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Friedrich Herbst, Vienna, AUT;
Amjad Parvaiz, Portsmouth, UK

Video Session

Lars Pahlmann Lecture
Markus Büchler, Lisboa, PRT

Honorary Lecture
Bill Heald, Lisboa, PRT

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Received: 20 May 2023 | Revised: 3 August 2023 | Accepted: 4 August 2023

DOI: 10.1111/codi.16737

ORIGINAL ARTICLE

Safety and efficacy of intraperitoneal drain placement after emergency colorectal surgery: An international, prospective cohort study

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Abstract

Aim: Intraperitoneal drains are often placed during emergency colorectal surgery. However, there is a lack of evidence supporting their use. This study aimed to describe the efficacy and safety of intraperitoneal drain placement after emergency colorectal surgery.

Method: COMPlicAted intra-abdominal collectionS after colorectal Surgery (COMPASS) is a prospective, international, cohort study into which consecutive adult patients undergoing emergency colorectal surgery were enrolled (from 3 February 2020 to 8 March 2020). The primary outcome was the rate of intraperitoneal drain placement. Secondary outcomes included rate and time-to-diagnosis of postoperative intraperitoneal collections, rate of surgical site infections (SSIs), time to discharge and 30-day major postoperative complications (Clavien–Dindo III–V). Multivariable logistic and Cox proportional hazards regressions were used to estimate the independent association of the outcomes with drain placement.

Results: Some 725 patients (median age 68.0 years; 349 [48.1%] women) from 22 countries were included. The drain insertion rate was 53.7% (389 patients). Following multivariable adjustment, drains were not significantly associated with reduced rates (odds ratio [OR] = 1.56, 95% CI: 0.48–5.02, $p = 0.457$) or earlier detection (hazard ratio [HR] = 1.07, 95% CI: 0.61–1.90, $p = 0.805$) of collections. Drains were not significantly associated with worse major postoperative complications (OR = 1.26, 95% CI: 0.67–2.36, $p = 0.478$), delayed hospital discharge (HR = 1.11, 95% CI: 0.91–1.36, $p = 0.303$) or increased risk of SSIs (OR = 1.61, 95% CI: 0.87–2.99, $p = 0.128$).

Conclusion: This is the first study investigating placement of intraperitoneal drains following emergency colorectal surgery. The safety and clinical benefit of drains remain uncertain. Equipoise exists for randomized trials to define the safety and efficacy of drains in emergency colorectal surgery.

KEYWORDS
drain, emergency colorectal surgery, postoperative outcomes

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INTRODUCTION

Intraperitoneal drains are placed after emergency colorectal surgery on the assumption that they will create a path of least resistance for the evacuation of serum, blood, pus and/or faeces [1, 2]. Drains might also be placed to act as indicators of postoperative intraperitoneal events, such as haemorrhage or anastomotic leak [3].

Recent evidence demonstrated no diagnostic and/or therapeutic benefit associated with drain placement after elective colorectal surgery [4–8]. Our most recent analysis of the COMPlicAted intra-abdominal collectionS after colorectal Surgery (COMPASS) dataset strengthened the evidence for lack of clinical benefit from drain placement after elective colorectal surgery by showing that rather than being of clinical benefit, drain placement was associated with prolonged hospital stay and increased surgical site infection (SSI) risk [9]. However, it remains unclear whether these findings can be extrapolated to the emergency setting because of the absence of literature investigating clinical outcomes associated with drain placement after emergency colorectal surgery.

Given the paucity of evidence, this analysis of the COMPASS study aimed to describe the use of intraperitoneal drains in emergency colorectal surgery, and their safety and efficacy.

What does this paper add to the literature?

This is the first study to describe intraperitoneal drain placement after emergency colorectal surgery. The safety and clinical benefit of drains remain uncertain. These results warrant a randomized control trial to define the efficacy of drains after emergency colorectal surgery.

METHODS

Study design

COMPASS is a prospective, multicentre, cohort study in which international variation in intraperitoneal drain placement after colorectal surgery, as well as its safety and efficacy, are described. An international study management group, with input from patient representatives, developed the protocol (Appendix S1) [10]. This analysis was performed according to STrengthening the Reporting of OBservational studies in Epidemiology (STROBE) reporting guidelines for observational studies [11].

The COMPASS study was delivered by a student- and trainee-led collaborative group [12]. All hospitals routinely performing colorectal surgery in Europe, Australasia and South Africa could enrol in the study. Routine, anonymized data were collected with no change to clinical care pathways. Prior to data collection, confirmation of appropriate local and/or national regulatory approval, according to country-specific regulations, was required. Of the original five, 14-day predefined data-collection periods, only the first two (3 February 2020 to 17 February 2020 and 23 February 2020 to 8 March 2020) were completed; the latter three were cancelled because of the COVID-19 pandemic [13]. To determine the accuracy and completeness of data, an independent validation exercise was preplanned. Data accuracy was determined by assessing the information supplied for 10 planned data points (age, sex, American Society of Anesthesiologists [ASA] classification, previous abdominal surgery, cardiovascular disease, diabetes mellitus, operative approach, drain insertion, major postoperative complications graded using the Clavien–Dindo classification system and SARS-CoV-2 infection); case ascertainment was determined by assessing the percentage of eligible participants recruited into in the study.

Eligibility criteria

Consecutive adult patients (≥18 years of age) undergoing emergency colorectal surgery for any indication (malignant or benign) were eligible for inclusion in the study, and the full list of surgical procedures suitable for inclusion is available within the study protocol [10]. Patients undergoing the following procedures were excluded: (i) operations without colorectal resection, or appendicectomies without more extensive colorectal resection; (ii) operations that were not primarily colorectal procedures (e.g., primarily urological, gynaecological or vascular procedures, or major multivisceral surgery such as pelvic exenteration); and (iii) operations without an abdominal incision (e.g., transanal procedures).

Furthermore, in response to the COVID-19 pandemic, retrospective validation of the SARS-CoV-2 infection status of patients was conducted by a collaborator independent of the original data-collection team at each site. All patients noted to have been diagnosed with a preoperative SARS-CoV-2 infection (in the 7 days preceding surgery) were excluded, based on (i) positive laboratory test/CT chest scan or (ii) clinical diagnosis (no laboratory test or CT chest scan performed) [14]. Any patients diagnosed with SARS-CoV-2 infection postoperatively were still included.

Outcome measures

The primary outcome was the rate of intraperitoneal drain placement. Secondary outcomes included: (i) rate and time-to-diagnosis (measured in whole days) of intraperitoneal postoperative collections, defined as collections which altered the normal postoperative course (e.g., requiring medical, radiological, endoscopic or surgical intervention) [15]; (ii) rate of 30-day drain-specific complications, including SSI (Centers for Disease Control and Prevention definition [16]), cutaneous irritation at the drain site (defined as reversible damage of the skin associated with rash, dry skin, itchiness, erythema and/or hives), small bowel evisceration and herniation of omentum (defined as prolapse of small bowel and/or omentum through the drain site after removal of the drain), bowel injury (defined as

intra-operative identification or CT-proven drain-related iatrogenic bowel perforation); (iii) overall 30-day adverse event rates, defined using the highest Clavien–Dindo classification score applicable [17]; and (iv) length of postoperative hospital stay.

Explanatory variables

The main explanatory variable of interest was intraperitoneal drain insertion. The reasons for drain insertion were recorded as: contaminated or dirty surgery [18], excessive intra-operative blood loss or fluid collections (because of a lack of standardized accurate measurements, the description 'excessive' was used at the discretion of the data collector, based on operative notes and the surgeon's verbal report), poor vascularization of the anastomosis or a positive air leak test. Drain insertion was classified as prophylactic if the reason for insertion was recorded as 'surgeon preference' and/or 'prophylaxis for anastomosis', or no reason could be identified.

Additional variables were collected to risk-adjust outcomes for the following potential confounding factors: age (years); sex (male or female); smoking status (current [including those who stopped smoking within 6 weeks of surgery], previous, never); body mass index (BMI), classified as underweight (BMI <18.5 kg/m^2), normal weight (BMI = 18.5–24.9 kg/m^2), overweight (BMI = 25.0–30.0 kg/m^2) or obese (BMI >30.0 kg/m^2); ASA classification (Grade I–V); cardiovascular and metabolic diseases (ischaemic heart disease, cerebrovascular disease, peripheral artery disease and diabetes mellitus); previous abdominal surgery; immunosuppression status (defined as treatment with any known immunosuppressive drug, current chemotherapy or if the last chemotherapy cycle was within 12 weeks of the operation); anticoagulation therapy (defined as the use of any known antiplatelet or antithrombotic agent); operative approach (open or minimally invasive) and indication (malignancy or benign); transfusion of red cells; operative contamination (clean-contaminated, contaminated or dirty [18]); and intra-operative complications (vascular or organ injury).

Statistical analysis

Patient demographics, perioperative variables and outcomes were compared for the drain and no-drain groups. Categorical variables were cross-tabulated and compared using the chi-squared or Fisher's exact tests. Continuous variables were summarized as median (interquartile range) and compared using the Mann–Whitney test. For time-to-event data, patients were censored at 30 days after surgery or when death occurred. Time-to-event variables were compared using the Log-rank test. Funnel plots with 95% CI and 99% CI were used to portray the drain insertion rates (unadjusted and risk-adjusted) of participating centres.

Mixed-effect multivariable logistic regression and Cox-proportional hazard regression were performed to derive risk-adjusted drain insertion rates and to determine whether drain placement was independently associated with the occurrence or timing of postoperative complications. Logistic regression was used to analyse binary outcomes (drain insertion rates, occurrence of major postoperative complications, postoperative intraperitoneal collections and SSIs), and Cox-proportional hazard regression was performed to analyse time-to-event data (time to discharge, and time to diagnosis of intraperitoneal collections). For all models, clinically plausible preoperative and perioperative factors associated with drain insertion and clinical outcomes were incorporated into the modelling approach as fixed effects and hospital was used as a random effect. Patients who had incomplete data for explanatory variables were excluded from the analysis. To minimize the risk of model overfitting, reduced models with a limited number of explanatory variables were produced. Final model selection was guided by expert opinion: variables included in the reduced models were patients' demographics and perioperative factors most clinically relevant to the outcomes of interest.

All effect estimates were presented as odds ratios (ORs) for binary outcome data and hazard ratios (HRs) for time-to-event data, with 95% CI. The threshold for statistical significance was set a priori as $p < 0.050$. All analyses were performed using R version 4.1.1 (R Foundation for Statistical Computing, Vienna, Austria) with the tidyverse and finalfit packages.

RESULTS

Cohort characteristics

Of 2673 eligible patients from 22 countries, 725 (349 [48.1%] women) (median age 68.0 years) undergoing emergency colorectal surgery at 139 hospitals were included in the analysis (Figure 1 and Table 1). A full breakdown of operative procedures and indications is provided in Tables S1 and S2. Surgeries were performed for benign indications (55.6%), with large bowel obstruction (13.4%), diverticular disease (12.6%) and inflammatory bowel disease (9.2%) being the most common benign pathologies (Table S2). Malignancy was the underlying pathology in 44.0% of patients. Colonic resections comprised 70.2% of the cohort; stoma formation/closure with no resection accounted for 18.6% and rectal resections for 10.3% (Table 1). The three most

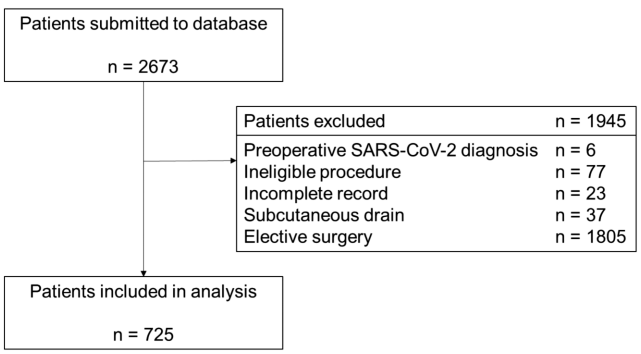

FIGURE 1 Flow diagram of patient inclusion and exclusion.

TABLE 1 Preoperative and intra-operative variables stratified according to intraperitoneal drain placement.

	No drain ($n = 336$)	Drain ($n = 389$)	Total ($n = 725$)	p[a]
Preoperative variables				
Age (years)				
Median (IQR)	69.0 (56.0–76.0)	68.0 (56.0–76.0)	68.0 (56.0–76.0)	0.758[c]
Sex				
Female	160 (47.6)	189 (48.6)	349 (48.1)	0.853
Male	176 (52.4)	200 (51.4)	376 (51.9)	
Smoking status				
Never	136 (40.5)	154 (39.6)	290 (40.0)	0.768
Previous	77 (22.9)	100 (25.7)	177 (24.4)	
Current[a]	62 (18.5)	72 (18.5)	134 (18.5)	
Missing	61 (18.2)	63 (16.2)	124 (17.1)	
BMI				
Underweight-Normal	131 (39.0)	155 (39.8)	286 (39.4)	0.456
Overweight	79 (23.5)	116 (29.8)	195 (26.9)	
Obese	69 (20.5)	81 (20.8)	150 (20.7)	
Missing	57 (17.0)	37 (9.5)	94 (13.0)	
ASA score				
I–II	163 (48.5)	191 (49.1)	354 (48.8)	0.996
III–V	171 (50.9)	198 (50.9)	369 (50.9)	
Missing	2 (0.6)	0 (0.0)	2 (0.3)	
Previous abdominal surgeries				
No	193 (57.4)	235 (60.4)	428 (59.0)	0.491
Yes	142 (42.3)	154 (39.6)	296 (40.8)	
Missing	1 (0.3)	0 (0.0)	1 (0.1)	
Previous stoma				
No	300 (89.3)	366 (94.1)	666 (91.9)	0.035
Yes	35 (10.4)	23 (5.9)	58 (8.0)	
Missing	1 (0.3)	0 (0.0)	1 (0.1)	
Anticoagulation therapy				
No	249 (74.1)	304 (78.1)	553 (76.3)	0.235
Yes	87 (25.9)	85 (21.9)	172 (23.7)	
Diabetes mellitus				
No	278 (82.7)	339 (87.1)	617 (85.1)	0.115
Non-IDDM	43 (12.8)	42 (10.8)	85 (11.7)	
IDDM	15 (4.5)	8 (2.1)	23 (3.2)	
Cardiovascular disease				
No	272 (81.0)	322 (82.8)	594 (81.9)	0.589
Yes	64 (19.0)	67 (17.2)	131 (18.1)	
Immunosuppression status				
No	282 (83.9)	331 (85.1)	613 (84.6)	0.743
Yes	54 (16.1)	58 (14.9)	112 (15.4)	
Intra-operative variables				
Underlying pathology				
Benign	174 (51.8)	229 (58.9)	403 (55.6)	0.073
Malignancy	160 (47.6)	159 (40.9)	319 (44.0)	
Missing	2 (0.6)	1 (0.3)	3 (0.4)	

TABLE 1 (Continued)

	No drain ($n = 336$)	Drain ($n = 389$)	Total ($n = 725$)	p[a]
Perforated bowel				
No	299 (89.0)	262 (67.4)	561 (77.4)	<0.001
Yes	36 (10.7)	126 (32.4)	162 (22.3)	
Missing	1 (0.3)	1 (0.3)	2 (0.3)	
Type of surgery				
Colon resection	215 (64.0)	294 (75.6)	509 (70.2)	<0.001
Rectum (±colon) resection	23 (6.8)	52 (13.4)	75 (10.3)	
Stoma formation/closure	96 (28.6)	39 (10.0)	135 (18.6)	
Missing	2 (0.6)	4 (1.0)	6 (0.8)	
Surgical approach				
Minimally invasive	126 (37.5)	82 (21.1)	208 (28.7)	<0.001
Open	209 (62.2)	306 (78.7)	515 (71.0)	
Missing	1 (0.3)	1 (0.3)	2 (0.3)	
Surgical wound				
Clean-contaminated	293 (87.2)	227 (58.4)	520 (71.7)	<0.001
Contaminated/Dirty	42 (12.5)	161 (41.4)	203 (28.0)	
Missing	1 (0.3)	1 (0.3)	2 (0.3)	
Operation duration (min)				
Median (IQR)	150.0 (100.0–191.5)	180.0 (122.0–240.0)	160.0 (120.0–215.0)	<0.001[c]
Intra-operative anastomosis				
No	189 (56.2)	211 (54.2)	400 (55.2)	0.630
Yes	145 (43.2)	176 (45.2)	321 (44.3)	
Missing	2 (0.6)	2 (0.5)	4 (0.6)	
Intra-operative vascular, bowel or other organ injury				
No	319 (94.9)	359 (92.3)	678 (93.5)	0.144
Yes	16 (4.8)	30 (7.7)	46 (6.3)	
Missing	1 (0.3)	0 (0.0)	1 (0.1)	
Intra-operative blood transfusion				
No	324 (96.4)	362 (93.1)	686 (94.6)	0.056
Yes	11 (3.3)	26 (6.7)	37 (5.1)	
Missing	1 (0.3)	1 (0.3)	2 (0.3)	

Note: Values are given as *n* (%) unless stated as given as median (IQR).

Abbreviations: ASA, American Society of Anesthesiologists; BMI, body mass index; IDDM, insulin-dependent diabetes mellitus; IQR, interquartile range.

[a]Includes those who stopped smoking within 6 weeks of surgery.

[b]Chi-squared or Fisher's exact test.

[c]Mann–Whitney test.

common operations were sigmoid colectomy (24.4%), right hemicolectomy (19.6%) and formation of stoma (ileostomy or colostomy) with no resection (16.1%) (Table S1). A full breakdown of operative procedures and indications is provided in Tables S1 and S2.

Overall, 389 (53.7%) patients received a drain (data not shown), of whom 179 (46.0%) had a prophylactic drain and 210 (54.0%) a drain with a defined indication. The reasons for drain placement were (inserted drains could have more than one indication): contaminated or dirty surgery (137 of 254, 53.9%); excessive intra-operative fluid collection (73 of 254, 28.7%); excessive intra-operative blood loss (28 of 254, 11.0%); poor vascularization of the anastomosis (14 of 254, 5.5%); and a positive air leak test (2 of 254, 0.8%). Data validation was performed using information from 574 patients (79.1% of the cohort), with 93.6% data accuracy and 96.7% case ascertainment.

Intraperitoneal drain placement

Patients with and without drains had similar demographics and baseline comorbidities (Table 1). Similar underlying pathologies were

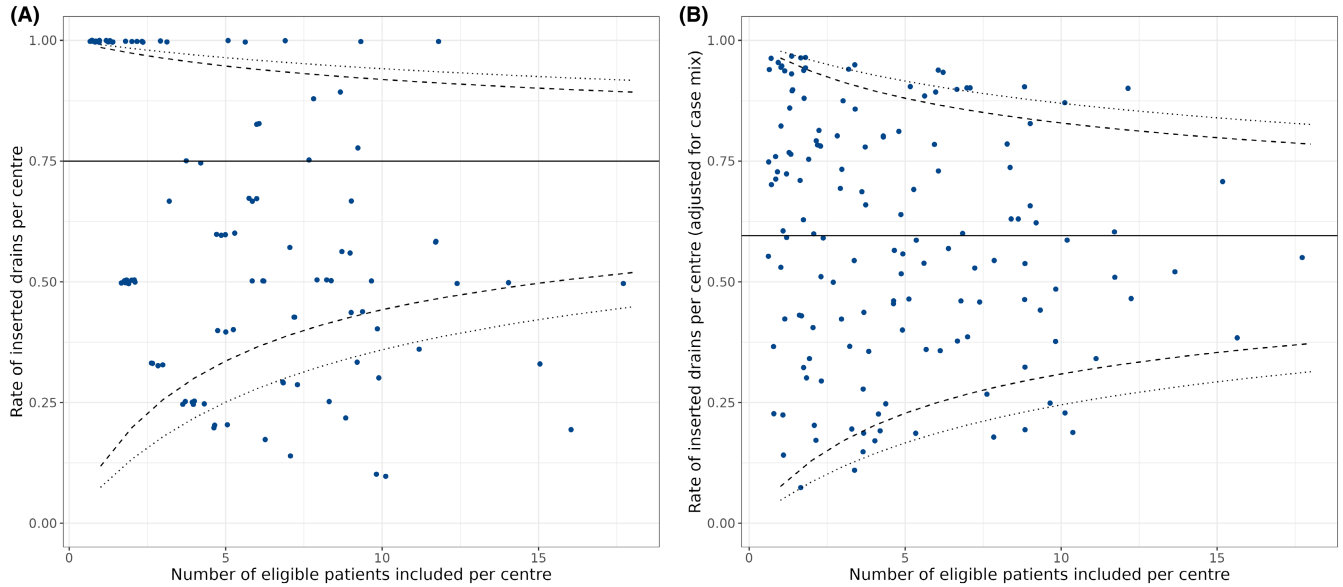

FIGURE 2 Funnel plots for rate of intraperitoneal drain placement per centre: overall rate (A) and adjusted for case mix (B). Dots, solid lines, dashed lines and dotted lines represent single centres, overall median, 95% CI and 99% CI, respectively.

observed between the two groups. Patients with drain placement more frequently had contaminated or dirty operations, an open surgical approach and/or longer operations. There were no differences in the rates of intra-operative complications or anastomosis formation (Table 1).

Among all intraperitoneal drains placed at 139 centres, the median rate of drain placement per centre was 75.0% (interquartile range [IQR]: 47.0–100) (Figure 2A). This substantial variation in practice could not be explained based on case mix following adjustment using a mixed-effects logistic regression model (median 58.5%; IQR: 26.6–85.5) (Figure 2B).

Postoperative outcomes

On univariable analysis, a similar proportion of patients was not discharged following their index operation and was still admitted to hospital at 30 days. However, those who received drains had a longer postoperative hospital stay (median: 11.0 days for patients with drain placement vs. 10.0 days for patients with no drain placement; $p = 0.003$) (Table 2). After adjustment using Cox proportional hazard regression, no significant difference was found (Table 3).

Before risk adjustment, a higher rate of SSIs (19.7% vs. 10.2%; $p = 0.001$), major postoperative complications (20.4% vs. 13.3%; $p = 0.017$) and intraperitoneal collections (9.7% vs. 4.7%; $p = 0.019$) was found among patients who received drains. However, there was no difference in time to diagnosis of collections (median 7.0 days for patients with drain placement vs. 9.0 days for patients with no drain placement; $p = 0.185$) (Table 2). After adjustment using mixed-effects models, no significant differences were demonstrated between those who did or did not receive a drain (Table 3 and Tables S3–S7).

DISCUSSION

Current evidence has demonstrated no clinical benefit associated with drain placement after elective colorectal surgery, with some evidence suggesting that drains cause harm [4–9]. However, literature reporting the use of drains after emergency colorectal surgery is limited and it remains unclear whether these findings can be extrapolated to the emergency setting. This is the first study to describe the use of intraperitoneal drains in emergency colorectal surgery and the safety and efficacy of this practice.

In our study, drain placement after emergency colorectal surgery was widespread. Most drains were placed because of contaminated or dirty operations, or excessive intra-operative fluid collection, suggesting how the most common rationale behind drain placement in the emergency setting is to evacuate any residual intraperitoneal contamination. However, most operations were clean-contaminated and almost half of drains were placed for prophylactic reasons alone. This could suggest that drain placement was significantly influenced by surgeon's preference, rather than dictated by clinical need. This was reflected in the significant variation in drain placement practice observed across participating centres, which persisted after adjusting for the case mix.

The hypothesized benefit of drainage after colorectal surgery is to help treat or prevent intraperitoneal complications, such as recurrent intraperitoneal contamination or anastomotic leakage [1, 2]. Current evidence, including our most recent analysis of the COMPASS dataset, demonstrated no clinical benefit from drain placement after elective colorectal surgery [6–9]. Following multivariable adjustment in the present cohort, drain placement was not significantly associated with greater odds of detection of intraperitoneal collections. Similarly, no significant difference in the time to diagnosis of intraperitoneal collections was observed. Therefore, this analysis of the COMPASS dataset

TABLE 2 30-day postoperative outcomes according to intraperitoneal drain insertion.

	No drain	Drain	Total	*p*[a]
Surgical site infections				
No	290 (89.8)	301 (80.3)	591 (84.7)	0.001
Yes	33 (10.2)	74 (19.7)	107 (15.3)	
Surgical site infections at drain site				
No	–	355 (94.7)	–	–
Yes	–	20 (5.3)	–	
Postoperative intraperitoneal collections				
No	303 (95.3)	335 (90.3)	638 (92.6)	0.019
Yes	15 (4.7)	36 (9.7)	51 (7.4)	
Time to diagnosis of postoperative intraperitoneal collections (days)				
Median (IQR)	9.0 (7.5–12.5)	7.0 (3.8–11.8)	8.0 (5.0–12.5)	0.710[b]
Postoperative major complications (Clavien–Dindo III–V)				
No	280 (86.7)	300 (79.6)	580 (82.9)	0.017
Yes	43 (13.3)	77 (20.4)	120 (17.1)	
Postoperative diagnosis of SARS-CoV-2 infections				
No	336 (100.0)	389 (100.0)	725 (100.0)	–
Yes	0 (0.0)	0 (0.0)	0 (0.0)	
Admission outcome				
Discharged	266 (84.2)	307 (82.7)	573 (83.4)	0.860
Ongoing	31 (9.8)	41 (11.1)	72 (10.5)	
Died	19 (6.0)	23 (6.2)	42 (6.1)	
Duration of hospital stay (days)				
Median (IQR)	10.0 (6.0–15.8)	11.0 (8.0–19.0)	10.0 (7.0–18.0)	0.048[b]

Note: Values are given as *n* (%) unless stated as given as median (IQR).

[a]Chi-squared or Fisher's exact test.

[b]Log-rank test.

TABLE 3 Summary of mixed-effect multivariable logistic and Cox proportional hazards regression models of drain-related outcomes within 30 days of surgery.

	Univariable OR/HR (95% CI)	Multilevel OR/HR (95% CI)
Multivariable logistic regression		
Postoperative major complications (Clavien–Dindo III–V) (number in model = 515)		
Drain	1.67 (1.12–2.53, $p = 0.013$)	1.26 (0.67–2.36, $p = 0.478$)
Postoperative intraperitoneal collections (number in model = 550)		
Drain	2.17 (1.19–4.16, $p = 0.015$)	1.56 (0.48–5.02, $p = 0.457$)
Surgical site infections (number in model = 559)		
Drain	2.16 (1.40–3.39, $p = 0.001$)	1.61 (0.87–2.99, $p = 0.128$)
Cox proportional hazards regression		
Time to discharge (number in model = 658)		
Drain	0.85 (0.72–1.00, $p = 0.049$)	1.11 (0.91–1.36, $p = 0.303$)
Time to diagnosis of postoperative intraperitoneal collection (number in model = 51)		
Drain	1.11 (0.60–2.05, $p = 0.744$)	1.07 (0.61–1.90, $p = 0.805$)

Note: ORs are shown for multivariable logistic regression analyses and HRs for Cox proportional hazards regression analyses. The reference group is no drain.

Abbreviations: HR, hazard ratio; OR, odds ratio.

suggests that drain placement is not significantly associated with clinical benefit after emergency colorectal surgery.

Intraperitoneal drains have the potential to be harmful to patients and there is evidence to suggest that they might promote SSIs, prolong hospital stay and cause anxiety after elective colorectal surgery [4, 9, 19]. In the present cohort, following multivariable adjustment, there was no significant difference between patients who did and did not receive drains after emergency colorectal surgery in major postoperative

complication rates, SSI rates and length of hospital stay. This should not be interpreted as drains having a protective effect after emergency colorectal surgery, but rather as the potential harmful effect of drains, as observed on univariable analysis, being not statistically significant in the context of emergency operations and in comorbid, potentially critically ill, patients, who are already prone to worse outcomes. The safety of drain placement in the emergency setting is unclear.

There are some limitations to this study. As a result of its observational nature, limited conclusions can be drawn from our findings. Multivariable analyses were used to adjust for potentially confounding factors. However, drain placement was at the discretion of the surgeon and this introduced a selection bias, which could not be completely accounted for in this analysis. This prospective analysis of real-world practice nevertheless offers equipoise towards an adequately powered and well-designed randomized control trial, which will account for this selection bias and better define the efficacy of drains after emergency colorectal surgery. Another potential weakness was the sample size of the study: the relatively low frequency of the events of interest limits the strength of our study findings. However, as this is the first study on the use of drains in emergency colorectal surgery, our findings can be used for future statistical power and sample size estimations. In addition, we included, in our analyses, stoma operations without bowel resection. This was to provide a detailed description of the use of drains across all emergency colorectal surgery operations. However, the inclusion of these types of operations might have affected the study findings: patients undergoing stoma operations without bowel resection might be less prone to complications, such as intraperitoneal collections, and might have a shorter hospital stay. Moreover, data on indications for drain placement were collected from clinical notes. Some surgeons might insert drains for reasons not specified in COMPASS or might not routinely document the specific indication. Finally, COMPASS overlapped with the onset of the COVID-19 pandemic, which potentially introduced a confounding factor for postoperative morbidity and mortality [14]. A validation of the included data was performed, with assessment of the SARS-CoV-2 infection rates, which showed that no recorded postoperative cases were present in this cohort.

This large, multicentre, prospective cohort study is the first to describe intraperitoneal drain placement after emergency colorectal surgery. Our findings showed that drain insertion is widespread and that a significant variation in practice exists. The safety and clinical benefit of drains are unclear. These results warrant a randomized control trial to define the efficacy and safety of drains after emergency colorectal surgery.

AUTHOR CONTRIBUTIONS

All collaborators participated in data collection. Local, regional and national leads participated in study management with oversight from the Study Management Group. All collaborators from the Writing Group participated in drafting the manuscript and all individuals agreed for its submission. The Expert Advisory Group supervised the protocol design and final manuscript. The corresponding author attests that all listed collaborators meet required criteria and that no others have been omitted. Alessandro Sgrò is the statistical and overall guarantor.

ACKNOWLEDGEMENTS

The protocol for the COMPASS project was pre-published; however, this study was not pre-registered at an institutional registry. The authors are grateful to the European Society of Coloproctology (ESCP) Executive for providing facilities to host collaborator meetings in Vienna (September 2019); and to the Student Audit and Research in Surgery (STARSurg) collaborative, the Portuguese Surgical Research Collaborative (PTSurg), the Italian Surgical Research Group (ItSurg), the Student-Initiated German Medical Audit (SIGMA) collaborative and the Trials and Audit in Surgery by Medical Students in Australia and New Zealand (TASMAN) collaborative for assistance with study dissemination. They thank the Birmingham Surgical Trials Consortium at the University of Birmingham (UK) for support with online data capture.

FUNDING INFORMATION

None.

CONFLICT OF INTEREST STATEMENT

None.

ETHICS STATEMENT

Participating centres registered the study locally and obtained ethical approval according to country-specific procedures.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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SUPPORTING INFORMATION

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

How to cite this article: EuroSurg Collaborative. Safety and efficacy of intraperitoneal drain placement after emergency colorectal surgery: An international, prospective cohort study. Colorectal Dis. 2023;00:1–11. https://doi.org/10.1111/codi.16737

APPENDIX A

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