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ORIGINAL ARTICLE

Postoperative outcomes and identification of risk factors for complications after emergency intestinal stoma surgery – a multicentre retrospective study

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Abstract

Aim: Approximately 4000 patients in the UK have an emergency intestinal stoma formed each year. Stoma-related complications (SRCs) are heterogeneous but have previously been subcategorized into early or late SRCs, with early SRCs generally occurring within 30 days postoperatively. Early SRCs include skin excoriation, stoma necrosis and high output, while late SRCs include parastomal hernia, retraction and prolapse. There is a paucity of research on specific risk factors within the emergency cohort for development of SRCs. This paper aims to describe the incidence of SRCs after emergency intestinal surgery and to identify potential risk factors for SRCs within this cohort.

Method: Consecutive patients undergoing emergency formation of an intestinal stoma (colostomy, ileostomy or jejunostomy) were identified prospectively from across three acute hospital sites over a 3-year period from the ELLSA (Emergency Laparotomy and Laparoscopic Scottish Audit) database. All patients were followed up for a minimum of 1 year. A multivariate logistic regression model was used to identify risk factors for early and late SRCs.

Results: A total of 455 patients were included (median follow-up 19 months, median age 64 years, male:female 0.52, 56.7% ileostomies). Early SRCs were experienced by 54.1% of patients, while 51% experienced late SRCs. A total of 219 patients (48.1%) had their stoma sited preoperatively. Risk factors for early SRCs included end ileostomy formation [OR 3.51 (2.24–5.49), $p < 0.001$], while preoperative stoma siting was found to be protective [OR 0.53 (0.35–0.83), $p = 0.005$]. Patient obesity [OR 3.11 (1.92–5.03), $p < 0.001$] and reoperation for complications following elective surgery [OR 4.18 (2.01–8.69), $p < 0.001$] were risk factors for late SRCs.

Conclusion: Stoma-related complications after emergency surgery are common. Preoperative stoma siting is the only truly modifiable risk factor to reduce SRCs, and further research should be aimed at methods of improving the frequency and accuracy of this in the emergency setting.

KEYWORDS
complications, emergency, laparotomy, stoma, stoma siting

INTRODUCTION

The formation of an intestinal stoma is often a life-changing event for a patient and can result in a variety of complications. These complications have previously been subcategorized into early or late stoma-related complications (SRCs) [1, 2]. Early SRCs, which tend to occur in the first 30 postoperative days, include peristomal skin excoriation, mucocutaneous separation, high stoma output, peristomal infections and ischaemia or necrosis. Late SRCs, those which occur at any stage after the initial 30 days [3], include parastomal hernia, prolapse, retraction, stenosis and leakage of effluent.

Risk factors have been identified for the development of SRCs in the elective setting. These include modifiable risk factors such as obesity [4, 5], smoking [6] and lack of preoperative stoma siting [7], as well as nonmodifiable risk factors such as the type of stoma [8, 9], male sex [10], comorbidities such as diabetes [11] and stoma formation in an emergency setting [6, 12, 13].

Although stoma formation in the emergency setting has been identified as being implicated in SRCs, identification of specific risk factors within this cohort has been lacking. Furthermore, most evidence from the emergency setting to date reports on short-term postoperative SRCs [1, 3, 14], which may underestimate their prevalence. It is evident that those undergoing emergency stoma surgery are often a completely distinct cohort from those operated on under elective conditions [13, 15].

An estimated 4000 people in the UK have a stoma formed as an emergency each year [13, 16]. Only between 33% and 50% of these patients eventually undergo surgery to restore intestinal continuity [17–19], therefore the consequences of SRCs have potentially huge implications for patients and health-care systems alike. Those who suffer from SRCs are more likely to be readmitted to hospital and may require reoperation [6, 20], both of which bring financial implications for health-care institutions [21] as well as possible psychological distress for patients themselves [22]. Therefore, identifying potential risk factors for SRCs in patients undergoing emergency stoma surgery should be a priority for health-care providers.

This study aims to describe the long-term outcomes of emergency stoma formation, and to describe the prevalence of SRCs and their risk factors in a cohort of patients undergoing emergency stoma surgery, to minimize these in future.

What does this paper add to the literature?

This is one of the largest cohorts to describe short- and long-term complications after emergency intestinal stoma surgery, and one of the few to identify specific risk factors for stoma-related complications within this group. This research emphasizes the vital importance of preoperative stoma siting for reducing complications in the emergency setting.

METHOD

All consecutive patients aged 18 years old and above undergoing emergency laparotomy or laparoscopic surgery (EmLap) were identified retrospectively across three acute hospital sites in a single health board between January 2019 and January 2022. These sites included one teaching hospital and two district general hospitals, all providing acute general surgery care. Patients were identified from the prospectively managed ELLSA (Emergency Laparotomy and Laparoscopic Scottish Audit [23]) database which included patients according to National Emergency Laparotomy Audit (NELA) criteria [24] (Appendix S1). ELLSA is a Scottish Government initiative supported by the Modernising Patient Pathways Programme.

Additional criteria for inclusion were the formation of an intestinal stoma (colostomy, ileostomy or jejunostomy) via an open procedure as an independent procedure or as part of another procedure and patients undergoing emergency refashioning of a preexisting intestinal stoma, if a midline laparotomy was performed [25]. Nephrostomy, ileal conduit, gastrostomy or any stoma formed purely for the purpose of feeding were excluded. Laparoscopic formation of an intestinal stoma as a primary procedure was also excluded as it did not satisfy the NELA criteria.

Data collection

Data collected from patients' records included patient demographic and surgical information. Demographic factors were age, sex, deprivation (as measured by Scottish Index of Multiple Deprivation 2020 SIMD decile [26]), Rockwood Clinical Frailty Scale if over 65 years old [27] and comorbidities [smoking status, American Society of Anesthesiologists (ASA) physical status, body mass index (BMI), current immunosuppression, diabetes or cardiovascular disease]. Surgical factors were type of stoma, preoperative stoma siting, presence of malignancy, reoperation for complications following elective surgery and timing [out of hours (OOH), defined as operations taking place at weekends, bank holidays or between 6 p.m. and 8 a.m. on weekdays [28]]. Two dependent variables were recorded: presence of early SRCs and presence of late SRCs. The 30-day mortality rate and mortality by time of follow-up were also recorded.

Follow-up

All patients were followed up from the date of their operation until data collection in January 2023, with each patient receiving a minimum of 1 year of follow-up after their index operation. Any patient who was lost to follow-up was excluded, except those patients who died. Patients were followed up by stoma care practitioners as required depending on clinical progress as an in-patient, and

subsequently with a telephone call within 1 week of discharge and plans for a face-to-face appointment within 4 weeks of discharge. Patients were then seen back at a stoma-practitioner clinic at 6 weeks, 3 months, 6 months and then yearly for 2–3 years. Patients had unrestricted access to contact the stoma practitioners for earlier review over this period and had standard surgical follow-up based on consultant preference, which was dependent on their pathology and clinical progress.

Definition of complications

Stoma-related complications were assessed prospectively by stoma care practitioners and defined according to previously published literature [29, 30]. Peristomal moisture associated skin damage (PMASD) was included if it was significant enough to require alterations to the stoma appliance [29]. High-output stoma was defined as a stoma producing more than 1.5 L of effluent in a 24-h period [31]. Mucocutaneous separation was assessed subjectively by stoma care practitioners with no distinct definition. Stoma leakage was defined as stoma effluent exuding outside the appliance and significantly soiling clothing or bedding, with management requiring alterations to the appliance [32]. A parastomal hernia was defined as a clinically or radiologically detectable bulge adjacent to the stoma site and was included if symptomatic or asymptomatic [33]. Retraction was defined as the stoma aperture being 5 mm or more below the surface of the skin [29].

Ethical approval

Formal ethical approval for this project was not required as it involved analysis of precollected anonymized data. The data collection for ELLSA data is covered by preexisting Caldicott approval.

Statistical analysis

Normally distributed data are reported as mean (standard deviation), with median and interquartile range (IQR) used when not normally distributed. Student's *t*-test is used to compare means of normally distributed data. The chi-square test was used to compare categorical variables. A *p*-value of ≤0.05 was considered to be statistically significant. The 95% confidence intervals are reported where available. Statistical analysis was performed on SPSS (Statistical Package for Social Sciences, version 28, IBM).

In order to create an appropriate regression model, the above 15 independent explanatory variables were determined a priori based on previous research and consensus as potentially being associated with stoma-related outcomes [1, 11, 29, 30, 34, 35]. Univariate logistic regression analyses were performed with variables to determine significant associations with the two dependent outcome variables (presence of early SRCs and presence of late SRCs). Any relationship with a *p*-value <0.05 for prediction of the dependent outcome in binomial regression analysis was included in the multivariate regression analysis for each dependent outcome variable.

This paper is reported in accordance with STROBE guidelines with attached completed checklist.

RESULTS

A total of $n=1676$ patients underwent EmLap across the three sites in the 3-year study period; 28.9% ($n=484$) of these patients underwent emergency stoma surgery. Of these 484, 6% ($n=29$) were lost to follow-up, yielding $n=455$ patients for analysis.

Patient demographics

Details of baseline patient demographics can be seen in Table 1. Patients had a median age of 64 years (IQR 21, range 18–92 years) and 52% were male. Levels of socio-economic deprivation in this cohort were high, with 34.7% of patients being from the two most deprived SIMD deciles. Current smokers comprised 34.7% of patients and 75% had an ASA grade ≥3. Twenty-four per cent of patients were obese (BMI > 30 kg/m^2) and 18% were classified as frail (i.e. Rockwood clinical frailty scale ≥5), in keeping with expected data for EmLap patients [36].

Most patients underwent surgery for complicated diverticulitis, and a total of 164 patients (36%) had a Hartmann's procedure performed (i.e. a sigmoid colectomy with end colostomy) (Table 2, Appendix S2). A diagnosis of malignancy that was directly implicated in the reason for their surgery (82% colorectal cancer, 12% peritoneal malignancy and 6% other malignancies) was present in 105 patients; 14 other patients had an active cancer diagnosis currently being treated but not related to their operation. In total, 73 patients (16%) had a diagnosis of inflammatory bowel disease, with an approximate 50% split between ulcerative colitis and Crohn's disease.

Of the 455 emergency stoma patients, 258 (56.7%) had an ileostomy formed while 189 (41.5%) had a colostomy. The remaining eight patients had a jejunostomy (Table 2).

Patients had a median postoperative length of stay of 17 days (IQR 12 days, maximum 203 days) and were followed up for a median of 19 months postoperatively (IQR 11 months), with each patient receiving a minimum of 12 months' follow-up as outlined in the methodology.

Prevalence of SRCs

A summary of SRCs for this cohort can be seen in Table 3. In total, over 75% of patients experienced SRCs, with 54.1% of patients experiencing early SRCs and 51% late SRCs. The most common early SRC was PMASD and the most prevalent late complication was the presence of a parastomal hernia. There was no statistically

TABLE 1 Details of baseline patient demographics.

Demographic	
Age (years), median (IQR)	64 (21)
<65	229 (50.3%)
65–74	125 (27.5%)
≥75	101 (22.2%)
Male	235 (51.6%)
SIMD	
1 (most deprived quintile)	158 (34.7%)
2	68 (14.9%)
3	75 (16.5%)
4	62 (14.3%)
5 (least deprived quintile)	81 (17.8%)
Past medical history	
Cardiovascular disease	197 (43.3%)
Diabetes	70 (15.4%)
Immunosuppression	114 (25.1%)
Smoker	158 (34.7%)
ASA grade	
1	2 (0.4%)
2	112 (24.6%)
3	195 (42.9%)
4	129 (28.4%)
5	17 (3.7%)
BMI (kg/m^2), median (IQR)	24.9 (8)
Obese	108 (23.7%)
Rockwood Clinical Frailty Scale	
1–3 (not frail)	279 (61.3%)
Frailty score 4 (at risk of frailty)	94 (20.7%)
Frailty score 5–9 (frail)	82 (18.0%)
Operative factors	
Malignancy	119 (26.1%)
Complication from elective surgery	51 (11.2%)
Timing (OOH)	194 (42.6%)
Marked preoperatively	219 (48.1%)
Types of stoma	
Ileostomy	258 (56.9%)
	(220 end, 38 loop)
Colostomy	189 (41.5%)
	(176 end, 13 loop)
Jejunostomy	8 (1.8%)
	(6 end, 2 loop)

Note: values are given as *n* (%) unless otherwise stated.

Abbreviations: ASA, American Society of Anesthesiologists; BMI, body mass index; IQR, interquartile range; OOH, out of hours; SIMD, Scottish Index of Multiple Deprivation.

significant difference in incidence of SRCs between different hospital sites ($p=0.553$). A consultant surgeon was the primary operator in 71.4% of cases and there was no difference in early (57.2% vs. 53.8%, $p=0.511$) or late (51.6% vs. 48.5%, $p=0.533$) SRC incidence between consultant and nonconsultant primary operator.

Exploration of risk factors for SRCs

Table 4 gives the prevalence of stoma siting and baseline demographics for this cohort. A total of 219 patients had their stoma sited preoperatively (48.1%), with most of these patients being sited by a stoma nurse specialist (86.8%). Patients who had their stoma sited preoperatively were most likely to be immunosuppressed (31.1% vs. 19.5%, $p=0.004$), were more likely to have an underlying diagnosis of malignancy (30.6% vs. 22%, $p=0.038$) and were less likely to be smokers (29.7% vs. 39.4%, $p=0.029$). These patients were also less likely to be operated on OOH (25.1% vs. 58.9%, $p<0.001$), but there was no difference in ASA score between these groups (ASA ≥3 72.1% vs. 77.5%, $p=0.221$). Table 5 shows the impact of stoma siting on individual complication rates. Those who had their stoma sited had reduced rates of early SRCs (48.4% vs. 59.3%, $p=0.019$), which can be accounted for by lower rates of PMASD (32% vs. 45%, $p=0.004$), stoma ischaemia/necrosis (2.3% v 7.2%, $p=0.014$) and mucocutaneous separation (3.2% vs. 8.1%, $p=0.026$). There was no statistically significant difference in late SRCs between those who were sited and those who were not (47.5% vs. 54.2%, $p=0.15$).

Postoperative outcomes

The 30-day mortality rate was 9.7%, which is comparable to rates reported by other sources for patients undergoing EmLap (9.2% NELA [24], 9% ELLSA [23]). Ninety-day and 1-year mortality rates were 13% and 19.1%, respectively. Almost one in four patients had died by time of end of follow-up (24.8% at median 19 months follow-up), and it could be suggested that 3.5% of patients underwent 'futile surgery' (i.e. mortality <72 h after their operation [37]).

In total, 157 patients (34.5%) experienced significant morbidity within 30 days postoperatively (i.e. Clavien–Dindo score ≥3 and therefore requiring re-intervention, resulting in organ dysfunction or death [38]). Grade IIIa complications (requiring intervention under local anaesthesia/radiology) were experienced by 8.6% of patients, 10.3% experienced IIIb complications (reintervention required under general anaesthetic) and 5.9% experienced grade IV complications (causing end organ dysfunction).

By the end of follow-up, 34 patients (7.5%) had undergone surgical reoperation specifically due to SRCs (indication: stoma retraction $n=9$, parastomal hernia $n=8$, obstruction at level of stoma $n=6$, stenosis $n=4$, prolapse $n=4$, abscess/collection at stoma $n=3$).

Risk factors for long-term outcomes

The results from the multivariate logistic regression analysis for the two previously described dependent outcomes can be seen in

TABLE 2 Underlying aetiology for emergency stoma surgery and the type of stoma formed.

Aetiology for emergency stoma formation	Total	Colostomy		Ileostomy		Jejunostomy
		End (*N* = 176)	Loop (*N* = 13)	End (*N* = 220)	Loop (*N* = 38)	(*N* = 8)
Diverticular disease	118 (25.9%)	102	2	11	3	0
Cancer	105 (23.1%)	32	6	50	17	0
Crohn's	37 (8.1%)	1	0	32	1	3
Ulcerative colitis	36 (7.9%)	1	0	35	0	0
Hernia	29 (6.4%)	5	0	20	3	1
Ischaemia	24 (5.3%)	2	2	17	1	2
Iatrogenic	19 (4.2%)	6	1	8	3	1
Stercoral	15 (3.3%)	15	0	0	0	0
Adhesions	13 (2.9%)	1	1	9	1	1
Others	59 (14.5%)	11	1	38	9	0

TABLE 3 Prevalence of stoma-related complications.

Early (54.1%)	*n* (%)	Late (51%)	*n* (%)
PMASD	176 (38.7)	Parastomal hernia	83 (18.2)
High-output	94 (20.7)	Leakage	72 (15.8)
Separation	26 (5.7)	Retraction	64 (14.1)
Necrosis/ischaemia	22 (4.8)	Prolapse	29 (6.4)
Infection	14 (3.1)	Granuloma	14 (3.1)
		Stenosis	11 (2.4)

Abbreviation: PMASD, peri-stomal moisture associated skin damage.

TABLE 4 Stoma siting demographics.

	Stoma sited preoperatively	Stoma not sited preoperatively	*p*-value
Total	219 (48.1%)	236 (51.9%)	
Age (years)	63	66	0.253(a)
Sex	Male 47.5%	Male 55.1%	0.105(b)
Immunosuppressed	68 (31.1%)	46 (19.5%)	**0.004(b)**
CVD	86 (39.3%)	111 (47.0%)	0.108(b)
Diabetes	36 (16.4%)	34 (14.4%)	0.604(b)
Smoker	65 (29.7%)	93 (39.4%)	**0.029(b)**
ASA grade ≥3	158 (72.1%)	183 (77.5%)	0.229(b)
Body mass index (kg/m^2)	24.0	25.6	0.409(a)
Obese	45 (20.5%)	63 (26.7%)	0.124(b)
Malignancy	67 (30.6%)	52 (22.0%)	**0.038(b)**
Complication from elective surgery	23 (10.5%)	28 (11.9%)	0.645(b)
Timing (OOH)	55 (25.1%)	139 (58.9%)	**<0.001(b)**
Frail	34 (15.5%)	48 (20.3%)	0.181(b)
Stoma-type	101 (end ileostomy most prevalent) (46.1%)	119 (end ileostomy most prevalent) (50.4%)	0.331(b)

Note: Statistical test used: (a) Mann–Whitney *U*-test; (b) Pearson chi-square test. Significant associations ($p < 0.05$) highlighted in bold.

Abbreviations: ASA, American Society of Anesthesiologists; CVD, cardiovascular disease; OOH, out of hours; SIMD, Scottish Index of Multiple Deprivation.

TABLE 5 Stoma siting and incidence of complications.

	Stoma sited preoperatively	Stoma not sited preoperatively	*p*-value
Total	219 (48.1%)	236 (51.9%)	
Early SRCs	106 (48.4%)	140 (59.3%)	**0.019**
PMASD	70 (32.0%)	106(44.9%)	**0.004**
High-output	45 (20.5%)	49 (20.8%)	0.954
Ischaemia/necrosis	5 (2.3%)	17 (7.2%)	**0.014**
Separation	7 (3.2%)	19 (8.1%)	**0.026**
Late SRCS	104 (47.5%)	128 (54.2%)	0.150
Hernia	43 (19.6%)	40 (16.9%)	0.459
Retraction	30 (13.7%)	34 (14.4%)	0.828
Prolapse	17 (7.8%)	12 (5.1%)	0.243
Stenosis	5 (2.3%)	6 (2.5%)	0.857

Abbreviations: PMASD, Peristomal moisture associated skin damage; SRC, stoma-related complication. Values in bold indicate significance level of p<0.05.

Values in bold indicate significance level of $p < 0.05$.

Figures 1A and B. Two risk factors and one protective factor were identified for the development of early SRCs. The type of stoma created was a significant risk factor, with end ileostomies [OR 3.51 (2.24–5.49, $p<0.001$)] and loop ileostomies [OR 3.15 (1.44–6.86), $p<0.001$] being independently associated with early SRCs. Deprivation was also found to be independently associated with an increased risk of early complications, with the early SRC rate increasing by 20% for every decile of deprivation as measured on the SIMD scale [OR 1.20 (1.05–1.23), $p=0.002$]. Stoma siting was found to be a protective factor against the development of early SRCs, and those who had their stoma sited preoperatively had an almost 50% smaller chance of developing early SRCs [OR 0.53 (0.35–0.83), $p=0.005$]. Immunosuppression was found to be a risk factor on univariate regression, but not when the multivariate regression model was created ($p=0.003$ and $p=0.086$, respectively). OOH surgery was not found to be a significant risk factor in the univariate regression model and was therefore not carried over to the multivariate model [OR 0.88 (0.61–1.29), $p=0.511$].

Two risk factors were identified for the development of late stoma complications: patient obesity, and those operated on for complications following elective surgery. Those who were obese had over threefold higher odds of late SRCs [OR 3.11 (1.92–5.03), $p<0.001$] compared with those who were not, and patients undergoing emergency surgery for complications following elective complications had an even greater likelihood of developing late SRCs [OR 4.18 (2.01–8.69), $p<0.001$]. Most patients who had an emergency stoma formed as part of an elective complication had suffered from an anastomotic leak after surgery for rectal cancer or inflammatory bowel disease (57.7% of elective complication cohort).

DISCUSSION

This work includes one of the largest cohorts reporting long-term outcomes after emergency stoma surgery available in the literature, and one of the few to identify specific risk factors for SRCs within the emergency cohort. We have demonstrated that preoperative stoma siting reduces early stoma complications by almost 50%, independent of ASA grade or timing of surgery. However, increasing socio-economic deprivation and ileostomy formation were found to increase the risk of early SRCs. Patient obesity, and those operated on for complications after elective surgery were demonstrated to increase the odds of late stoma complications (such as parastomal hernia, stoma retraction and stoma leakage) by over three-fold.

Previous work has repeatedly demonstrated that emergency surgery is a risk factor for complications across multiple surgical specialities, but particularly in abdominal surgery [12, 13, 39]. This holds true in those undergoing emergency stoma surgery, where a recent meta-analysis has estimated the risk of short-term complications at 52.1% (95% CI 47%–63%) [6], but with a large heterogeneity of incidence reported between studies. It has been proposed that rates of complications are higher in the emergency cohort due to a combination of patient factors (e.g. critical illness, patient obesity and coagulopathy [4, 40]), operative factors (i.e. OOH operating, peritonitis, contamination and thickened mesentery [8, 12]) and surgeon factors (i.e. noncolorectal surgeons operating outside their usual speciality [13]). The collection of data from consecutive patients across several acute hospital sites providing emergency general surgery care means that the risk factors identified within this research can be extrapolated to any centre providing a similar service.

Preoperative stoma siting in the elective setting has become the gold standard of care, along with close counselling by stoma practitioners and surgeons about the future implications of living with a stoma. In the elective setting, this has been shown to reduce the rate of complications [10, 35] and improve patients' quality of life [11, 15]. Due to the time constraints involved with emergency patients such prolonged counselling may not be

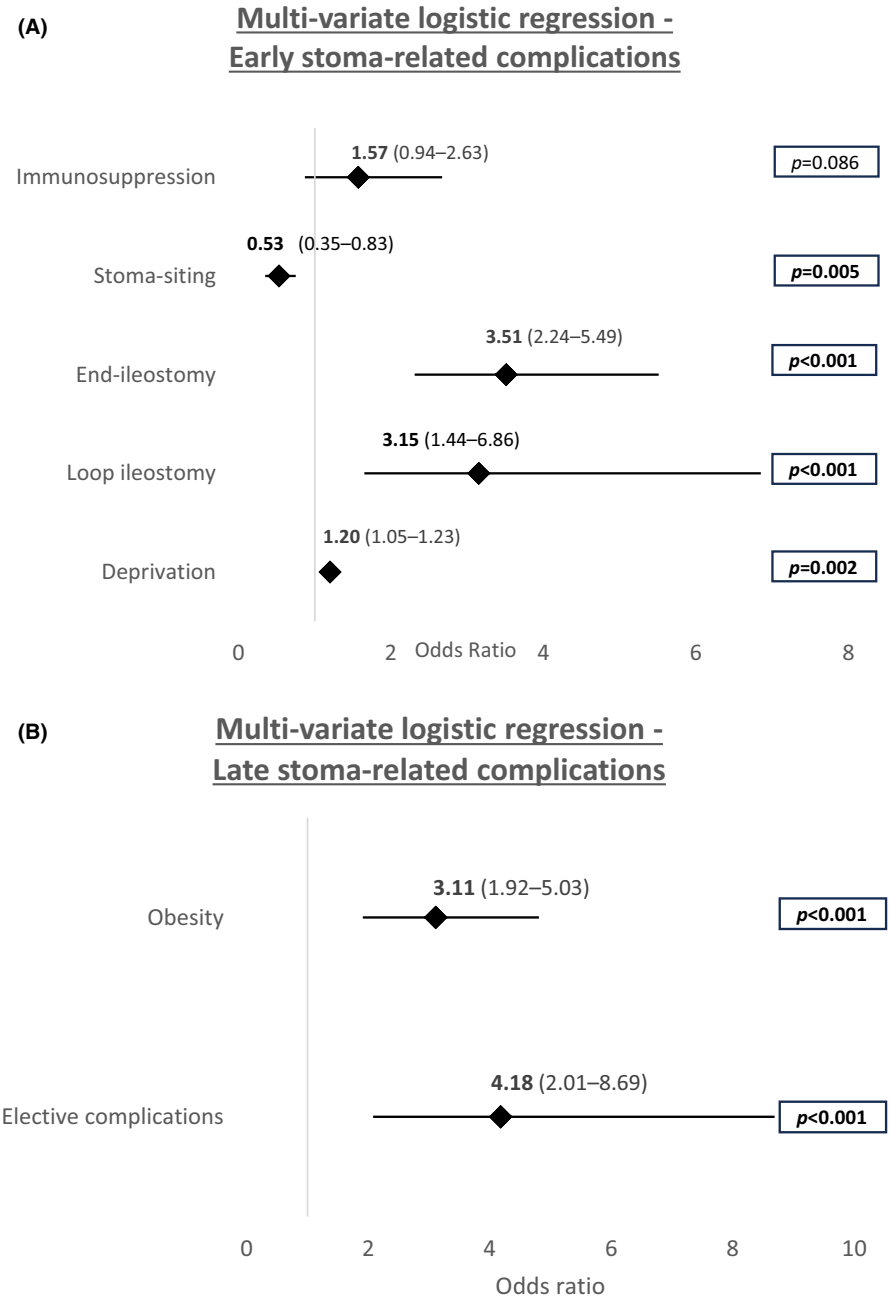

FIGURE 1 (A) Risk factors for early stoma-related complications. (B) Risk factors for late stoma-related complications.

feasible, but we propose that stoma siting should be occurring much more frequently in the emergency setting. We have demonstrated that around half of the patients in this cohort had their stoma sited preoperatively, and those who did had a substantially lower rate of early stoma complications. This is hypothesized to be because appropriate stoma siting is likely to avoid abdominal folds and creases, and therefore reduce the risk of PMASD [4, 41]. Mutually agreed site marking between patient and stoma practitioner allows the patient to confirm visualization of site which will, in turn, increase the efficacy of postoperative stoma care and reduce SRCs. Also, appropriate stoma siting often leads to the stoma being placed more cranially on the abdominal wall, which may reduce stoma tension, leading to a reduced incidence of stoma ischaemia or necrosis [42]. This is one of the only truly modifiable risk-factors identified within this research, so focusing on how this can be improved must be a research priority.

In this cohort, patients were more likely to have their stoma sited preoperatively if their operation took place during normal working hours (74.9% vs. 41.1%, $p < 0.001$). This is presumed to be due to the increased presence of stoma nurse practitioners during working hours, demonstrated by the fact that most patients had their stoma sited by a stoma nurse practitioner (86.8%). Nonetheless, consideration must be given to the fact that stoma siting may be a surrogate marker for patients who are less unwell and have more time to have their stoma appropriately sited during working hours. However, we have demonstrated that there is no difference in patients with ASA ≥ 3 between these groups, and therefore assessed to be more acutely unwell and comorbid.

Furthermore, timing of operation and ASA status were not predictive factors for early or late SRCs in the regression model, so we feel confident that this a truly representative relationship with stoma-siting. Patients who were classified as immunosuppressed were more likely to have their stoma-sited preoperatively, which we hypothesize is accounted for by the high prevalence of patients with medically refractory ulcerative colitis within this cohort who are more likely to be seen by a stoma nurse practitioner preoperatively.

In a West of Scotland cohort, it has been shown that fewer than 10% of surgical trainees had formal undergraduate stoma training and two in three had no postgraduate training in stoma siting [42]. Therefore, ensuring adequate training and education of the responsible operator, including consultant surgeons, to perform this in EmLap cases should be a research priority for the future. Over 95% of the EmLap cohort have a preoperative CT scan [24], therefore the potential exists to utilize imaging to guide optimum preoperative stoma siting [43]. This is particularly important in the obese population and those with a pendulous abdominal apron, where stoma siting can be challenging, particularly if the patient cannot sit up. One particular radiological method, involving measurement of the distance between the origin of the superior mesenteric artery and the skin, demonstrated that stomas sited in the upper abdomen may be of increased benefit in this population due to the thinner abdominal wall [43]. However, utilization of radiological methods for stoma siting in the emergency cohort needs further validation. Furthermore, given the findings in this study emphasizing the importance of preoperative stoma siting in the emergency setting, the authors feel that a collaborative approach is required, potentially involving surgical associations, to optimize trainee and consultant education as well as to explore novel stoma siting methods; this is a vital focus for future research.

Increasing socio-economic deprivation was associated with an increased risk of early SRCs within this cohort. The underlying reasons behind this are clearly multifactorial but potentially remarkably interesting, and certainly worth exploring in more depth. In the elective setting, socio-economic deprivation has been associated with an increased risk of complications and has been shown to be associated with an increased risk of 30-day mortality in those undergoing emergency laparotomy in the NELA population [44–46]. Levels of socio-economic deprivation were high in the cohort of patients included in this study. The association of deprivation with early SRCs, such as PMASD, could be a result of reduced stoma self-care and under-recognition of early SRCs, which has been suggested in previous literature [3, 47].

Some of the limitations of this research include the potential for reporting bias for SRCs, as those who site stomas preoperatively may not report complications as frequently. Another possible limitation is the timeframe in which this research was performed. This was mostly during the COVID-19 pandemic, which meant that a lot of the specialist nurses involved in data collection for these patients may have been redeployed to different roles and this may have led to temporary changes in surgical practice during this period. Further, contemporaneous analysis of this database is required to determine whether this was a significant factor for patient outcomes. Another potential limitation of these data is the inclusion of patients having a refashioning of their existing stoma, as these patients may have increased risk of SRCs due to the repeated procedures on the abdominal wall. The authors felt it was vital to include these patients in this cohort, as it provides a real-life representation of all patients undergoing emergency stoma surgery as outlined by NELA criteria [25]. Furthermore, it could be argued that preoperative stoma siting is potentially even more significant for this cohort of patients than for those having an index stoma created. Finally, patients undergoing a laparoscopic defunctioning stoma as an independent procedure were not included in this dataset as they do not satisfy the NELA criteria. This is probably because they are often not truly 'emergency' patients and are often operated on in a semi-elective setting a few days after admission, so their demographics may be quite different from the included patients. However, further work to investigate the differences between these groups, and to determine if there are any further risk factors to be identified within this cohort, would be of benefit.

CONCLUSION

Stoma-related complications after emergency stoma surgery are very common, with three in four patients experiencing these. Preoperative stoma siting can reduce the odds of early SRCs by half, and this must be done more routinely in the emergency setting. Fewer than 50% of emergency stoma patients have their stoma sited preoperatively, and therefore further education and training of surgeons to perform this routinely, particularly OOH when stoma practitioners are unlikely to be available, is a priority. Further research to assess the impact of SRCs on patients' quality of life is required.

AUTHOR CONTRIBUTIONS

Scott MacDonald: Conceptualization; investigation; writing – original draft; methodology; writing – review and editing; project administration; data curation. **Li-Siang Wong:** Writing – review and editing; data curation. **Hwei Jene Ng:** Data curation; writing – review and editing. **Claire Hastings:** Conceptualization; writing – review and editing; data curation; resources. **Immogen Ross:** Resources; data curation; writing – review and editing; conceptualization. **Tara Quasim:** Conceptualization; writing – review and editing; visualization; supervision. **Susan Moug:** Supervision; writing – review and editing; visualization; conceptualization.

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CONFLICT OF INTEREST STATEMENT

The authors have no formal conflict of interest to declare.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ETHICS STATEMENT

Formal ethical approval was not required for this retrospective cohort study.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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