected mortality and morbidity after colorectal surgery. A prospective multicenter international study was conducted on a total of 1,349 patients and found increasing WHR significantly increased the risk of postoperative complications. In multivariate analysis, the WHR predicted intraoperative complications, open conversion, perioperative medical complications, and reinterventions, whereas BMI was a risk factor only for abdominal wall complications. Thus, an elevated WHR is an accurate predictor of increased risk for adverse events after elective colorectal surgery and should be evaluated routinely to assist with counseling patients preoperatively.³⁴

Nutritional Status

Adequate perioperative nutrition is important in the healing process and success of surgery to limit postoperative complications. It is well known that severe undernutrition is related to poor outcomes.³⁷ Despite an increasing percentage of obese patients in the Western world, malnutrition is still present and is sometimes difficult to recognize and treat accordingly. Disease-related malnutrition in patients who are overweight is not necessarily associated with low BMI. European Society for Clinical Nutrition and Metabolism (ESPEN) has recently defined diagnostic criteria for malnutrition:

Criteria 1: BMI $<18.5 \text{ kg/m}^2$

Criteria 2: Combined: weight loss $>10\%$ or $>5\%$ over 3 months and reduced BMI (<20 or $<22 \text{ kg/m}^2$ in patients younger and older than 70 years, respectively) or a low fat-free mass index (<15 and $<16 \text{ kg/m}^2$ in females and males, respectively).³⁷

Utilizing Nutritional Risk Screening, patients at risk for malnutrition can be recognized preoperatively and an appropriate intervention can be implemented for patients undergoing elective colorectal surgery. In addition, serum albumin concentration has been studied and proven to be an accurate predictive parameter for postoperative outcomes.³⁸ Preoperative nutritional evaluation should include but is not limited to:

- Screening for disease-related malnutrition by utilizing ESPEN criteria for malnutrition and Nutritional Risk Screening on first evaluation
- Regular follow-up of weight and BMI
- Nutritional counseling
- Preoperative serum albumin <3 or $<30 \text{ g/L}$ (with no evidence of hepatic or renal dysfunction).

By recognizing patients at risk for disease-related malnutrition prior to elective colorectal surgery, patients can undergo preoperative conditioning to improve postoperative outcomes such as decreased length of stay, SSI, anastomotic leak, and other surgical complications.^{24,28,37,38} Hence, nutrition status prior to surgery is an important prognostic predictor for the success of surgery and should be emphasized in the preoperative evaluation of patients undergoing elective colorectal surgery so that appropriate interventions can be implemented, if warranted.

Smoking and Alcohol Consumption

It is well known that smoking and alcohol consumption negatively impact a patient's overall health. In one study, smoking and alcohol consumption increased anastomotic leak rate significantly.³⁹ Smoking increased the risk of anastomotic leak with a relative risk of 3.18 (1.44–7.00).³⁹ Additionally, alcohol abusers had a relative risk of 7.18 (1.20–43.01) compared with abstainers with respect to risk for anastomotic leak.³⁹ Moreover, alcohol consumption increases postoperative morbidity by two- to threefold.³⁹ The most common complications include bleeding, as well as wound and cardiopulmonary complications.^{40,41} Smoking similarly negatively affects recovery by increasing risk for pulmonary and wound complications.⁴⁰ The Enhanced Recovery After Surgery society recommends both smoking and alcohol consumption to be

stopped 4 weeks prior to surgery.⁴¹ Therefore, it is important to educate patients on the importance of cessation of smoking and alcohol consumption prior to elective colorectal surgery to reduce postoperative complications and maximize their likelihood for success.

How Can We Best Optimize Our Patients to Minimize Postoperative Complications?

As mentioned earlier, there are many modifiable risk factors that can be identified preoperatively and appropriate interventions can be applied to enhance a patient's recovery and reduce the risk for postoperative complications. Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) and American Society of Colon and Rectal Surgeons (ASCRS) recently published clinical practice guidelines for enhanced recovery after colon and rectal surgery.⁴⁰ Additionally, patients and clinicians can utilize the Strong for Surgery program to target four areas significantly affects surgical outcomes: nutrition, glycemic control, medication management, and smoking cessation.⁴² This section will focus on how to optimize modifiable factors to minimize postoperative complications.

Preoperative Discussion and Ostomy Education

Taking the time to discuss with patients prior to admission about discharge criteria have shown to reduce hospital length of stay and complication rates in several studies.⁴⁰ Discharge criteria for colorectal surgery have been defined as tolerance of oral intake, recovery of lower gastrointestinal (GI) function, adequate pain control with oral analgesia, ability to mobilize, ability to perform self-care, no evidence of complications or untreated medical problems, adequate postdischarge support, and patient willingness to leave the hospital.⁴³ Thus, having a preoperative discussion on discharge criteria to allow patients time to digest and understand the requirements for discharge will help decrease postoperative confusion, assist in the recovery process, and eventually potentially limit postoperative complications. The creation of an ileostomy also significantly affects a patient's recovery. This can provide physical and logistical, as well as psychosocial challenges. Ileostomy creation carries with it a significant risk for readmission and kidney injury secondary to dehydration. Nagle et al reduced readmission rate from 35.4 to 21.4% and readmission from dehydration from 15.5 to 0% after implementing an ileostomy pathway.⁴⁴ The pathway involved patients in ostomy management and educated patients on avoiding dehydration. In addition, many studies have demonstrated patient's ostomy education was most effective preoperatively with improved postoperative quality of life, decreased stoma-related complications, and increased patient's independence postoperatively.⁴⁰ These studies demonstrate the importance of preoperative education and discussion to reduce postoperative ostomy-related complications.

Nutrition

As mentioned earlier, perioperative malnutrition is considered as a modifiable risk factor that can reduce postoperative morbidity. Nutritional support has shown to reduce

infections, hospital length of stay, and costs.^{37,38} However, recommendations on patient selection, timing, and type of nutritional support are still debated. In general, patients who meet criteria for severe malnutrition per ESPEN guideline will benefit from nutritional supplementation and may require postponing elective, major colorectal surgery until malnutrition is addressed.⁴⁵

Conventionally, enteral nutritional support is recommended 10 to 14 days prior to major surgery to patients with severe nutritional risk.^{37,45} For selecting which type of nutritional supplements to use, Moya et al (SONVI study) demonstrated, in a multicenter randomized clinical trial, the benefit of immune-enhancing feeding compared with conventional hypercaloric hypernitrogenous supplementation (control group) on decreasing infectious complications on patients with colorectal resection.⁴⁶ Patients in the immunonutrition group had a significant decrease in infectious complication compared with the control group (10.7 vs. 23.7%).⁴⁶ Specifically, this study demonstrated a significant decrease in wound infections (5.7%) in the immunonutrition group compared with 16.4% in control group.⁴⁶ The SONVI study provided patients with immunonutrition 7 days prior to colorectal resection and 5 days postoperatively.⁴⁶ In addition, Zhang et al conducted a systemic review of 19 randomized controlled trials to compare immunonutrition to a regular diet preoperatively. They demonstrated a significant reduction in length of stay and postoperative infectious complication in patients supplemented with immunonutrition compared with those patients utilizing a regular diet.⁴⁷

The old dogma of prolonged preoperative fasting has been disputed and considered unnecessary in most patients.^{37,40} Current literature recommends that patients undergoing elective surgery should be allowed to drink clear fluids until 2 hours prior to anesthesia and solids should be allowed until 6 hours prior to undergoing general anesthesia. Carbohydrate loading should be encouraged before surgery to nondiabetic patients to attenuate insulin resistance induced by surgery and starvation.^{40,41} In diabetic patients, carbohydrate loading can be given along with the diabetic medication.⁴¹ Awad et al demonstrated in a meta-analysis of randomized controlled trials, the potential for decreased length of stay with carbohydrate loading 2 to 4 hours preoperatively.⁴⁸ Exceptions to this recommendation are emergent surgery and patients with high risk of aspiration with GI dysmotility disorders such as gastroparesis or gastroesophageal reflux disease.^{37,40}

In conclusion, patients who are screened as at risk for malnutrition preoperatively would likely benefit from a preoperative immune-enriched nutritional supplement 7 days prior to surgery and for 5 days postoperatively. Patients with no known risk for aspiration should be allowed to drink clear fluids until 2 hours prior to general anesthesia to avoid prolonged fasting time. Carbohydrate loading prior to surgery should be routinely used to attenuate insulin resistance induced by surgical stress and fasting.

Prehabilitation

Prehabilitation aims to enhance a patient's functional capacity preoperatively in anticipation of physiological stress

from the surgery.⁴⁹ Preparing a patient prior to surgery by means of prehabilitation has shown to benefit a patient's postoperative functional exercise capacity compared with traditional rehabilitation postoperatively.^{50,51} By utilizing a multimodal prehabilitation program with preoperative conditioning interventions such as exercise, nutritional assessment, whey protein supplementation, and anxiety-coping techniques, Minnella et al demonstrated a significant improvement in walking capacity throughout the perioperative period compared with patients who received traditional postoperative rehabilitation.⁵¹ Gillis et al demonstrated a higher proportion of patients in the prehabilitation group recovered to at or above their baseline exercise capacity at 8 weeks compared with the rehabilitation group (84 vs. 62%; $p = 0.049$).⁵⁰ Prehabilitation is not limited to exercise but should also focus on preoperative conditioning of patients to enhance postoperative outcomes. It includes nutritional supplementation, smoking cessation, optimal medical management, and psychosocial support.^{49–51} Future research should focus on the specifics of prehabilitation and its effect on postoperative outcomes.

Bowel Preparation

One of our most salient and controversial topics is the utilization of bowel cleansing prior to elective colorectal surgery. The most recent recommendation from ASCRS and SAGES in 2017 does recommend mechanical bowel preparation (MBP) with oral antibiotic bowel preparation (OBP) prior to colorectal surgery.⁴⁰ They did recognize the previous recommendation from 2013 guidelines for perioperative care in elective colonic surgery and 2011 Cochrane review that showed no benefit to MBP. Nevertheless, a recent meta-analysis of seven randomized controlled trials of 1,769 patients comparing MBP + OBP and OBP alone demonstrated a reduction in total surgical site and incisional site infections (total: 7.2 vs. 16.0%, $p < 0.00001$; incisional 4.6 vs. 12.1%, $p < 0.00001$) with no difference in the rate of organ/space infection after elective colorectal surgery.⁵² Similarly, there are other retrospective studies demonstrated decreasing SSI and other postoperative complications such as *Clostridium difficile* colitis and anastomotic leak.⁴⁰ Thus, currently, it is recommended to utilize MBP with OBP before colorectal surgery to reduce postoperative infectious complications.

Conclusion

Postoperative complications after colorectal surgery are common, despite our fervent efforts to avoid them. Nevertheless, efforts to better understand risk factors and preoperative risk mitigation strategies may continue to lead to improved outcomes. With utilization of risk stratification systems such as ACS risk calculator and POSSUM, we can provide patients with more objective data to make informed consent and understand their individual preoperative risk profile. In addition, we, as surgeons, can prepare for, and anticipate potential postoperative complications, and in turn make efforts to optimize perioperative outcomes, benefiting the patient, surgeon, and health care system as a whole.

Conflict of Interest

None declared.

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