Supplementary materials

Evaluation of a quality improvement intervention to reduce anastomotic leak following right hemicolectomy (EAGLE): A pragmatic, batched stepped-wedged, cluster-randomised trial in 64 countries.

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Appendix A: Online educational modules

Modules overview and overarching curriculum

Complete?

Module 1: Decision making

This module discusses the need for patient stratification and introduces a simple online anastomosis risk calculator.

Commence Module

Module 2: ESCP Safe-anastomosis Checklist

This module introduces the ESCP Safe-anastomosis Checklist as a tool that can be used in your daily practice to ensure safety steps are followed for every procedure.

Commence Module

Module 3: Preparing for the anastomosis

This module discusses how to prepare the bowel for anastomosis, and common concepts between handsewn and stapled anastomoses.

Commence Module

Module 4: Stapled Anastomosis

This module reviews the evidence for best practice in stapled ileocolic anastomosis, and how to perform a systematic check of the anastomosis on the right side.

Commence Module

Module 5: Handsewn Anastomosis

This module reviews the evidence for best practice in handsewn ileocolic anastomosis.

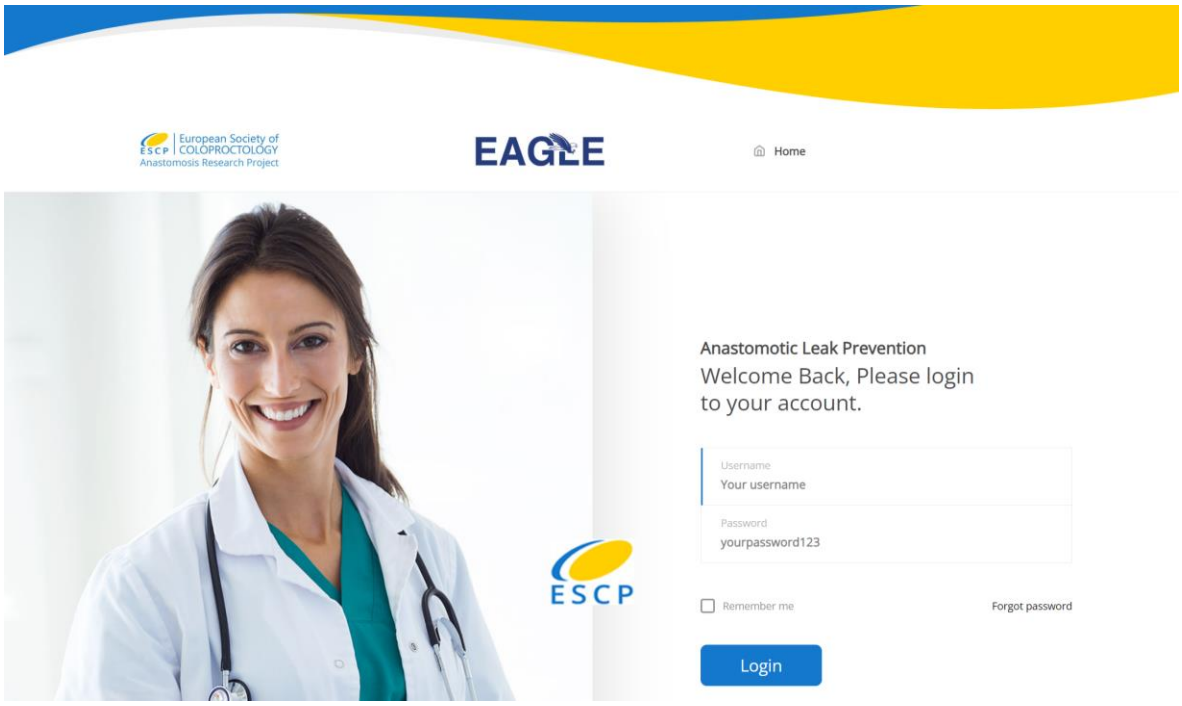
Commence Module

Summary: Safe Anastomosis Programme Key Learning Points

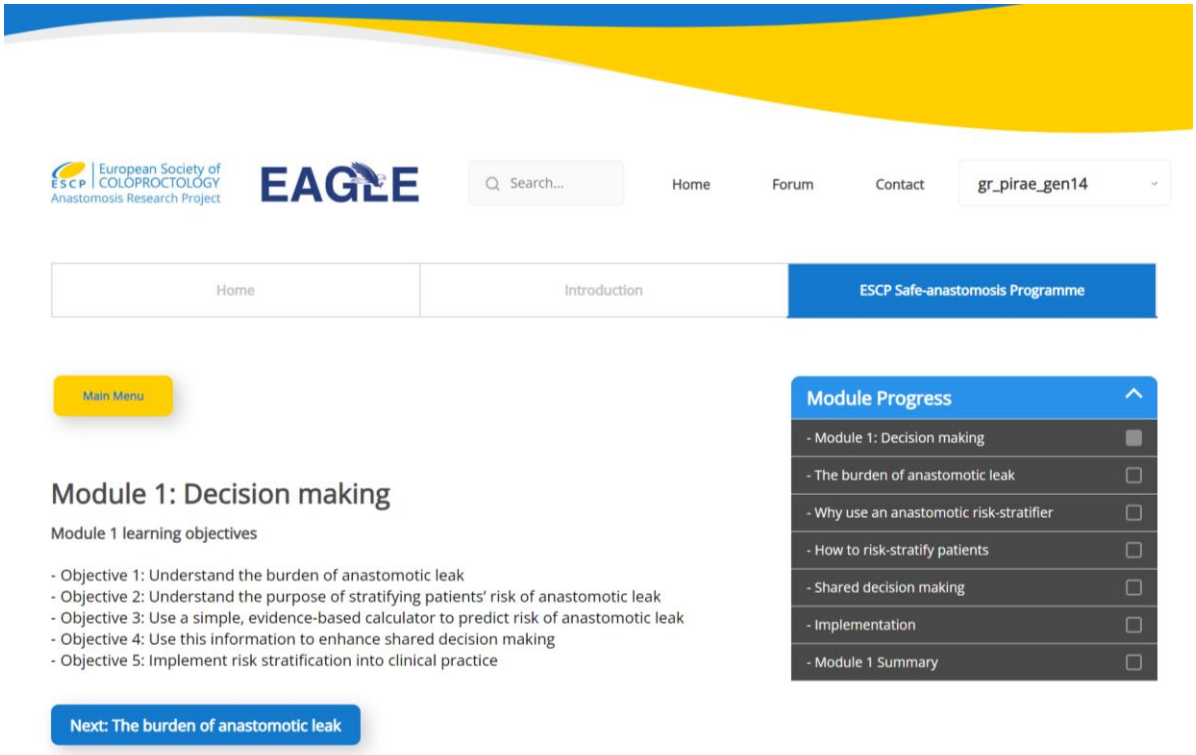
This is a summary of the key learning points from the five online modules

Commence Module

Front page welcome screen



Module 1 – example of module stem screen



Principles of staplers and device specific education

It is important to have an appreciation of the different staple heights provided by different staplers.

The ESCP Safe-anastomosis programme recommends that if you are thinking about moving to a larger stapler type in the presence of thickened tissues (gold, or green), to discuss whether a stapled anastomosis is definitely the most appropriate choice.

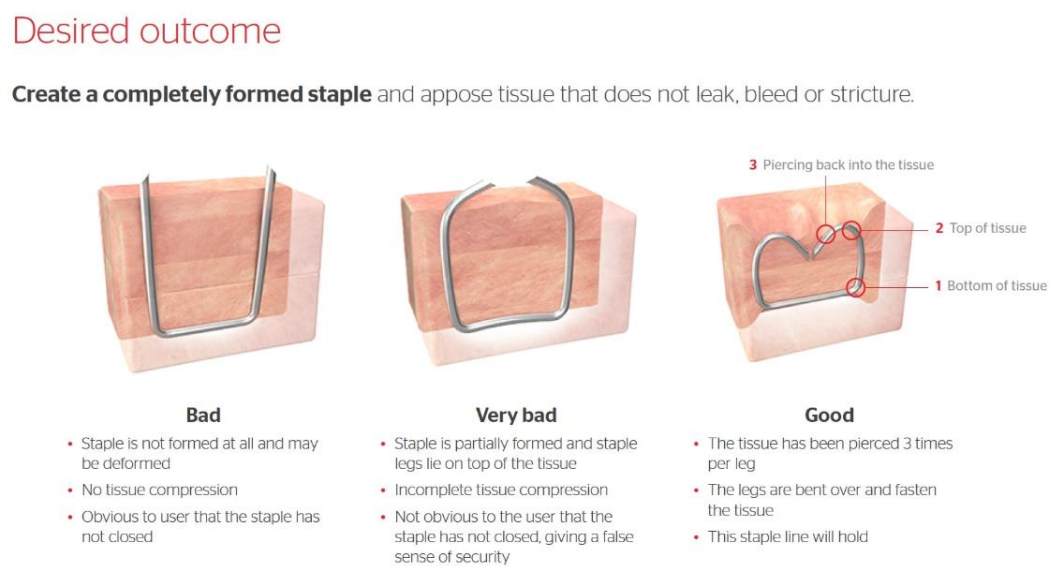
Stapler sizes and staple height

	Tissue.	Open staple height.
White	Vascular.	2.5 mm.
Blue	Standard.	3.5 mm.
Gold	Standard/thick.	3.8 mm.
Green	Thick.	4.1 mm.

Optimal user of stapler

It is essential to choose the right stapler for the tissue type and thickness you wish to anastomose.

• **Correct stapler selection ensures: ▼**



This video shows a discussion between surgeons about choice of anastomotic technique in diseased bowel:

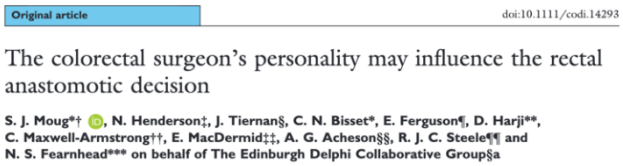
Human factors and team dynamics training

European Society of COLOPROCTOLOGY Anastomosis Research Project | EAGLE | Search... | Home | Forum | Contact | gr_pirae_gen14

Home | Introduction | ESCP Safe-anastomosis Programme

Main Menu

Human factors and anastomotic decision making


Original article

doi:10.1111/codi.14293

The colorectal surgeon's personality may influence the rectal anastomotic decision

S. J. Moug*† , N. Henderson‡, J. Tiernan§, C. N. Bisset*, E. Ferguson¶, D. Harji**, C. Maxwell-Armstrong††, E. MacDermid‡‡, A. G. Acheson§§, R. J. C. Steele¶¶ and N. S. Fearnhead*** on behalf of The Edinburgh Delphi Collaborative Group§a

Surgeons' personalities influence anastomotic decision making!

Related paper: The colorectal surgeon's personality may influence the rectal anastomotic decision

An ACPGBI (Association of Coloproctologists of Great Britain and Ireland) Delphi Consensus group demonstrated that surgeons were less likely to make an anastomosis in the following situations:

- The surgeon had recently received criticism at a departmental audit meeting
- The anaesthetist was not their usual anaesthetist
- There were no anastomotic leaks in the surgeon's patients for over one year

These 'human factors' could bring unwanted variation into clinical practice, encouraging risk-promoting or risk-averse practices to the detriment of our patients.

By involving the multidisciplinary theatre team in anastomotic decision making, the ESCP Safe-anastomosis checklist aims to share decision-making responsibility with other key care providers, improve situational awareness and allow objective reassessment of preoperative risk and any intra-operative events that may influence a surgeon's decision.

However, the ultimate decision will always lie with the surgeon.

Appendix B: ESCP Safe Anastomosis checklist

Name

Date of Birth

Hospital no

Sticker

ESCP SAFE ANASTOMOSIS CHECKLIST

Step 1: Are there any concerns from the anaesthetist or theatre team?

Such as:

- Haemodynamic instability
- Blood loss or transfusion
- Unexpected prolonged operation (>4 hours)

Step 2: Does the surgical team feel it is appropriate to proceed to anastomosis?

What was the calculated pre-operative risk of anastomotic leak?
http://www.anastomoticleak.com

Are there any unforeseen intra-operative complications that could increase the risk, such as:

- Contamination of the operative field
- Technical challenges

→ If **yes** to anastomosis…

Step 3: What type of anastomosis is planned?

Consider if there any factors that might limit the safety of a *stapled* anastomosis, such as bowel oedema or inflammation

→ Stapled	→ Handsewn
Consider: • What configuration is planned? • What instruments are required? • What stapler size is required? • How will you test the anastomosis?	*Consider:* • What configuration is planned? • What type of sutures are required? • Interrupted or continuous? • How will you test the anastomosis?

Completed by: Role Name

Date Signature

PLEASE FILE THIS COMPLETED DOCUMENT IN THE PATIENT'S MEDICAL RECORDS

Appendix C: Definitions and additional links

Classification of surgical wounds[1]

Clean — an incision in which no inflammation is encountered in a surgical procedure, without a break in sterile technique, and during which the respiratory, alimentary, and genitourinary tracts are not entered.
Clean-contaminated — an incision through which the respiratory, alimentary, or genitourinary tract is entered under controlled conditions but with no contamination encountered.
Contaminated — an incision undertaken during an operation in which there is a major break in sterile technique or gross spillage from the gastrointestinal tract, or an incision in which acute, non-purulent inflammation is encountered. Open traumatic wounds that are more than 12–24 hours old also fall into this category.
Dirty or infected — an incision undertaken during an operation in which the viscera are perforated or when acute inflammation with pus is encountered during the operation (for example, emergency surgery for faecal peritonitis), and for traumatic wounds where treatment is delayed, and there is faecal contamination or devitalised tissue present.

1. Center for Disease Control - National Healthcare Safety Network. Surgical site infection events (SSI). Accessed 03/07/2023, 2023. https://www.cdc.gov/nhsn/pdfs/pscmanual/9pscssicurrent.pdf

World Bank income group classification: fiscal year 2023[2]

Gross national income per capita, calculated using the World Bank Atlas method:

Low-income economies	$1,085 or less in 2021
Lower middle-income economies	$1,086 to $4,255
Upper middle-income	$4,256 to $13,205
High-income economies	$13,205 or more

2. World Bank Income Group. World Bank income group classification: fiscal year 2023. Accessed 03/07/2023, 2023. https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups

Clinical anastomotic leak

An anastomotic leak diagnosed clinically by the local surgical team, without any formal imaging or scans. The parameters were left to the discretion and normal practices of the local team.

EAGLE trial patient inclusion criteria[3]:

• Adults ≥18 years of age.
• Right colectomy, defined as any colonic transection with the distal resection margin proximal to the splenic flexure.
• Procedures for any pathology (benign or malignant), via any operative approach (open, laparoscopic, robotic or converted).
• Patients undergoing elective (during a planned admission), expedited or emergency surgery (during an unplanned admission).
• Patients undergoing colectomy and a synchronous procedure on a different organ e.g. hepatic metastatectomy.

Patient exclusion criteria:

• Patients undergoing more than one gastrointestinal anastomosis during the index operation.
• In Crohn's disease, additional upstream strictureplasty or resection/anastomosis to treat disease or strictures at the same operation.
• Patients undergoing concurrent hyperthermic intra-peritoneal chemotherapy (HIPEC) and/or cytoreductive surgery.

• Individual patients should only be included in EAGLE once. Following the index EAGLE study procedure, patients undergoing further operative treatment within the study window should not have repeated entries created.

3. ESCP Eagle Safe Anastomosis Collaborative. ESCP Safe Anastomosis ProGramme in CoLorectal SurgEry (EAGLE): Study protocol for an international cluster randomised trial of a quality improvement intervention to reduce anastomotic leak following right colectomy. *Colorectal Dis*. Oct 2021;23(10):2761-2771. doi:10.1111/codi.15806

Link to example of an investigator's webinar:

https://www.youtube.com/watch?v=EEpwDIgbmu0 (from 5th June 2023)

Appendix D: Supplementary Figures and Tables

Baseline characteristics

Supplemental Table 1: Patient and operative factors by region

Factors	Levels	Africa (n=187)	Asia (n=468)	Europe (n=2554)	Oceania (n=33)	South America (n=222)
Body mass index >30	No	145 (77.5%)	419 (90.5%)	1988 (78.4%)	22 (66.7%)	167 (76.3%)
	Yes	42 (22.5%)	44 (9.5%)	549 (21.6%)	11 (33.3%)	52 (23.7%)
Pre-operative total protein level (g/dL)	<=4	56 (30.9%)	27 (6.3%)	143 (6.2%)	0 (0.0%)	4 (1.9%)
	4.5 – 5.5	44 (24.3%)	84 (19.6%)	515 (22.5%)	2 (6.5%)	40 (19.1%)
	6.0 – 7.5	71 (39.2%)	275 (64.1%)	1544 (67.4%)	28 (90.3%)	161 (77.0%)
	>=8	10 (5.5%)	43 (10.0%)	88 (3.8%)	1 (3.2%)	4 (1.9%)
Oral anti-coagulants	No	172 (92.0%)	426 (91.2%)	2098 (82.6%)	30 (90.9%)	202 (92.2%)
	Yes	15 (8.0%)	41 (8.8%)	443 (17.4%)	3 (9.1%)	17 (7.8%)
Timing of surgery	Elective (planned)	83 (53.2%)	291 (69.8%)	1814 (78.7%)	15 (60.0%)	153 (81.0%)
	Emergency (unplanned)	73 (46.8%)	126 (30.2%)	490 (21.3%)	10 (40.0%)	36 (19.0%)
Indication for surgery	Malignancy	111 (60.0%)	339 (72.6%)	2030 (79.8%)	26 (81.3%)	186 (84.9%)
	Inflammatory bowel disease	30 (16.2%)	19 (4.1%)	233 (9.2%)	2 (6.3%)	1 (0.5%)
	Other	44 (23.8%)	109 (23.3%)	281 (11.0%)	4 (12.4%)	32 (14.6%)
	Missing	2	1	10	1	3

Supplementary Table 2a): Stratification variables of hospitals by batch in sequence 1. Percentage (%) represented down columns.

Factor	Levels	Batch																Total
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
Beds	<500	3 (37.5)	5 (45.5)	4 (40.0)	4 (50.0)	2 (33.3)	3 (42.9)	3 (37.5)	3 (37.5)	2 (28.6)	5 (62.5)	1 (20.0)	2 (33.3)	4 (50.0)	4 (57.1)	4 (66.7)	4 (57.1)	53 (44.2)
	≥500	5 (62.5)	6 (54.5)	6 (60.0)	4 (50.0)	4 (66.7)	4 (57.1)	5 (62.5)	5 (62.5)	5 (71.4)	3 (37.5)	4 (80.0)	4 (66.7)	4 (50.0)	3 (42.9)	2 (33.3)	3 (42.9)	67 (55.8)
Referral hospital	Yes	6 (75.0)	8 (72.7)	7 (70.0)	7 (87.5)	4 (66.7)	6 (85.7)	5 (62.5)	6 (75.0)	6 (85.7)	7 (87.5)	4 (80.0)	6 (100.0)	7 (87.5)	7 (100.0)	5 (83.3)	5 (71.4)	96 (80.0)
	No	2 (25.0)	3 (27.3)	3 (30.0)	1 (12.5)	2 (33.3)	1 (14.3)	3 (37.5)	2 (25.0)	1 (14.3)	1 (12.5)	1 (20.0)	0 (0.0)	1 (12.5)	0 (0.0)	1 (16.7)	2 (28.6)	24 (20.0)
Region	Africa	0 (0.0)	1 (9.1)	1 (10.0)	1 (12.5)	0 (0.0)	0 (0.0)	1 (12.5)	0 (0.0)	0 (0.0)	1 (12.5)	1 (20.0)	1 (16.7)	0 (0.0)	1 (14.3)	0 (0.0)	0 (0.0)	8 (6.7)
	Asia	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (16.7)	4 (57.1)	4 (50.0)	3 (37.5)	3 (42.9)	2 (25.0)	2 (40.0)	0 (0.0)	2 (25.0)	0 (0.0)	1 (16.7)	1 (14.3)	23 (19.2)
	Europe	8 (100.0)	9 (81.8)	9 (90.0)	7 (87.5)	5 (83.3)	3 (42.9)	3 (37.5)	4 (50.0)	2 (28.6)	4 (50.0)	1 (20.0)	4 (66.7)	4 (50.0)	4 (57.1)	4 (66.7)	5 (71.4)	76 (63.3)
	South America	0 (0.0)	1 (9.1)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (12.5)	2 (28.6)	1 (12.5)	1 (20.0)	1 (16.7)	2 (25.0)	1 (14.3)	0 (0.0)	1 (14.3)	11 (9.2)
	Oceania	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (14.3)	1 (16.7)	0 (0.0)	2 (1.7)
Country income	Low	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (14.3)	2 (25.0)	0 (0.0)	0 (0.0)	1 (12.5)	1 (20.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	5 (4.2)
	Middle	2 (25.0)	5 (45.5)	2 (20.0)	3 (37.5)	2 (33.3)	2 (28.6)	3 (37.5)	2 (25.0)	5 (71.4)	3 (37.5)	2 (40.0)	6 (100.0)	6 (75.0)	2 (28.6)	2 (33.3)	2 (28.6)	49 (40.8)
	High	6 (75.0)	6 (54.5)	8 (80.0)	5 (62.5)	4 (66.7)	4 (57.1)	3 (37.5)	6 (75.0)	2 (28.6)	4 (50.0)	2 (40.0)	0 (0.0)	2 (25.0)	5 (71.4)	4 (66.7)	5 (71.4)	66 (55.0)

Supplementary Table 2b): Stratification variables of hospitals by batch in sequence 2. Percentage (%) represented down columns.

Factor	Levels	Batch																Total
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
Beds	<500	5 (41.7)	0 (0.0)	3 (33.3)	5 (62.5)	4 (50.0)	3 (42.9)	3 (60.0)	4 (57.1)	1 (14.3)	4 (57.1)	3 (42.9)	4 (50.0)	4 (50.0)	1 (16.7)	3 (50.0)	2 (33.3)	49 (42.6)
	≥500	7 (58.3)	4 (100.0)	6 (66.7)	3 (37.5)	4 (50.0)	4 (57.1)	2 (40.0)	3 (42.9)	6 (85.7)	3 (42.9)	4 (57.1)	4 (50.0)	4 (50.0)	5 (83.3)	3 (50.0)	4 (66.7)	66 (57.4)
Referral hospital	Yes	9 (75.0)	2 (50.0)	7 (77.8)	6 (75.0)	6 (75.0)	5 (71.4)	3 (60.0)	7 (100.0)	6 (85.7)	7 (100.0)	6 (85.7)	7 (87.5)	7 (87.5)	4 (66.7)	5 (83.3)	4 (66.7)	91 (79.1)
	No	3 (25.0)	2 (50.0)	2 (22.2)	2 (25.0)	2 (25.0)	2 (28.6)	2 (40.0)	0 (0.0)	1 (14.3)	0 (0.0)	1 (14.3)	1 (12.5)	1 (12.5)	2 (33.3)	1 (16.7)	2 (33.3)	24 (20.9)
Region	Africa	1 (8.3)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (14.3)	1 (20.0)	2 (28.6)	0 (0.0)	1 (14.3)	2 (28.6)	1 (12.5)	2 (25.0)	1 (16.7)	0 (0.0)	0 (0.0)	12 (10.4)
	Asia	0 (0.0)	0 (0.0)	1 (11.1)	1 (12.5)	0 (0.0)	1 (14.3)	3 (60.0)	1 (14.3)	2 (28.6)	1 (14.3)	1 (14.3)	2 (25.0)	2 (25.0)	1 (16.7)	3 (50.0)	1 (16.7)	20 (17.4)
	Europe	11 (91.7)	4 (100.0)	8 (88.9)	7 (87.5)	8 (100.0)	5 (71.4)	1 (20.0)	4 (57.1)	2 (28.6)	2 (28.6)	4 (57.1)	4 (50.0)	3 (37.5)	3 (50.0)	2 (33.3)	5 (83.3)	73 (63.5)
	South America	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	3 (42.9)	3 (42.9)	0 (0.0)	1 (12.5)	1 (12.5)	1 (16.7)	1 (16.7)	0 (0.0)	10 (8.7)
	Oceania	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Country income	Low	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (14.3)	2 (40.0)	0 (0.0)	0 (0.0)	1 (14.3)	2 (28.6)	0 (0.0)	0 (0.0)	0 (0.0)	1 (16.7)	0 (0.0)	7 (6.1)
	Middle	3 (25.0)	1 (25.0)	1 (11.1)	1 (12.5)	2 (25.0)	1 (14.3)	1 (20.0)	3 (42.9)	5 (71.4)	4 (57.1)	2 (28.6)	4 (50.0)	5 (62.5)	2 (33.3)	1 (16.7)	1 (16.7)	37 (32.2)
	High	9 (75.0)	3 (75.0)	8 (88.9)	7 (87.5)	6 (75.0)	5 (71.4)	2 (40.0)	4 (57.1)	2 (28.6)	2 (28.6)	3 (42.9)	4 (50.0)	3 (37.5)	4 (66.7)	4 (66.7)	5 (83.3)	71 (61.7)

Supplementary Table 2c): Stratification variables of hospitals by batch in sequence 3. Percentage in brackets (%) represented down columns.

Factor	Levels	Batch																Total
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
Beds	<500	6 (35.3)	2 (100.0)	3 (37.5)	4 (50.0)	3 (37.5)	3 (50.0)	3 (37.5)	5 (55.6)	2 (33.3)	4 (66.7)	3 (50.0)	4 (50.0)	5 (62.5)	3 (42.9)	3 (50.0)	3 (42.9)	56 (46.7)
	≥500	11 (64.7)	0 (0.0)	5 (62.5)	4 (50.0)	5 (62.5)	3 (50.0)	5 (62.5)	4 (44.4)	4 (66.7)	2 (33.3)	3 (50.0)	4 (50.0)	3 (37.5)	4 (57.1)	3 (50.0)	4 (57.1)	64 (53.3)
Referral hospital	Yes	12 (70.6)	1 (50.0)	6 (75.0)	7 (87.5)	6 (75.0)	5 (83.3)	6 (75.0)	5 (55.6)	5 (83.3)	4 (66.7)	6 (100.0)	6 (75.0)	7 (87.5)	6 (85.7)	4 (66.7)	4 (57.1)	90 (75.0)
	No	5 (29.4)	1 (50.0)	2 (25.0)	1 (12.5)	2 (25.0)	1 (16.7)	2 (25.0)	4 (44.4)	1 (16.7)	2 (33.3)	0 (0.0)	2 (25.0)	1 (12.5)	1 (14.3)	2 (33.3)	3 (42.9)	30 (25.0)
Region	Africa	1 (5.9)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (16.7)	1 (12.5)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	3 (37.5)	0 (0.0)	1 (14.3)	0 (0.0)	0 (0.0)	7 (5.8)
	Asia	0 (0.0)	0 (0.0)	0 (0.0)	2 (25.0)	0 (0.0)	1 (16.7)	3 (37.5)	2 (22.2)	2 (33.3)	1 (16.7)	1 (16.7)	0 (0.0)	2 (25.0)	1 (14.3)	1 (16.7)	2 (28.6)	18 (15.0)
	Europe	16 (94.1)	2 (100.0)	8 (100.0)	5 (62.5)	8 (100.0)	4 (66.7)	4 (50.0)	7 (77.8)	3 (50.0)	2 (33.3)	1 (16.7)	3 (37.5)	6 (75.0)	4 (57.1)	4 (66.7)	5 (71.4)	82 (68.3)
	South America	0 (0.0)	0 (0.0)	0 (0.0)	1 (12.5)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (16.7)	3 (50.0)	3 (50.0)	2 (25.0)	0 (0.0)	0 (0.0)	1 (16.7)	0 (0.0)	11 (9.2)
	Oceania	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (16.7)	0 (0.0)	0 (0.0)	1 (14.3)	0 (0.0)	0 (0.0)	2 (1.7)
Country income	Low	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (16.7)	1 (12.5)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	3 (37.5)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	5 (4.2)
	Middle	4 (23.5)	1 (50.0)	2 (25.0)	2 (25.0)	2 (25.0)	1 (16.7)	3 (37.5)	4 (44.4)	3 (50.0)	3 (50.0)	5 (83.3)	3 (37.5)	2 (25.0)	3 (42.9)	2 (33.3)	2 (28.6)	42 (35.0)
	High	13 (76.5)	1 (50.0)	6 (75.0)	6 (75.0)	6 (75.0)	4 (66.7)	4 (50.0)	5 (55.6)	3 (50.0)	3 (50.0)	1 (16.7)	2 (25.0)	6 (75.0)	4 (57.1)	4 (66.7)	5 (71.4)	73 (60.8)

Supplementary Table 3: Patient demographics by sequence

Factors	Levels	Sequence			
		1	2	3	Total
Age (years)	Median (IQR)	67.0 (56.0 to 76.0)	68.0 (56.0 to 77.0)	69.0 (57.0 to 77.0)	68.0 (56.0 to 77.0)
Sex	Female	414 (47.4%)	777 (48.5%)	472 (48.3%)	1663 (48.1%)
	Male	460 (52.6%)	826 (51.5%)	506 (51.7%)	1792 (51.9%)
BMI* > 30	No	669 (76.7%)	1287 (80.8%)	785 (80.6%)	2741 (79.7%)
	Yes	203 (23.3%)	306 (19.2%)	189 (19.4%)	698 (20.3%)
Known diabetes	No	698 (80.0%)	1265 (78.8%)	775 (79.2%)	2738 (79.2%)
	Yes	175 (20.0%)	340 (21.2%)	204 (20.8%)	719 (20.8%)
History of IHD or CVA**	No	700 (80.1%)	1295 (80.7%)	761 (77.8%)	2756 (79.7%)
	Yes	174 (19.9%)	309 (19.3%)	217 (22.2%)	700 (20.3%)
Smoking status	No	584 (67.0%)	1042 (65.5%)	662 (67.9%)	2288 (66.6%)
	Yes - Current smoker (or stopped <6 weeks)	111 (12.7%)	217 (13.6%)	117 (12.0%)	445 (12.9%)
	Yes - Ex smoker (stopped >6 weeks)	176 (20.2%)	332 (20.9%)	196 (20.1%)	704 (20.5%)
Oral anti-coagulants	No	750 (86.0%)	1367 (85.3%)	811 (83.4%)	2928 (84.9%)
	Yes	122 (14.0%)	235 (14.7%)	162 (16.6%)	519 (15.1%)
Pre-operative total protein level (g/dL)	4.5	43 (5.2%)	122 (8.5%)	53 (6.1%)	218 (6.9%)
	5	48 (5.8%)	88 (6.1%)	44 (5.1%)	180 (5.7%)
	5.5	83 (10.0%)	130 (9.0%)	74 (8.5%)	287 (9.1%)
	6	133 (16.0%)	179 (12.4%)	130 (14.9%)	442 (14.1%)
	6.5	160 (19.3%)	233 (16.2%)	159 (18.3%)	552 (17.6%)
	7	191 (23.0%)	327 (22.7%)	185 (21.3%)	703 (22.4%)
	7.5	96 (11.6%)	176 (12.2%)	110 (12.6%)	382 (12.2%)
	≤4	47 (5.7%)	120 (8.3%)	63 (7.2%)	230 (7.3%)
	≥8	30 (3.6%)	64 (4.4%)	52 (6.0%)	146 (4.6%)
Pre-operative haemoglobin (g/dL)	100-109	132 (15.1%)	262 (16.4%)	163 (16.8%)	557 (16.2%)
	110-119	138 (15.8%)	270 (16.9%)	143 (14.8%)	551 (16.0%)
	120-129	141 (16.2%)	267 (16.7%)	135 (13.9%)	543 (15.8%)
	130-139	110 (12.6%)	201 (12.6%)	145 (15.0%)	456 (13.3%)
	60-69	3 (0.3%)	14 (0.9%)	2 (0.2%)	19 (0.6%)
	70-79	26 (3.0%)	38 (2.4%)	19 (2.0%)	83 (2.4%)
	80-89	81 (9.3%)	103 (6.4%)	78 (8.1%)	262 (7.6%)
	90-99	105 (12.0%)	188 (11.8%)	110 (11.4%)	403 (11.7%)
	< 60	16 (1.8%)	18 (1.1%)	19 (2.0%)	53 (1.5%)
	≥140	121 (13.9%)	236 (14.8%)	154 (15.9%)	511 (14.9%)

*BMI = kg/m^2
**IHD – ischemic heart disease, CVA- cerebral vascular accident

Supplementary Table 4: Patient demographics by batch. Percentage (%) represented down columns.

Factors	Levels	Batch																Total
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
Age (years)	Median (IQR)	71.0 (62.5 to 79.0)	67.0 (57.0 to 74.0)	70.0 (60.0 to 79.0)	66.5 (55.0 to 77.0)	71.0 (62.0 to 78.0)	70.0 (59.0 to 79.0)	66.0 (53.0 to 74.0)	65.0 (51.5 to 76.0)	61.5 (47.0 to 74.0)	65.0 (53.0 to 76.0)	64.0 (52.5 to 72.0)	68.0 (56.0 to 76.0)	65.0 (50.8 to 74.2)	68.0 (59.5 to 75.0)	72.0 (59.0 to 79.0)	68.0 (55.0 to 77.0)	68.0 (56.0 to 77.0)
Sex	Female	233 (51.7)	72 (43.9)	134 (46.7)	108 (44.6)	137 (54.8)	88 (48.6)	115 (50.0)	126 (44.5)	76 (47.5)	60 (42.9)	65 (40.9)	73 (43.2)	119 (55.9)	75 (44.9)	79 (49.4)	103 (51.8)	1663 (48.1)
	Male	218 (48.3)	92 (56.1)	153 (53.3)	134 (55.4)	113 (45.2)	93 (51.4)	115 (50.0)	157 (55.5)	84 (52.5)	80 (57.1)	94 (59.1)	96 (56.8)	94 (44.1)	92 (55.1)	81 (50.6)	96 (48.2)	1792 (51.9)
BMI*>30	No	356 (79.3)	116 (70.3)	240 (83.9)	186 (77.2)	191 (76.7)	148 (81.8)	182 (79.5)	230 (81.3)	131 (83.4)	105 (74.5)	131 (82.4)	130 (76.9)	176 (83.4)	122 (75.8)	131 (82.9)	166 (83.0)	2741 (79.7)
	Yes	93 (20.7)	49 (29.7)	46 (16.1)	55 (22.8)	58 (23.3)	33 (18.2)	47 (20.5)	53 (18.7)	26 (16.6)	36 (25.5)	28 (17.6)	39 (23.1)	35 (16.6)	39 (24.2)	27 (17.1)	34 (17.0)	698 (20.3)
Known diabetes	No	361 (80.0)	128 (77.6)	220 (76.7)	186 (76.9)	190 (76.0)	152 (84.0)	186 (80.9)	236 (83.4)	132 (82.5)	116 (82.3)	119 (74.8)	135 (79.9)	169 (79.3)	123 (73.7)	122 (76.2)	163 (81.9)	2738 (79.2)
	Yes	90 (20.0)	37 (22.4)	67 (23.3)	56 (23.1)	60 (24.0)	29 (16.0)	44 (19.1)	47 (16.6)	28 (17.5)	25 (17.7)	40 (25.2)	34 (20.1)	44 (20.7)	44 (26.3)	38 (23.8)	36 (18.1)	719 (20.8)
History of IHD or CVA**	No	337 (74.7)	122 (73.9)	233 (81.2)	191 (78.9)	186 (74.4)	154 (85.1)	182 (79.1)	228 (80.6)	133 (83.1)	117 (83.0)	130 (81.8)	137 (81.1)	170 (80.2)	141 (84.4)	128 (80.5)	167 (83.5)	2756 (79.7)
	Yes	114 (25.3)	43 (26.1)	54 (18.8)	51 (21.1)	64 (25.6)	27 (14.9)	48 (20.9)	55 (19.4)	27 (16.9)	24 (17.0)	29 (18.2)	32 (18.9)	42 (19.8)	26 (15.6)	31 (19.5)	33 (16.5)	700 (20.3)
Smoking status	No	269 (59.8)	109 (66.5)	197 (69.1)	162 (67.5)	172 (68.8)	115 (63.5)	161 (70.0)	166 (59.1)	110 (71.0)	89 (63.1)	116 (73.4)	112 (66.3)	137 (65.2)	109 (65.7)	122 (77.2)	142 (71.4)	2288 (66.6)
	Yes - Current (or stopped <6 weeks)	79 (17.6)	20 (12.2)	40 (14.0)	29 (12.1)	26 (10.4)	24 (13.3)	22 (9.6)	61 (21.7)	17 (11.0)	18 (12.8)	18 (11.4)	17 (10.1)	22 (10.5)	26 (15.7)	9 (5.7)	17 (8.5)	445 (12.9)
	Yes Ex smoker (stopped >6 weeks)	102 (22.7)	35 (21.3)	48 (16.8)	49 (20.4)	52 (20.8)	42 (23.2)	47 (20.4)	54 (19.2)	28 (18.1)	34 (24.1)	24 (15.2)	40 (23.7)	51 (24.3)	31 (18.7)	27 (17.1)	40 (20.1)	704 (20.5)
Oral anti-coagulants	No	356 (79.3)	137 (83.0)	244 (85.3)	197 (81.4)	207 (82.8)	151 (83.4)	199 (86.5)	238 (84.7)	144 (90.0)	120 (85.1)	143 (89.9)	153 (90.5)	184 (86.4)	149 (89.2)	140 (89.2)	166 (84.3)	2928 (84.9)
	Yes	93 (20.7)	28 (17.0)	42 (14.7)	45 (18.6)	43 (17.2)	30 (16.6)	31 (13.5)	43 (15.3)	16 (10.0)	21 (14.9)	16 (10.1)	16 (9.5)	29 (13.6)	18 (10.8)	17 (10.8)	31 (15.7)	519 (15.1)
Pre-op total protein (g/dL)	4.5	37 (8.6)	5 (3.1)	19 (6.9)	21 (9.3)	23 (11.8)	1 (0.7)	8 (3.7)	26 (10.6)	7 (4.6)	9 (7.6)	19 (11.9)	3 (1.8)	13 (6.9)	11 (8.5)	3 (2.0)	13 (7.2)	218 (6.9)

*BMI = kg/m^2

**IHD – ischemic heart disease, CVA- cerebral vascular accident

Supplement Table 5: Operative factors by sequence.

Factors	Levels	Sequence			
		1	2	3	Total
Timing of surgery	Elective (planned)	618 (70.8%)	1063 (66.2%)	675 (68.9%)	2356 (68.1%)
	Expedited (within two weeks of decision)	89 (10.2%)	151 (9.4%)	127 (13.0%)	367 (10.6%)
	Emergency (unplanned)	166 (19.0%)	391 (24.4%)	178 (18.2%)	735 (21.3%)
Indication for surgery	Malignancy	711 (81.7%)	1190 (74.4%)	791 (81.0%)	2692 (78.1%)
	Inflammatory bowel disease	50 (5.7%)	156 (9.8%)	79 (8.1%)	285 (8.3%)
	Other	109 (12.5%)	254 (15.9%)	107 (11.0%)	470 (13.6%)
Bowel preparation	None	190 (21.8%)	318 (19.9%)	238 (24.4%)	746 (21.6%)
	Mechanical bowel preparation only	168 (19.3%)	278 (17.4%)	188 (19.2%)	634 (18.4%)
	Mechanical bowel preparation with oral antibiotics	514 (58.9%)	1006 (62.8%)	551 (56.4%)	2071 (60.0%)
American Society of Anaesthesiologists (ASA) grade	Grade I	103 (11.8%)	205 (12.9%)	91 (9.4%)	399 (11.6%)
	Grade II	394 (45.2%)	755 (47.6%)	449 (46.3%)	1598 (46.6%)
	Grade III	331 (38.0%)	551 (34.7%)	379 (39.1%)	1261 (36.8%)
	Grade IV	42 (4.8%)	67 (4.2%)	47 (4.8%)	156 (4.5%)
	Grade V	2 (0.2%)	9 (0.6%)	4 (0.4%)	15 (0.4%)
Primary operating surgeon	Consultant colorectal surgeon	460 (52.7%)	805 (50.2%)	526 (53.8%)	1791 (51.8%)
	Trainee colorectal surgeon	80 (9.2%)	236 (14.7%)	92 (9.4%)	408 (11.8%)
	Consultant general surgeon	263 (30.1%)	339 (21.1%)	258 (26.4%)	860 (24.9%)
	Trainee general surgeon	70 (8.0%)	224 (14.0%)	102 (10.4%)	396 (11.5%)
Most senior surgeon in theatre	Consultant colorectal surgeon	530 (60.6%)	1072 (66.8%)	630 (64.3%)	2232 (64.5%)
	Trainee colorectal surgeon	26 (3.0%)	34 (2.1%)	27 (2.8%)	87 (2.5%)
	Consultant general surgeon	272 (31.1%)	402 (25.1%)	274 (28.0%)	948 (27.4&)
	Trainee general surgeon	46 (5.3%)	96 (6.0%)	49 (5.0%)	191 (5.5%)
Operative approach	Open	385 (44.1%)	801 (49.9%)	447 (45.6%)	1633 (47.2%)
	Laparoscopic (completed)	401 (45.9%)	636 (39.6%)	443 (45.2%)	1480 (42.8%)
	Laparoscopic (converted to open)	68 (7.8%)	140 (8.7%)	55 (5.6%)	263 (7.6%)
	Robotic (completed)	19 (2.2%)	26 (1.6%)	35 (3.6%)	80 (2.3%)
	Robotic (converted to open)	1 (0.1%)	2 (0.1%)	0 (0.0%)	3 (0.1%)
Operative field contamination	Clean	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
	Clean-contaminated	762 (87.2%)	1332 (83.3%)	884 (90.3%)	2978 (86.3%)
	Contaminated	83 (9.5%)	178 (11.1%)	65 (6.6%)	326 (9.4%)
	Dirty	29 (3.3%)	89 (5.6%)	30 (3.1%)	148 (4.3%)

Supplement Table 6: Operative factors by batch. Percentage (%) represented down columns.

Factors	Levels	Batch																Total
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
Timing of surgery	Elective (planned)	326 (72.3)	119 (72.1)	197 (68.6)	205 (84.7)	195 (78.0)	124 (68.5)	156 (67.8)	193 (68.2)	102 (63.8)	94 (66.7)	104 (65.4)	91 (53.9)	144 (67.9)	97 (58.1)	110 (68.8)	99 (49.3)	2356 (68.1)
	Expedited (within two weeks of decision)	37 (8.2)	20 (12.1)	17 (5.9)	11 (4.6)	17 (6.8)	16 (8.8)	21 (9.1)	30 (10.6)	17 (10.6)	18 (12.8)	8 (5.0)	41 (24.3)	36 (17.0)	28 (16.8)	7 (4.4)	43 (21.4)	367 (10.6)
	Emergency (unplanned)	88 (19.5)	26 (15.8)	73 (25.4)	26 (10.7)	38 (15.2)	41 (22.7)	53 (23.0)	60 (21.2)	41 (25.6)	29 (20.6)	47 (29.6)	37 (21.9)	32 (15.1)	42 (25.2)	43 (26.9)	59 (29.4)	735 (21.3)
Indication for surgery	Malignancy	363 (80.5)	134 (81.7)	207 (72.4)	201 (83.4)	218 (87.2)	144 (80.4)	170 (74.2)	202 (71.6)	130 (81.8)	97 (69.3)	123 (77.4)	138 (82.1)	166 (77.9)	136 (81.4)	123 (77.4)	140 (70.0)	2692 (78.1)
	Inflammatory bowel disease	42 (9.3)	9 (5.5)	32 (11.2)	16 (6.6)	19 (7.6)	13 (7.3)	18 (7.9)	51 (18.1)	3 (1.9)	12 (8.6)	4 (2.5)	13 (7.7)	33 (15.5)	2 (1.2)	7 (4.4)	11 (5.5)	285 (8.3)
	Other	46 (10.2)	21 (12.8)	47 (16.4)	24 (10.0)	13 (5.2)	22 (12.3)	41 (17.9)	29 (10.3)	26 (16.4)	31 (22.1)	32 (20.1)	17 (10.1)	14 (6.6)	29 (17.4)	29 (18.2)	49 (24.5)	470 (13.6)
Bowel preparation	None	103 (22.8)	60 (36.4)	49 (17.1)	41 (16.9)	33 (13.2)	53 (29.6)	30 (13.0)	63 (22.3)	20 (12.7)	46 (32.6)	61 (38.4)	31 (18.3)	63 (29.7)	8 (4.8)	25 (15.6)	60 (30.0)	746 (21.6)
	Mechanical bowel preparation only	83 (18.4)	10 (6.1)	24 (8.4)	53 (21.9)	74 (29.6)	33 (18.4)	29 (12.6)	89 (31.6)	40 (25.3)	40 (28.4)	16 (10.1)	17 (10.1)	37 (17.5)	50 (29.9)	23 (14.4)	16 (8.0)	634 (18.4)
	Mechanical bowel preparation with oral antibiotics	265 (58.8)	95 (57.6)	213 (74.5)	148 (61.2)	143 (57.2)	93 (52.0)	171 (74.3)	130 (46.1)	98 (62.0)	55 (39.0)	82 (51.6)	121 (71.6)	112 (52.8)	109 (65.3)	112 (70.0)	124 (62.0)	2071 (60.0)
American Society of Anaesthesiologists (ASA) grade	Grade I	42 (9.3)	16 (9.7)	30 (10.5)	32 (13.3)	18 (7.2)	30 (16.7)	21 (9.5)	28 (10.0)	21 (13.3)	12 (8.5)	35 (22.0)	18 (10.7)	33 (15.6)	20 (12.4)	16 (10.1)	27 (13.6)	399 (11.6)
	Grade II	201 (44.7)	81 (49.1)	114 (39.7)	109 (45.2)	104 (41.8)	71 (39.4)	117 (53.2)	147 (52.7)	82 (51.9)	67 (47.5)	77 (48.4)	67 (39.6)	105 (49.5)	77 (47.8)	87 (54.7)	92 (46.2)	1598 (46.6)
	Grade III	183 (40.7)	63 (38.2)	123 (42.9)	96 (39.8)	115 (46.2)	69 (38.3)	70 (31.8)	92 (33.0)	50 (31.6)	46 (32.6)	40 (25.2)	73 (43.2)	68 (32.1)	55 (34.2)	47 (29.6)	71 (35.7)	1261 (36.8)
	Grade IV	23 (5.1)	5 (3.0)	19 (6.6)	4 (1.7)	10 (4.0)	10 (5.6)	10 (4.5)	8 (2.9)	5 (3.2)	15 (10.6)	5 (3.1)	11 (6.5)	6 (2.8)	9 (5.6)	9 (5.7)	7 (3.5)	156 (4.5)
	Grade V	1 (0.2)	0 (0.0)	1 (0.3)	0 (0.0)	2 (0.8)	0 (0.0)	2 (0.9)	4 (1.4)	0 (0.0)	1 (0.7)	2 (1.3)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (1.0)	15 (0.4)
Primary operating surgeon	Consultant colorectal surgeon	229 (50.8)	84 (50.9)	150 (52.3)	151 (62.4)	136 (54.4)	88 (48.6)	136 (59.1)	201 (71.5)	59 (36.9)	92 (65.2)	75 (47.2)	77 (45.6)	100 (47.2)	84 (50.6)	75 (46.9)	54 (26.9)	1791 (51.8)
	Trainee colorectal surgeon	41 (9.1)	20 (12.1)	37 (12.9)	17 (7.0)	25 (10.0)	24 (13.3)	32 (13.9)	11 (3.9)	18 (11.2)	12 (8.5)	25 (15.7)	16 (9.5)	46 (21.7)	35 (21.1)	31 (19.4)	18 (9.0)	408 (11.8)
	Consultant general surgeon	120 (26.6)	46 (27.9)	47 (16.4)	53 (21.9)	58 (23.2)	65 (35.9)	45 (19.6)	49 (17.4)	48 (30.0)	22 (15.6)	43 (27.0)	67 (39.6)	42 (19.8)	33 (19.9)	34 (21.2)	88 (43.8)	860 (24.9)
	Trainee general surgeon	61 (13.5)	15 (9.1)	53 (18.5)	21 (8.7)	31 (12.4)	4 (2.2)	17 (7.4)	20 (7.1)	35 (21.9)	15 (10.6)	16 (10.1)	9 (5.3)	24 (11.3)	14 (8.4)	20 (12.5)	41 (20.4)	396 (11.5)
Most senior surgeon in theatre	Consultant colorectal surgeon	264 (58.5)	97 (58.8)	215 (74.9)	171 (70.7)	173 (69.2)	101 (55.8)	172 (74.8)	214 (75.6)	75 (46.9)	107 (75.9)	91 (57.2)	97 (57.4)	153 (71.8)	109 (65.7)	115 (71.9)	78 (38.8)	2232 (64.5)
	Trainee colorectal surgeon	16 (3.5)	8 (4.8)	8 (2.8)	6 (2.5)	7 (2.8)	5 (2.8)	2 (0.9)	1 (0.4)	8 (5.0)	5 (3.5)	8 (5.0)	3 (1.8)	5 (2.3)	5 (3.0)	0 (0.0)	0 (0.0)	87 (2.5)
	Consultant general surgeon	138 (30.6)	54 (32.7)	55 (19.2)	58 (24.0)	64 (25.6)	65 (35.9)	41 (17.8)	55 (19.4)	53 (33.1)	23 (16.3)	53 (33.3)	66 (39.1)	48 (22.5)	52 (31.3)	36 (22.5)	87 (43.3)	948 (27.4)
	Trainee general surgeon	33 (7.3)	6 (3.6)	9 (3.1)	7 (2.9)	6 (2.4)	10 (5.5)	15 (6.5)	13 (4.6)	24 (15.0)	6 (4.3)	7 (4.4)	3 (1.8)	7 (3.3)	0 (0.0)	9 (5.6)	36 (17.9)	191 (5.5)
Operative approach	Open	216 (47.9)	72 (43.6)	119 (41.5)	100 (41.3)	102 (40.8)	66 (36.5)	108 (47.0)	124 (43.8)	90 (56.2)	57 (40.4)	99 (62.3)	99 (58.6)	98 (46.0)	94 (56.3)	73 (45.6)	116 (57.7)	1633 (47.2)
	Laparoscopic (completed)	184 (40.8)	81 (49.1)	142 (49.5)	111 (45.9)	125 (50.0)	83 (45.9)	105 (45.7)	135 (47.7)	50 (31.2)	62 (44.0)	57 (35.8)	59 (34.9)	91 (42.7)	64 (38.3)	64 (40.0)	67 (33.3)	1480 (42.8)
	Laparoscopic (converted to open)	30 (6.7)	7 (4.2)	22 (7.7)	13 (5.4)	23 (9.2)	27 (14.9)	17 (7.4)	19 (6.7)	15 (9.4)	19 (13.5)	2 (1.3)	11 (6.5)	23 (10.8)	6 (3.6)	15 (9.4)	14 (7.0)	263 (7.6)
	Robotic (completed)	21 (4.7)	5 (3.0)	4 (1.4)	17 (7.0)	0 (0.0)	5 (2.8)	0 (0.0)	5 (1.8)	4 (2.5)	3 (2.1)	1 (0.6)	0 (0.0)	1 (0.5)	3 (1.8)	7 (4.4)	4 (2.0)	80 (2.3)
	Robotic (converted to open)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.4)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.6)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.6)	0 (0.0)	3 (0.1)
Operative field contamination	Clean	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
	Clean-contaminated	343 (76.1)	153 (92.7)	255 (88.9)	228 (94.2)	229 (91.6)	157 (86.7)	199 (86.5)	246 (86.9)	142 (88.8)	123 (87.2)	132 (83.0)	143 (84.6)	185 (87.3)	142 (88.2)	140 (87.5)	161 (80.1)	2978 (86.3)
	Contaminated	87 (19.3)	8 (4.8)	23 (8.0)	10 (4.1)	19 (7.6)	19 (10.5)	18 (7.8)	25 (8.8)	12 (7.5)	13 (9.2)	8 (5.0)	18 (10.7)	20 (9.4)	11 (6.8)	12 (7.5)	23 (11.4)	326 (9.4)
	Dirty	21 (4.7)	4 (2.4)	9 (3.1)	4 (1.7)	2 (0.8)	5 (2.8)	13 (5.7)	12 (4.2)	6 (3.8)	5 (3.5)	19 (11.9)	8 (4.7)	7 (3.3)	8 (5.0)	8 (5.0)	17 (8.5)	148 (4.3)

Supplementary Table 7: Patient demographics and operative factors in patients excluded from the primary outcome analysis

Factors	Levels	Pre-intervention	Post-intervention	Total
Age (years)	Median (IQR)	65.0 (48.0 to 76.0)	68.5 (60.0 to 76.8)	67.0 (54.2 to 76.0)
Sex	Female	134 (57.3%)	100 (53.8%)	234 (55.7%)
	Male	100 (42.7%)	86 (46.2%)	186 (44.3%)
BMI*>30	No	190 (83.0%)	142 (76.3%)	332 (80.0%)
	Yes	39 (17.0%)	44 (23.7%)	83 (20.0%)
Known diabetes	No	185 (79.4%)	127 (68.6%)	312 (74.6%)
	Yes	48 (20.6%)	58 (31.4%)	106 (25.4%)
History of IHD or CVA**	No	185 (79.7%)	129 (69.4%)	314 (75.1%)
	Yes	47 (20.3%)	57 (30.6%)	104 (24.9%)
Smoking status	No	141 (61.6%)	116 (62.4%)	257 (61.9%)
	Yes - Current (or stopped <6 weeks)	48 (21.0%)	46 (24.7%)	94 (22.7%)
	Yes - Ex smoker (stopped >6 weeks)	40 (17.5%)	24 (12.9%)	64 (15.4%)
Oral anti-coagulants	No	194 (83.3%)	159 (85.5%)	353 (84.2%)
	Yes	39 (16.7%)	27 (14.5%)	66 (15.8%)
Pre-operative total protein level (g/dL)	4.5	34 (15.9%)	21 (11.9%)	55 (14.1%)
	4.5-5.5	72 (33.6%)	58 (32.8%)	130 (33.2%)
	6.0-7.5	104 (48.6%)	97 (54.8%)	201 (51.4%)
	≥8	4 (1.9%)	1 (0.6%)	5 (1.3%)
Pre-operative haemoglobin (g/dL)	< 60	17 (7.3%)	0 (0.0%)	17 (4.1%)
	60-89	32 (13.8%)	36 (19.6%)	68 (16.3%)
	90-119	96 (41.4%)	84 (45.7%)	180 (43.3%)
	120-139	50 (21.6%)	47 (25.5%)	97 (23.3%)
	≥140	37 (15.9%)	17 (9.2%)	54 (13.0%)
Timing of surgery	Elective (planned)	88 (37.6%)	94 (50.8%)	182 (43.4%)
	Expedited (within two weeks of decision)	23 (9.8%)	18 (9.7%)	41 (9.8%)
	Emergency (unplanned)	123 (52.6)	73 (39.5)	196 (46.8%)
Indication for surgery	Malignancy	135 (57.7%)	122 (65.9%)	257 (61.3%)
	Inflammatory bowel disease	27 (11.5%)	12 (6.5%)	39 (9.3%)
	Other	72 (30.8%)	51 (27.6%)	123 (29.4%)
Bowel preparation	None	48 (20.5%)	27 (14.5%)	75 (17.9%)
	Mechanical bowel preparation only	28 (12.0%)	34 (18.3%)	62 (14.8%)
	Mechanical bowel preparation with oral antibiotics	158 (67.5%)	125 (67.2%)	283 (67.4%)
American Society of Anaesthesiologists (ASA) grade	Grade I	32 (14.0%)	12 (6.5%)	44 (10.6%)
	Grade II	88 (38.4%)	78 (41.9%)	166 (40.0%)
	Grade III	82 (35.8%)	73 (39.2%)	155 (37.3%)
	Grade IV	20 (8.7%)	22 (11.8%)	42 (10.1%)
	Grade V	7 (3.1%)	1 (0.5%)	8 (1.9%)
Primary operating surgeon	Consultant colorectal surgeon	86 (36.8%)	75 (40.3%)	161 (38.3%)
	Trainee colorectal surgeon	25 (10.7%)	21 (11.3%)	46 (11.0%)
	Consultant general surgeon	62 (26.5%)	63 (33.9%)	125 (29.8%)
	Trainee general surgeon	61 (26.1%)	27 (14.5%)	88 (21.0%)
Most senior surgeon in theatre	Consultant colorectal surgeon	112 (48.1%)	102 (54.8%)	214 (51.1%)
	Trainee colorectal surgeon	4 (1.7%)	5 (2.7%)	9 (2.1%)
	Consultant general surgeon	94 (40.3%)	64 (34.4%)	158 (37.7%)
	Trainee general surgeon	23 (9.9%)	15 (8.1%)	38 (9.1%)
Operative approach	Open	172 (73.5%)	114 (61.3%)	286 (68.1%)
	Laparoscopic (completed)	46 (19.7%)	59 (31.7%)	105 (25.0%)
	Laparoscopic (converted to open)	13 (5.6%)	9 (4.8%)	22 (5.2%)
	Robotic (completed)	3 (1.3%)	4 (2.2%)	7 (1.7%)
	Robotic (converted to open)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Operative field contamination	Clean	0 (0.0%)	0 (0.0%)	0 (0.0%)
	Clean-contaminated	137 (59.3%)	123 (66.1%)	260 (62.4%)
	Contaminated	54 (23.4%)	40 (21.5%)	94 (22.5%)
	Dirty	40 (17.3%)	23 (12.4%)	63 (15.1%)

*BMI = kg/m^2, **IHD – ischemic heart disease, CVA- cerebral vascular accident

Secondary outcomes

Supplementary Table 8: Secondary outcomes in the pre-intervention group, by batch, percentage (%) down columns

Outcomes	Levels	Batch																
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
Clinical leak	No	241 (97.6)	39 (97.5)	104 (90.4)	118 (95.2)	139 (92.7)	87 (93.5)	114 (97.4)	142 (95.3)	70 (92.1)	57 (90.5)	77 (96.2)	77 (96.2)	91 (91.9)	68 (86.1)	73 (93.6)	97 (98.0)	1594 (94.4)
	Yes	6 (2.4)	1 (2.5)	11 (9.6)	6 (4.8)	11 (7.3)	6 (6.5)	3 (2.6)	7 (4.7)	6 (7.9)	6 (9.5)	3 (3.8)	3 (3.8)	8 (8.1)	11 (13.9)	5 (6.4)	2 (2.0)	95 (5.6)
	(Missing)	0	0	0	1	0	0	4	4	0	0	0	0	7	0	1	0	17
Mortality	No	247 (94.6)	41 (97.6)	121 (96.8)	123 (97.6)	151 (96.8)	91 (94.8)	116 (95.9)	151 (97.4)	84 (97.7)	66 (97.1)	86 (98.9)	80 (90.9)	106 (96.4)	78 (90.7)	82 (98.8)	104 (92.9)	1727 (95.8)
	Yes	14 (5.4)	1 (2.4)	4 (3.2)	3 (2.4)	5 (3.2)	5 (5.2)	5 (4.1)	4 (2.6)	2 (2.3)	2 (2.9)	1 (1.1)	8 (9.1)	4 (3.6)	8 (9.3)	1 (1.2)	8 (7.1)	75 (4.2)
	(Missing)	0	0	0	0	0	0	5	6	0	0	0	0	8	2	2	2	25
Re-operation	No	244 (93.5)	40 (95.2)	109 (87.2)	120 (95.2)	143 (91.7)	90 (93.8)	117 (96.7)	144 (92.9)	77 (89.5)	60 (88.2)	84 (96.6)	79 (89.8)	102 (93.6)	73 (83.9)	80 (95.2)	106 (93.8)	1668 (92.5)
	Yes	17 (6.5)	2 (4.8)	16 (12.8)	6 (4.8)	13 (8.3)	6 (6.2)	4 (3.3)	11 (7.1)	9 (10.5)	8 (11.8)	3 (3.4)	9 (10.2)	7 (6.4)	14 (16.1)	4 (4.8)	7 (6.2)	136 (7.5)
	(Missing)	0	0	0	0	0	0	5	6	0	0	0	0	9	1	1	1	23
Re-admission	No	243 (93.1)	41 (97.6)	117 (93.6)	115 (91.3)	148 (94.9)	93 (96.9)	115 (95.0)	146 (94.2)	76 (88.4)	63 (92.6)	82 (94.3)	82 (93.2)	88 (80.0)	82 (94.3)	77 (92.8)	112 (99.1)	1680 (93.1)
	Yes	18 (6.9)	1 (2.4)	8 (6.4)	11 (8.7)	8 (5.1)	3 (3.1)	6 (5.0)	9 (5.8)	10 (11.6)	5 (7.4)	5 (5.7)	6 (6.8)	22 (20.0)	5 (5.7)	6 (7.2)	1 (0.9)	124 (6.9)
	(Missing)	0	0	0	0	0	0	5	6	0	0	0	0	8	1	2	1	23
Length of stay	<=10	197 (75.5)	33 (78.6)	89 (71.2)	104 (82.5)	112 (71.8)	70 (72.9)	94 (77.0)	117 (75.0)	64 (76.2)	54 (79.4)	72 (82.8)	61 (69.3)	75 (68.2)	47 (56.6)	61 (71.8)	77 (69.4)	1327 (73.7)
	>10	64 (24.5)	9 (21.4)	36 (28.8)	22 (17.5)	44 (28.2)	26 (27.1)	28 (23.0)	39 (25.0)	20 (23.8)	14 (20.6)	15 (17.2)	27 (30.7)	35 (31.8)	36 (43.4)	24 (28.2)	34 (30.6)	473 (26.3)
	(Missing)	0	0	0	0	0	0	4	5	2	0	0	0	8	5	0	3	27
Unplanned admission to intensive care	No	247 (95.4)	40 (97.6)	122 (97.6)	124 (98.4)	152 (97.4)	93 (97.9)	120 (97.6)	146 (93.6)	83 (98.8)	67 (98.5)	87 (100.0)	82 (93.2)	108 (98.2)	77 (89.5)	83 (97.6)	104 (92.0)	1735 (96.3)
	Yes	12 (4.6)	1 (2.4)	3 (2.4)	2 (1.6)	4 (2.6)	2 (2.1)	3 (2.4)	10 (6.4)	1 (1.2)	1 (1.5)	0 (0.0)	6 (6.8)	2 (1.8)	9 (10.5)	2 (2.4)	9 (8.0)	67 (3.7)
	(Missing)	2	1	0	0	0	1	3	5	2	0	0	0	8	2	0	1	25
Stoma without primary anastomosis	No	247 (94.6)	40 (95.2)	115 (92.0)	125 (99.2)	150 (96.2)	93 (96.9)	121 (96.0)	151 (95.0)	76 (88.4)	63 (92.6)	80 (92.0)	80 (90.9)	105 (89.7)	79 (89.8)	79 (92.9)	99 (86.8)	1703 (93.4)
	Yes	14 (5.4)	2 (4.8)	10 (8.0)	1 (0.8)	6 (3.8)	3 (3.1)	5 (4.0)	8 (5.0)	10 (11.6)	5 (7.4)	7 (8.0)	8 (9.1)	12 (10.3)	9 (10.2)	6 (7.1)	15 (13.2)	121 (6.6)
	(Missing)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Defunctioning ileostomy with primary anastomosis	No	256 (98.5)	42 (100.0)	124 (99.2)	124 (98.4)	155 (99.4)	95 (99.0)	119 (94.4)	142 (89.3)	86 (100.0)	68 (100.0)	84 (96.6)	86 (97.7)	110 (94.0)	87 (98.9)	83 (98.8)	111 (98.2)	1772 (97.3)
	Yes	4 (1.5)	0	1 (0.8)	2 (1.6)	1 (0.6)	1 (1.0)	7 (5.6)	17 (10.7)	0	0	3 (3.4)	2 (2.3)	7 (6.0)	1 (1.1)	1 (1.2)	2 (1.8)	49 (2.7)
	(Missing)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Supplementary Table 9: Secondary outcomes in the post-intervention group, by batch, percentage (%) down columns

Outcomes	Levels	Batch																
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
Clinical leak	No	115 (98.3)	106 (91.4)	146 (95.4)	102 (99.0)	78 (96.3)	81 (96.4)	85 (97.7)	94 (97.9)	49 (98.0)	52 (88.1)	58 (98.3)	72 (94.7)	54 (87.1)	66 (97.1)	52 (92.9)	77 (95.1)	1287 (95.5)
	Yes	2 (1.7)	10 (8.6)	7 (4.6)	1 (1.0)	3 (3.7)	3 (3.6)	2 (2.3)	2 (2.1)	1 (2.0)	7 (11.9)	1 (1.7)	4 (5.3)	8 (12.9)	2 (2.9)	4 (7.1)	4 (4.9)	61 (4.5)
	(Missing)	0	0	0	0	0	0	0	0	6	0	2	0	0	0	0	0	8
Mortality	No	122 (93.8)	115 (96.6)	156 (96.3)	107 (100.0)	81 (95.3)	82 (97.6)	90 (96.8)	102 (97.1)	54 (96.4)	62 (95.4)	58 (93.5)	75 (94.9)	61 (96.8)	67 (95.7)	64 (94.1)	79 (94.0)	1375 (96.0)
	Yes	8 (6.2)	4 (3.4)	6 (3.7)	0	4 (4.7)	2 (2.4)	3 (3.2)	3 (2.9)	2 (3.6)	3 (4.6)	4 (6.5)	4 (5.1)	2 (3.2)	3 (4.3)	4 (5.9)	5 (6.0)	57 (4.0)
	(Missing)	0	0	0	0	0	0	0	0	7	0	2	0	0	0	0	0	9
Re-operation	No	123 (94.6)	104 (87.4)	154 (95.1)	104 (97.2)	81 (95.3)	78 (92.9)	83 (89.2)	101 (96.2)	52 (92.9)	56 (86.2)	58 (93.5)	72 (91.1)	56 (88.9)	69 (98.6)	60 (88.2)	81 (96.4)	1332 (93.0)
	Yes	7 (5.4)	15 (12.6)	8 (4.9)	3 (2.8)	4 (4.7)	6 (7.1)	10 (10.8)	4 (3.8)	4 (7.1)	9 (13.8)	4 (6.5)	7 (8.9)	7 (11.1)	1 (1.4)	8 (11.8)	3 (3.6)	100 (7.0)
	(Missing)	0	0	0	0	0	0	0	0	7	0	2	0	0	0	0	0	9
Re-admission	No	121 (93.1)	114 (95.8)	155 (95.7)	102 (95.3)	81 (95.3)	78 (92.9)	86 (92.5)	99 (94.3)	50 (89.3)	60 (92.3)	62 (100.0)	78 (98.7)	55 (87.3)	64 (91.4)	66 (97.1)	80 (95.2)	1351 (94.3)
	Yes	9 (6.9)	5 (4.2)	7 (4.3)	5 (4.7)	4 (4.7)	6 (7.1)	7 (7.5)	6 (5.7)	6 (10.7)	5 (7.7)	0	1 (1.3)	8 (12.7)	6 (8.6)	2 (2.9)	4 (4.8)	81 (5.7)
	(Missing)	0	0	0	0	0	0	0	0	7	0	2	0	0	0	0	0	9
Length of stay	<=10	96 (74.4)	89 (74.8)	135 (83.3)	85 (83.3)	67 (78.8)	61 (72.6)	55 (59.8)	83 (79.0)	40 (71.4)	33 (50.8)	42 (67.7)	50 (64.1)	43 (68.3)	56 (80.0)	48 (70.6)	61 (72.6)	1044 (73.3)
	>10	33 (25.6)	30 (25.2)	27 (16.7)	17 (16.7)	18 (21.2)	23 (27.4)	37 (40.2)	22 (21.0)	16 (28.6)	32 (49.2)	20 (32.3)	28 (35.9)	20 (31.7)	14 (20.0)	20 (29.4)	23 (27.4)	380 (26.7)
	(Missing)	1	0	0	5	0	0	1	0	7	0	2	1	0	0	0	0	17
Unplanned admission to intensive care	No	129 (99.2)	115 (96.6)	158 (98.1)	107 (100.0)	82 (96.5)	76 (92.7)	92 (98.9)	98 (93.3)	55 (94.8)	59 (90.8)	59 (96.7)	77 (98.7)	61 (96.8)	69 (98.6)	65 (95.6)	79 (96.3)	1381 (96.8)
	Yes	1 (0.8)	4 (3.4)	3 (1.9)	0	3 (3.5)	6 (7.3)	1 (1.1)	7 (6.7)	3 (5.2)	6 (9.2)	2 (3.3)	1 (1.3)	2 (3.2)	1 (1.4)	3 (4.4)	3 (3.7)	46 (3.2)
	(Missing)	0	0	1	0	0	2	0	0	5	0	3	1	0	0	0	2	14
Stoma without primary anastomosis	No	117 (90.0)	116 (97.5)	153 (94.4)	103 (96.3)	80 (95.2)	84 (100.0)	87 (93.5)	96 (91.4)	56 (88.9)	59 (90.8)	61 (95.3)	76 (96.2)	62 (98.4)	68 (97.1)	55 (82.1)	81 (96.4)	1354 (94.1)
	Yes	13 (10.0)	3 (2.5)	9 (5.6)	4 (3.7)	4 (4.8)		6 (6.5)	9 (8.6)	7 (11.1)	6 (9.2)	3 (4.7)	3 (3.8)	1 (1.6)	2 (2.9)	12 (17.9)	3 (3.6)	85 (5.9)
	(Missing)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Defunctioning ileostomy with primary anastomosis	No	130 (100.0)	119 (100.0)	157 (96.9)	107 (100.0)	82 (97.6)	83 (98.8)	91 (98.9)	103 (98.1)	63 (100.0)	62 (95.4)	61 (95.3)	79 (100.0)	62 (98.4)	69 (100.0)	62 (92.5)	83 (100.0)	1413 (98.4)
	Yes	0	0	5 (3.1)	0	2 (2.4)	1 (1.2)	1 (1.1)	2 (1.9)	0	3 (4.6)	3 (4.7)	0	1 (1.6)	0	5 (7.5)	0	23 (1.6)
	(Missing)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Subgroup analyses

Supplementary Table 10: Subgroup analysis of anastomotic leak by number of beds per hospital, presented by batch

	Anastomotic leak rate			
Batch	Pre-intervention	Post-intervention	Pre-intervention	Post-intervention
	<500 beds		>=500 beds	
Total	71 (11.0%)	44 (9.5%)	99 (9.4%)	85 (9.6%)
1	5 (5.7%)	1 (4.3%)	17 (10.7%)	9 (9.6%)
2	2 (22.2%)	4 (9.5%)	3 (9.7%)	11 (14.9%)
3	6 (15.4%)	3 (7.3%)	7 (9.2%)	7 (6.2%)
4	8 (18.2%)	2 (5.1%)	4 (4.9%)	3 (4.7%)
5	4 (9.3%)	0 (0.0%)	13 (12.1%)	4 (8.5%)
6	5 (14.7%)	3 (15.0%)	4 (6.8%)	3 (4.7%)
7	2 (5.3%)	2 (3.6%)	3 (3.8%)	4 (12.5%)
8	5 (6.5%)	3 (7.7%)	9 (12.5%)	5 (8.8%)
9	2 (14.3%)	0 (0.0%)	6 (9.7%)	5 (12.8%)
10	7 (17.5%)	7 (25.0%)	3 (13.0%)	4 (12.9%)
11	6 (13.3%)	3 (20.0%)	1 (2.9%)	1 (2.3%)
12	5 (12.5%)	3 (18.8%)	3 (7.5%)	7 (11.7%)
13	6 (10.2%)	3 (13.6%)	3 (7.5%)	9 (22.5%)
14	2 (25.0%)	2 (18.2%)	12 (16.9%)	2 (3.5%)
15	2 (7.1%)	2 (7.1%)	5 (9.8%)	2 (7.1%)
16	4 (10.8%)	6 (16.2%)	6 (9.7%)	9 (20.5%)

Supplementary Table 11: Subgroup analysis of anastomotic leak by right colectomy volume per hospital per year, presented by batch

	Anastomotic leak rate			
Batch	Pre-intervention	Post-intervention	Pre-intervention	Post-intervention
	<10 patients		>=10 patients	
Total	55 (9.4%)	50 (9.8%)	115 (10.4%)	79 (9.4%)
1	3 (2.9%)	1 (2.9%)	19 (13.4%)	9 (11.0%)
2	3 (20.0%)	1 (3.6%)	2 (8.0%)	14 (15.9%)
3	6 (13.3%)	6 (12.5%)	7 (10.0%)	4 (3.8%)
4	6 (16.7%)	1 (5.6%)	6 (6.7%)	4 (4.7%)
5	2 (6.7%)	2 (4.4%)	15 (12.5%)	2 (5.6%)
6	6 (12.5%)	3 (12.5%)	3 (6.7%)	3 (5.0%)
7	0 (0.0%)	5 (14.7%)	5 (5.7%)	1 (1.9%)
8	3 (8.8%)	3 (8.3%)	11 (9.6%)	5 (8.3%)
9	4 (10.3%)	5 (12.2%)	4 (10.8%)	0 (0.0%)
10	5 (14.7%)	6 (18.8%)	5 (17.2%)	5 (18.5%)
11	0 (0.0%)	3 (15.0%)	7 (11.1%)	1 (2.6%)
12	6 (12.8%)	2 (10.0%)	2 (6.1%)	8 (14.3%)
13	6 (14.6%)	3 (12.0%)	3 (5.2%)	9 (24.3%)
14	2 (8.0%)	2 (6.9%)	12 (22.2%)	2 (5.1%)
15	3 (11.1%)	3 (8.6%)	4 (7.7%)	1 (4.8%)
16	0 (0.0%)	4 (10.5%)	10 (11.9%)	11 (25.6%)

Supplementary Table 12: Subgroup analysis of anastomotic leak by early or late recruitment of participating hospital, presented by batch

	Anastomotic leak rate			
Batch	Pre-intervention	Post-intervention	Pre-intervention	Post-intervention
	Early (Batches 1-8)		Late (Batches 9-16)	
Total	97 (9.4%)	64 (7.6%)	73 (11.1%)	65 (12.7%)
1	22 (8.9%)	10 (8.5%)	NA	NA
2	5 (12.5%)	15 (12.9%)	NA	NA
3	13 (11.3%)	10 (6.5%)	NA	NA
4	12 (9.6%)	5 (4.9%)	NA	NA
5	17 (11.3%)	4 (4.9%)	NA	NA
6	9 (9.7%)	6 (7.1%)	NA	NA
7	5 (4.3%)	6 (6.9%)	NA	NA
8	14 (9.4%)	8 (8.3%)	NA	NA
9	NA	NA	8 (10.5%)	5 (10.0%)
10	NA	NA	10 (15.9%)	11 (18.6%)
11	NA	NA	7 (8.8%)	4 (6.8%)
12	NA	NA	8 (10.0%)	10 (13.2%)
13	NA	NA	9 (9.1%)	12 (19.4%)
14	NA	NA	14 (17.7%)	4 (5.9%)
15	NA	NA	7 (8.9%)	4 (7.1%)
16	NA	NA	10 (10.1%)	15 (18.5%)

Supplementary Table 13: Subgroup analysis of anastomotic leak by health service expenditure (World Bank definition), presented by batch

	Anastomotic leak rate					
Batch	Pre-intervention	Post-intervention	Pre-intervention	Post-intervention	Pre-intervention	Post-intervention
	Low		Middle		Top	
Total	21 (17.5%)	14 (12.5%)	27 (9.3%)	20 (11.2%)	122 (9.5%)	95 (9.0%)
1	0 (0.0%)	0 (0.0%)	1 (4.3%)	1 (11.1%)	21 (9.4%)	9 (8.3%)
2	0 (0.0%)	0 (0.0%)	1 (12.5%)	2 (9.1%)	4 (12.5%)	13 (13.8%)
3	1 (50.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	12 (11.2%)	10 (6.8%)
4	0 (0.05)	0 (0.0%)	0 (0.0%)	1 (16.7%)	12 (10.8%)	4 (4.1%)
5	0 (0.0%)	0 (0.0%)	3 (15.8%)	0 (0.0%)	14 (10.7%)	4 (5.6%)
6	3 (27.3%)	1 (16.7%)	0 (0.0%)	0 (0.0%)	6 (7.4%)	5 (6.8%)
7	0 (0.0%)	0 (0.0%)	2 (33.3%)	0 (0.0%)	3 (3.6%)	6 (8.5%)
8	0 (0.0%)	1 (6.2%)	5 (8.3%)	2 (11.8%)	9 (10.1%)	5 (7.9%)
9	3 (13.0%)	3 (18.8%)	1 (4.0%)	2 (10.0%)	4 (14.3%)	0 (0.0%)
10	1 (20.0%)	0 (0.0%)	0 (0.0%)	2 (50.0%)	9 (15.5%)	9 (18.0%)
11	5 (25.0%)	2 (12.5%)	1 (3.0%)	0 (0.0%)	1 (3.7%)	2 (9.5%)
12	2 (20.0%)	0 (0.0%)	3 (12.5%)	1 (7.7%)	3 (6.5%)	9 (16.7%)
13	1 (14.3%)	1 (50.0%)	4 (9.5%)	3 (12.5%)	4 (8.0%)	8 (22.2%)
14	0 (0.0%)	0 (0.0%)	3 (21.4%)	4 (21.1%)	11 (16.9%)	0 (0.0%)
15	0 (0.0%)	1 (20.0%)	3 (20.0%)	1 (50.0%)	4 (6.5%)	2 (4.1%)
16	5 (41.7%)	5 (26.3%)	0 (0.0%)	1 (33.3%)	5 (5.8%)	9 (15.3%)

Supplementary Table 14: Subgroup analysis of anastomotic leak by World Bank income group, presented by batch

	Anastomotic leak rate			
Batch	Pre-intervention	Post-intervention	Pre-intervention	Post-intervention
	Low/middle Income		High Income	
Total	60 (11.7%)	37 (10.1%)	110 (9.3%)	92 (9.4%)
1	3 (6.0%)	1 (4.5%)	19 (9.6%)	9 (9.5%)
2	3 (23.1%)	3 (8.3%)	2 (7.4%)	12 (15.0%)
3	1 (12.5%)	0 (0.0%)	12 (11.2%)	10 (6.8%)
4	0 (0.0%)	2 (10.0%)	12 (10.6%)	3 (3.6%)
5	3 (10.3%)	0 (0.0%)	14 (11.6%)	4 (6.0%)
6	3 (15.0%)	1 (9.1%)	6 (8.2%)	5 (6.8%)
7	2 (5.9%)	1 (4.0%)	3 (3.6%)	5 (8.1%)
8	8 (8.7%)	2 (7.7%)	6 (10.5%)	6 (8.6%)
9	5 (9.1%)	3 (8.1%)	3 (14.3%)	2 (15.4%)
10	5 (17.2%)	4 (19.0%)	5 (14.7%)	7 (18.4%)
11	7 (14.6%)	2 (9.1%)	0 (0.0%)	2 (5.4%)
12	4 (13.3%)	2 (4.1%)	4 (8.0%)	8 (29.6%)
13	5 (10.2%)	4 (15.4%)	4 (8.0%)	8 (22.2%)
14	3 (21.4%)	4 (21.1%)	11 (16.9%)	0 (0.0%)
15	3 (18.8%)	2 (20.0%)	4 (6.3%)	2 (4.3%)
16	5 (38.5%)	6 (27.3%)	5 (5.8%)	9 (15.3%)

Supplementary Table 15: Subgroup analysis of anastomotic leak by proportion of surgeons completing online learning modules in each hospital, presented by batch

	Anastomotic leak rate					
Batch	Pre-intervention	Post-intervention	Pre-intervention	Post-intervention	Pre-intervention	Post-intervention
	<50%		50-79%		>=80%	
Total	59 (8.3%)	61 (13.8%)	50 (10.5%)	44 (10.2%)	61 (12.2%)	24 (5.1%)
1	2 (4.0%)	0 (0.0%)	5 (4.4%)	6 (6.8%)	15 (18.1%)	4 (14.8%)
2	3 (8.6%)	1 (6.2%)	2 (40.0%)	12 (28.6%)	0 (0.0%)	2 (3.4%)
3	3 (6.5%)	5 (12.5%)	5 (17.2%)	4 (5.7%)	5 (12.5%)	1 (2.3%)
4	2 (10.5%)	2 (5.9%)	5 (9.3%)	2 (5.6%)	5 (9.6%)	1 (3.0%)
5	8 (9.8%)	3 (8.8%)	6 (17.1%)	0 (0.0%)	3 (9.1%)	1 (2.6%)
6	1 (2.4%)	3 (8.1%)	3 (21.4%)	2 (11.1%)	5 (13.2%)	1 (3.4%)
7	0 (0.0%)	3 (60.0%)	2 (3.0%)	1 (2.6%)	3 (7.1%)	2 (4.7%)
8	4 (5.9%)	3 (7.7%)	5 (16.7%)	5 (20.0%)	5 (9.8%)	0 (0.0%)
9	2 (11.1%)	2 (13.3%)	2 (5.6%)	0 (0.0%)	4 (18.2%)	3 (13.6%)
10	7 (13.2%)	9 (20.0%)	3 (30.0%)	2 (14.3%)	0 (0.0%)	0 (0.0%)
11	1 (2.6%)	2 (10.0%)	2 (8.0%)	1 (33.3%)	4 (23.5%)	1 (2.8%)
12	3 (5.4%)	10 (20.8%)	1 (8.3%)	0 (0.0%)	4 (33.3%)	0 (0.0%)
13	6 (8.5%)	9 (20.0%)	0 (0.0%)	0 (0.0%)	3 (12.0%)	3 (20.0%)
14	12 (22.6%)	2 (8.7%)	0 (0.0%)	2 (7.4%)	2 (7.7%)	0 (0.0%)
15	2 (5.1%)	2 (15.4%)	2 (15.4%)	1 (6.2%)	3 (11.1%)	1 (3.7%)
16	3 (8.1%)	5 (18.5%)	7 (23.3%)	6 (42.9%)	0 (0.0%)	4 (10.0%)

Supplementary Table 16: Subgroup analysis of anastomotic leak by indication for surgery, presented by batch

	Anastomotic leak rate			
Batch	Pre-intervention	Post-intervention	Pre-intervention	Post-intervention
	Benign		Malignant	
Total	54 (15.6%)	29 (11.8%)	114 (8.5%)	100 (9.1%)
1	9 (20.0%)	1 (4.5%)	13 (6.4%)	9 (9.5%)
2	1 (25.0%)	3 (15.0%)	4 (11.1%)	12 (12.6%)
3	4 (14.8%)	3 (7.3%)	9 (10.2%)	7 (6.3%)
4	3 (12.0%)	0 (0.0%)	9 (9.1%)	5 (5.5%)
5	6 (27.3%)	0 (0.0%)	11 (8.6%)	4 (5.4%)
6	3 (18.8%)	2 (12.5%)	5 (6.6%)	4 (5.9%)
7	1 (4.3%)	2 (10.0%)	4 (4.3%)	4 (6.1%)
8	5 (12.5%)	4 (16.7%)	9 (8.3%)	4 (5.6%)
9	2 (12.5%)	0 (0.0%)	6 (10.2%)	5 (10.6%)
10	5 (25.0%)	2 (13.3%)	5 (11.6%)	9 (20.9%)
11	0 (0.0%)	3 (18.8%)	7 (10.1%)	1 (2.3%)
12	1 (7.7%)	0 (0.0%)	6 (9.1%)	10 (15.2%)
13	3 (15.0%)	5 (33.3%)	6 (7.6%)	7 (14.9%)
14	4 (22.2%)	0 (0.0%)	10 (16.4%)	4 (6.5%)
15	1 (7.1%)	0 (0.0%)	6 (9.2%)	4 (8.3%)
16	6 (18.2%)	4 (33.3%)	4 (6.1%)	11 (16.2%)

Supplementary Table 17: Subgroup analysis of anastomotic leak by urgency of procedure, presented by batch

	Anastomotic leak rate			
Batch	Pre-intervention	Post-intervention	Pre-intervention	Post-intervention
	Elective		Expedited/Emergency	
Total	106 (8.9%)	75 (7.7%)	64 (12.9%)	54 (14.7%)
1	14 (7.8%)	7 (7.4%)	8 (11.8%)	3 (13.0%)
2	3 (11.1%)	8 (9.0%)	2 (15.4%)	7 (25.9%)
3	10 (11.4%)	9 (8.3%)	3 (11.1%)	1 (2.2%)
4	11 (10.6%)	3 (3.2%)	1 (4.8%)	2 (20.0%)
5	13 (10.5%)	4 (6.6%)	4 (15.4%)	0 (0.0%)
6	4 (6.2%)	4 (6.8%)	5 (17.9%)	2 (8.0%)
7	3 (3.5%)	3 (4.8%)	2 (6.5%)	3 (12.0%)
8	8 (7.1%)	2 (3.1%)	6 (16.2%)	6 (18.8%)
9	7 (13.7%)	3 (7.9%)	1 (4.0%)	2 (16.7%)
10	6 (13.6%)	5 (13.2%)	4 (21.1%)	6 (28.6%)
11	6 (10.0%)	1 (2.9%)	1 (5.0%)	3 (12.5%)
12	3 (7.3%)	7 (15.6%)	5 (12.8%)	3 (9.7%)
13	6 (10.3%)	8 (15.7%)	3 (7.3%)	4 (36.4%)
14	4 (7.8%)	0 (0.0%)	10 (35.7%)	4 (14.8%)
15	4 (6.2%)	3 (6.7%)	3 (20.0%)	1 (9.1%)
16	4 (10.0%)	8 (14.0%)	6 (10.2%)	7 (29.2%)

Supplementary Table 18: Subgroup analysis of anastomotic leak by ASA grade, presented by batch

	Anastomotic leak rate			
Batch	Pre-intervention	Post-intervention	Pre-intervention	Post-intervention
	ASA 1-3		ASA 3-5	
Total	88 (8.8%)	64 (8.1%)	79 (11.6%)	64 (11.7%)
1	10 (7.0%)	6 (9.2%)	12 (11.5%)	4 (7.7%)
2	2 (7.4%)	4 (6.0%)	3 (23.1%)	11 (22.4%)
3	8 (13.1%)	5 (6.7%)	5 (9.3%)	5 (6.4%)
4	7 (9.9%)	3 (4.8%)	5 (9.4%)	2 (5.0%)
5	7 (10.3%)	1 (2.2%)	10 (12.2%)	3 (8.8%)
6	9 (17.3%)	2 (4.3%)	0 (0.0%)	4 (10.8%)
7	2 (2.6%)	3 (5.7%)	1 (2.8%)	3 (9.7%)
8	5 (6.1%)	4 (5.8%)	9 (13.6%)	3 (12.5%)
9	7 (13.7%)	2 (6.7%)	1 (4.2%)	3 (15.0%)
10	5 (13.5%)	6 (17.1%)	5 (19.2%)	5 (20.8%)
11	2 (3.6%)	2 (4.5%)	5 (20.0%)	2 (13.3%)
12	5 (10.6%)	5 (16.1%)	3 (9.1%)	5 (11.1%)
13	5 (7.1%)	7 (17.9%)	4 (14.3%)	5 (21.7%)
14	2 (5.0%)	2 (4.4%)	12 (32.4%)	2 (10.0%)
15	4 (7.0%)	3 (8.8%)	3 (14.3%)	1 (4.5%)
16	8 (13.8%)	9 (18.4%)	1 (2.6%)	6 (18.8%)

Supplementary Table 19: Subgroup analysis of anastomotic leak by operative approach, presented by batch

	Anastomotic leak rate			
Batch	Pre-intervention	Post-intervention	Pre-intervention	Post-intervention
	Open		Laparoscopic/robotic	
Total	124 (13.7%)	88 (12.8%)	46 (5.8%)	41 (6.2%)
1	17 (12.7%)	7 (15.2%)	5 (4.4%)	3 (4.2%)
2	5 (17.9%)	9 (20.0%)	0 (0.0%)	6 (8.5%)
3	7 (14.3%)	5 (6.8%)	6 (9.1%)	5 (6.2%)
4	7 (12.1%)	3 (6.4%)	5 (7.5%)	2 (3.6%)
5	12 (16.4%)	2 (5.1%)	5 (6.5%)	2 (4.8%)
6	5 (11.9%)	2 (4.2%)	4 (7.8%)	4 (11.1%)
7	4 (8.5%)	4 (7.4%)	1 (1.4%)	2 (6.1%)
8	11 (13.8%)	7 (16.3%)	3 (4.3%)	1 (1.9%)
9	5 (9.8%)	5 (14.7%)	3 (12.0%)	0 (0.0%)
10	5 (15.6%)	8 (24.2%)	5 (16.1%)	3 (11.5%)
11	5 (11.6%)	4 (9.1%)	2 (5.4%)	0 (0.0%)
12	6 (12.5%)	8 (15.4%)	2 (6.2%)	2 (8.3%)
13	6 (10.5%)	5 (16.7%)	3 (7.1%)	7 (21.9%)
14	13 (25.5%)	4 (12.9%)	1 (3.6%)	0 (0.0%)
15	7 (17.1%)	3 (11.5%)	0 (0.0%)	1 (3.3%)
16	9 (13.2%)	12 (27.3%)	1 (3.2%)	3 (8.1%)

Supplementary Table 20: Subgroup analysis of anastomotic leak by anastomotic technique, presented by batch

	Anastomotic leak rate			
Batch	Pre-intervention	Post-intervention	Pre-intervention	Post-intervention
	Handsewn		Stapled	
Total	71 (11.8%)	45 (9.3%)	99 (9.1%)	83 (9.6%)
1	7 (6.0%)	4 (8.9%)	15 (11.5%)	6 (8.3%)
2	4 (23.5%)	4 (14.3%)	1 (4.3%)	11 (12.5%)
3	7 (15.9%)	4 (5.2%)	6 (8.5%)	6 (7.9%)
4	2 (4.5%)	1 (2.4%)	10 (12.3%)	4 (6.5%)
5	8 (11.8%)	3 (11.1%)	9 (11.0%)	1 (1.9%)
6	4 (12.1%)	2 (8.0%)	5 (8.3%)	4 (6.8%)
7	4 (6.8%)	3 (8.6%)	1 (1.7%)	3 (5.8%)
8	3 (7.7%)	2 (8.7%)	11 (10.2%)	6 (8.2%)
9	1 (5.3%)	4 (22.2%)	7 (12.3%)	1 (3.1%)
10	5 (20.0%)	3 (13.0%)	5 (13.2%)	8 (22.2%)
11	5 (16.1%)	4 (11.1%)	2 (4.1%)	0 (0.0%)
12	5 (22.7%)	1 (2.6%)	3 (5.2%)	9 (24.3%)
13	4 (16.0%)	2 (15.4%)	5 (6.8%)	10 (20.4%)
14	3 (12.0%)	1 (8.3%)	11 (20.4%)	3 (5.4%)
15	2 (14.3%)	2 (14.3%)	5 (7.7%)	1 (2.4%)
16	7 (30.4%)	5 (18.5%)	3 (3.9%)	10 (18.5%)

Supplementary Table 21: Subgroup analysis of anastomotic leak by the grade of the primary operating surgeon, presented by batch

	Anastomotic leak rate			
Batch	Pre-intervention	Post-intervention	Pre-intervention	Post-intervention
	Trainee		Consultant	
Total	38 (10.3%)	33 (11.0%)	132 (10.0%)	96 (9.2%)
1	7 (15.6%)	2 (6.9%)	15 (7.4%)	8 (9.1%)
2	1 (25.0%)	4 (14.3%)	4 (11.1%)	11 (12.5%)
3	4 (12.9%)	4 (7.8%)	9 (10.7%)	6 (5.9%)
4	0 (0.0%)	1 (5.9%)	12 (11.0%)	4 (4.7%)
5	2 (5.6%)	1 (6.7%)	15 (13.2%)	3 (4.5%)
6	0 (0.0%)	0 (0.0%)	9 (10.8%)	6 (8.8%)
7	1 (3.0%)	0 (0.0%)	4 (4.8%)	6 (7.5%)
8	3 (27.3%)	2 (18.2%)	11 (8.1%)	6 (7.1%)
9	3 (11.5%)	1 (8.3%)	5 (10.0%)	4 (10.5%)
10	2 (18.2%)	1 (9.1%)	8 (15.4%)	10 (20.8%)
11	0 (0.0%)	1 (9.1%)	7 (11.9%)	3 (6.2%)
12	1 (7.7%)	3 (27.3%)	7 (10.4%)	7 (10.8%)
13	1 (3.6%)	4 (13.8%)	8 (11.4%)	8 (24.2%)
14	4 (17.4%)	2 (8.3%)	10 (17.9%)	2 (4.7%)
15	4 (12.9%)	2 (18.2%)	3 (6.2%)	2 (4.4%)
16	5 (16.7%)	5 (27.8%)	5 (7.2%)	10 (15.9%)

Supplementary Table 22: Subgroup analysis of anastomotic leak by the specialty of the primary operating surgeon, presented by batch

	Anastomotic leak rate			
Batch	Pre-intervention	Post-intervention	Pre-intervention	Post-intervention
	General		Colorectal	
Total	84 (13.9%)	55 (12.5%)	86 (7.9%)	74 (8.1%)
1	12 (10.6%)	4 (18.2%)	10 (7.5%)	6 (6.3%)
2	4 (25.0%)	4 (10.3%)	1 (4.2%)	11 (14.3%)
3	4 (12.9%)	5 (9.1%)	9 (10.7%)	5 (5.1%)
4	1 (4.0%)	2 (5.0%)	11 (11.0%)	3 (4.8%)
5	9 (15.8%)	2 (10.5%)	8 (8.6%)	2 (3.2%)
6	8 (24.2%)	3 (9.1%)	1 (1.7%)	3 (5.9%)
7	2 (8.7%)	2 (9.5%)	3 (3.2%)	4 (6.1%)
8	5 (13.2%)	4 (17.4%)	9 (8.3%)	4 (5.5%)
9	3 (7.7%)	4 (14.8%)	5 (13.5%)	1 (4.3%)
10	5 (22.7%)	2 (18.2%)	5 (12.2%)	9 (18.8%)
11	5 (17.2%)	4 (18.2%)	2 (3.9%)	0 (0.0%)
12	5 (17.2%)	3 (7.7%)	3 (5.9%)	7 (18.9%)
13	5 (14.3%)	2 (16.7%)	4 (6.3%)	10 (20.0%)
14	6 (19.4%)	0 (0.0%)	8 (16.7%)	4 (6.8%)
15	2 (10.0%)	1 (5.9%)	5 (8.5%)	3 (7.7%)
16	8 (12.7%)	13 (25.5%)	2 (5.6%)	2 (6.7%)

Sensitivity analyses

Supplementary Table 23: Pre-operative leak risk calculator component only

		Pre-operative leak risk calculator	
		No	Yes
Anastomotic leak	No	1305/1454 (89.6%)	1409/1546 (91.1%)
	Yes	149/1454 (10.4%)	137/1546 (8.9%)
	Missing	26	11
Mortality	No	1502/1573 (95.5%)	1563/1621 (96.4%)
	Yes	71/1573 (4.5%)	58/1621 (3.6%)
	Missing	20	13
Re-operation	No	1449/1574 (92.1%)	1521/1621 (93.9%)
	Yes	125/1574 (7.9%)	100/1621 (6.1%)
	Missing	19	13
Re-admission	No	1478/1574 (93.9%)	1514/1621 (93.4%)
	Yes	96/1574 (6.1%)	107/1621 (6.6%)
	Missing	19	13
Length of stay	≤10 days	1150/1570 (73.3%)	1203/1616 (74.4%)
	>10 days	420/1570 (26.7%)	413/1616 (25.6%)
	Missing	23	18
Unplanned admission to intensive care	No	1507/1568 (96.1%)	1575/1620 (97.2%)
	Yes	61/1568 (3.9%)	45/1620 (2.8%)
	Missing	25	14

Supplementary Table 24: Intra-operative leak risk calculator component only

		Intra-operative leak risk calculator	
		No	Yes
Anastomotic leak	No	1928/2145 (89.9%)	784/854 (91.8%)
	Yes	217/2145 (10.1%)	70/854 (8.2%)
	Missing	28	12
Mortality	No	2193/2288 (95.8%)	869/902 (96.3%)
	Yes	95/2288 (4.2%)	33/902 (3.7%)
	Missing	30	4
Re-operation	No	2116/2290 (92.4%)	853/902 (94.6%)
	Yes	174/2290 (7.6%)	49/902 (5.4%)
	Missing	28	4
Re-admission	No	2139/2290 (93.4%)	850/902 (94.2%)
	Yes	151/2290 (6.6%)	52/902 (5.8%)
	Missing	28	4
Length of stay	≤10 days	1673/2287 (73.1%)	675/896 (75.3%)
	>10 days	614/2287 (26.9%)	221/896 (24.7%)
	Missing	31	10
Unplanned admission to intensive care	No	2197/2284 (96.2%)	882/901 (97.9%)
	Yes	87/2284 (3.8%)	19/901 (2.1%)
	Missing	34	5

Supplementary Table 25: Safe anastomosis checklist component only

		Safe anastomosis checklist	
		No	Yes
Anastomotic leak	No	1305/1454 (89.7%)	1412/1551 (91.1%)
	Yes	149/1454 (10.3%)	139/1551 (8.9%)
	Missing	23	11
Mortality	No	1497/1566 (95.6%)	1571/1630 (96.4%)
	Yes	69/1566 (4.4%)	59/1630 (3.6%)
	Missing	22	12
Re-operation	No	1447/1568 (92.3%)	1526/1630 (93.6%)
	Yes	121/1568 (7.7%)	104/1630 (6.4%)
	Missing	20	12
Re-admission	No	1471/1568 (93.9%)	1523/1630 (93.4%)
	Yes	96/1568 (6.1%)	107/1630 (6.6%)
	Missing	20	12
Length of stay	≤10 days	1120/1565 (71.6%)	1233/1624 (75.9%)
	>10 days	445/1565 (28.4%)	391/1624 (24.1%)
	Missing	23	18
Unplanned admission to intensive care	No	1502/1564 (96.0%)	1582/1627 (97.2%)
	Yes	62/1564 (4.0%)	45/1627 (2.8%)
	Missing	24	15

Supplementary Table 26: Online educational modules component only

		Online educational modules	
		No	Yes
Anastomotic leak	No	1416/1562 (90.6%)	1298/1439 (90.2%)
	Yes	146/1562 (9.4%)	141/1439 (9.8%)
	Missing	26	12
Mortality	No	1599/1674 (95.5%)	1463/1517 (96.5%)
	Yes	75/1674 (4.5%)	54/1517 (3.5%)
	Missing	23	11
Re-operation	No	1559/1676 (93.0%)	1410/1517 (93.0%)
	Yes	117/1676 (7.0%)	107/1517 (7.0%)
	Missing	21	11
Re-admission	No	1573/1676 (93.8%)	1417/1517 (93.4%)
	Yes	103/1676 (6.2%)	100/1517 (6.6%)
	Missing	21	11
Length of stay	≤10 days	1226/1675 (73.2%)	1123/1509 (74.4%)
	>10 days	449/1675 (26.8%)	386/1509 (25.6%)
	Missing	22	19
Unplanned admission to intensive care	No	1607/1670 (96.2%)	1473/1516 (97.2%)
	Yes	63/1670 (3.8%)	43/1516 (2.8%)
	Missing	27	12

Supplementary Table 27: Anastomotic leak rate pre- and post-intervention by surgeon engagement rate for sequence 2 hospitals only

Engagement rate per hospital-team	Anastomotic leak Pre-intervention	Anastomotic leak Post-intervention
<50%	31/403 (7.7%)	39/287 (13.6%)
50-79%	18/159 (11.3%)	13/126 (10.3%)
≥80%	35/254 (13.8%)	8/178 (4.5%)

Supplementary Table 28: Engagement rates in surgeons with the online educational modules, implementation rates in clinical practice on patients and anastomotic leak rates in those patients.

Engagement of hospital-teams with modules	Implementation of all components introduced in the modules in patients (per-protocol)	Anastomotic leak	No implementation of one or more component(s) in patients	Anastomotic leak
50% or less	449/1302 (34.5%)	53/449 (11.8%)	853/1303 (65.5%)	77/853 (9.0%)
50%-79%	316/726 (43.5%)	34/316 (10.8%)	410/726 (56.5%)	38/410 (9.3%)
80% or more	505/966 (52.3%)	28/505 (5.5%)	461/966 (47.7%)	57/461 (12.4%)

Checklists

Supplementary Table 29: CONSORT-SW extension checklist for the stepped wedge cluster randomised trial

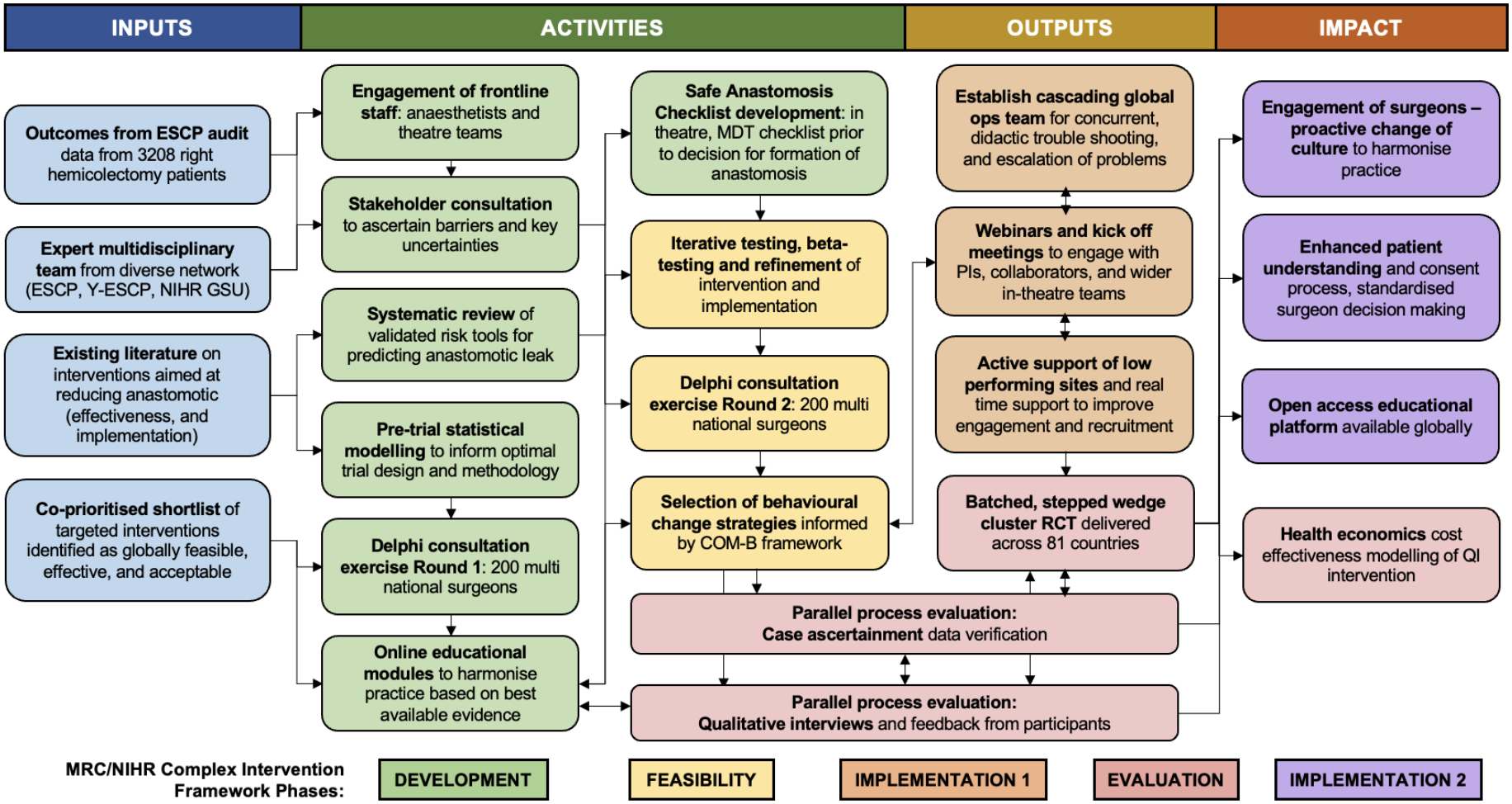
Topic	Item no	Checklist item	Section
Title and abstract			
	1a	Identification as a stepped wedge cluster randomised trial in the title.	Title
	1b	Structured summary of trial design, methods, results, and conclusions (see separate SW-CRT checklist for abstracts).	Title
Introduction			
Background and objectives	2a	Scientific background. Rationale for using a cluster design and rationale for using a stepped wedge design.	Rationale
	2b	Specific objectives or hypotheses.	Intro
Methods			
Trial design	3a	Description and diagram of trial design including definition of cluster, number of sequences, number of clusters randomised to each sequence, number of periods, duration of time between each step, and whether the participants assessed in different periods are the same people, different people, or a mixture.	Trial design
	3b	Important changes to methods after trial commencement (such as eligibility criteria), with reasons.	Pragmatic design
Participants	4a	Eligibility criteria for clusters and participants.	Clusters /participants
	4b	Settings and locations where the data were collected.	Participants
Interventions	5	The intervention and control conditions with sufficient details to allow replication, including whether the intervention was maintained or repeated, and whether it was delivered at the cluster level, the individual participant level, or both.	Development of QI intervention
Outcomes	6a	Completely defined prespecified primary and secondary outcome measures, including how and when they were assessed.	Outcomes
	6b	Any changes to trial outcomes after the trial commenced, with reasons.	N/A
Sample size	7a	How sample size was determined. Method of calculation and relevant parameters with sufficient detail so the calculation can be replicated. Assumptions made about correlations between outcomes of participants from the same cluster. (see separate checklist for SW-CRT sample size items).	Sample size
	7b	When applicable, explanation of any interim analyses and stopping guidelines.	Sample size
Randomisation			
Sequence generation	8a	Method used to generate the random allocation to the sequences of treatments.	Randomisation

	8b	Type of randomisation; details of any constrained randomisation or stratification, if used.	Randomisation
Allocation concealment mechanism	9	Specification that allocation was based on clusters; description of any methods used to conceal the allocation from the clusters until after recruitment.	Randomisation
Implementation	10a	Who generated the randomisation schedule, who enrolled clusters, and who assigned clusters to sequences.	Randomisation
	10b	Mechanism by which individual participants were included in clusters for the purposes of the trial (such as complete enumeration, random sampling; continuous recruitment or ascertainment; or recruitment at a fixed point in time), including who recruited or identified participants.	Randomisation
	10c	Whether, from whom and when consent was sought and for what; whether this differed between treatment conditions.	Patient participation
Blinding	11a	If done, who was blinded after assignment to sequences (eg, cluster level participants, individual level participants, those assessing outcomes) and how.	Blinding
	11b	If relevant, description of the similarity of treatments.	N/A
Statistical methods	12a	Statistical methods used to compare treatment conditions for primary and secondary outcomes including how time effects, clustering and repeated measures were considered.	Statistical analysis
	12b	Methods for additional analyses, such as subgroup analyses, sensitivity analyses, and adjusted analyses.	Statistical analysis
Results			
Participant flow (a diagram is strongly recommended)	13a	For each treatment condition or allocated sequence, the numbers of clusters and participants who were assessed for eligibility, were randomly assigned, received intended treatments, and were analysed for the primary outcome (see separate SW-CRT flow chart).	Figure 2
	13b	For each treatment condition or allocated sequence, losses and exclusions for both clusters and participants with reasons.	Supplementary Figure 2-5
Recruitment	14a	Dates defining the steps, initiation of intervention, and deviations from planned dates. Dates defining recruitment and follow-up for participants.	Pragmatic trial
	14b	Why the trial ended or was stopped.	Sample size
Baseline data	15	Baseline characteristics for the individual and cluster levels as applicable for each treatment condition or allocated sequence.	Results
Numbers analysed	16	The number of observations and clusters included in each analysis for each treatment condition and whether the analysis was according to the allocated schedule.	Results
Outcomes and estimation	17a	For each primary and secondary outcome, results for each treatment condition, and the estimated effect size and its precision (such as 95% confidence interval); any correlations (or covariances) and time effects estimated in the analysis.	Results

	17b	For binary outcomes, presentation of both absolute and relative effect sizes is recommended.	Results
Ancillary analyses	18	Results of any other analyses performed, including subgroup analyses and adjusted analyses, distinguishing prespecified from exploratory.	Results
Harms	19	Important harms or unintended effects in each treatment condition (for specific guidance see CONSORT for harms).	N/A
Discussion			
Limitations	20	Trial limitations, addressing sources of potential bias, imprecision, and, if relevant, multiplicity of analyses.	Discussion
Generalisability	21	Generalisability (external validity, applicability) of the trial findings. Generalisability to clusters or individual participants, or both (as relevant).	Discussion
Interpretation	22	Interpretation consistent with results, balancing benefits and harms, and considering other relevant evidence.	Discussion
Other information			
Registration	23	Registration number and name of trial registry.	Methods
Protocol	24	Where the full trial protocol can be accessed, if available.	Methods
Funding	25	Sources of funding and other support (such as supply of drugs), and the role of funders.	Methods
Research ethics review	26	Whether the study was approved by a research ethics committee, with identification of the review committee(s). Justification for any waiver or modification of informed consent requirements.	Methods

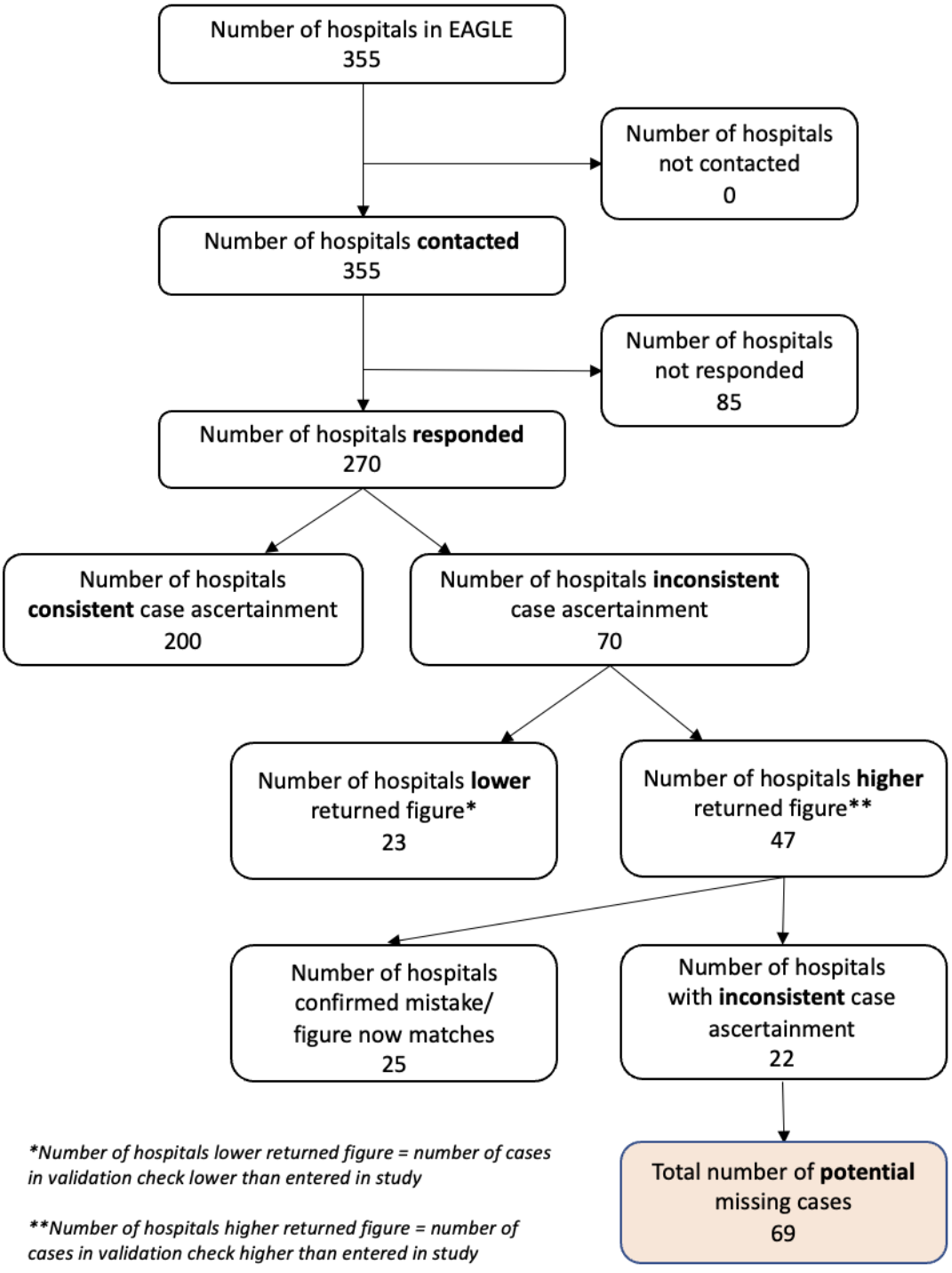
Figures

Supplementary Figure 1: Development and delivery of the EAGLE RCT mapped to the MRC/NIHR complex interventions framework.



Case ascertainment

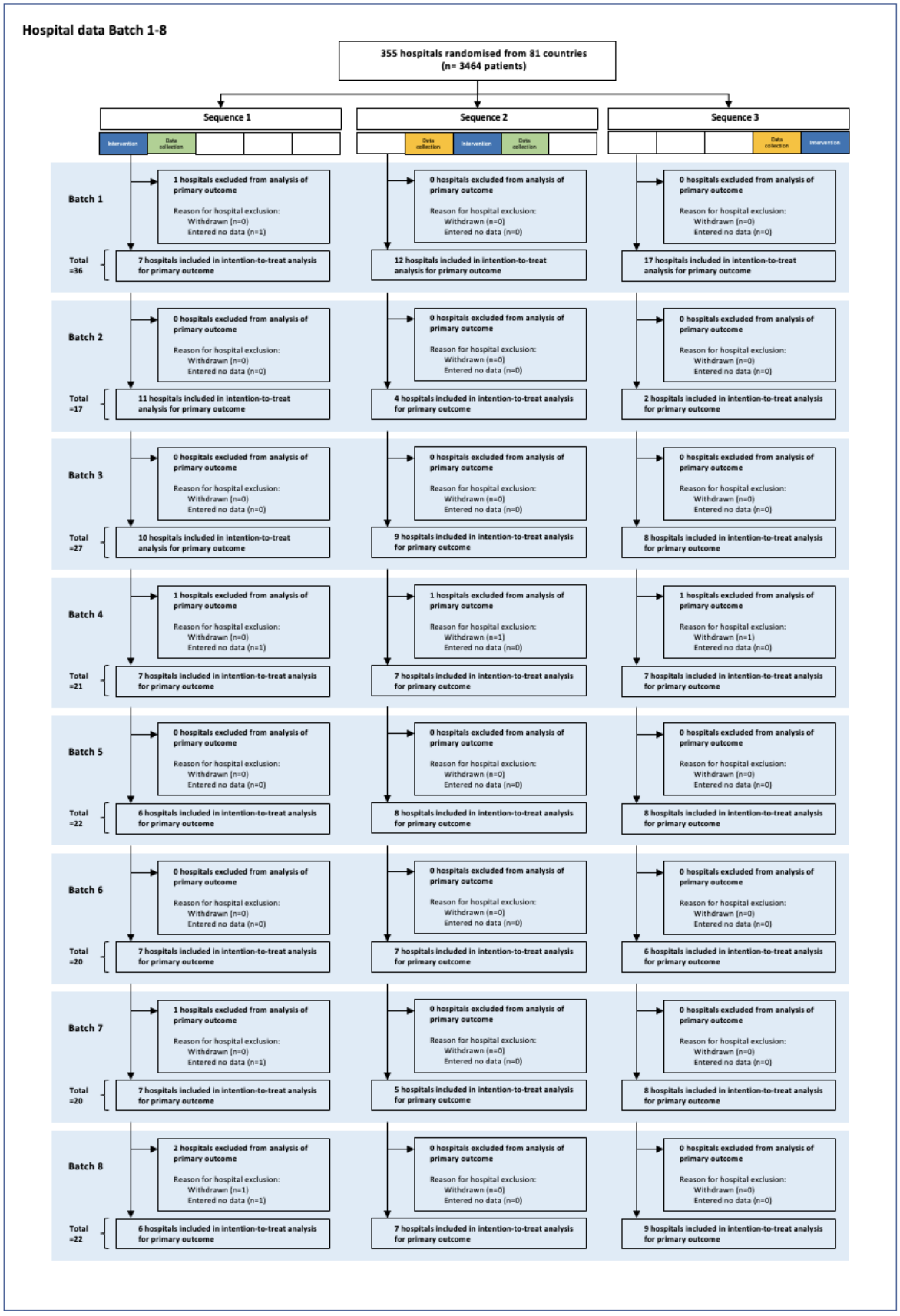
Supplementary Figure 2: Case ascertainment flowchart



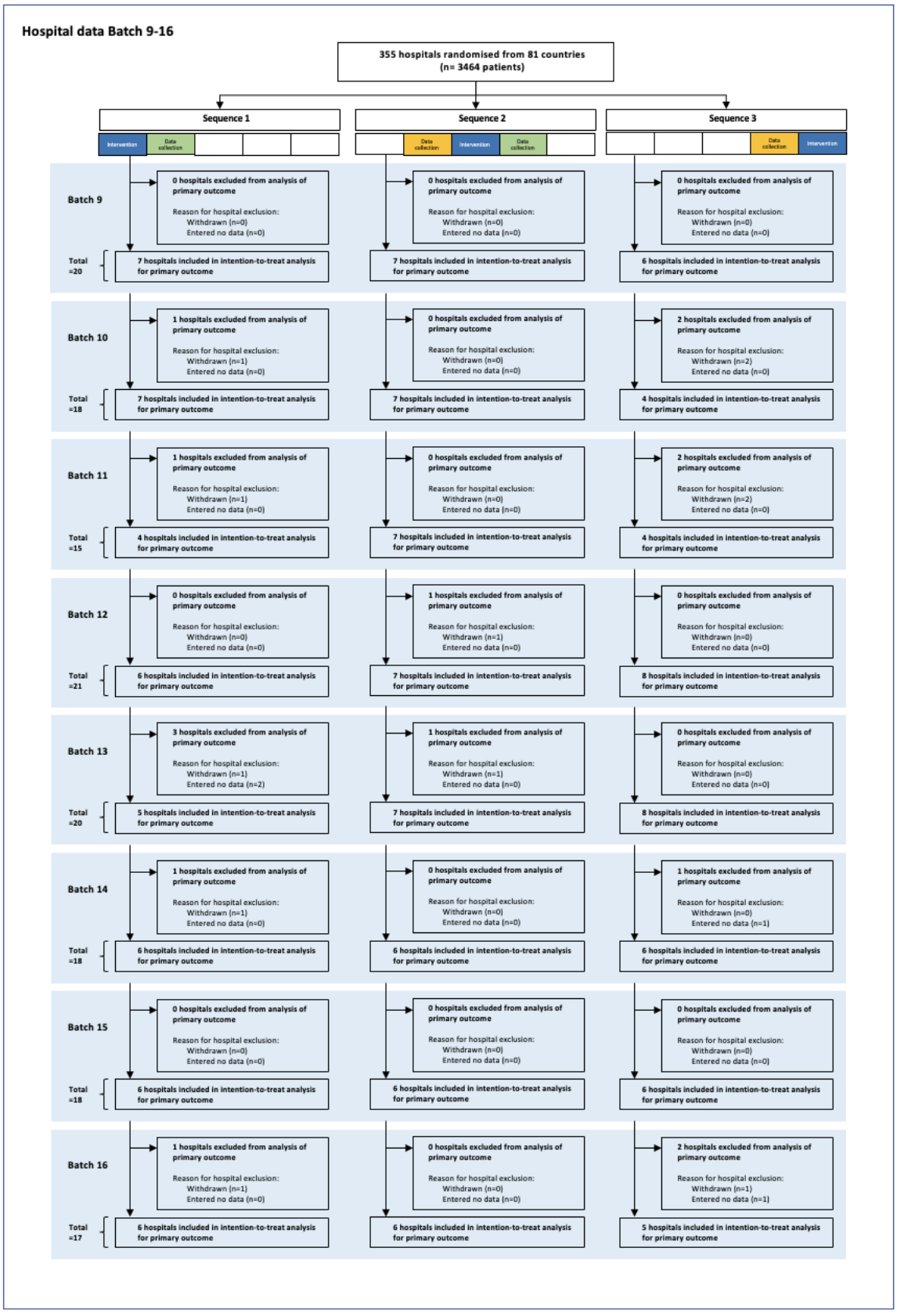
Case ascertainment and data validation

Of the 270/332 (81.3%) hospital-teams that carried out case ascertainment, 22/270 (8.1%) reported inconsistent data (the number of right colectomy operations were different to the number recorded on REDCap; specifically, that the case ascertainment number was higher than the number on REDCap), Supplementary Figure 5. These 22 sites reported a total of 69 missed cases. Extrapolated across the full dataset, the estimated number of missed cases was 85/3268 (2.5%). Of the 71 hospital-teams who completed the data validation, 710 data points were checked for accuracy (10 per hospital-team). 27/710 data points were noted as inaccurate (3.8%). None of the hospital-teams had more than 10% overall inaccurate data.

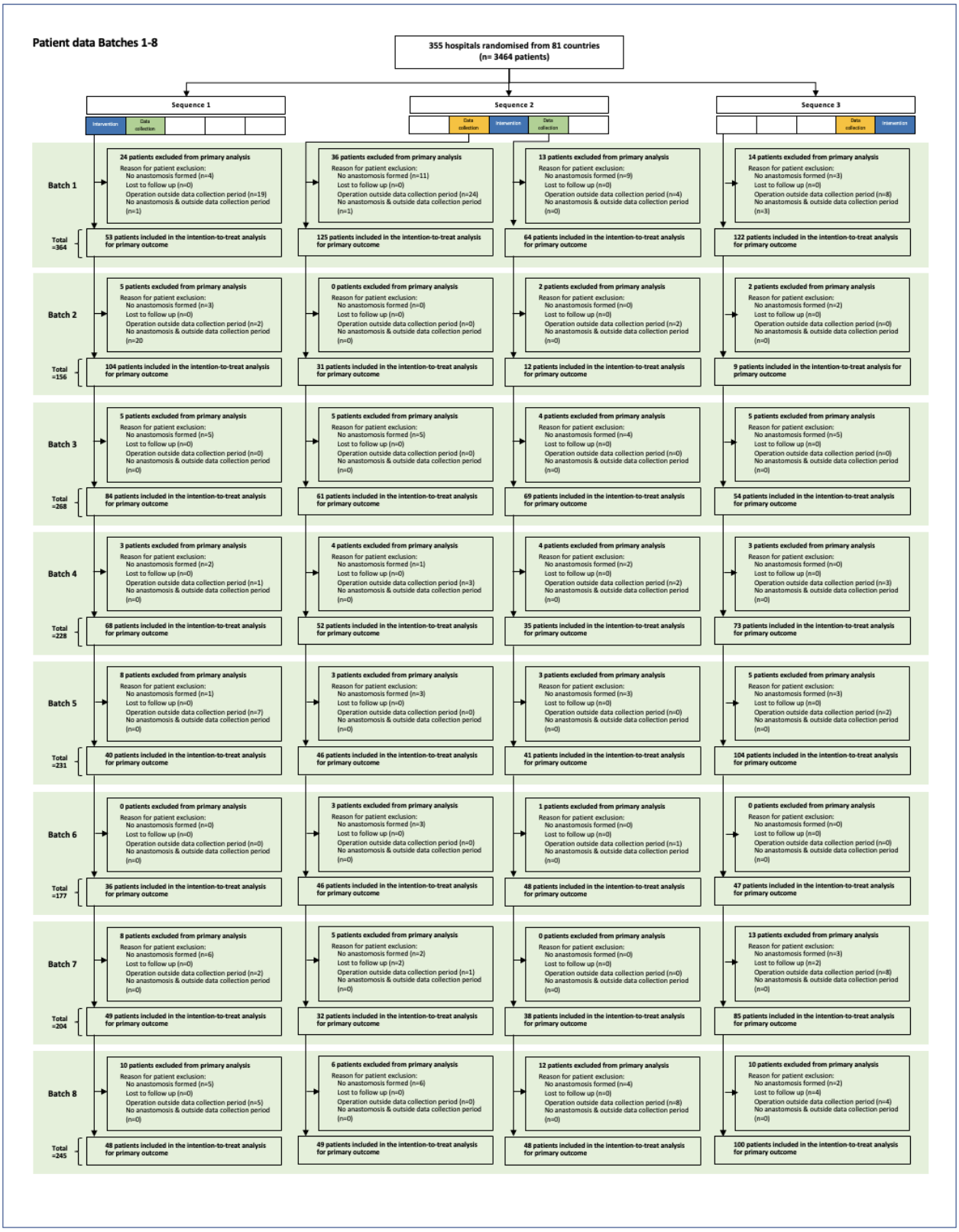
Supplementary Figure 3a) Detailed consort diagram of hospital level data by randomisation sequence – part 1



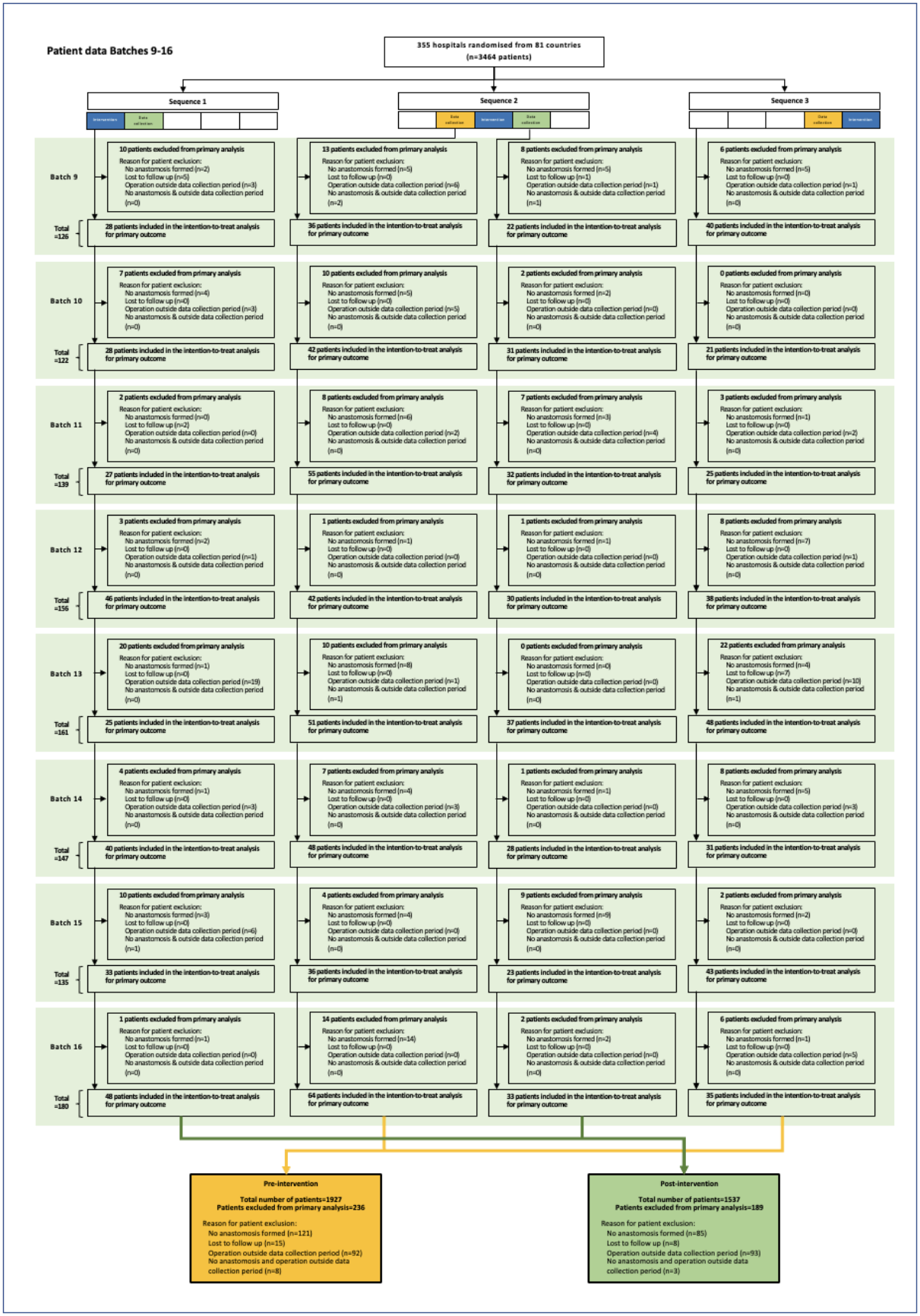
Supplementary Figure 3b) Detailed consort diagram of hospital level data by randomisation sequence – part 2



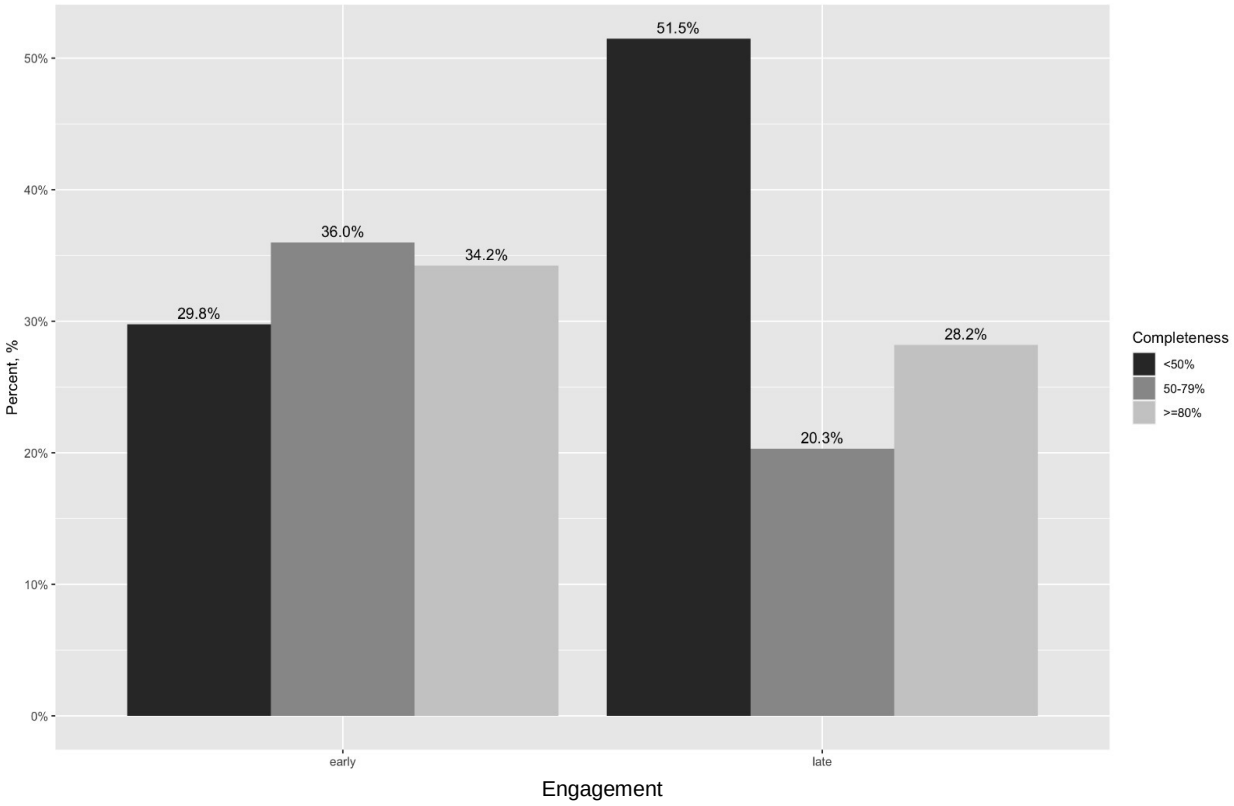
Supplementary Figure 4a) Detailed consort diagram of patient level data by randomisation sequence – part 1



Supplementary Figure 4b) Detailed consort diagram of patient level data by randomisation sequence – part 2



Supplementary Figure 5: Proportion of hospital-teams completing online educational modules (engagement) split by those with early (batches 1-8) participation and late (batches 9-16) participation.

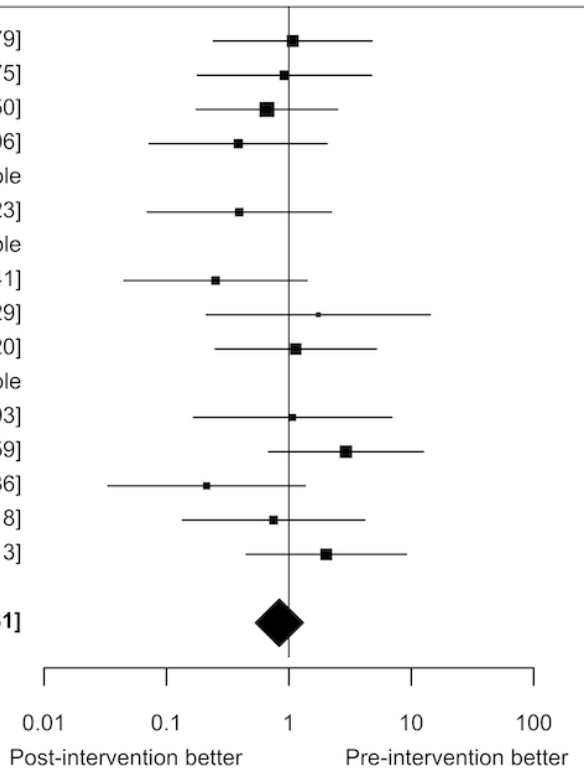


Sensitivity analyses

Supplementary Figure 6: Per-protocol sensitivity analysis of primary outcome (completion of all three components of QI intervention) across all batches

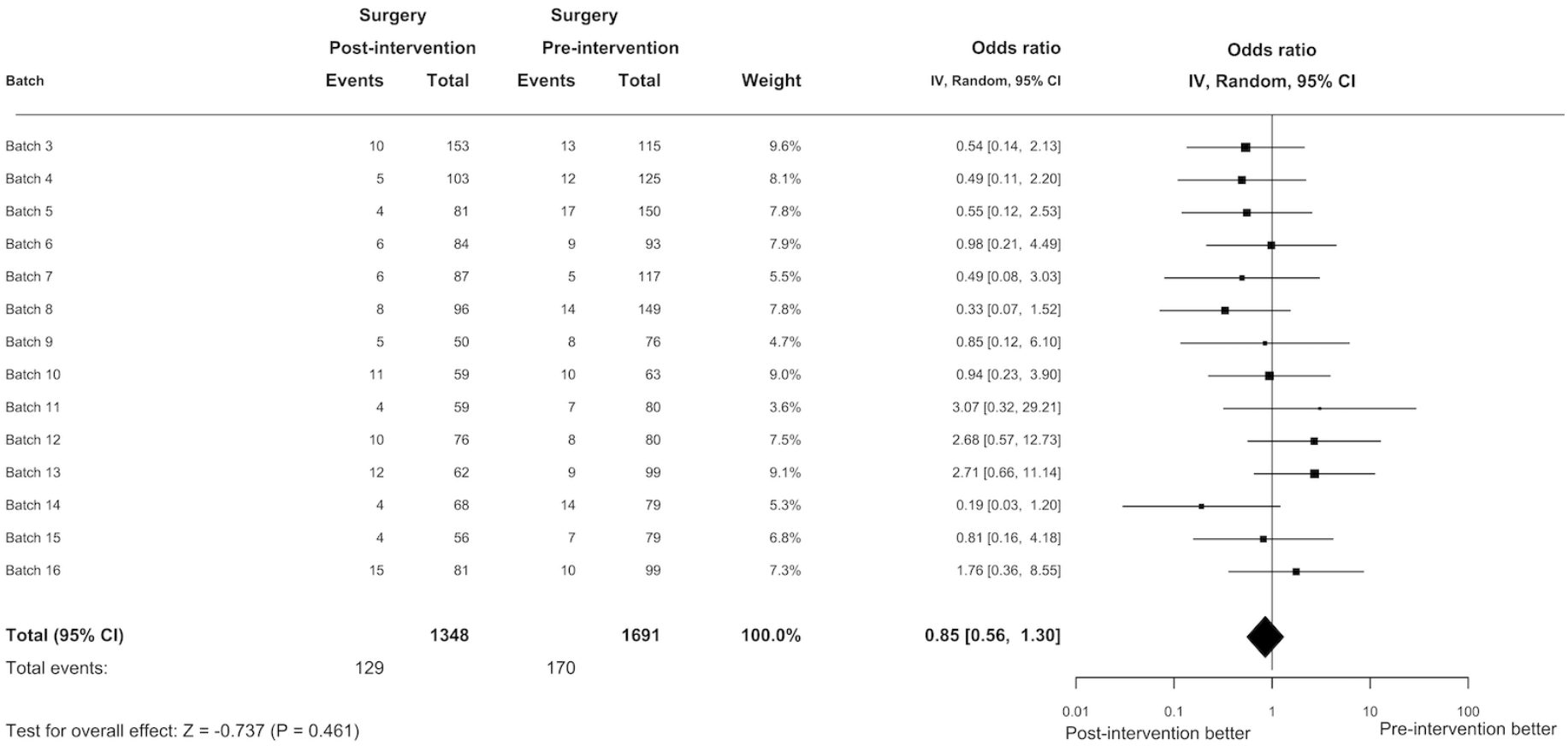
Batch	Surgery Post-intervention Events	Total	Surgery Pre-intervention Events	Total	Weight	Odds ratio IV, Random, 95% CI
Batch 1	7	86	22	247	9.1%	1.08 [0.24, 4.79]
Batch 2	12	101	5	40	7.6%	0.92 [0.18, 4.75]
Batch 3	9	117	13	115	11.6%	0.66 [0.18, 2.50]
Batch 4	3	86	12	125	7.3%	0.39 [0.07, 2.06]
Batch 5	0	47	17	150		Not estimable
Batch 6	3	62	9	93	6.8%	0.39 [0.07, 2.23]
Batch 7	5	80	5	117		Not estimable
Batch 8	3	60	14	149	6.9%	0.25 [0.05, 1.41]
Batch 9	5	39	8	76	4.6%	1.74 [0.21, 14.29]
Batch 10	7	35	10	63	8.8%	1.14 [0.25, 5.20]
Batch 11	3	48	7	80		Not estimable
Batch 12	3	39	8	80	5.9%	1.07 [0.17, 6.93]
Batch 13	9	47	9	99	9.6%	2.93 [0.68, 12.59]
Batch 14	4	61	14	79	5.9%	0.21 [0.03, 1.36]
Batch 15	3	41	7	79	6.9%	0.75 [0.13, 4.18]
Batch 16	13	65	10	99	9.0%	2.02 [0.45, 9.13]
Total (95% CI)		**1014**		**1691**	**100.0%**	**0.84 [0.53, 1.31]**
Total events:	89		170			

Test for overall effect: Z = -0.774 (P = 0.439)



***** Each batch analysed using a mixed effects logistic regression model adjusting for hospital number of beds, country income, type of hospital (referral vs. non-referral), sex, urgency, and data collection period. Hospital included as a random effect. Overall effect pooled in a random effects meta-analysis using the inverse variance approach of DerSimonian and Laird.

Supplementary Figure 7: Sensitivity analysis of QI intervention on anastomotic leak rate excluding the first two batches, which were paused due to the COVID-19 pandemic (meta-analysed across batches 3 to 16*)



***** Each batch analysed using a mixed effects logistic regression model adjusting for hospital number of beds, country income, type of hospital (referral vs. non-referral), sex, urgency, and data collection period. Hospital included as a random effect. Overall effect pooled in a random effects meta-analysis using the inverse variance approach of DerSimonian and Laird.

Appendix E: List of authors

Writing team (alphabetical)
Nicholas Avellaneda, Mahmoud Al Masri, Abylai Baimakhanov, Dinesh Balasubramaniam, Aneel Bhangu, Konstantinos Bouchagier, Osman Bozbiyik, Anu Carpelan, Carina Chwat, Miguel Cunha, Brett E Dawson, Maria Victoria Duque Mallen, Mark Bremholm Ellebæk, Tomás Elosua Gonzalez, Mohamedraed Elshami, Ildar Fakhradiyev, Omer Faruk Ozkan, Francesco Fleres, Kaori Futaba, Gaetano Gallo, Dhruv Ghosh, James C Glasbey, Ewen Harrison, Richard L Hooper, Ritu Jain, Sivesh Kamarajah, Sreejith Kannummal Veetil, Erdinc Kamer, James Keatley, Charles H Knowles, Mukhtar Kulimbet, Pawanindra Lal, Elizabeth Li*, Bala Mahesh Polamreddy, Ana Minaya-Bravo, Rohin Mittal, Dion Gregory Morton**, Luis Roberto Manzione Nadal, Ionut Negoi, Dmitri Nepogodiev, Omar Omar*, Francesco Pata, Thomas Pinkney, Mark A Potter, Matteo Rottoli, Guilherme Santos, Iain Smith, Antonino Spinelli, Mary Venn*.

**Joint first authors, **Senior author, and overall guarantor*

Data Analysis
Omar Omar, Elizabeth Li, Richard Hooper, Dion Morton.

Ops team and meta-coordinators (alphabetical)
Edward Bywater, Brett E Dawson, Mohamedraed Elshami, Jonathan Evans, James C Glasbey, Richard L Hooper, Sivesh Kamarajah, James Keatley, Elizabeth Li, Laura Magill, Siobhan McKay, Dion Gregory Morton, Dmitri Nepogodiev, Omar Omar, Daniel Osei Bordom, Joana Simões, Mary L Venn.

Co-ordinators (alphabetical)
Ademola Adeyeye, Nicolas Avellaneda, Nicolas Buchs, Liam Cato, Miguel Cunha, David Finch, Gaetano Gallo, Garzali Ibrahim Umar, Ana Minaya Bravo, Helio Moreira Junior, Peter Neary, Francesco Pata, Tomas Poskus, April Roslani, Elgun Samadov, Mohammed Sbaih, Mostafa Shalaby, Baljit Singh, Aad Sinha, Armen Vardanyan

Educational team (alphabetical)
Sanjay Chaudhry, Matteo Frasson, James C Glasbey, Elizabeth Li, Ana Minaya-Bravo, Ionut Negoi, Mark A Potter (Chair), Jim Millward, Luis Sánchez-Guillén, Jasper Stijns, David D E Zimmerman.

Data Monitoring Committee (alphabetical)
David Beard, Marion Campbell, Susan Moug

ESCP Research Committee (alphabetical)
Erman Aytac, Sue Blackwell, Pamela Buchwald, Sharfuddin M. Chowdhury, Dragomir Dardanov, Audrius Dulskas, Muhammed Elhadi, Alaa El-Hussuna (Chair 2021-current), Zoe Garoufalia, Muhammad Imran Aslam, Michael Kelly, Charles Knowles, Beatriz Mendes, Dion Morton, Simon Ng, Gianluca Pellino, Thomas Pinkney (Chair 2014-2021), Shaji Sebastian, Emre Sivrikoz, Antonino Spinelli, Patricia Tejedor, Carolynne Vaizey

ESCP Global Research Committee:
Nicolas Avellaneda (Argentina), Romina Bianchi (Argentina), Pamela Buchwald (Sweden), Peter Christensen (Denmark), James Keatley (ESCP Research Manager, United Kingdom), Suk-Hwan Lee (Korea), Varut Lohsiriwat (Thailand), Surendra Kumar Mantoo (Singapore), Luqman Mazlan (Malaysia), Dion Morton (Co-Chair, United Kingdom), Simon Ng (Co-Chair, Hong Kong), Jun Won Um (Korea), Jaw Yuan Wang (Taiwan), Jun Watanabe (Japan), Hongwei Yao (China)

Collaborators (country in alphabetical order, and hospital)

Algeria

Etablissement Hospitalier et Universitaire

Aicha Benguedddach, Anisse Tidjane, Benali Tabeti, Chakib Behilil, Nabil Boudjenan-Serradj, Salim Bensafir, Sif El Islam Meharzi,

University Hospital Center, Dr Tidjani Damerdji

Abdenour Aissat, Amine Khayreddine Ghouali, Khadidja Larabi, Omar Riffi, Salah Eddine Oussama Kacimi, Smain Nabil Mesli, Walid Rezoug,

Argentina

Churruca-Visca

Alejandro Mitidieri, Alvarado José, Chaves Pablo, Cristian Ariel Rodriguez, Maria Florencia Panettiere, Nicolas Barbalace, Tricarico Juan,

Grupo Galeno

Jose Lucena, Anabella Houdin, Eugenia Fernandez, Julio Lococo, Luis Pedro, Mariana Loban, Pablo Vecchio,

Hospital Universitario Cemic

Ariel Grinblat, Augusto Carrie, Federico Veracierto, Mateo Santillan, Milena Napolitano, Nicolas Avellaneda, Sonia La Rosa,

Nueva Proctologia

Carla Mariela Gonzalez, Ezequiel Ferro, Juan Pablo Muñoz, Tatiana Ventorutti,

Penna Hospital

Claudia Cabrera, Claudia Carrizo, Claudio Mospane, Fabio Leiro, Julieta Espino, Mauro Trama, Romina Bianchi,

Hospital Español de Buenos Aires

Analia Potolicchio, Franco Dindri, Lourdes Buey, Nicolas Lucas, Pablo Catalano, Romina Astilleta, Yenny Quiroga,

Hospital Universitario Austral

Carina Chwat, Diego Valli, Flavia Alexandre, Gladys Martres, Guillermo Rosato, Gustavo Lemme, Veronica Romero,

Clinica Universitaria Reina Fabiola

Alejandro Marcelo Doniquian, Diana Alejandra Pantoja Pachajoa, Florencia Llahi, Juan Maria Fiorenza, Matias Parodi, Noelia Ocaña,

Hospital Privado de Comunidad

Alfredo Gallardo, Andres Valenzuela, Juan Perriello, Rodolfo Nador,

Hospital Luis Lagomaggiore

Claudio Fermani, Lorena Garay, Pablo Blanco, Santiago Villalobos,

Sanatorio Laprida
Federico Posner, Nicolas Vieyra, Pablo Fiorito, Paula Ciabattari,

Aruba
Dr. Horacio E Oduber Hospital
Chantal de Kort, Deepu Daryanani, Justin Smit, Martijn Pieter Gosselink, Nadeche Janssen,

Australia
Bendigo Health
Anna Feiss, Chun Hin Angus Lee, Danielle Taylor, John Edington, Nevin Chen, Wei Ming Ong,

Austria
Barmherzige Brüder Graz
Felix Aigner, Gabriele Moitzi, Geza Gemes, Markus Braumille, Martin Mitteregger, Seitinger Gerald, Stefan Uranitsch,

Medical University of Graz
Armin Belarmino, James Waha, Judith Kahn, Michael Treiber, Peter Schemmer, Saulius Mikalauskas,

Azerbaijan
Leyla Medical Center
Arturan Ibrahimli, Elgun Samadov, Elnara Orujova, Ilgar Namazov, Jhale Alikhanli, Mohsum Asgarov,

Bahrain
King Hamad University Hospital
Aymen Kutkut, Ebrahim Almahmeed, Hasan Aljawder, Isam Juma, Keith Johnston, Mirza Faraz Saeed, Sara Khairi,

Bosnia And Herzegovina
University Clinical Center Tuzla
Ervin Matovic, Mediha Omerasevic, Samir Delibegovic, Samir Hodzic,

Brazil
Hospital do Servidor Público Estadual-Francisco Morato de Oliveira
Angela Genoefa Rudell, Jamile Fuzari, José Francisco Farah, Luis Roberto Manzione Nadal, Maria Beatriz Alves Dos Santos, Renato Arioni Lupinacci, Talison Silas Pereira,

Felicio Rocho
Alexandre da Silveira Sete, Antônio Lacerda Filho, Bruno Lucena de Souza Pires, Fábio Lopes de Queiroz, Hélida Aline Tomacheski Amaral, Marco Antônio Miranda Dos Santos, Simone Chaves de Miranda Silvestre,

Hospital das Clínicas da Universidade Federal de Minas Gerais/Ebserh
Bernardo Hanan, Claudilaine Reis, Gabriela Cassia, Magda da Luz, Marina Delgado, Renato Campanati, Rodrigo Silva,

Orizonti

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Katherine Hodge, James Balfour, Katrina Mcintosh, Louis Buijs, Mark A Potter, Michael Yule, Peter G Vaughan-Shaw, Scott Smith, Tom Anderson,

Royal Devon And Exeter Hospital

Frank D Mcdermott, Ian R Daniels, Judy Tapp, Neil Smart, Niroshini Rajaretnam, Robert Bethune, Thomas Clark,

James Paget Univeristy Nhs Foundation Trust Hospital

Christina Delimpalta, Christopher Liao, Gail Banham, Lalani Induruwage, Vamsi Velchuru,

East Sussex Healthcare (Conquest Hospital And Eastbourne District General Hospital)

Anna Lawrence, Atiqur Rahman, James Bennett, Marwa Badawi, Raj Harshen,

King George Hospital

Aman Bhargava, Kalyani Gorrela, Maher Jumah, Mary Venn, Matthew Hanson, Shobhit Arya, Tiffany Atendido,

East Kent Hospitals Nhs Foundation Trust

Ashish Shrestha, Esther Cook, Iskandar Rakhimov, Jen Collins, Nadeen Alamin, Natalia Vigneswaran, Pradeep Basnyat,

Kettering General Hospital

Aliaa Shamardal, Anil Chacko, Dinamulla Wanshantha, George Bisheet, Hamdi Ebdewi, Mohamed Abdellatif, Patricia Adu-Poku,

Lincoln County Hospital

Anil Tore, Ferdinand Adams, Kate Allen, Khalil Ahmed, Nikhil Kulkarni,

Newham University Hospital

Abhishek Chitnis, Hitesh Patel, Jim Magsino, Varun Sarodaya,

Royal London Hospital

Annamaria Minicozzi, Charlotte Dempsy, Haleemasahdia Ahmed, Hitesh Patel, Jayan Dewantha Jayasinghe, Mohamed Hazem Okail, Mohamed Thaha, Stephen Hallworth,

The Whittington Hospital

Chetan Parmar, Lorna Chua, Michail Pizanias, Rashid Samin, Trudi Young,

Luton And Dunstable University Hospital

Jayesh Sagar, Liu Yorkmui, Nicholas Cirocchi, Safia Ahmed, Sara Castillo Barreda, Shantata Kudchadkar,

Tunbridge Wells Hospital

Aleksandra Baker, Balaji Jayasankar, Dinesh Balasubramaniam, James Jackson, Kirolas Abdelsaid, Mohamed Hassan, Shradda Shetty,

Royal Lancaster Infirmary

Chris Coldwell, Emma Davies, Helmy Nader, Maria Raistrick, Ondrej Ryska, Paul Hawkin, Thomas Raymond,

Churchill Hospital

Caroline Witjes, Katrien Van de Steen, Nicholas Crabtree, Stephen Boyce, Wilhelmina Somera,

Jersey General Hospital

Andrew Woodward, Karena Ryan, Miklos Kassai, Muhammad Aleem,

Morriston Hospital Swansea

Anil Ghosh, Dani Rixson, Eleanor Lewis, Noel Lynch,

Musgrove Park Hospital

Charmaine Shovelton, Ewa Zywicka, Francesca Guest, Jess Barton, Rebecca Purnell, Richard Bamford, Thomas Teare,

Royal Cornwall Hospital

Benita Adams, Gaspard Chmielewski, Iain Smith, Laura Smith, Lewis Connolly, Rachel Niblett,

Wrightington, Wigan & Leigh Nhs Foundation Trust

Amal Singh, Gail Halliwell, Marius Paraoan, Nicholas Doree, Peter Asaad,

Wirral University Teaching Hospital

Claire Kilbride, Holly Carpenter, Jeremy Wilson, Juliette Fletcher, Kesav Aditya Vijayagopal, Malaz Abbakar, Tilemachos Zaimis,

Yeovil District Hospital

Adam Walsh, Agnieszka Kubisz-Pudelko, Jolanta Nono, Lucy Pippard, Manish Chowdhary, Richard Dalton, Tamer Moussa,

Uruguay

Medica Uruguaya

Fabiana Dominguez, Gonzalo Solla, Jacqueline Curbelo, Marcelo Laurini, Marcelo Viola, Noelia Brito,

Yemen, Rep.

Al-Thawra Modern General Hospital

Ahmed Al-Alnsi, Hamza Al-Naggar, Lamis Saryah, Mohammed Al-Shehari, Ramzi Alsayadi, Roqia'A Al-Hutheifi, Sarah Shream,

Data handling

Samerah Saeed, Eleanor Margaret Spurring