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Review

A Review of Postoperative Complications in Colon Cancer Surgery: The Need for Patient-Centered Therapy

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Abstract: Surgery continues to be the primary therapeutic approach for patients diagnosed with colon cancer. Unfortunately, postoperative complications have been shown to negatively impact short-term patient outcomes, long-term oncological prognosis, and overall healthcare costs. The risk factors of postoperative complications are multiple, being linked to the patient's general condition (lifestyle, comorbidities, etc.), the state of the neoplastic disease, as well as the drug and surgical treatments applied. If these factors are associated, the incidence of postoperative complications especially increases in the form of anastomotic leakage, bleeding, infections, postoperative ileus, and stoma-related complications. It is not surprising that these conditions are common causes of prolonged hospitalization in colon surgery, being associated with high rates of morbidity and mortality. Literature data show that the management of the oncological patient, especially if treated surgically and even more so when they develop postoperative complications, is difficult. It is a direct consequence of the fact that such cases can be quite different from each other, so that the development of a common therapeutic protocol is not possible. Therefore, the purpose of this review is to update and highlight the main risk factors for unfavorable outcomes in patients diagnosed and treated surgically for colon cancer, determine what are the most common postoperative complications, and how the course towards severe forms of evolution is influenced by various clinical and biological parameters. Data used for this review were collected from literature published between 2013 and 2025, using several parameters presented in the text. Consequently, the management strategy for these postoperative complications must be primarily based on an early, multidisciplinary and personalized approach, which appear to significantly improve the therapeutic results obtained.

Keywords: colon cancer; surgery; anastomotic leakage; anastomotic bleeding; surgical site infections; postoperative ileus; stoma-related complications

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1. Introduction

Colon cancer is the third most common cancer in the general population, as well as a leading cause of death from malignancy (53,200 cancer-related deaths per year in the United States) [1]. The primary treatment method for colon cancer (scheduled or emergency) is

surgery followed by chemotherapy, with five-year survival rates depending on the stage of the disease. Even though the survival rate through such a complex treatment method seems to be gradually increasing, approximately 30–40% of patients unfortunately experience subsequent relapses [2].

General preoperative risk factors that may influence the outcome of patients with colon tumors include age, sex, general condition (nutritional status, etc.), associated comorbidities, presence of systemic inflammatory response (SIRS), etc. [3]. Infectious, epidemiological and social factors interfere with patients' access to health services, thus contributing to the post-therapeutic evolution of patients with colon cancer [4].

Specific preoperative risk factors, such as the stage of the primary tumor at diagnosis (large size, invasion of adjacent structures) and its possible local complications (intestinal obstruction, lower gastrointestinal bleeding or digestive perforation), as well as the presence of peritoneal or systemic metastases are determining factors for the prognosis of patients with colon cancer [5].

All of these risk factors contribute to the occurrence of postoperative complications, which significantly influence morbidity, mortality and quality of life. Thus, approximately 40% of patients will develop one or more postoperative complications (anastomotic fistula, massive blood loss, and postoperative sepsis) [6], leading to a decrease in overall survival (up to 1 year) compared to patients without complications [7].

Consequently, the identification of these pre-existing risk factors (especially in the case of patients who present in the emergency) is particularly important, as they allow a careful monitoring of patients predisposed to complications. When a postoperative complication is suspected, a good knowledge of the clinical manifestations and treatment methods is essential for obtaining the best possible outcome.

The aim of this review is to update the main risk factors, preventive measures and specific therapies for postoperative complications in patients with colon cancer. These data are not only complex and interdependent but also have different degrees of severity, which is why they cannot be standardized in the form of defined protocols. A good knowledge of diagnosis and therapeutic management proved not only to be able to increase the patient's outcomes but also to improve the quality of life and reduce health care costs.

2. Materials and Methods

For this review, a literature search was performed using the PubMed, Elsevier and Google Scholar databases, in the period 2013–2025. The key words in the selection of articles were: "postoperative complications in colon cancer", "postsurgical complications in colon cancer", "short-term outcomes in colon cancer", "anastomotic leak in colon surgery", "anastomotic leak in colon cancer", "wound complications in colon surgery", "stoma-related complications", "stoma-related complications in colon cancer" and "septic complications in colon cancer". From the identified articles, we included in the analysis narrative descriptive studies, systematic reviews, meta-analyses, randomized controlled trials, cohort studies and observational studies. Exclusion criteria included the unavailability of full-text articles, publications in languages other than English, as well as case reports, opinion papers, and conference proceedings.

3. Discussions

3.1. Postoperative Complications

Early surgical/local postoperative complications are a major cause of increased mortality and morbidity in patients with colon cancer. In the long term, such complications may lead (by creating a prolonged pro-inflammatory microenvironment) to an increased rate of local recurrence and/or liver metastases [8].

In addition to these local complications, unfavorable postoperative outcomes can also be systemic in the form of pneumonia, acute cardiovascular failure (especially in elderly patients associating comorbidities) [9], delirium, etc., which lead to a much more difficult recovery for the patient [7]. All these complications lead to a significant decrease in the patient's quality of life and thus to an increased need for medical care, in some cases even leading to a reduction in overall survival by more than a year [6]. Table 1 presents a summary of surgical postoperative complications and appropriate therapeutic management.

Table 1. Surgical postoperative complications and therapeutic management.

Complications	Risk Factors	Management
Anastomotic leakage	• Advanced age [10] • Male sex [11] • Smoking [12] • Obesity and diabetes [13] • Sarcopenia [14] • Serological parameters: neutrophil/lymphocyte ratio > 2.66 [15], anemia and blood products administration [16] • Surgical risk factors: Emergency presentation [17], ASA score > 3 [18] • Pathologic factors: tumor > 4 cm in size, low differentiation grade [15,16]	• Surgical management: Acute Physiology and Chronic Health Evaluation (APACHE) score > 2, presence of generalized peritonitis • Colonoscopic management: stents [19], polyurethane foam sponges [20] • Drainage
Anastomotic bleeding	• Surgical technique: inadequate preparation of the bowel, mechanical [21] and latero-lateral anastomosis [22]	• Surgical management: hemodynamic instability, massive bleeding [23] • Endoscopic management: epinephrine injection [24] and/or injection of sclerosing agents (risk of necrosis and perforation, hemoclips, diathermocoagulation [25]
Postoperative infections	• Obesity [26] • Male sex • Diabetes [13] • Surgery-related factors: emergency setting, stoma formation [27], prolonged surgery, ASA > 3 [28]	• Surgical treatment: drainage, removing the predisposing factors (anastomotic leak, contaminated prothesis, etc.) [29] • Preventive methods: skin cleansing, adhesive strips (low or no benefit) [30], aspiration and lavage of the wound [31], preparation of the large bowel [32], intraoperative attitude (use of triclosan coated wire [33], drainage tubes [34])
Postoperative ileus	• Emergency surgery [35] • Prolonged surgical time (extensive manipulation of the bowel, extensive use of opioids) [36]	• Pharmacological attitude: prokinetic drugs (metoclopramide, erythromycin, etc.) that decreases the symptoms' intensity [37], supportive measures: parenteral nutrition, nasogastric drainage [36] • Preventive methods: administration of alvimopan [38], reduction of opioids use (epidural catheter, COX2 selective nonsteroidal anti-inflammatory drugs [39], chewing gum [40] and coffee usage [41])
Peristomal dermatitis	• Surgical technique deficiencies (improperly sized stoma, distance < 50 mm between skin and intestine) [42]	• Pharmacological attitude: ceramide-based gels [43], cyanoacrylate agents [44], barrier substances (zinc oxide, antiperspirants, etc.) [45] • Application of convex barrier
Mucocutaneous dehiscence	• Emergency surgery • Inadequate surgical technique (excessive tension, overuse of coagulation instruments) [46] • Malnutrition	• Isolation of the abdominal wall (lavage, antiseptic solutions) • Usage of alginate gels (if dehiscence is at fascial level [47]) • Surgical treatment (mobilization or new stoma [48]) if dehiscence is below fascial level [48]
Ischemia and necrosis	• Emergency set surgery [49] • Atherosclerosis and vascular disorders [50] • Diabetes [13]	• Surgical treatment: debridement if necrosis is <2 cm [50] associated with negative pressure drainage [51], new stoma formation (necrosis > 2 cm)

3.1.1. Anastomotic Leakage

Anastomotic leakage (anastomotic fistula) is characterized by the leakage of intraluminal contents following the suture of two cavity organs [17]. Regarding risk factors and therapeutic management, it can be divided into early fistulas (with symptoms appearing in the first 5–8 days) and late fistulas (appearing between 8 and 30 days after surgery) [52]. Early dehiscence is usually caused by failure of surgical technique (microvascular injury, local tension, etc.) [53], being associated with fecal peritonitis and thus high mortality rates. In contrast, late fistulas occur more frequently in immunocompromised patients, those with obesity or exposed to radiotherapy [17]. Whatever the cause and size, late fistulas can usually lead to the development of a persistent pelvic abscess [52]. Anastomotic fistulas can be classified into three grades in terms of severity. Grade 1 does not cause pathological fluid leakage, and laboratory tests are normal. Grade 2 involves abdominal pain, purulent fluid, leukocytosis, and elevated inflammatory markers. In grade 3, the patient develops fecal peritonitis and multiple organ dysfunction, in which case prompt surgical intervention is the only therapeutic approach to improve the patient's prognosis [54].

Risk factors for anastomotic fistula include: advanced age and capillary fragility (due to reduced healing capacity) [10], male gender (due to the influence of androgen hormones that inhibit epithelialization through phospholipase D) [11], smoking (due to the vasoconstrictor and prothrombotic effects of nicotine on small blood vessels) [12], obesity and high blood sugar levels (which reduce the inflammatory response by altering neutrophil adhesion, chemotaxis, opsonization, phagocytosis, as well as by inducing inappropriate vasodilation) [13], sarcopenia (due to the synthesis, degradation and thus alteration of protein functions) [14], and finally due to preoperative factors, such as neutrophil/lymphocyte ratio > 2.66 [15], anemia and administration of blood products [16]. Emergency presentation due to complications [17], an ASA score > 3 [18], and a tumor > 4 cm in size with poor differentiation may also contribute to the occurrence of an anastomotic fistula [15,16].

Regardless of the risk factors, the nature (early or late) of the anastomotic fistula and the surgical technique used, cellular and humoral mechanisms involve a marked release of catecholamines, prostaglandins and growth factors, which indirectly suppress immune (antitumor) defense mechanisms. On the other hand, the presence of diffuse peritoneal infection and marked local inflammation increases vascular permeability and promotes cell migration to capture the large number of pathogens present [17]. The inflammatory and infectious consequences of an anastomotic fistula imply an increased risk of local neoplastic recurrence, while survival decreases from 4.7% to 1.9%, especially in patients with tumors located in the distal colon [55]. Most studies show that the presence of such a complication usually requires specific treatment and prolonged hospitalization, which delay the start of chemotherapy [56].

To prevent the occurrence of this complication, appropriate intraoperative assessment is necessary. This can vary from the usual mechanical patency tests of the anastomosis, up to endoscopic visualization or evaluation of the local vascularization using photoluminescent substances. Mechanical tests include instilling air, saline, or methylene blue into the digestive tract to assess the tightness of the anastomosis [57]. Angiographic assessment of anastomotic viability using indocyanine green can reduce the risk of anastomotic fistula to 3.3%, compared to the 8.5% risk associated with traditional assessment methods [58]. The best results with this technique were observed especially in cases where ultra-low anastomosis was performed for rectal or rectosigmoid junction tumors [59].

Early diagnosis of an anastomotic fistula is essential for reducing the length of hospital stay, mortality and morbidity rates, and improving the oncological prognosis as well as the patient's quality of life [60]. Depending on the patient, anastomotic leak can manifest clinically differently, from an asymptomatic radiological finding to sepsis through peri-

tonitis and multi-organ failure. However, in most patients, postoperative anastomotic fistula manifests as a sudden onset of fever, tachypnea, oliguria, changes in the quantity or quality of drainage, prolonged ileus, or abdominal pain. Such signs must be recognized early, because an unrecognized anastomotic fistula can progress to multiple organ failure [17]. Useful paraclinical tools for early diagnosis include procalcitonin and C-reactive protein, the latter being controversial due to its low specificity. However, in association with signs or symptoms suggestive for anastomotic fistula, C-reactive protein becomes highly predictive [61]. In addition, the concomitant use of C-reactive protein and procalcitonin provides greater sensitivity and specificity for detecting (or excluding) an anastomotic fistula, especially on days 3–5. Abdominal–pelvic computed tomography can also be used, which in most medical centers is still the gold standard for diagnosis [61,62].

The management of anastomotic fistulas can be either conservative or surgical, depending on the clinical presentation of the patient, comorbidities, the time elapsed from the anastomosis to the appearance of the drainage, etc. Nonoperative management is usually preferred in young patients in good general condition, low-flow fistulas, and in patients with proximal fecal diversion at initial surgery [20]. Factors that determine a surgical therapeutic approach for patients with anastomotic fistulas include the presence of multiple abscesses or fistulas identified on imaging, and/or an Acute Physiology and Chronic Health Evaluation (APACHE) score > 2 [63]. Patients with generalized peritonitis require exploratory laparotomy, resection of the anastomosis, and the performance of a terminal colostomy (to reduce the risk of subsequent septic contamination of the peritoneum), which in more than 50% of cases remains in the form of a permanent colostomy [17]. Another surgical approach for patients with anastomotic fistula is the creation of an ileostomy upstream of the anastomosis, followed by placement of a pelvic drain. This technique allows for effective lavage of the abdominal cavity and diversion of fecal contents to the stoma, while reducing the operation time [64].

A minimally invasive approach can be applied via laparoscopy, as the risk of conversion to open surgery has been shown to be low in such cases. Laparoscopic techniques depend on the patient and available resources, from laparoscopic diversion ileostomy plus transanal anastomotic drainage to percutaneous drainage or new procedures, such as endoluminal vacuum-assisted therapy. Generally, abundant lavage of the peritoneal cavity and safe stoma formation can be performed with minimal intraoperative incidents. Such incidents, when they occur, can still be managed laparoscopically by an experienced surgical team [65]. Expandable colonoscopic stents may also be considered, if available. They limit communication between the peritoneal cavity and the digestive lumen, allowing remission of the septic syndrome and tissue repair and thus favoring the closure of the defect. The use of such devices resulted in a 73.3% success rate, with only 9.3% of patients requiring additional surgery to close the anastomotic defect [19]. Polyurethane foam sponges can also be placed through the colonoscope, this technique allowing drainage of the peritoneal cavity and promoting granulation and tissue repair. However, this method is not widely used due to the multiple endoscopic procedures that are required, which over time can lead to strictures or necrosis at the anastomotic site [20].

3.1.2. Anastomotic Bleeding

Gastrointestinal bleeding at the level of the anastomosis is a complication that can be encountered in different degrees of severity, from mild hematochezia (occurring during the first postoperative stool) to massive hemorrhage (requiring blood transfusions, minimally invasive hemostasis, or even surgery) [66]. With an incidence of approximately 0.5%, bleeding begins in most cases within the first 24 h postoperatively and can continue

until day 6 postoperatively, thus leading to prolonged hospitalization (with an average of 11 days) [67].

The causes of bleeding at the anastomosis site are generally related to deficiencies in surgical technique, in which the mesenteric surface of the digestive tract (involved in the suture) is not prepared and adequately delimited from the mesentery (the local vessels are not properly ligated). In general, performing manual anastomoses has the advantage of being performed under visual control, so it presents a lower risk of bleeding compared to the use of mechanical devices. In support of this, patients who underwent right colon resections followed by end-to-end mechanical ileocolic anastomosis experienced postoperative bleeding in 4.9% of cases, compared to another group of patients who underwent manual anastomosis in which no bleeding was observed [21]. Other studies suggest that any side-to-side anastomosis performed on the antimesenteric side should be checked for possible sources of bleeding, especially when performed with a stapler [22].

Therapeutic management of bleeding at the anastomosis site involves performing colonoscopy, which allows both objectification of the diagnosis (placement of the lesion, assessment of bleeding flow) and specific therapeutic maneuvers (hemostatic methods, such as adrenaline injection, diathermocoagulation, mechanical methods of hemostasis or a combination of them) [25]. Even though it is considered a minimally invasive treatment method (the insufflation of pressurized air, local trauma, risk of damage to the anastomosis or favoring the formation of fistulas at this level), the results obtained show that the associated risks are relatively low, with only 10% of patients experiencing colonoscopic complications [68]. Failure of minimally invasive treatment with massive bleeding and hemodynamic instability usually requires laparotomy, in which either the anastomosis is resected and reconstructed or it is removed from the digestive circuit and a stoma is created [23].

Relatively similar results were found in centers where only conservative treatment (without endoscopy) was effective to stop anastomotic bleeding [69]. Thus, the use of diluted epinephrine (1:10,000) appears to be a stable and safe hemostatic method, so that it is frequently used to treat hemorrhage. Epinephrine-induced vasoconstriction promotes platelet aggregation and subsequent formation of a higher quality clot [24]. In a similar way, injection of sclerosing agents, such as alcohol, ethanolamine, and polidocanol, may be useful for their tamponade effect. Such drugs should, however, be administered with caution because they are associated with a higher risk of local necrosis, perforation, and ulceration. Hemoclips or diathermocoagulation are other methods that can be used to control bleeding at the anastomosis site. Unfortunately, none of these methods has proven to be superior to the other, so its choice is at the discretion of the endoscopist (depending on the available materials, the doctor's experience, etc.) [25].

3.1.3. Postoperative Infections

Surgical site infections are defined as the presence of local infection after the intervention, either at the incision site or in the vicinity of tissues exposed during operation. They have significant implications for the patient, the medical team, and the healthcare system due to the complex impact of pathogenic agents on both the body and the patient's quality of life [70]. Patients undergoing lower gastrointestinal surgery are more severely affected, due to the high risk of contamination and the severe course specific to virulent microbes (gram-positive cocci/enterococci, gram-negative bacilli/enterobacteriaceae, pseudomonas, anaerobes, etc.) [71,72]. In support of this, postoperative infections from colon interventions are encountered approximately four times more often than in other types of surgeries [73].

Factors that lead to the occurrence of infections at the wound site are mainly represented by contamination with bacteria from the colon. If the virulence of the germs is

increased, infection can occur even in cases of minimal microbial inoculations [74]. In the case of polymicrobial contamination (aerobic and anaerobic colon flora), the phenomenon of bacterial synergy is described, which significantly increases the aggressiveness on tissues [75]. In addition to the risk of contamination with colon bacteria in patients undergoing colon surgery, there is also the risk of contamination with commensal skin flora (*S. aureus* being responsible for approximately 20% of postoperative wound infections) [76] or with healthcare-associated pathogenic flora [77].

Factors that favor infection in patients undergoing colon cancer surgery include obesity (by reduced tissue oxygen supply and altered collagen synthesis) [26], male gender, diabetes mellitus, stoma formation (bacterial translocation through the intestinal wall and skin contamination during stoma formation) [27], performing surgery in an emergency setting (a fast cleaning increases the risk of wound contamination), prolonged duration of surgery, a higher ASA score, and insufficient time for adequate correction of the patient's comorbidities [28]. In the case of association of several risk factors, the infection rate can reach up to 30% of cases [78].

Topographically, postoperative infections can be in the form of superficial infections (at the skin and subcutaneous tissue level), deep infections (at the muscle and fascia level), and infections localized to the viscera and/or peritoneal cavity. Clinically, the postoperative infections most often occur within the first 14 days after surgery or procedures involving the digestive tract [79]. Such infection should be suspected when drainage is purulent or when signs of wound dehiscence are present (local induration with or without drainage), all correlating with systemic signs, such as fever or chills [80].

From a pathophysiological point of view, abdominal wall incision and surgical procedures lead to destruction of blood vessels and tissues, which activate multiple and interrelated cellular reactions (coagulation cascade, platelet activation, bradykinin cascade, activation of mast cells and neutrophils, etc.). These mechanisms are complemented by the process of local vasodilation, which further favors the migration of immune cells to phagocytize potentially foreign bacteria. Vasodilation is often associated by increased capillary permeability that favors the extravasation of fibrin, which further forms (through precipitation) a barrier that prevents bacterial penetration [77].

The management of postoperative infections includes both preventive methods (decreasing the predisposing factors) and general therapeutic measures (intraoperative and postoperative). When infections are bacteriologically confirmed, they are treated with conservative, surgical, or combined methods [29].

Regarding prevention, it is recommended to perform local skin cleansing with antiseptic solutions along with hair removal, to reduce contamination of the postoperative wound with commensal germs. Notable benefits have been identified by applying antiseptic solutions based on chlorhexidine and povidone-iodine to the patient's skin, the former being preferred because its combination with alcohol increases bactericidal capacity [81]. Several studies show that hair removal appears to offer a significant reduction in the risk of wound infection [82]. Other studies suggest that application of antiseptic-impregnated adhesive strips before surgery reduces both endogenous and exogenous contamination of the skin during surgery [83]. However, no clear benefit of this method has been found in high-risk surgical procedures, such as colon surgery [30,84].

Mechanical preparation of the large bowel and/or administration of prophylactic antibiotics are also effective methods for preventing postoperative infectious complications and anastomotic fistulas [32]. Combining mechanical preparation with antibiotic therapy in patients undergoing open surgery for colon tumors resulted in decreased mortality, morbidity and rates of anastomotic fistulas [85], compared to cases in which a single preoperative preparation method was used [86,87]. For prevention, oral administration

of either neomycin or erythromycin in combination with metronidazole appears to have similar results [88]. Alternatively, ertapenem or a combination of a second-generation cephalosporin with metronidazole can be administered 30 min before incision [89].

Intraoperative wound irrigation with antiseptic solutions (such as povidone-iodine) promotes mobilization and elimination of devitalized tissue and reduces local microbial flora (mechanical and antiseptic actions) [60]. It is superior to simple saline irrigation [90], which does not appear to be as effective in controlling wound infections as the use of lavage and jet irrigation systems (simple saline irrigation associating higher rates of postoperative infection) [31,91].

The nature of the suture material used to close the abdominal wall may also influence the rate of infectious complications at the wound site, as pathogens may adhere to the suture thread and subsequently proliferate. Literature data show that the monofilament suture is most appropriate for operations with high septic risk, such as colon surgery [29]. Monofilament sutures are based on several materials (polydioxanone, polypropylene, nylon, etc.) being used in patients at high risk of infection [92]. Triclosan-coated sutures, although more expensive, appear to be superior in terms of reducing wound infection rates and preventing prolonged hospitalization [33].

A simple but effective method for combating postoperative colon infections is the placement of drainage tubes to prevent or eliminate possible intraperitoneal collections. Drains have proven extremely useful in treating hemorrhagic and infectious complications, especially in association with a rapid recovery protocol when it significantly decreases the rate of mortality, morbidity, or reoperations [35,93]. In the absence of a rapid recovery protocol, drainage can negatively affect the patient's overall condition, as it increases the need for analgesics, reduces mobility, and increases the risk of respiratory infections associated with prolonged hospitalization [35]. Applying a tight dressing to the postoperative wound and connecting it to a negative pressure suction device may also be helpful in preventing surgical site infections. Negative pressure promotes drainage of fluids released from the wound (caused by tissue trauma during surgery) and prevents bacterial colonization at the surgical site. The use of suction procedure in patients undergoing major surgery (colon cancer, gastric and pancreatic resections, etc.) appears to reduce the risk of local infection by up to 50% [94].

3.1.4. Postoperative Ileus

Postoperative ileus is defined as the temporary cessation of motor activity of the digestive tract; for a defined period of time, it is a common reaction caused by anesthetic–surgical procedures. If persistent, intestinal paresis leads to abdominal distention, vomiting, and the patient's inability to eat, ultimately leading to prolonged hospitalization [36]. Peristaltic movements in the digestive tract are supported by the interstitial cells of Cajal, which are modulated by sympathetic and parasympathetic fibers, as well as inflammatory and infectious factors [95].

Intraoperative manipulation of intestinal loops leads to infiltration of the mucosa with leukocytes (in response to trauma), which subsequently decreases the contractile strength of smooth muscles in that area [35]. In addition, the synthesis of inflammatory factors produced by macrophages (via COX2 and nitric oxide) [96,97] decreases the activity of autonomic fibers that regulate peristaltic activity. Splanchnic nerve fibers may increase sympathetic activity during surgery, decreasing motility via vasoactive intestinal polypeptide (VIP) [36,95]. All of these factors, in combination with the effects of anesthetic drugs (which interact with central nervous and opioid receptors in the intestine), contribute to the onset and persistence of postoperative ileus [98].

Therapeutic management of postoperative ileus is generally symptomatic (there is currently no specific treatment to restore intestinal transit), being related especially to the signs and symptoms expressed in the postoperative period. The modern approach is mainly based on supportive measures, such as intestinal decompression via nasogastric tube, parenteral nutrition, and crystalloid solutions to maintain blood homeostasis [36]. Numerous measures can be taken to prevent the occurrence of postoperative ileus, many of which are already integrated into the management of patients with colon cancer [99]. Thus, crystalloid solutions should be administered but only in adequate amounts, as excessive intake may increase intestinal edema and worsen postoperative ileus [80]. Conversely, fluid restriction may promote gastric emptying [100] but with the risk of hypotension and acute kidney injury in susceptible individuals [101].

Administration of prokinetic substances (metoclopramide or acetylcholinesterase inhibitors) may be useful for reducing intense and disturbing symptoms [37]. In addition, alvimopan or methylnaltrexone (μ-receptor antagonists that do not cross the blood–brain barrier) appears to reduce the occurrence/extent of postoperative ileus, reducing patient hospitalization by approximately 0.62 days [38]. These medications also involve a reduction/avoidance of opioids that are administered for pain control. The epidural catheter can only be used for open interventions, as minimally invasive surgeries do not seem to benefit from this procedure [102]. The use of COX-2 selective NSAIDs, such as celecoxib, is recommended to reduce paralytic ileus (caution for diclofenac and ketorolac which are associated with a higher risk of anastomotic fistula) [39,103].

Other preventive methods include the administration of chewing gum, which stimulates parasympathetic activity and the resumption of intestinal transit but apparently without affecting the length of hospital stay [40]. Postoperative coffee consumption can stimulate gastrin secretion and can also interact with opioid receptors, thus diminishing the anesthetic effect and favoring the restoration of intestinal transit (while maintaining the same duration of hospitalization) [41].

3.1.5. Early Complications of Stoma Formation

Stoma formation is a common therapeutic option in colon cancer, both in emergency and elective surgeries. This method significantly improves survival rates, but the procedure involves a decrease in quality of life, especially in cases where stoma-related complications occur during hospitalization. Such complications can reach up to 80%, being associated with substantial care costs due to the necessary skin care products and devices and prolonged hospitalization [104,105].

- Peristomal Irritant Contact Dermatitis

Peristomal irritant contact dermatitis is one of the most common complications caused by prolonged contact of fecal matter with the patient's skin. The causes of this complication may be related to the poor quality of the bag used, it is not changed properly, the stoma is of inappropriate size, etc. [42]. The nature and quantity of the excreted materials influence the rate and evolution of this complication. Thus, a diet based on excessive intake of water, digestive juices, spices, etc., can cause multiple and severe skin microlesions. In addition, an increased volume of fluid (especially ileal) can easily spread to the skin, thus favoring skin damage [104].

In the case of dermatitis and other associated lesions caused by skin exposure to the fluid discharged through the stoma, it is first necessary to close the area between the pouch and the intestinal segment to minimize skin exposure to aggressive factors [42]. The risk of irritation is higher when the distance between the end of the intestine and the skin surface reaches 50 mm. In such cases, it is necessary to apply a convex barrier to increase the prominence of the stoma in the pouch, thus reducing the size and severity of skin

complication [43]. The application of ceramide-based gels increases the local healing rate and also improves patient satisfaction by reducing pruritus, local pain, and decreasing fluids leaking through the stoma [106].

The addition of cyanoacrylate-based sealants may be useful for patients with pre-existing lesions, promoting healing but with the risk of notable allergic reactions [44]. Other barrier substances (e.g., zinc oxide-based ointments, antiperspirants, or pectin-based hydrocolloid powder) also provide faster healing rates with minimal discomfort [45]. If the reaction persists after applying these measures, topical steroid treatment should be added to reduce inflammation. Triamcinolone or beclomethasone sprays are preferred because they dry quickly and do not affect the barrier function of other products or the adhesion of the gel around the stoma. In exceptional cases, injectable corticosteroids may also be helpful [107].

- Mucocutaneous Dehiscence

Mucocutaneous dehiscence is another possible complication, especially in patients undergoing emergency surgery or those with terminal colostomies. Possible causes include improper surgical technique (excessive tension on the bowel, excessive use of coagulation instruments on the colon mucosa) leading to poor contact between the skin and the colon mucosa and causing local infection and suppuration [46].

Management consists of lavage with isotonic solutions as well as isolation of the abdominal wall as much as possible. Infections or malnutrition are frequently encountered/precursors to such a complication and must be addressed appropriately. If the dehiscence is superficial, it must be closed quickly to prevent the infection from progressing deeper. When dehiscence occurs at the fascial level, alginate-based gels can be used with good results [47]. Surgical treatment involves partial mobilization of the proximal intestine and suturing it to the skin. Whenever possible, it is still preferable to close the abdominal breach and create a new stoma [48], which can be performed as a day surgery in selected cases [108].

- Ischemia and Necrosis of the Intestinal Segment

Ischemia and necrosis of the intestinal segment protruding from the peritoneal cavity through the skin is a severe complication of stoma, especially in hospitalized patients undergoing emergency surgery [49]. The main cause of this complication is related to vascularization (compression of small vessels at the fascial level, local tension or pre-existing vascular disorders), which becomes insufficient and thus unable to ensure the necessary blood flow to the stoma [50]. Such vascular problems usually occur in the superficial fascia area, leading to local necrosis in the immediate postoperative period [109].

Stoma necrosis is treated therapeutically depending on its extent. If superficial, only debridement (without surgery) is required [110], which must be performed carefully due to the risk of retraction and stenosis [50]. When necrosis exceeds 2 cm, surgery can be considered, especially since it is easy to perform early postoperatively (weak adhesions, minimal mesenteric edema) [110]. Other therapeutic approaches for the management of a necrotic stoma include the use of transparent bags (which allow for successive assessments and repeated debridements) [107], as well as the use of negative pressure dressings (to isolate the affected area) [51].

Surgical treatment is indicated when the necrotic area extends beyond the fascia. The technique used involves the resection of the entire affected ischemic intestine but with caution in order to maintain sufficient mobility of the remaining intestine to reach the skin. During late surgery, several changes occur (such as mesenteric edema and inflammatory adhesions) that make it difficult to mobilize the digestive tube to the skin [111].

4. Conclusions

Although the surgical management of colon cancer has evolved over time, postoperative complications still remain frequently encountered in practice, especially in patients hospitalized and operated on under emergency conditions. When surgery must be performed urgently, preoperative preparation of the patient (correction of hydroelectrolytic, hemodynamic and metabolic imbalances) is most often performed in a limited/insufficient period of time. In addition, associated comorbidities and other possible risk factors not only increase the rate of postoperative complications but also require specific therapeutic measures.

Depending on the severity, each postoperative complication has different forms of clinical manifestation. Due to the nature and variability of these complications, diagnosis and treatment cannot be rigorously standardized. A good knowledge of the risk factors, diagnostic possibilities and treatment options, allow both an early diagnosis of postoperative complications and an adequate therapeutic management, which in most cases turns out to be personalized. Such patient-centered therapy could reduce the risk of postoperative complications, improving quality of life and survival rates, while reducing costs in healthcare systems. Future studies should be focused on discovery of new drug classes (antibiotics, anesthetics, etc.) with low impact on intestinal motility, microbiota, metabolic and immunity mechanisms, as well as minimally invasive surgical techniques, in order to decrease as much as possible postoperative complications.

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