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Sepsis In Emergency Colorectal Surgery

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1. Abstract

Colorectal surgery is associated with a high sepsis rate. Intra-abdominal sepsis may be spontaneous (at time of colonic catastrophe) or postoperative. The relative contributions to sepsis control depend on (a) the initial severity of infection (disease factor), (b) timeliness and adequacy of attempts at treatment (surgeon factor) and (c) the patient's general health and consequent ability to withstand the process (patient factor). The aim of the study is to elucidate the relative contributions of the patient, disease and surgeon- related factors in the prognosis of sepsis, sepsis source control failure and its mitigation in emergency colorectal surgery. A retrospective literature search was performed to identify original published studies on sepsis manifestation and prevention in colorectal surgery. Relevant articles were searched from relevant chapters in specialized texts and all included. The prevention of the progression of sepsis is by early goal-directed therapy, and sepsis source control. Sepsis control is the priority in perforated colorectal cancer before a definitive oncological resection. The presence of viable organisms in the surgical field prior to wound closure and the inter-individual variation in the host-defence mechanisms are most important factors in postoperative sepsis. The patient and disease factors predominate in the prognosis of sepsis in emergency colorectal surgery, but the surgeon-related factors can influence the morbidity and mortality.

2. Introduction

Post -operative infection is an important complication of colorectal surgery with a high surgical site infection rate (SSI) rate. This is because of the contaminated nature of surgery, the preoperative status of the patients being mostly of high American Society of Anaesthetists (ASA) 3-5, and the longer duration of the operations [1, 2]. Continued efforts are therefore needed to minimize postoperative infection. SSI is classified into superficial incisional involving the skin and subcutaneous tissue, deep incisional involving the deep soft tissue (fascia and muscle) and the organ/space surgical site infection equivalent to intraperitoneal sepsis [1]. In emergency colorectal surgery, for example colorectal perforation, there is normally contamination of the peritoneal cavity and the mortality can be greater than 50% despite systemic antibiotic therapy [3]. In elective (planned) colorectal surgery generally considered as being 'clean-contaminated' the mortality is less than 1% [3, 4]. The Association of Coloproctology of Great Britain and Ireland (ACPGBI) guidelines for elective colorectal surgery suggests a SSI rate of < 10%, an anastomotic leak rate for colonic resection of < 4%, a mortality from sepsis of < 1% and a perioperative mortality of < 5%. In emergency surgery with imminent or frank faecal contamination, mortality from sepsis can be greater than 50% due to faecal peritonitis, inadequate preoperative optimisation, advanced nature of the disease and patient- related factors (co-morbidity). The perioperative mortality should be less than 20% [5]. A greater proportion of elderly patients undergo emergency and relatively more complex and contaminated procedures and, smoking and alcohol abuse by affecting the microcirculation remain the major risk factors for anastomotic leakage in colorectal surgery (patient factor) [1-7]. Intra-abdominal sepsis in colorectal surgery can occur either spontaneously (at time of the colorectal catastrophe) e.g. perforated diverticular disease, complications of colorectal cancer (CRC) or postoperatively (late) as a complication of surgery such as wound or deep abdominal infection. Postoperative sepsis is usually caused by anastomotic breakdown, inadequate elimination of sepsis, an unrecognized perforation or an infected haematoma. Anastomotic failure can predispose intra-abdominal sepsis and vice-versa. The incidence of anastomotic leak (AL) vary between 3-22% which indicates a multifactorial ae-

tiology including the inconsistency of definitions. AL may be radiological, (grade A requiring no active therapeutic intervention), subclinical (grade B managed with antibiotics, interventional or transanal drainage), or clinical (grade C managed with surgical intervention such as Hartmann's procedure or creation of a defunctioning ileostomy) [6, 7]. Clinical leak is an independent predictor of mortality (40%) which is higher than most natural conditions [3]. This may be due to the fact that sepsis is the leading cause of death and corroborated by the fact that delayed diagnosis worsens the prognosis. Early anastomotic disruption is usually from mechanical (technical) failure manifesting clinically by the 4th- 6th postoperative day (early leak). Late anastomotic disruption (> 1 week) is usually due to healing (biological) failure from ischaemia, tension, or inherent disease. The effects of an early anastomotic leak would probably be obviated by bowel preparation, but most leaks occur late after the patient has recommenced oral feeding so that any value of preoperative bowel preparation will have been lost. A 7- day cohort study on the mortality after surgery in Europe showed a 12- fold variation in 30- day mortality rate following emergency abdominal surgery in the UK. There was a 3.6% mortality in the best performing hospital but a 41.7% mortality rate in the worst [8]. However, in Kigali, Rwanda, in the developing world there was a mortality rate of < 17% where surgery was performed < 24 h of admission [9]. These indicate that surgical outcome depends on a complex interaction of many factors and the success obtained with the early onset (< 24 h) of specific therapeutic procedures. Decision- making (surgeon factor) was a critical determinant of outcome and, the timeliness of intervention from the collaboration between the surgeon, intensivist and radiologist is crucial [4, 5, 9]. The mortality from postoperative intraperitoneal sepsis increases with each operation to treat recurrent or persistent sepsis [10-13]. This is due to the deteriorating septic state of the patient superimposed on the stress of surgery and, the increased dissection required by re-operative surgery with increased risk of injury and ischaemia to tissues. Therefore, the best opportunity to eradicate infection is the first operation. Mortality is lower when operations are conducted by consultant anaesthetists and surgeons rather than trainees and where patients have ready access to treatment in intensive care [8, 9]. The inter-individual variation in host-defence mechanisms and end-organ responsiveness may play a significant role in determining the initial physiological response to major sepsis and this in turn may be a key determinant of outcome (patient factor). This is exacerbated by the immunodepressive effect of major surgery and the increased susceptibility to infection with intracellular listeria and mycobacteria and the opportunistic candidia and staphylococcus infections [14, 15]. This may explain why a patient with minimal bacterial contamination at surgery may develop a pelvic abscess whereas another patient with massive faecal contamination after stercoral perforation may not develop infective complications. Patient factor was also important as most patients were over 65 years with co-morbidity and often seriously ill with internal haemorrhage or a bowel perforation [8]. This review elucidates the relative contributions of the patient, disease, and surgeon- related factors in the prognosis of sepsis, sepsis source control failure and its mitigation in emergency colorectal surgery.

3. Decision-Making In Emergency Colorectal Surgery

Emergency presentations constitute about 20% of admissions for colorectal cancer with obstruction (80%) and perforation (20%) [3]. The majority of patients presenting as emergency tend to be elderly with worse performance status, tumours proximal to the splenic flexure with worse biology (T4), more metastases and, are less likely to have major curative resections. All these reflects the higher 90- day 8.9% mortality [16]. Bakker et al's national audit in the Netherlands demonstrated similar demography. Emergency surgery had the highest risks for postoperative death (8.5% emergency vs 3.4% elective), entailed older male patients with high comorbidity, advanced and perforated tumours and predominance of right- sided tumours [17]. The short-term prognosis of the emergency patient is mainly determined by deranged pre-operative physiology and co-morbidities. This is corroborated by a study which demonstrated that post-operative mortality in the emergency setting was not always the direct result of the surgical procedure but very often the direct result of pre-existing co-morbidity (patient factor) [18]. As 14% of all patients requiring emergency surgery undergo a laparoscopic procedure, a multicentre, randomised controlled trial (LaCeS2) compared the cost- effectiveness of laparoscopic and open colorectal surgery for patients with emergency colorectal problems. Clinical and health related quality of life were similar. The conversion rate to open was 39% and the 30 -day postoperative complication rate was 27% in the laparoscopic arm and 42% in the open arm. This acceptable safety profile of both approaches will influence the decision- making process in the management of colorectal disease [19].

Table 1: Mannheim Peritonitis Scoring system [9].

Risk factor	Score
Age > 50 years old	5
Female sex	5
Organ failure	7
Malignancy	4
Preoperative duration of peritonitis > 24 hours	4
Origin of sepsis not colonic	4
Diffuse generalized	6
peritonitis	
Exudate	
Clear	0
Cloudy or purulent	6
Faecal	12

Table 2: Factors influencing morbidity and mortality from intra-abdominal sepsis in colorectal surgery.

Patient-related factors
• Age
• Comorbidity
• Disease process
• Immune/organ response
• Patient's life style (smoking, alcohol abuse)
Perioperative (anaesthetic)
• Hypotension
• Hypoxia
• Hypothermia
Surgeon-related factors
• Decision-making
• Surgical procedure & technique

3.1. Colorectal Perforation

Decisions about surgery in the emergency setting is made on an individual basis. It may be difficult to reach the correct pre-operative diagnosis in many patients with colonic perforations. Patients often present with generalized peritonitis, and, although there may be clues in the history the definitive diagnosis is mostly established at laparotomy even following a contrast-enhanced CT scan in the haemodynamically stable patient. The most common operative finding in patients with a colonic perforation in the Western world is a perforated inflammatory mass in the sigmoid colon, but a strangulated sigmoid volvulus in Africa, S. America, Middle east and Eastern Europe which is resected with or without primary anastomosis [1-5, 9, 20-22]. In the former, the differentiation between diverticular disease and carcinoma may be difficult. Current opinion favours resection of the inflammatory phlegmon and its perforation, with or without primary anastomosis [5] In benign disease such as perforated diverticular disease the former policy of peritoneal drainage, construction of a proximal defunctioning stoma and subsequent colonic resection followed by closure of the stoma (3-stage procedure) carries a postoperative mortality of 30% [20]. The stoma does not protect against continued faecal contamination from the perforated segment. Thus, the importance of 'source control' of sepsis. As postoperative mortality from AL is high, anastomosis is avoided when the risks are high such as after emergency (l) sided colonic resection in the presence of major contamination and abscess formation. This is accentuated by the tenuous blood supply of the left colon. In these cases a Hartmann's procedure (resection of the rectal/distal colon lesion, over-sewing or exteriorization of the rectal stump, formation of a left iliac fossa colostomy with subsequent reversal (2-stage procedure) is the safest option. Gross faecal loading of the colon should be evacuated to avoid stercoral perforation and obstruction proximal to a stoma. [20, 23]. However, it brings its own peculiar set of problems. A left iliac fossa colostomy brought out under tension can result in complications as problematic as poor anastomosis. Early complications include stomal ischaemia and necrosis, retraction, infection, and dermatological issues while late complications can involve parastomal hernia, prolapse and stenosis. Breakdown of the suture line on the rectal stump can lead to significant peritonitis particularly if the intraperitoneal portion is long and packed with stool. The rectum should be routinely washed out per anum as a prophylactic measure to reduce the risk and, in case a cancer has been unknowingly resected may minimize intraluminal spread. Thus, the requirement of access to the rectum in emergency left-sided colonic procedures. Reversal of Hartmann's can be a difficult procedure with increased complications including anastomotic leakage. Thus 30–50% of Hartmann's procedures are never actually reversed [24, 25].

However, optimal perioperative anaesthetic care would avoid hypotension, hypoxia and hypothermia and allow primary resection and anastomosis (PRA) in the emergency setting and, promote anastomotic healing in the critical first 48 h after surgery (surgeon-related factor) [4]. A systematic review comparing outcomes following PRA and Hartmann's procedure in emergency surgery for acute diverticulitis demonstrated a mortality of 7.4% and 15.6% respectively and, these results have not improved over the intervening 25 years [24]. Although PRA during an emergency admission is increasingly being promoted, even in the presence of generalised or faecal peritonitis [25], it remains controversial and should be used selectively when circumstances are favourable. Patients with a toxic megacolon as a complication of inflammatory bowel disease (IBD) or infective colitis require a subtotal colectomy with preservation of the rectal stump and formation of a terminal ileostomy. This allows the option of construction of an ileorectal anastomosis or an ileo-anal pouch once the sepsis has resolved. However, light clothing, hot climate, high residue diet (vegetables), sepsis-induced high ileostomy output and poor availability of appliances all make the management of an ileostomy more difficult in the tropics [22], and so a primary ileorectal anastomosis is usually preferred unless the rectum is extensively diseased with stricture formation.

There is a wide heterogeneity in the presentation of perforated colorectal cancer. It may be contained perforation at the tumour site or proximal to the tumour or, with free perforation at tumour site, proximal to tumour in same segment or different segment e.g. caecum. These would require different treatment strategies [26]. However, perforation per se is not an independent predictor of poor outcome. The biology of the obstructing or perforating tumour is most important and, generalized peritonitis has poor short-term outcome. The decision- making which may be influenced by whether it is from a general surgeon or a colorectal surgeon and, the effect of anastomotic leak on local recurrence of tumour should be considered [27, 28]. In perforated CRC the short- term survival is determined by sepsis. Free perforation has a poor outcome. If early sepsis-related mortality is excluded overall cancer survival may be favourable. If sepsis is con-

trolled, radical resection and aggressive treatment may be warranted [29]. Therefore, management of sepsis with non-resection of primary tumour at first operation is the first priority, before returning later in a more stable patient for a definitive elective oncological resection. It can be difficult to carry out definitive oncological surgery at first operation. A defunctioning stoma, control of sepsis prior to definitive oncological surgery has a better overall outcome [27, 30, 31]. The principle is similar to damage control surgery in the setting of extensive abdominal injury in trauma & major sepsis surgery. Damage-control surgery +/- laparostomy because of bowel oedema entails acute resection of sepsis and stapling off the bowel ends, drainage, and delayed reconstruction at re-look laparotomy 48 h after correction of physiology (hypothermia- temp< 340C, acidosis- pH<7.2, coagulopathy- PT<16s). This vicious cycle (the lethal triad) from a prolonged operation is avoided [32]. Large bore drains are useful in sepsis following inadequate peritoneal lavage or residual sepsis, but should be placed in the appropriate dependent areas of the abdominal cavity such as the paracolic gutters, pelvis and subphrenic spaces away from the intestine.

3.2. Colorectal Obstruction

The main causes of large bowel obstruction (LBO) are malignancy and volvulus of the sigmoid colon. The sigmoid and recto-sigmoid junction are the commonest site of malignant LBO. Less common causes of LBO are diverticular disease, hernia, ischaemic and anastomotic stricture. Inflammatory bowel disease is a very unusual cause, but strictures from any cause may precipitate obstruction by proximal faecal impaction. Faecal impaction alone rarely causes obstruction. Left- sided lesions precipitate obstructive symptoms at an earlier stage because the content of the left colon is more solid than the right side. The consequences of colonic obstruction are progressive dehydration, electrolyte imbalance and systemic toxicity due to migration of toxins and bacteria translocation either through the intact but ischaemic bowel or through a perforation. Obstructing carcinoma of right colon is usually amenable to resection and primary anastomosis. The ileum has a good blood supply and there is rarely a need to dysfunction the bowel proximally. It is treated by right hemicolectomy and of splenic flexure by extended right hemicolectomy especially if there is doubt about the viability of the caecum. This provides a lympho-vascular clearance of the tumour and the obstructed right colon, and results in a well vascularised ileo-colonic anastomosis. The higher mortality in colonic obstruction reflects the features of closed loop obstruction. The features are right iliac fossa tenderness indicating caecal distension and imminent caecal perforation if the caecal diameter is |greater than 15cm as a result of the competent ileocaecal valve, or operative problems with the weight of the grossly distended fluid-filled small bowel from an incompetent ileocaecal valve. This provides a difficult right hemicolectomy which include decompressing small bowel, clearing the duodenum early, resecting the cancer and anastomosing if possible, and creating a protective loop ileostomy if anastomosis is futile. It is also important to assess the downstream colon prior to anastomosis [33]. In colorectal surgery adequate mobilization of the colon is essential so that there is redundant gut on at least one side of the anastomosis, so preventing tension at the suture line. For left-sided anastomosis, the tumour location and patient anatomy would play a major role in determining the surgeon's decision to mobilise the splenic flexure. Maintenance of gut perfusion is by preventing hypoxia and hypotension to which the large bowel is particularly sensitive. This is ensured by visible pulsation at the proximal anastomotic segment or visible bleeding at the cut ends. Indocyanine green (ICG) fluorescence imaging of the microcirculation of the anastomotic segments [34] is advocated. A short- coming of ICG is that although healthy, viable bowel ends are joined together, blood pressure may fall in the early postoperative period or the blood becomes haemoconcentrated because of inadequate fluid replacement leading to sludging in the peri-anastomotic arteries. The area of the bowel may infarct, over a number of days and finally perforate as a clinical anastomotic leak [4, 35]. Thus, the creation of a defunctioning loop ileostomy for high risk colorectal anastomosis [5, 36] is now routine in addition to active observation. In open colorectal surgery the interrupted serosubmucosal anastomosis is still the gold standard [37], and the majority of randomized prospective studies found no difference in leak rate between stapled and hand-sewn anastomosis but more stenosis in the former [5, 38]. With regard to inherent disease, Sun et al [39] had demonstrated an elevated anastomotic leak rate after elective colectomy for inflammatory bowel disease (IBD) and diverticulitis than for cancer. IBD patients have the highest risk and, were more likely to undergo non-operative interventional treatment than those with colon cancer and polyps. It is important to avoid bowel anastomosis in highly active antiretroviral therapy (HAART)- naïve human immunodeficiency virus/ acquired immune deficiency syndrome (HIV/AIDS) patients (patient/surgeon factors) [40]. Hartmann's procedure is appropriate for sigmoid and recto-sigmoid lesions, and rarely for obstructed rectal cancers. The potential for anastomotic failure following acute resection is completely avoided, and the operation is less complicated than a restorative resection which in addition requires taking down the splenic flexure. Primary left sided anastomosis on an unprepared obstructed colon is not generally regarded as appropriate, although some surgeons have achieved good results in selected cases. On-table lavage of the colon for an obstructing rectal lesion amenable to primary resection where preservation of colon above a low anastomosis is desired is safe and effective in experienced hands [41]. Occasionally a subtotal colectomy with ileocolic or ileorectal anastomosis is indicated if in the obstructed colon, the quality of the proximal bowel is poor with respect to anastomosis, because of oedema, faecal loading, shut down of the splanchnic blood supply, and an inconsistent marginal vessel. The anastomosis has a good blood supply from the ileum and proximal diversion is unnecessary. The clearance of any synchronous carcinoma and avoidance of surveillance colonoscopy are further advantages. However, a multicentre trial (The SCOTIA study

group) of lavage and anastomosis versus subtotal colectomy had a respectable leak rate of 5% with in-hospital mortality of 11%. Segmental resection of obstructed colon cancer provides better long- term results than subtotal colectomy [42, 43]. Even in the obstructed left colon cancer patient with caecal ischaemia or diastatic perforation colon-sparing strategy may still represent a valid and safe alternative to subtotal colectomy [31].

Colonic endoluminal stenting of malignant left-sided colonic obstruction as a bridge to surgery may provide the surgical advantages of a higher primary anastomosis rate, a lower anastomotic leak rate and, a lower overall stoma rate [44]. The disadvantages include the higher local tumour perforation rate predisposing local tumour recurrence and poor outcome, the less likely use in closed loop obstruction and cost-effectivity [45]. The simple decompressing transverse colostomy may still be effective in acting as a bridge to elective definitive oncological surgery in left-sided obstructive colon cancer. Veld et al demonstrated significantly fewer post-resection complications, lower 90-day mortality 1.7 vs 7.2%, more laparoscopic resections 56.8 vs 9.2%. more primary anastomoses and fewer permanent stomas [46]. A study by the same Dutch group comparing decompressing stomas with stents demonstrated more primary anastomoses (86% vs 75%), fewer postoperative complications with no difference in local recurrence (5.1% vs 15%) and, oncologically no difference in local recurrence, disease free survival and overall survival at 3 years [47]. This indicates the need for further randomized control trials on colonic stents. At present, international guidelines do not agree on the optimal management of malignant left-sided large bowel obstruction [48]. The treatment of distal colonic obstruction is individually tailored to each patient [5, 44] and, the empiric choice on the surgical technique is predominantly driven by patient and disease characteristics. Acute colonic pseudo-obstruction (Ogilvie syndrome) from colonic hypomotility occurs in critically ill or postoperative patients producing a massive but reversible dilatation of the colon. It may carry a mortality as high as 45% if not colonoscopically, or operatively decompressed following failure of conservative treatment or laparotomy not performed when clinical signs indicate caecal ischaemia or perforation [49]

Rectal cancer, although common rarely causes obstruction because of the rectal capacity and rectal bleeding and tenesmus heralds the diagnosis. The infrequent completely obstructing or perforated rectal cancer requires proximal defunctioning, draining the sepsis, staging the tumour and referral to the medical oncologist for chemoradiotherapy prior to an elective (planned) oncological anterior or abdomino-perineal (AP) resection [5, 43].

4. Conclusion

The patient and disease factors have the greatest impact on the prognosis of sepsis in emergency colorectal surgery but, the surgeon factor (decision-making and surgical technique) can influence the morbidity and mortality.

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