Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

Real-World Variation in Rectal Cancer Care: Benchmarking Quality Indicators Across 22 Hospitals

Cédric Schraepen
cedric.schraepen@kuleuven.be

University Hospitals Leuven
André D'Hoore
University Hospitals Leuven
Kris Vanhaecht
KU Leuven – University of Leuven
Gabriele Bislenghi
University Hospitals Leuven
Leen van Langenhoven
I-BioStat, KU Leuven & University of Hasselt
Albert Wolthuis
University Hospitals Leuven
Ellen Coeckelberghs
KU Leuven – University of Leuven

Research Article

Keywords: Quality of care, rectal cancer, real-world data, practice variation, care pathways, quality improvement

Posted Date: September 14th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-10535544/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License. Read Full License

Additional Declarations: No competing interests reported.

Abstract

Introduction

Variation in adherence to evidence-based rectal cancer care pathways in non-centralized healthcare systems remains poorly characterized. This study assessed hospital-level variation in rectal cancer surgical care across Flanders using predefined quality indicators.

Methods

A retrospective multicentre observational study was conducted in 22 Flemish hospitals (3 academic, 19 non-academic). Each hospital contributed data on 20 consecutive adults undergoing elective curative-intent surgery for rectal adenocarcinoma between 2020 and 2024 (total n = 430). Eligible procedures were total mesorectal excision or abdominoperineal resection. Adherence to patient-level quality indicators, derived from international guidelines and national expert consensus, was calculated as the proportion of eligible patients receiving the recommended intervention. Hospital-level variation was expressed as minimum–maximum ranges.

Results

Mean age was 68.8 years and 67.9% of patients were male; 80.7% underwent total mesorectal excision and 19.3% abdominoperineal resection. Adherence to diagnostic staging was high, with colonoscopy in 100%, thoracoabdominal CT in 97.2%, and pelvic MRI in 94.2%. Overall adherence across indicators ranged from 13.0% to 100.0%, and hospital-level adherence from 53.1% to 79.8%. The lowest adherence and widest inter-hospital variation were observed for oral antibiotic administration (13.0%), avoidance of pelvic drain placement (13.0%), postoperative low anterior resection syndrome assessment (24.5%), and early urinary catheter removal (43.7%). At least one in-hospital complication occurred in 46.7% of patients; 90-day anastomotic leakage, reintervention, mortality, and readmission rates were 17.5%, 19.5%, 2.8%, and 21.1%.

Conclusion

In a high-resource, non-centralized European setting with mature guideline frameworks in colorectal surgery, perioperative rectal cancer care showed marked, unwarranted variation in strongly recommended quality indicators (e.g. oral antibiotics, drain avoidance, early urinary catheter removal, and LARS assessment). These gaps represent immediate, high-yield targets for system-level improvement.

Introduction

Rectal cancer surgery remains one of the most complex domains in oncological care, requiring accurate staging, coordinated multidisciplinary decision-making, technically demanding procedures, and structured perioperative management. Despite advances in imaging, neoadjuvant treatment, minimally invasive techniques, and enhanced recovery programs, postoperative morbidity after rectal cancer surgery remains substantial (1). In Belgium, rectal cancer surgery is performed in both academic and non-academic hospitals and is not formally centralized, which underscores the importance of transparent monitoring of care processes and outcomes.

International guidelines provide evidence-based quality indicators (QIs) for rectal cancer management (2–4). However, translating these recommendations into routine practice is challenging, and considerable variability in adherence to guideline-based care persists across hospitals and healthcare systems (5, 6). Organizational factors such as structured care pathways, multidisciplinary collaboration, and systematic outcome monitoring are considered key determinants of high-quality care. Care pathways have been proposed as structured multidisciplinary tools to organize, standardize, and continuously evaluate care processes across the patient journey (7, 8), and have been associated with improved organization of care delivery (9). In Flanders, such pathway-oriented quality improvement has been supported for more than two decades through the Netwerk Klinische Paden (NKP), a learning network coordinated by Katholieke Universiteit Leuven (KULeuven) that supports hospitals in the development, implementation, evaluation, and continuous follow-up of care pathways. Quality improvement collaboratives have been proposed as effective instruments to reduce unwarranted variation and to support implementation of evidence-based practice (10, 11). In colorectal surgery, a Breakthrough Improvement Collaborative (BIC) focusing on enhanced recovery after elective colectomy previously demonstrated that structured peer learning and feedback can significantly improve protocol adherence and reduce length of stay in a multicentre setting (12).

Rectal cancer care, however, encompasses a broader and more complex pathway than colon surgery, extending from diagnostic staging to long-term functional outcomes. To address this, a comprehensive framework of key patient-level interventions for elective rectal cancer surgery through literature review and national expert consensus was co-developed (13). This framework forms the basis for several work packages within the Breakthrough Improvement Collaborative for Rectal Cancer (BIC4ReCa); the current study reports the results of the surgery work package. While this framework defines optimal care, insight into its real-world implementation is currently lacking. Mapping existing practice is an essential first step towards targeted quality improvement. Previous studies have shown important variation in colorectal care processes and outcomes (5, 14), Feedback on delivered care, benchmarking and knowledge sharing should provide the necessary tools and guidance to set up hospital specific improvement initiatives and bridge the gap between guidelines and delivered care.

Therefore, the present study within the BIC4ReCa collaborative aimed to (1) describe current real-world rectal cancer care across Flemish hospitals using standardized patient-level QIs, (2) quantify variation within and between centres, and (3) establish a baseline for future collaborative improvements.

Methods

A multicentre retrospective cohort study was conducted within the BIC4ReCa study. The manuscript was prepared in accordance with the STROBE recommendations for observational studies The analysis included 22 Flemish hospitals (3 academic, 19 non-academic).. Adult patients (≥ 18 years) who underwent elective curative-intent surgery for rectal adenocarcinoma between 2020 and 2024 were included. Eligible procedures comprised total mesorectal excision (TME) and abdominoperineal resection (APR). Patients undergoing local excision, pelvic exenteration, or with metastatic disease were excluded, as were those with hereditary colorectal cancer syndromes, inflammatory bowel disease–associated malignancy, or synchronous colorectal tumors.

To reduce selection bias, local coordinators were instructed to include the last 20 consecutive eligible patients discharged or deceased before June 30, 2024. Because of this fixed case-based sampling strategy, the calendar period represented by the included cohort differed between hospitals depending on volume. The case report form (CRF) was aligned with a previously established framework of key patient-level interventions for rectal cancer

surgery (10). Collected variables covered patient and tumor characteristics, staging, neoadjuvant treatment, perioperative care, pathology reporting, and short-term outcomes. Absence of documentation was recorded as “not documented”.

The primary outcome was variation in care delivery across these co-defined QIs. Adherence to the QIs was assessed according to international guideline recommendations and defined as the proportion of eligible patients in whom the recommended intervention was performed. Adherence to QIs was defined as the percentage of patients with the preferred treatment for that indicator, with not-documented information being considered as non-adherence. Hospital-level variation was expressed as aggregated proportions and minimum–maximum ranges across centres. Secondary outcomes included short-term postoperative outcomes (length of stay, complications, reintervention, readmission, and mortality in hospital or within 90 days after discharge).

Analyses were descriptive and performed using SAS version 9.4 (SAS Institute Inc., Cary, NC, USA). Categorical variables were presented as frequencies and percentages of the overall cohort, and continuous variables as means ± SD or medians (IQR/range) as appropriate. No inferential statistical testing was performed.

The study was approved by the ethics committees of all participating hospitals with the Ethics Committee Research UZ/KU Leuven acting as coordinating committee (S69783). Data was anonymized and reported in aggregated form.

Results

Study population

As hospitals were instructed to include the last 20 consecutive eligible patients before June 30, 2024, the time span represented by the included cohort varied across centres. Included patients underwent surgery in 2020 (1 patient, 0.2%), 2021 (18, 4.2%), 2022 (68, 15.8%), 2023 (190, 44.2%), and 2024 (153, 35.6%). The median look-back period required to identify 20 consecutive eligible patients was 1.73 years (IQR 1.10–2.47; range 0.34–3.52). Based on the inclusion criteria and inclusion period per hospital, estimated annual volumes of curative rectal cancer resections varied widely between hospitals, from approximately 6 to 62 procedures per year (median 9.5; IQR 8.3–14.8).

A total of 430 patients undergoing elective surgery for rectal adenocarcinoma (TME or APR) were included across the participating centres. Baseline characteristics are summarized in Table 1. The mean age was 68.8 ± 12.0 years, most patients were male (n = 292, 67.9%), and the mean body mass index (BMI) was 26.4 ± 4.7 kg/m². Most patients were classified as ASA II (n = 238, 55.3%) or ASA III (n = 120, 27.9%), with 7.2% of cases lacking an ASA score. Clinical stage at diagnosis was stage I in 23.7%, stage II in 17.9%, and stage III in 57.0% of patients. Tumors were located in the distal rectum in 51.9% and in the proximal rectum in 47.9% of patients.

Regarding preoperative treatment, 184 patients (42.8%) underwent primary surgery without neoadjuvant therapy. Among the remaining patients, 41 (9.5%) received long-course chemoradiotherapy, 130 (30.2%) received total neoadjuvant therapy (TNT), and 52 (12.1%) received chemotherapy alone. Immunotherapy was administered in 4 patients (0.9%). In terms of surgical procedures, 347 patients (80.7%) underwent TME and 83 (19.3%) underwent APR. The surgical approach was laparoscopic in 247 patients (57.4%), robotic in 161 (37.4%), and open in 22 (5.1%). Among patients undergoing TME with reconstruction (n = 322), 196 (60.9%) received a diverting stoma.

General anesthesia was administered alone in 253 patients (58.8%) and combined with epidural anesthesia in 88 (20.5%), local infiltration in 73 (17.0%), or spinal anesthesia in 16 (3.7%). A urinary catheter was placed in 426 patients (99.1%), with a median duration of 3 days (IQR 1–5; range 0–173). Half of the patients (51.9%) received a nasogastric tube at timing of surgery; duration was available in 218 cases, with removal on the day of placement in 141 patients (64.7%) (IQR 0–1; range 0–16 days). A pelvic drain was placed in 373 patients (86.7%) for a median duration of 4 days (IQR 3–7; range 0–55).

Quality Indicator Adherence

Adherence to the predefined QIs (10) showed substantial variation within and between organizations (Figure 1). Interpretation of the QIs according to the guidelines is given in Table 2. Overall adherence ranged from 13.0% to 100% across QIs and from 53.1% to 79.8% across hospitals; hospital-level ranges represent the minimum to maximum adherence observed across participating centres.

Adherence to *diagnostic staging indicators* was high with limited inter-hospital variation. Colonoscopy was performed in all 430 patients (100%). Thoracoabdominal CT and pelvic MRI were performed in 418 (97.2%, range 85–100%) and 405 (94.2%, range 85–100%) patients, respectively. However, preoperative microsatellite status testing, although achieved in 378 patients (87.9%) overall, showed wide variation between hospitals (range 55–100%).

Adherence to *perioperative process indicators* was generally lower and much more heterogeneous. Mechanical bowel preparation was used in 318 patients (74.0%), but adherence ranged from 20% to 100% across hospitals. Oral antibiotics were given in only 13.0% of patients, with some centres reporting no use at all and others near-complete uptake (range 0–100%). Preoperative stoma site marking was documented in 273 patients (63.5%, range 0–100%).

Intraoperatively, intravenous antibiotic prophylaxis consisting of a single pre-incision dose administered within 60 minutes before incision was documented in 76.5% of cases (range 0–100%), Epidural analgesia was still used in 17.9% of patients undergoing minimally invasive surgery (range 0–100%). Inspection of circular stapler donuts in stapled anastomoses occurred in 86.4% of procedures (range 0–100%). Avoidance of surgical drain placement had the lowest adherence among intraoperative indicators, with drains omitted in only 13.0% of patients (range 0–70%).

Postoperatively, stoma education prior to discharge was documented in 273 of 304 patients with a stoma (89.8%, range 44–100%). A nasogastric tube remained in place beyond the day of surgery in 24.4% of patients, with marked inter-hospital variation (0–100% among patients in whom a tube was placed). Adequate early urinary catheter removal (within 24–48 hours) occurred in fewer than half of patients (43.7%, range 0–85%), and postoperative low anterior resection syndrome (LARS) score reporting was documented in only 24.5% of patients (range 0–61%).

Short-term outcomes

Overall, 46.7% of patients experienced at least one in-hospital complication. The most frequent in-hospital complications were prolonged ileus (17.0%), stoma-related complications (14.1%), and urinary retention (10.0%). The 90-day anastomotic leakage, reintervention, and mortality rates were 17.5% (range 6–41%), 19.5% (range 5–35%), and 2.8% (range 0–10%), respectively. Readmission within 90 days after discharge occurred in 21.1% of

patients (range 0–65%). Considerable interhospital variation was observed across most short-term outcomes (Table 3).

Discussion

This multicentre study demonstrates substantial variation in rectal cancer care across Flemish hospitals at both the individual QI and hospital level. In Belgium, rectal cancer surgery is not centralized and is performed in both academic and non-academic centres, reflecting a high-resource yet non-centralized European healthcare setting. The present data therefore capture real-world delivery of rectal cancer care within a guideline-dense environment. While adherence to diagnostic staging was consistently high, several perioperative QIs showed incomplete uptake and wide inter-hospital variability, highlighting persistent challenges in translating evidence-based recommendations into routine practice and in closing well-defined implementation gaps.

Diagnostic staging was highly standardized, with near-universal use of colonoscopy, thoracoabdominal CT, and pelvic MRI. This likely reflects the strong integration of imaging and multidisciplinary decision-making into oncological care pathways and is consistent with previous European data (5), suggesting that similar standardization of staging is common in other high-resource settings. In contrast, perioperative indicators demonstrated greater heterogeneity, consistent with prior reports showing incomplete implementation of ERAS-based care in routine colorectal practice (6, 15).

Four indicators showed overall adherence below 50%: oral antibiotic administration, avoidance of a pelvic drain, postoperative LARS score reporting, and early removal of urinary catheter (< = 48h). For some indicators, such as combined bowel preparation and oral antibiotics, the supporting evidence and corresponding guideline recommendations have become stronger over recent years, suggesting that implementation may lag behind evolving evidence and recent guideline updates (4, 15, 16). For others, including drain use, persistent variation may reflect historical practice patterns and surgeon preference (17). Likewise, prolonged urinary catheterization remains common despite well-described adverse effects and recommendations favoring early removal (4). By contrast, low reporting of LARS scores likely reflects the broader challenge of integrating standardized functional outcome assessment into routine follow-up despite consensus recommendations(18).

Four other perioperative indicators demonstrated adherence between approximately 60 and 80%, combined with wide inter-hospital variation: mechanical bowel preparation, preoperative stoma site marking, nasogastric tube management and intravenous antibiotic prophylaxis. Such patterns suggest that these interventions are not yet uniformly embedded in perioperative pathways and may still depend on local routines, workflow design, or surgeon preference. Importantly, even indicators with relatively high overall adherence demonstrated wide hospital-level ranges, indicating that aggregated performance may obscure meaningful institutional differences. Comparable between-hospital variation in colorectal surgical pathways has been described in earlier European studies and is generally considered a marker of unwarranted practice variation rather than case-mix differences alone, reinforcing the likelihood that similar gaps exist in other non-centralized healthcare systems. (5).

An important consideration when interpreting these findings is that the included QIs do not all represent the same type of care process. Some reflect direct clinical actions (e.g. oral antibiotics, drain avoidance, urinary catheter removal), whereas others capture structured assessment or documentation practices (e.g. LARS score reporting) or broader organizational processes such as patient education. As a result, lower observed adherence may reflect

different underlying barriers, ranging from disagreement with evidence to workflow design, documentation infrastructure, or limited integration of patient-reported outcome measurement into routine follow-up.

The observed variation likely reflects differences in pathway organization rather than individual decision-making alone. In addition, the fixed 20-case sampling strategy resulted in variable look-back periods across hospitals (median 1.73 years, IQR 1.10–2.47), likely reflecting differences in case accrual and serving as a proxy for centre volume. Together, these findings suggest that organizational factors, including pathway design, implementation culture, and audit and feedback mechanisms, play an important role in explaining variation. This interpretation is supported by previous collaborative work in colorectal surgery: within the Flemish Breakthrough Improvement Collaborative for Colon Cancer (BIC4CRC), structured benchmarking, feedback, and peer learning improved protocol adherence and reduced hospital stay after elective colectomy (12). Although rectal cancer surgery encompasses a broader and more complex pathway than colectomy, overlap in perioperative ERAS principles suggests that prior exposure to colorectal quality improvement initiatives may have differed between participating hospitals and may partly contribute to variation in current practice. Future work within the collaborative should therefore also explore centre-level organizational and structural characteristics that may help explain variation in performance, such as hospital size, teaching status, colorectal surgical volume, and prior experience with care pathways or quality improvement collaboratives. Collecting such data may help identify contextual factors associated with higher adherence and support more tailored implementation strategies across hospitals.

Overall short-term outcomes were within ranges reported in contemporary rectal cancer series, where postoperative morbidity frequently exceeds 40% and anastomotic leakage remains a major concern (1, 5). The observed 90-day mortality of 2.8% is comparable to published European data. Notably, nearly half of patients experienced at least one in-hospital complication, underlining the ongoing burden of morbidity after rectal cancer surgery despite contemporary staging, neoadjuvant treatment, and minimally invasive approaches. This emphasizes the continued need for systematic quality improvement in this high-risk surgical population.

The major strength of this study lies in its multicentre design, inclusion of both academic and non-academic hospitals, and use of predefined QIs aligned with international guidelines and consensus recommendations. By operationalizing adherence through explicit criteria, we provide a transparent benchmark that can be used by hospitals and collaboratives to compare performance, identify unwarranted variation, and focus quality improvement efforts on the most pronounced gaps.

Several limitations should be acknowledged. First, the retrospective design relies on electronic health record documentation; absence of documentation was classified as non-adherence and may therefore underestimate actual performance. However, non-documentation in hospital records also has clinical relevance and may itself represent a quality gap. Second, the included QIs are not all supported by the same type or strength of evidence, and for some indicators recommendations have evolved over time. Third, the limited number of patients per hospital may accentuate apparent institutional variation. Although the use of consecutive case inclusion was intended to reduce selective case sampling, retrospective data collection cannot fully exclude selection or reporting bias at the local level. Restricting inclusion to 20 patients per hospital enhanced feasibility and comparability of participation but may also have amplified random variation and limited representativeness of centre-level performance, particularly for lower-volume institutions. Finally, analyses were descriptive and not risk adjusted. Evaluating associations between process adherence and clinical outcomes, as well as long-term

oncologic and functional outcomes, was beyond the scope of this study and warrants investigation in future research.

Conclusion

In this multicentre study from a high-resource, non-centralized European healthcare system, rectal cancer surgery showed substantial unwarranted variation in adherence to guideline-based quality indicators at both the patient and hospital level. Even in this guideline-dense setting, perioperative rectal cancer care exhibits marked, unwarranted variation in strongly recommended indicators (e.g. oral antibiotics, drain avoidance, early urinary catheter removal, and LARS assessment) which represent immediate, high-yield targets for system-level improvement. These findings support wider benchmarking of rectal cancer QIs and provide a real-world reference point for other countries aiming to identify similar implementation gaps and strengthen guideline-based rectal cancer pathways

Declarations

Author Contributions

All authors contributed to the study conception and design. Material preparation, data collection, and analysis were performed by CS, LL and EC. The first draft of the manuscript was written by CS. All authors commented on previous versions of the manuscript and approved the final version

Funding: The authors declare that no funding was received for this study.

Competing Interests: The authors declare that they have no competing interests.

Acknowledgement

The authors thank all local coordinators and members of the BIC4ReCa collaborative for their contributions to data collection and pathway implementation. Artificial intelligence–based tools were used solely for language editing and drafting assistance. All study design, data analysis, interpretation, and final wording were performed and verified by the authors.

References

1. Rawla P, Sunkara T, Barsouk A. Epidemiology of colorectal cancer: incidence, mortality, survival, and risk factors. Prz Gastroenterol. 2019;14(2):89-103.
2. Kehlet H. Multimodal approach to control postoperative pathophysiology and rehabilitation. Br J Anaesth. 1997;78(5):606-17.
3. Fearon KC, Ljungqvist O, Von Meyenfeldt M, Revhaug A, Dejong CH, Lassen K, et al. Enhanced recovery after surgery: a consensus review of clinical care for patients undergoing colonic resection. Clin Nutr. 2005;24(3):466-77.
4. Gustafsson UO, Rockall TA, Wexner S, How KY, Emile S, Marchuk A, et al. Guidelines for perioperative care in elective colorectal surgery: Enhanced Recovery After Surgery (ERAS) Society recommendations 2025. Surgery. 2025;184:109397. doi:10.1016/j.surg.2025.109397.

5. van Zelm R, Coeckelberghs E, Sermeus W, De Buck van Overstraeten A, Weimann A, Seys D, et al. Variation in care for surgical patients with colorectal cancer: protocol adherence in 12 European hospitals. Int J Colorectal Dis. 2017;32(10):1471-8.
6. Alcántara-Moral M, Serra-Aracil X, Gil-Egea MJ, Frasson M, Flor-Lorente B, Garcia-Granero E. Observational cross-sectional study of compliance with the fast track protocol in elective surgery for colon cancer in Spain. Int J Colorectal Dis. 2014;29(4):447-53.
7. De Bleser L, Depreitere R, De Waele K, Vanhaecht K, Vlayen J, Sermeus W. Defining pathways. J Nurs Manag. 2006;14(7):553-63.
8. Lawal AK, Rotter T, Kinsman L, Machotta A, Ronellenfitsch U, Scott SD, et al. What is a clinical pathway? Refinement of an operational definition to identify clinical pathway studies for a Cochrane systematic review. BMC Med. 2016;14(1):35.
9. Seys D, Bruyneel L, Deneckere S, Kul S, Van der Veken L, van Zelm R, et al. Better organized care via care pathways: a multicenter study. PLoS One. 2017;12(7):e0180398.
10. Schouten LM, Hulscher ME, van Everdingen JJ, Huijsman R, Grol RP. Evidence for the impact of quality improvement collaboratives: systematic review. BMJ. 2008;336(7659):1491-4.
11. Hulscher ME, Schouten LM, Grol RP, Buchan H. Determinants of success of quality improvement collaboratives: what does the literature show? BMJ Qual Saf. 2013;22(1):19-31.
12. Coeckelberghs E, Vanhaecht K, Seys D, Cox B, Bislenghi G, Wolthuis AM, et al. A breakthrough improvement collaborative significantly reduces hospital stay after elective colectomy for cancer across a healthcare system. Ann Surg. 2022;276(5):e828-36.
13. Schraepen C, Bislenghi G, Vanhaecht K, D'Hoore A, Wolthuis A, Coeckelberghs E. Defining key interventions for rectal cancer surgery: a literature review and expert panel consensus. Int J Colorectal Dis. 2025;40:241. doi:10.1007/s00384-025-05028-z.
14. Pisarska M, Pędziwiatr M, Małczak P, Major P, Ochenduszko S, Zub-Pokrowiecka A, et al. Do we really need full compliance with ERAS protocol in laparoscopic colorectal surgery? A prospective cohort study. Int J Surg. 2016;36(Pt A):293-300.
15. Irani JL, Hedrick TL, Miller TE, Lee L, Steinhagen E, Shogan BD, et al. Clinical practice guidelines for enhanced recovery after colon and rectal surgery from the American Society of Colon and Rectal Surgeons and the Society of American Gastrointestinal and Endoscopic Surgeons. Surg Endosc. 2023;37(1):1-32.
16. Carmichael JC, Keller DS, Baldini G, Bordeianou L, Weiss E, Lee L, et al. Clinical practice guideline for enhanced recovery after colon and rectal surgery from the American Society of Colon and Rectal Surgeons (ASCRS) and Society of American Gastrointestinal and Endoscopic Surgeons (SAGES). Surg Endosc. 2017;31(9):3412-36.
17. Christensen P, Im Baeten C, Espín-Basany E, Martellucci J, Nugent KP, Zerbib F, et al. Management guidelines for low anterior resection syndrome – the MANUEL project. Colorectal Dis. 2021;23(2):461-75.
18. Salvadalena G, Hendren S, McKenna L, Muldoon R, Netsch D, Paquette I, et al. WOCN Society and ASCRS position statement on preoperative stoma site marking for patients undergoing colostomy or ileostomy surgery. J Wound Ostomy Continence Nurs. 2015;42(3):249-52.
19. Bratzler DW, Dellinger EP, Olsen KM, Perl TM, Auwaerter PG, Bolon MK, et al. Clinical practice guidelines for antimicrobial prophylaxis in surgery. Am J Health Syst Pharm. 2013;70(3):195-283.

20. ESCP Safe Anastomosis ProGramme in ColoRectal SurgEry (EAGLE) Study Group. 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. 2021;23(10):2685-93.
21. Tou S, Gallagher AG, Bislenghi G, Farinha R, Wolthuis A. European expert consensus on a structured approach to circular stapling anastomosis in minimally invasive left-sided colorectal resection. Colorectal Dis. 2025;27(2):e70037. doi:10.1111/codi.70037.
22. Bartley AN, Mills AM, Konnick E, Overman M, Ventura CB, Souter L, et al. Mismatch repair and microsatellite instability testing for immune checkpoint inhibitor therapy: guideline from the College of American Pathologists in collaboration with the Association for Molecular Pathology and Fight Colorectal Cancer. Arch Pathol Lab Med. 2022;146(10):1194-210.
23. National Comprehensive Cancer Network. NCCN Clinical Practice Guidelines in Oncology: Genetic/Familial High-Risk Assessment: Colorectal. Version 1.2025. Plymouth Meeting (PA): NCCN; 2025.
24. Glynne-Jones R, Wyrwicz L, Tiret E, Brown G, Rödel C, Cervantes A, Arnold D. Rectal cancer: ESMO clinical practice guidelines for diagnosis, treatment and follow-up. Ann Oncol. 2017;28(suppl 4):iv22-40.
25. Tan J, Ryan ÉJ, Davey MG, McHugh FT, Creavin B, Whelan MC, et al. Mechanical bowel preparation and antibiotics in elective colorectal surgery: systematic review and network meta-analysis of randomized clinical trials. BJS Open. 2023;7(3):zrad040. doi:10.1093
26. Koskenvuo L, Lunkka P, Varpe P, Hyöty M, Satokari R, Haapamäki C, et al. Morbidity after mechanical bowel preparation and oral antibiotics prior to rectal resection: the MOBILE2 randomized clinical trial. JAMA Surg. 2024;159(6):606-14.
27. Guadagni S, Catarci M, Masedu F, Karim ME, Clementi M, Ruffo G, et al. Abdominal drainage after elective colorectal surgery: propensity score-matched retrospective analysis of an Italian cohort. BJS Open. 2024;8(1):zrad107. doi:10.1093.

Tables

Table 1. Summary of baseline characteristics. SD = standard deviation

Variable	Result (n/%) or mean ± SD
Sex	
Male	292 (67.9)
Female	138 (32.1)
Age	68.8 ± 12.0 years
Body Mass Index (n = 412)	26.4 ± 4.7 kg/m²
Operation Type	
APR	83 (19.3)
TME	347 (80.7)
cT-stadium	
Tx	2 (0.5)
T1	20 (4.7)
T2	115 (26.7)
T3	252 (58.6)
T4	37 (8.6)
missing	4 .(0.9)
cN-stadium	
N0	183 (42.6)
N1	131 (30.5)
N2	111 (25.8)
N3	2 (0.5)
Nx	1 (0.1)
missing	2 (0.5)
Disease stage	
Stage I	102 (23.7)
Stage II	77 (17.9)
Stage III	245 (57.0)
Unknown	6 (1.4)
ASA-score	
I	39 (9.1)
II	238 (55.3)
III	120 (27.9)
IV	2 (0.5)
Missing	31 (7.2)
Diabetes	
Yes	87 (20.2)
No	325 (75.6)
Missing	18 (4.2)
Active Smoking	
Yes	72 (16.7)

No	313 (72.8)
Missing	45 (10.5)
Surgical approach	
Open	22 (5.1)
Laparoscopic	247 (57.4)
Robotic	161 (37.4)
Diverting ostomy*	196 (60.9)

* Calculated only on TME with reconstruction (322)

Table 2. Operationalized quality indicators (QIs) derived from international guideline recommendations

Quality indicator (QI)	Interpretation of Adherence	**Guidelines** / year	**Recommendation strength**	**Overall adherence (%)**
Oral antibiotics administered	Preoperative oral antibiotics recommended	**ASCRS 2024 (15), ERAS 2025 (4) ASCRS 2017 (16)**	Strong (moderate-quality evidence)	13.0
Avoidance of drain placement	Routine pelvic drains should be avoided	**ERAS 2025 (4)**	Evolving recommendation	13.0
Postoperative LARS score reported	Routine assessment of bowel function after rectal cancer surgery	**MANUEL consensus 2021 (17)**	Strong recommendation	24.5
Early removal of urinary catheter	Removal within 24–48 hours	**ERAS 2025 (4), ASCRS 2017 (16)**	Strong recommendation	43.7
Preoperative stoma site marking	Stoma site marking by a trained professional	**WOCN–ASCRS 2015 (18)**	Position statement	63.5
Mechanical bowel preparation (MBP)	Performance of full MBP	**ASCRS 2024 (15), ERAS2025 (4), EAES/SAGES/ESCP2023, ASCRS 2017 (16)**	Strong recommendation (moderate quality evidence)	74.0
Avoidance of prolonged nasogastric tube use	Removal on the day of surgery	**ASCRS 2017 (16), ERAS 2025 (4)**	Strong recommendation	75.6
IV antibiotic prophylaxis only at induction	Single dose prophylaxis within 60 minutes before incision	**ASHP 2013 (19)**	Strong recommendation	76.5
Avoidance of epidural anesthesia	Epidural analgesia not routinely recommended for minimally invasive surgery	**ASCRS 2017 (16), ERAS 2025 (4)**	Strong recommendation	82.1
Inspection of circular stapler donuts	Mandatory inspection and documentation of integrity of donuts	**ESCP2021 (20), European expert consensus 2025 (21)**	Expert consensus – Technical safety recommendation	86.4
Microsatellite status testing	Universal MSI/MMR testing preoperatively	**CAP 2022 (22) NCCN 2025 (23)**	Strong recommendation	87.9
Stoma education postoperatively	Structured patient education before discharge	**WOCN–ASCRS 2021 (18)**	Position statement	89.8
Preoperative Rectal MRI	Pelvic MRI recommended for	**ESMO 2017 (24)**	Strong recommendation	94.2

	rectal cancer staging			
Preoperative CT Thorax Abdomen	Thoracoabdominal CT executed preoperatively	**ESMO 2017 (24)**	Strong recommendation	97.2
Preoperative colonoscopy	Complete colonoscopy prior to curative surgery	**ESMO 2017 (24)**	Strong recommendation	100

Abbreviations: ASCRS: American Society of Colon and Rectal Surgeons; ASHP: American Society of Health-System Pharmacists; CT: computed tomography; ERAS: Enhanced Recovery After Surgery; ESMO: European Society for Medical Oncology; IV: intravenous; LARS: Low Anterior Resection Syndrome; MBP: mechanical bowel preparation; MMR: mismatch repair; MRI: magnetic resonance imaging; MSI: microsatellite instability; NG: nasogastric; CAP: college of American Pathologists; NCCN: National Comprehensive Cancer Network; SSI: surgical site infection; WOCN: Wound, Ostomy and Continence Nurses Society

Table 3. In-hospital and 90-day post-discharge outcomes following rectal cancer.

	Overall n (%)	Min n/N (%)	Max n/N (%)
In hospital outcome			
Any complication	201 (46.7)	5/20 (25.0)	17/20 (85.0)
Prolonged ileus > 4days	73 (17.0)	0 (0.0)	8/20 (40.0)
Stoma-related*	43 (14.1)	0 (0.0)	4/7 (23.5)
Urinary retention	43 (10.0)	0 (0.0)	10/20 (50.0)
Anastomotic leakage**	35 (10.9)	0 (0.0)	5/18 (27.8)
Reintervention	47 (10.9)	0 (0.0)	5/20 (25.0)
Mortality	3 (0.7)	0 (0.0)	1/20 (5.0)
90-day outcome †			
Anastomotic leakage**	56 (17.4)	1/16 (7.7)	7/17 (41.1)
Reintervention	84 (19.5)	1/20 (5.0)	7/20 (35.0)
Readmission ††	90 (21.1)	0 (0.0)	13/20 (65.0)
Mortality	12 (2.8)	0 (0.0)	2/20 (10.0)

* Calculation based only on patients with ileo- or colostomy (N = 304)

** Calculation based only on patients with anastomosis (N = 322)

† Ninety-day outcomes include complications occurring during the index hospital stay and up to 90 days following discharge.

†† Readmission rate based only on patients that were discharged alive (N = 427)

Figures

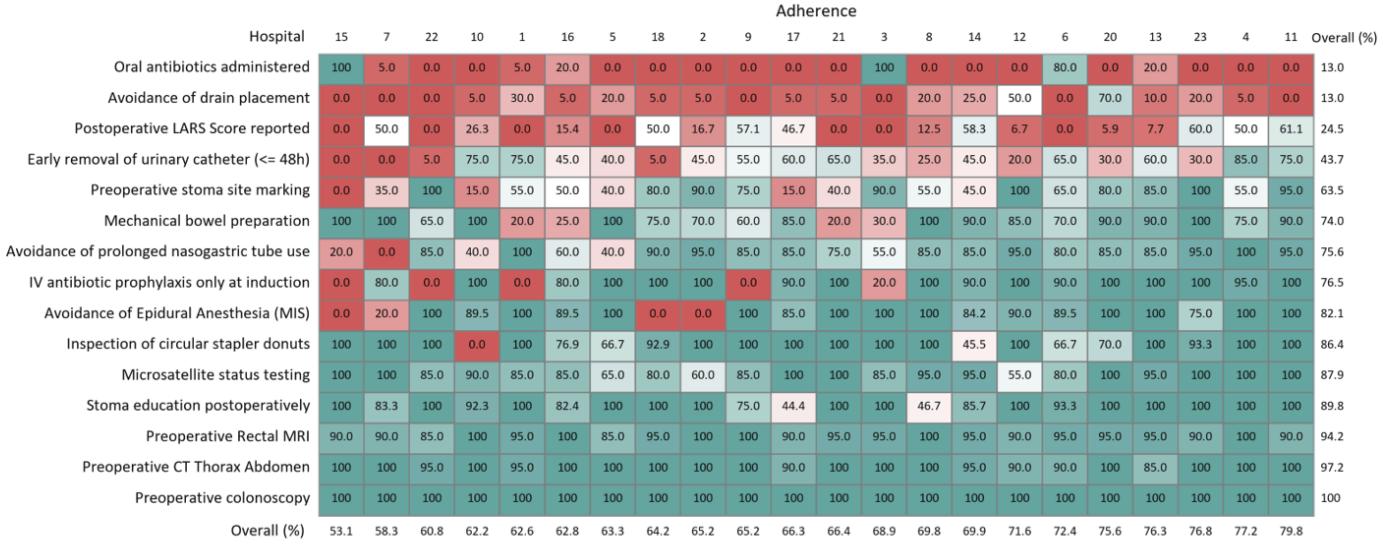


Figure 1

Heatmap showing hospital-level performance of quality indicators in rectal cancer care. Each cell reflects the percentage of cases with complete documentation for the specified indicator. Colors range from low (red) to high (green). The rightmost column shows overall performance across all hospitals for each indicator; the bottom row shows the overall score per hospital.