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ENHANCING PATIENT SAFETY IN COLORECTAL SURGERY: A PUBLIC HEALTH CONCERN-RISK FACTOR AND PREVENTIVE STRATEGIES -AN UPDATED REVIEW

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ABSTRACT

Background Colorectal surgery, whether performed openly or laparoscopically, encompasses a range of procedures to treat various conditions. The risk of complications during and after surgery can differ based on the type of operation and individual patient factors, some of which can be controlled and others that cannot. Complications can arise during the surgery itself or in the postoperative period, often while the patient is still hospitalized. These complications can significantly impact patient outcomes and recovery.

Objective: The objective is to identify and summarize the main perioperative complications of colorectal surgery, as well as the modifiable and non-modifiable risk factors in order to provide strategies for prevention, treatment and reduction of intra- and postoperative complications.

Methodology: A comprehensive review of existing research was conducted, searching databases such as MEDLINE, PubMed and the Google scholar, covering studies published between 2015-2024.

Results: This review aims to outline strategies for identifying and reducing complications during and after surgery. Recent advancements in treatment approaches and technology have been significant, largely due to the growing adoption of laparoscopic techniques. To ensure optimal patient outcomes, surgeon proficiency and cost-effectiveness, factors such as surgeon training, hospital volume and learning curves are crucial. Standardizing perioperative care is also vital in minimizing postoperative complications.

Conclusion: This review highlighted key perioperative complications in colorectal surgery, as well as modifiable and non-modifiable risk factors that are essential for both general surgeons and specialists to understand. Recognizing these risk factors and implementing strategies to prevent, manage or mitigate complications is critical to optimizing patient outcomes.

Keywords: Colorectal surgery, complications, laparoscopy, surgical site infection, anastomotic leakage.

INTRODUCTION

Colorectal surgery is a complex procedure performed to treat various conditions, including colorectal cancer, inflammatory bowel diseases and intestinal obstruction, often requiring significant reconstruction of the gastrointestinal tract[1]. These surgeries carry potential risks, many of which are common to major abdominal surgery and complications can occur during or after the procedure, typically while the patient is still hospitalized. The risk and type of complications can vary widely depending on the specific procedure, patient factors and surgeon experience. Historically, evaluating surgical outcomes has been challenging due to a lack of standardization in defining and grading complications[2,3]. However, the Clavien- Dindo Classification, offers a reliable and flexible system for categorizing complications based on the treatment required to address them. Complications can be broadly categorized into intraoperative and postoperative, with the former including issues such as bleeding and organ injury, later encompassing problems like wound infections, anastomotic leaks and bowel obstruction[4-6]. While some risk factors for these complications, such as patient age, nutritional status and surgeon expertise are increasingly recognized, other modifiable factors may also play a significant role in determining outcomes, highlighting the importance of preoperative optimization to minimize risks[7].

These procedures can be complex and carry significant risks, including intraoperative and postoperative complications that can impact patient outcomes and quality of life[8,9]. Despite advances in surgical techniques and perioperative care, complications remain a significant concern, underscoring the need for a comprehensive understanding of the risk factors and strategies for prevention and management[10]. By exploring the complexities of colorectal surgery and the challenges associated with managing complications, this review aims to contribute to the ongoing efforts to enhance the quality and safety of care for patients undergoing these procedures[11,12].

The primary objective of this review is to synthesize existing knowledge on the complications associated with colorectal surgery, with a focus on identifying key risk factors that contribute to these adverse outcomes. By examining the current literature, this review aims to provide a comprehensive understanding of the complexities involved in colorectal surgical procedures and their potential complications. Furthermore, it seeks to outline effective strategies for preventing, managing and mitigating these complications, ultimately enhancing patient care and outcomes in colorectal surgery. By highlighting the interplay between risk factors and complications, this review aspires to inform clinical practice and guide healthcare professionals in optimizing their approach to colorectal surgical patients.

OBJECTIVE OF STUDY

The primary objective of this review is to synthesize current knowledge on complications associated with colorectal surgery, with a focus on identifying key risk factors that contribute to adverse outcomes. By examining the existing literature, we seek to provide a comprehensive understanding of the complexities involved in colorectal surgical procedures and their potential complications, ultimately shedding light on the intricacies of these procedures and informing strategies for improvement.

METHODOLOGY

A literature search was carried out, using MEDLINE, PubMed and the Google scholar from 2015-2024 using the following terms: complications, risk factors, colorectal surgery, colorectal resection, laparoscopy, surgical site infection and anastomotic leakage. This review is a general overview that pro- vides an update on these topics for the reader.

PRE OPERATIVE RISK FACTORS

Understanding and identifying preoperative risk factors is crucial in the management of patients undergoing colorectal surgery. While some risk factors can be modified or mitigated before surgery, such as age, gender and prior abdominal surgery, are non-influencable and must be taken into account

when developing treatment plans. Recognizing these risk factors allows healthcare providers to tailor their approach to the individual needs of each patient, potentially reducing the risk of complications and improving outcomes.

NON INFLUENCABLE RISK FACTORS

Age and Gender as Risk Factors

Age is a significant consideration in the preoperative assessment of patients undergoing colorectal surgery. Geriatric patients, defined as those over 70 years of age generally have a low postoperative mortality rate, but certain factors can increase their risk of adverse events. These factors include a higher ASA classification, emergency surgery and a history of hypertension, pulmonary disease, neurologic disease or coronary artery disease[13,14]. Additionally, metastatic disease can increase the postoperative complication rate in patients over 80 years. Despite these risks, laparoscopic colorectal surgery has been shown to offer benefits for elderly patients, including shorter hospital stays and fewer complications compared to open surgery[15]. This makes laparoscopy a viable option for patients of all ages. Gender also plays a role in surgical risk with some studies suggesting that male patients are at higher risk of complications in both open and laparoscopic colorectal surgery[16,17]. Specifically, male gender has been associated with increased rates of anastomotic leakage after low rectal anastomoses[18].

Prior Abdominal Surgery and Adhesion Formation

Prior abdominal surgery is another non-influencable risk factor that can impact the outcome of colorectal surgery. Patients who have undergone previous abdominal surgery and are now undergoing laparoscopic colorectal resections are at higher risk of conversion to open surgery, inadvertent enterotomy, postoperative ileus, reoperation and longer operating times[19,20]. However, the overall incidence of complications and mortality rates may not differ significantly from those without prior surgery. The site of the initial surgery can also influence adhesion-related problems and readmission rates, with colon and rectal resections carrying a higher relative risk of adhesion-related complications[21]. The laparoscopic approach may offer some benefits in reducing postoperative adhesion formation but further long-term clinical studies are needed to fully understand its impact. By understanding these non-influencable risk factors, healthcare providers can better assess patient risk and develop strategies to optimize outcomes[22-24].

Comorbidities

Several factors increase the risk of complications in patients undergoing surgery. These include emergency surgery, significant weight loss and neurological comorbidities. Additionally, certain laboratory values such as low hematocrit, albumin or high creatinine levels can also predict postoperative morbidity and mortality. Identifying these risk factors before surgery is crucial[25].

A large study of over 5,800 patients found that certain parameters were strongly associated with perioperative death, including cancer diagnosis, ascites, electrolyte imbalances and pre-existing medical conditions like congestive heart failure. The study also found that nearly 28% of patients experienced one or more complications with the most common being prolonged ileus, pneumonia, respiratory failure and urinary tract infections[26-28]. Furthermore, certain postoperative complications, such as coma, cardiac arrest or renal failure were associated with high mortality rates exceeding 50%.

INFLUENCABLE RISK FACTORS

Obesity

Initially, it was believed that obese patients undergoing laparoscopic colorectal surgery would experience higher complication rates[30]. However, recent studies have shown that this approach is feasible and safe for obese patients, who still benefit from minimally invasive surgery[31]. Some studies have reported longer operating times, hospital stays and higher complication rates for obese

patients, as well as a higher rate of conversion to open surgery. Nevertheless, outcomes for patients who require conversion to open surgery appear comparable to those undergoing planned open surgery. Obese patients (BMI >25 kg/m2) are at higher risk for incisional hernias and surgical site infections[32-34]. To mitigate these risks, preoperative weight loss is recommended for overweight patients undergoing elective colorectal surgery, as comorbidities are a primary cause of complications.

Nutritional status

Malnutrition is a significant concern for surgeons, particularly in gastrointestinal (GI) surgery patients where its prevalence ranges from 30% to 50%. Recognized as an independent risk factor for perioperative morbidity, malnutrition's impact can be mitigated with proper nutritional support [35]. The Nutrition Risk Screening 2002 (NRS) score is a useful tool to assess nutritional status and identify patients at risk. Studies have shown that immunonutrition can reduce infectious complications, hospital stay and mortality[36]. Preoperative immunonutrition is particularly beneficial for malnourished patients. A study demonstrated that patients receiving preoperative immunonutrition had a lower incidence of postoperative infections compared to those receiving conventional nutrition support[37].

Enteral nutrition, especially immune-enhancing enteral nutrition (IEEN), has been shown to reduce postoperative morbidity. Early enteric nutrition postoperatively can improve recovery and total parenteral nutrition (TPN) can be used when enteral administration is not possible.

Preoperative bowel cleaning or not?

Over the last decades the presence of bowel content during surgery has been linked to anastomotic leakage and wound infection[38,39]. This dogma was based more on observational data than on solid evidence. Several well designed prospective randomized trials have shown that preoperative bowel cleaning does not prevent anastomotic leakage or wound infection in patients undergoing open or laparoscopic colorectal surgery [40-42]. More over, one study revealed even an increased risk of anastomotic leaks and wound infection after mechanical bowel preparation. In addition, inadequate mechanical bowel preparation leads to liquid bowel contents and increases the rate of intraoperative spillage [43,44]. Spillage of bowel contents may increase the rate of post- operative infectious complications. On the other hand, bowel preparation might decrease operating time by improving bowel handling during anastomosis and might be helpful when intestinal palpation is necessary for identification of a lesion [45]. In conclusion, bowel preparation is not routinely recommended but should be considered in individual cases, such as when a temporary loop ileostomy is planed.

Experience of the Surgeon and Influence of Case Load

The quality of surgical care is heavily influenced by the surgeon's experience, which is shaped by training, repetition and case load. Mastering a new surgical technique requires a learning curve, which is typically measured by parameters such as operating time, complications and conversion rates[46]. For laparoscopic colorectal resections, studies suggest that a steady state is reached after 30-35 operations. However, the learning curve can vary significantly between surgeons and it's essential to monitor meaningful parameters such as complication rates and length of stay [47]. The debate surrounding whether colorectal surgery should be performed by general surgeons or specialist colorectal surgeons is gaining importance. Research has shown that annual case load and specialized training in colorectal surgery significantly impact short-term and long-term outcomes[48].

Studies have demonstrated that high-volume centers (>10 procedures/year) have better outcomes, including shorter operating times, fewer complications and shorter hospital stays [49,50]. Additionally, hospitals with higher caseloads (>30 procedures/year) have improved long-term outcomes including lower local recurrence rates and better survival rates.

As a result, there is a growing trend towards centralizing specialized colorectal procedures to improve quality and minimize complications. This shift is driven by the need for increased quality assessment and the demand for minimal complication rates in surgery [51].

Preoperative Anemia

There is a high incidence of preoperative and postoperative anemia in patients undergoing major non cardiac surgery, with a coincident increase in blood utilization. Studies show that perioperative anemia is associated with increased postoperative complications and mortality [52]. In a recent study the 30-day mortality and
cardiac event rates increased, with either positive or negative deviations from normal hematocrit levels [53]. Consideration should be given to preoperative diagnosis and correction of anemia with iron, vitamin B12 and folate supplementation[54].

INTRA OPERATIVE RISK FACTORS

Open access to the abdominal cavity

The choice of incision depends on several factors, including the area to be exposed, the urgency of the operation and the surgeon's preference. Transverse incisions are associated with fewer postoperative complications, such as pain, respiratory issues and a lower risk of incisional hernia[55,56]. However, some studies suggest that transverse incisions may cause abdominal or neural dysfunction due to nerve or muscle damage[57]. In contrast, midline incisions are often preferred in emergency situations or when the diagnosis is uncertain, as they provide rapid access to the abdominal cavity and can be easily extended if needed.

Laparoscopic Access to the Abdominal Cavity

Endoscopic surgery carries a risk of complications during abdominal access including visceral injury, bleeding, intestinal perforation, vascular damage, adhesions and subcutaneous emphysema. To create a pneumoperitoneum, surgeons use one of four techniques: Veress needle, direct trocar insertion, optical trocar insertion or open laparoscopy[58-60]. The Veress needle and direct trocar insertion are considered blind techniques. While complication rates are generally low (<1%), some studies suggest that open-entry techniques may have a higher risk of visceral injury[61]. A survey of gynecologists found that many prefer the closed-entry technique, with a reported complication rate of 0.1% in over 31,000 procedures. The open-entry technique is often reserved for special cases, such as suspected adhesions or previous laparotomy[62-65].

Laparoscopic access techniques have varying complication rates. A study found that closed-entry techniques had lower complication rates (0.12%) compared to open-entry techniques (1.38%). The open-entry technique was associated with significantly more visceral lesions. Given the lack of evidence supporting one technique over the other, surgeons can consider specific recommendations[66]. For patients with suspected adhesions or umbilical hernia, left upper quadrant entry may be preferred. Careful Veress needle placement and adjustment of the needle angle based on patient BMI can also help minimize risks. Direct trocar insertion without prior pneumoperitoneum is a safe alternative, associated with fewer complications and faster procedure times[67,68].

The seriousness of vascular injury is high in comparison to visceral injuries during the abdominal access. These cases are rare and no evidence based recommendations of treatment can be given. Injuries to the main vascular structures need an immediate conversion and surgical repair. Small bowel injuries can be treated laparoscopically[69]. Severe lesions sometimes require segment resections and conversion to open surgery. Injuries of the liver or spleen are manageable with laparoscopic devices[70]. If severe bleeding continues a pre-emptive laparotomy is recommended.

Iatrogenic Injuries and How to Handle Them?

There is limited data regarding iatrogenic injuries in colorectal surgery. The main fears of the surgeon are vessel injury, damage to the spleen during colorectal surgery (incidence of 0.006%) or intestinal perforation and uretric injuries (incidence < 0.01%). Injuries to the abdominal or pelvic veins occur mainly in patients undergoing oncologic resections and those with difficult anatomic exposure, owing to previous operation, recur- rent tumor or radiation therapy. Most of the injuries can be repaired by primary suture or end-to-end anastomosis. Few injuries need interposition grafts,

patch venoplasty or venous ligation. Therefore a vascular surgeon should be available in hospitals where cancer resections are frequently performed [71].

Iatrogenic perforation of the bowel occurs either during adhesiolysis or inadvertently due to thermic lesion, the latter are often not recognized during the operation. The surgeon should prefer primary repair or resection with anastomosis. In laparoscopic cases the bowel injury should be sutured immediately as it might be difficult to localise later [72,73].

In general, the incidence of iatrogenic splenic injury is underestimated because of poor documentation. Sple- nectomy is considered a poor prognostic factor [74]. Splenic injury results in increased blood loss, longer hospital stay and higher mortality and infection rates. Splenic injury can be reduced by achieving good expo- sure, avoiding undue traction and careful division of splenic ligaments and adhesions. If the spleen is injured preservation is desirable and often feasible [75].

Which Instruments Help the Surgeon and Which May Harm the Patient?

To date, data available concerning studies which compare the safety of surgical devices are limited. Conven- tional monopolar electrosurgery has several short comings in laparoscopic surgery including the risk of thermal injury, difficult hemostasis and disturbing smoke production, making the use of additional tools like bipolar graspers, sutures or clips necessary. To over- come these problems and to reduce instrument changes, number of trocars and operation time, several multifunctional tools have been developed. The most popular devices are electro thermal bipolar vessel sealers and ultrasonically coagulating shears. In a recent prospective randomized study, it showed that bipolar vessel sealers and ultrasonic coagulation shears shorten dissection time in laparoscopic left-sided colectomy and are cost- effective compared to monopolar electro surgery. Other studies showed less operative blood loss and a decrease in operating time when the ultrasonic dissection device were used. For now it is still the preference of the surgeon as to which device is used [76,77].

Intraoperative Blood Loss and its Influence on Postoperative Outcome

Preoperative anemia and intraoperative blood transfusion are independent risk factors for intra and postoperative complications in colorectal surgery[78]. In a case-matched study of 147 patients undergoing colectomy using either an open or laparoscopic approach the open colectomy group required significantly more units of blood ($P = .003$) to maintain similar hemoglobin levels after surgery. Estimated blood loss ($P < .001$) and the number of patients who received transfusions on the day of surgery ($P = .002$), during the first 48 hours after surgery ($P = .005$) and dur- ing the entire hospital stay ($P = .003$) were significantly higher in the open colectomy group [79].

To prevent intraoperative blood loss and postoperative complications some laparoscopic surgeons prefer ultrasonic dissection with produces significantly less blood loss and thereby iron supplementation in preoperative anemic patients two weeks prior to surgery [80].

Operating time

The length of an operation can be influenced by various factors, including surgical technique, intraoperative complications, prior abdominal surgery and the surgeon's experience. Research has shown that longer operating times are associated with a higher risk of complications[81]. However, studies comparing laparoscopic and open approaches have found that while laparoscopic procedures may take longer, they do not necessarily lead to more complications. In fact laparoscopic surgery has been shown to have several benefits, including shorter hospital stays, fewer wound infections and less postoperative pain[82]. Despite this, there is a need for more studies to specifically evaluate the impact of operating time on postoperative outcomes.

POSTOPERATIVE RISK FACTORS

The management of postoperative care has undergone significant advancements particularly in the realms of pain control and nutrition, which play critical roles in determining patient outcomes following colorectal surgery[83]. Effective pain management is essential, especially given the shift

towards shorter hospital stays and more procedures being performed on an outpatient basis[84,85]. Various pain control modalities are employed in colorectal surgery, including patient-controlled anesthesia, opioids, nonsteroidal anti-inflammatory drugs and epidural anesthesia. Among these, epidural anesthesia has been demonstrated to offer superior pain control and improve bowel function although it is associated with potential complications such as hypotension, urinary retention and pruritus[86-88]. Notably, while epidural anesthesia provides numerous benefits, its use in isolation may not suffice to prevent postoperative morbidity and mortality, underscoring the importance of integrating it into a multimodal care strategy.

In the realm of postoperative nutrition, a paradigm shift has occurred, moving away from traditional practices towards more evidence-based approaches. The routine deployment of nasogastric tubes has largely been discontinued in favor of early enteral nutrition, which has been shown to be well-tolerated by patients in the immediate postoperative period, irrespective of the presence of traditional markers of gastrointestinal function. A growing body of evidence, including meta-analysis suggested that early enteral nutrition can lead to reduced postoperative infections, fewer anastomotic complications and shorter hospital stays[89,90]. The concept of "fast-track surgery" has gained considerable traction, emphasizing the importance of preoperative patient education, optimized pain relief through continuous epidural analgesia, early mobilization and the prompt resumption of oral nutrition[91-93]. Studies have demonstrated that fast-track surgery protocols can significantly improve postoperative pulmonary, cardiovascular and muscle function, while also preserving body composition and reducing the duration of hospital stay and convalescence period. Despite the proven benefits of fast-track surgery, the implementation of standardized and multidisciplinary care pathways can be challenging due to existing resistance[94]. Nonetheless, the accumulating evidence strongly supports the adoption of early enteral nutrition and fast-track surgery protocols as effective strategies to enhance patient outcomes and minimize postoperative complications. In a recently published analysis the advantages of early enteral feeding were not significant but showed a trend towards fewer postoperative complications[95].Early enteral nutrition was associated with reduced mortality. This review supports the notion that early commencement of enteral feeding may be of benefit compared to the nothing by mouth policy [96].A recent randomized study by our group compared the 30-day complication rate of patients who underwent a fast track protocol or standard care after open colonic surgery. The fast-track protocol significantly decreased the number of complications (16 of 76 in the fast-track group vs. 37 of 75 in the standard care group; $P = .0014$), resulting in shorter hospital stay (median, 5 days; range, 2-30 vs. 9 days, respectively; range, 6-30; $P < .0001$)[97-99]. Fluid restriction and effective epidural analgesia were the key factors that determine out- come in the fast-track program [100].

In summary, there is a growing body of evidence that early enteral nutrition improves outcome and reduces postoperative complications. Despite proven advantages of fast track surgery the implementation of a standar- dized and multidisciplinary care is difficult since resistance is still enormous.

COMPLICATIONS

Surgical site infection (SSI)

Colorectal operations are at best, clean-contaminated procedures, at times there is contamination of both

the peritoneal cavity and the surfaces of the surgical wound[101]. In addition, the diseases of the large bowel that require surgery tend to afflict elderly patients. Collectively, the combination of an unclean environment, major surgery and debilitated patients creates a situation that is associated with a very high incidence of wound infection. In open colorectal surgery,the incidence of SSI varies from 2-25% and is associated with BMI ≥ 30, crea- tion/revision/reversal of an ostomy, perioperative transfusion, male gender, ASA Score $\geq$ III and wound contamination [102,104].Some studies showed that perioperative oxygen supply and preoperative immunonutrition decreased surgical site infection significantly[105]. It is widely accepted that a laparoscopic approach lowers the rate of surgical site infection.As for laparoscopic appendectomies ,most surgeons use plastic wound protectors during

specimen removal after laparoscopic resection. This certainly facilitates extraction through a small incision, but there are no randomized controlled trials demonstrating a reduction in wound infection. The role of antibiotic prophylaxis in preventing postoperative complications in colorectal surgery is well established through many studies. However, there is still a debate about the duration of the antibiotic treatment and the kind of antibiotic which should be used. In summary, most studies favour one to three intra- venous doses of a second generation cephalosporin with or without metronidazole with the first dose being administered before skin incision.

Anastomotic leakage: Risk factors, diagnosis and treatment

Anastomotic leakage is the most serious complication specific to intestinal surgery and ranges from 2.9% to as high as 15.3%. At least one third of the mortality after colorectal surgery is attributed to leaks. Within this context, knowledge of factors influencing anastomotic healing appear even more important [106]. However, there is lack of a clear definition for what constitutes an anastomotic leak (radiological proven, clinically relevant, with or without abscess).

In general, the leakage rate for intraperitoneal anastomoses is significantly lower than for extraperitoneal ana- stomoses. Anterior rectal resections have the highest leakage rate of up to 24%.The main risk factors for anastomotic leakage using univariate analysis were male gender (OR = 3.5), previous abdominal surgery (OR = 2.4), Crohn's disease (OR = 3.3), rectal cancer < or = 12 cm from the anal verge (OR = 5.4) and prolonged operating time (P = 0.05 as a continuous vari- able and P = 0.01 when prolonged operative time was>120 min). Male gender, a history of previous abdominal surgery and the presence of a low cancer remained significant after multivariate analysis [107].

Most studies comparing high and low anterior resections have shown that the level of anastomosis is the most important predictive factor for leakage. The high- risk level for leakage varies between anastomoses from<10 to <5 cm from the anal verge depending on the cited study [108].

There seems to be no significant difference in leakage when comparing a handsewn and a stapled technique regardless of the level of anastomosis [109]. Intraoperative problems and postoperative strictures seem to be more frequent in stapled anastomosis. However, in a recent Cochrane review ileocolic stapler anastomoses were associated with fewer leaks than handsewn anastomoses .

The available data comparing the anastomotic leakage rate in laparoscopic or open operated patients showed no difference regardless of the level of the anastomosis. In cancer patients anastomotic leakage (regardless of open or laparoscopic technique) is associated with poor survival and a higher recurrence rate after curative resection .

Diagnosis and Treatment of anastomotic leakage

Because of the severity of the complications associated with an anastomotic leak, it is imperative to identify the problem and act as early as possible. Most groups base the diagnosis on clinical symptomatic leakage, manifested as gas, purulent or fecal discharge from the drain, purulent discharge from the rectum, pelvic abscess or peritonitis. It is usually necessary to obtain objective tests of anastomotic integrity because of the non-specific clinical signs. Water soluble enemas or CT scans are widely used for diagnosis of anastomotic leak. Interestingly, in two recent studies anastomotic leaks were more often diagnosed late in the postoperative period and more often after hospital discharge, or 12 days postoperatively [110]

Anastomotic leaks can be categorized into clinically significant and non-significant leaks. While subclinical leaks tend to have a more benign course, the quality of life and bowel function may not differ significantly between the two groups. For patients with pelvic abscess formation after colorectal surgery, CT scan-guided percutaneous drainage is often effective with a success rate of up to 80% particularly in hemodynamically stable, non-septic patients. However, in cases of free anastomotic leakage in the abdominal cavity, surgical intervention is usually indicated. Despite the potential for conservative management with antibiotics, early surgical repair is often necessary to improve patient

outcomes. Re-laparoscopy and lavage after laparoscopic operations can be a safe and effective approach, with fewer postoperative complications compared to open re-intervention[111].

Postoperative Bleeding

Postoperative bleeding after colorectal procedures is a rare but potentially serious complication. The risk of bleeding depends on the type of surgical procedure, patient comorbidities, and individual factors such as impaired clotting systems112-113]. In the early postoperative phase, abnormal heart rate and low blood pressure should be closely monitored and interpreted by the surgeon. Hemoglobin and hematocrit measurements can help determine blood loss and guide further management.

Ileus

Postoperative ileus is a common complication of gastrointestinal surgery, leading to prolonged hospital stays, increased morbidity and higher treatment costs[114]. The pathophysiology of postoperative ileus is multifactorial, with operating time and intraoperative blood loss identified as independent risk factors. Treatment options vary and studies are often difficult to compare due to differences in anesthesia protocols and patient comorbidities. Management typically involves a combination of approaches including limiting narcotic use, substituting alternative medications such as nonsteroidals and placing a thoracic epidural with local anesthetic[115]. Additionally, selective use of nasogastric decompression and correction of electrolyte imbalances are important considerations in the treatment of paralytic postoperative ileus[116].

Table 1 showed the importance of risk factors for intra- and postoperative complications

Risk factors	Intraoperative complication	Postoperative complication
Age	+	+
Male Gender	+	+
Malnutrition	+	++
Experience surgeon	(+)	+
ASA class > III	+	+
Preoperative anemia	+	++
Intraoperative blood transfusion	+	+
Operating time	+	+
Neoplasia	+	+
Bowel injury	+	+
Obesity	+	(+)
Prior myocardial infarction	(+)	+

CONCLUSION

This review provides a comprehensive overview of the key complications associated with colorectal surgery, highlighting their significance for specialists, general surgeons and gastroenterologists. We also discuss evidence-based strategies to minimize intraoperative and postoperative complications. Recent years have seen substantial advancements in treatment approaches and technological innovations, particularly with the widespread adoption of laparoscopic techniques. To ensure optimal patient outcomes, it is crucial to emphasize surgeon training, hospital volume and learning curves, which are essential for maximizing patient safety, evaluating surgeon expertise and determining cost-effectiveness. Furthermore, standardizing postoperative care is vital for reducing postoperative complications. Our review also summarizes the risk factors that influence intraoperative and postoperative complication rates, as outlined in Table 1, providing a valuable resource for healthcare professionals involved in the care of patients undergoing colorectal surgery.

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