Colorectal cancer (CRC) is the most common type of cancer in Europe. Approximately 1 in 20 men and 1 in 35 women will develop CRC at some point in their life. Oncological resection remains the mainstay of the curative treatment for colonic cancer. A high variability in both postoperative morbidity and implementation of minimally invasive surgery (MIS) persists. Over the last decade, surgical care for patients with CRC has become more standardized using enhanced recovery after surgery (ERAS) protocols. ERAS protocols, enhanced recovery pathways (ERPs), and care pathways are structured care methodologies, that facilitate adherence to these protocols and stimulate multidisciplinary collaboration. This multimodal approach was introduced by Kehlet in 1997. In 2005, the ERAS Group provided a structured enhanced recovery approach based on literature review. The goal of these pathways is to reduce the patient’s surgical stress response, preserve physiological function, and facilitate postoperative recovery.

**Keywords:** adherence, colorectal cancer, ERAS, improvement collaborative, quality improvement

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**A Breakthrough Improvement Collaborative Significantly Reduces Hospital Stay After Elective Colectomy for Cancer Across a Healthcare System**

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**Objective:** This multicenter study aimed to assess (1) the effect of an improvement collaborative on enhanced recovery after surgery (ERAS) protocol adherence after elective colectomy and (2) the association between adherence and patient outcomes.

**Background:** ERAS pathways provide a framework to standardize care processes and improve postoperative outcomes in patients after colon surgery. Despite growing evidence of its effectiveness, adherence to these guidelines remains a challenge.

**Methods:** This prospective, multicenter collaborative was initiated throughout 11 hospitals in Flanders, Belgium. A structured audit tool was used to study patient outcomes and adherence to 12 ERAS components, defined by the collaborative. Three retrospective audits (based on patient record analysis) were conducted in 2017, 2019, and 2021, respectively.

**Results:** Overall, 740 patients were included (45.4% female; mean ± SD age, 71 ± 12 years). The overall adherence increased from 42.8% in 2017 to 58.4% in 2019 and 69.2% in 2021. Compared with low adherence, length of stay was increasingly reduced by 1.3 days for medium [95% confidence interval (95% CI): –2.5; 0.0] and 3.6 days for high (95% CI: –4.9; –2.2), and up to 4.4 days for very high adherence (95% CI: –6.1; –2.7). Corresponding odds ratios for postoperative complications were 0.62 (95% CI: 0.33; 1.17), 0.19 (95% CI: 0.09; 0.43), and 0.14 (95% CI: 0.05; 0.39), respectively. No increase in 30-day readmissions was observed.

**Conclusions:** A peer-constructed improvement collaborative effectively increases adherence to an ERAS protocol in individual hospitals. Across time, length of stay and postoperative complications decreased significantly, and a dose-response relationship was observed.

**Keywords:** adherence, colorectal cancer, ERAS, improvement collaborative, quality improvement

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Despite increasing evidence in favor of the use of these standardized protocols, adherence to and implementation of ERAS protocols remains challenging in daily practice. A previous study noted only a 44% adherence rate across 12 European hospitals. One approach to successfully implement a complex multidisciplinary quality program such as ERAS is the Breakthrough Improvement Collaborative (BIC) methodology. In short, a BIC consists of 4 learning sessions and 3 action periods supported by a faculty of experts. The care process is optimized based on evidence, feedback, and knowledge sharing. Collaboratives have been implemented in different countries with diverse healthcare systems to achieve quality improvement across organizations. The efficacy of improvement collaboratives has been demonstrated in cardiac surgery, bariatric surgery, trauma surgery, general and vascular surgery, chronic heart failure, and neonatal intensive care units.

The aims of the present study were: (1) to evaluate the effect of an improvement collaborative on adherence to ERAS components after elective colectomy; and (2) to assess the relationship between protocol adherence and patient outcomes: length of stay and 30-day postoperative readmissions, and 30-day postoperative complications.

**METHODS**

**Study Population**

The BIC was launched in 11 hospitals within the Flemish region of Belgium. Included hospitals were a mix of academic/teaching, nonteaching small and large volume hospitals. This provides a cross sectional view on how colorectal surgical care is provided in our healthcare system. The annual caseload of colorectal resection for cancer of these hospitals varied between 30 and 300.

Adult patients admitted for elective nonmetastatic colon cancer surgery (ICD-10-CM Diagnosis Code C18) were included. Exclusion criteria were (1) emergency surgery; (2) severe dementia (DSM IV) or severe concomitant disease that might affect short-term outcomes; (3) rectal cancer surgery.

**BIC**

The BIC methodology is a structured improvement model, and consists of 4 learning sessions and 3 action periods with accompanying measurement occasions at the end of each action period. During the learning sessions, the focus is providing an overview of evidence and guidelines, feedback on clinical performance (adherence to ERAS components), and sharing (inter)national expertise, knowledge and best practices. During the action periods, improvement strategies are implemented at a hospital level, every hospital could have a different focus for improvement and another strategy to achieve that goal. Finally, after each action period a retrospective assessment is performed (record analysis of 25 consecutive patients) to record the effect of the newly introduced care program. During the entire project there was a continued support of the research team: (1) hospital-specific on-site training activities and learning sessions; (2) peer instructions and support in group meetings; and (3) interaction by e-mail, motivational conversations, and phone/Skype meetings.

Per participating center, the collaborative consisted of a surgeon, an involved anaesthesiologist, a nurse (specialist) and a quality assessor. There were 3 assessment periods, with a baseline in 2017, a second assessment in 2019, and a third in 2021. After each assessment, hospitals received peer-review and an anonymous feedback report with a benchmark for their adherence to ERAS components. A local study coordinator performed retrospective data collection. For the first assessment period, the last 25 consecutive patients treated in 2017 were included. For the second and third assessment periods, the research team randomly selected 25 patients per hospital who were admitted over the last 6 months. Participants were blinded for the assessment periods.

**Protocol Development of 12 Components**

The ERAS components were listed by a selected group of “experts,” based on previous research. For the present study,

| Table 1. Predefined ERAS Components |
|------------------------------------|
| **ERAS Component** | **Recommendation** | **Quality of Evidence** |
| PONV Screening | Multimodal postoperative nausea and vomiting (PONV) prophylaxis* | High |
| Sedative medication | Avoid routine sedative medication* | Moderate |
| Antibiotic prophylaxis | Intraoperative antibiotic prophylaxis should be given within 60 min before incision as a single-dose administration* | High |
| Carbohydrate loading | In elective colorectal surgery in patients without delayed gastric emptying; 6-h fasting for solids and 2-h for clear fluids including carbohydrate drinks*, §†‡ | High |
| Urinary catheterization | Early removal recommended. Patients at low risk should have routine removal of catheter on the first day after surgery*, § | High |
| Drain administration | Drainage of the peritoneal cavity and pelvis should not be performed routinely*, § | High |
| Nasogastric intubation | Postoperative nasogastric tubes should not be used routinely; if inserted during surgery, they should be removed before reversal of anesthesia* | High |
| Epidural anesthesia | Spinal anesthesia with low-dose opioids gives good analgesic effects. Early removal is recommended in order not to compromise recovery*, § | Moderate |
| Minimally invasive surgery | A minimally invasive approach (laparoscopic/robotic) is recommended*, § | High |
| Postoperative nutrition | Most patients can and should be offered food and oral nutritional supplements from the day of surgery*, § | Moderate |
| Postoperative opioid use | Avoid opioids and apply multimodal analgesia* | Moderate |
| Postoperative mobilization | Early mobilization*, § | Moderate |

*Gustafsson et al. 26
†Kielhorn et al. 27
‡Gianotti et al. 28
§Carmichael et al. 29
the focus was on components that were defined as clinically relevant (high level of evidence and/or high grade of recommendation), but that showed low adherence in clinical practice. Afterward, these components were discussed under peers of the collaborative to come to a final 12-component ERAS program. Some aspects of ERAS guidelines were not part of our 12-component program. However, perioperative fluid management certainly warrants attention as it is a major determinant in bowel and general recovery. A structured audit tool was used for the evaluation of patient characteristics and the 12 predefined ERAS components: postoperative nausea and vomiting screening and related medical therapy, avoidance of preoperative sedative medication, antibiotics prophylaxis, carbohydrate loading, avoidance of urinary catheterization, avoidance of abdominal drain, avoidance of nasogastric tube, avoidance of epidural anesthesia, MIS, early postoperative nutrition, avoidance of postoperative opioid use, and early postoperative mobilization (Table 1). The following 3 outcomes were evaluated: length of stay (LOS), 30-day postoperative complications, and 30-day unplanned readmission. A patient was considered to have a complication in case of one (or more) of the following adverse events: surgical site infection (superficial and deep), postoperative bleeding, more than 4 days of ileus and the occurrence of an anastomotic leakage.\textsuperscript{30}

This study was approved by the ethics committee of the University Hospitals Leuven (S60907) as the coordinating center. All participating centers provided consent for data sharing and analysis.

Statistical Analysis
ERAS adherence at the patient-level was arbitrarily categorized as low (< 6 components adhered to), medium (6–7 components), high (8–9 components), and very high (10–12 components). Patient characteristics and adherence to ERAS components are presented as the mean ± SD. Differences in patient characteristics and adherence to ERAS components between periods were assessed using the Student t test for continuous variables and the Pearson \( \chi^2 \) test for categorical variables. Statistical models investigating the association between outcomes (LOS, 30-day complications and 30-day unplanned readmissions) and period as well as between outcomes and adherence to ERAS components (in one and the same model) were adjusted for patient age, sex, ASA classification, and type of surgery (open versus laparoscopic/robotic). Models for LOS and readmissions were additionally adjusted for complications. Linear mixed models were used for continuous outcomes (LOS) and generalized estimation equations for binary outcomes (complications and 30-day readmissions). Statistical analyses were performed using SAS version 9.4, SAS Institute Inc., Cary, North Carolina.

RESULTS

Descriptives
A total of 740 patients were included, with 219, 252, and 269 in the first, second, and third period, respectively. Patient characteristics according to the period are summarized in Table 2. The mean age (SD) was 71 (12) years, and 45.4\% of patients were female. The proportion of patients who underwent MIS increased from 73.5\% in the first period to 89.6\% in the third period, and adherence to ≥ 8 ERAS components increased from 16.0\% to 68.8\%. Mean LOS (SD) decreased significantly from 9.4 (7.4) days in the first period to 6.3 (5.2) days in the third period (\( P < 0.001 \)). Complications and unplanned readmissions did not differ significantly between periods.

Improvement in Adherence to Predefined ERAS Components
The variation in adherence to ERAS components between hospitals is shown in Figure 1. Overall, the lowest adherence was observed for carbohydrate loading, opioid-free analgesia, and early mobilization after surgery. The highest adherence was observed for avoidance of sedative medication, antibiotic prophylaxis, and use of MIS. A significant increase in adherence to each of the 12 ERAS components from the first to the third period was observed (\( P < 0.001 \)) (Table 3). The largest improvement in adherence was observed for avoidance or early removal of the epidural anesthesia, avoidance or early removal of urinary catheters and early postoperative mobilization (with an improvement of 46\%, 39\%, and 37\%, respectively). The use of abdominal drains and nasogastric tubes reduced from 66\% to 41\%, and from 47\% to 17\%, respectively.

Dose Relation Between Adherence to ERAS Components and Patient Outcomes
Across the periods, LOS and postoperative complications were inversely related to ERAS protocol adherence (Table 4). Compared with the patient group with low protocol adherence (<6 components), LOS was 1.3 days [95\% confidence interval (95\% CI): −2.5; 0.0], 3.6 days [95\% CI: −4.9; −2.2], and 4.4 days [95\% CI: −6.1; −2.7] shorter in the medium (6–7 ERAS components), high (8–9 ERAS components), and very high (10–12 ERAS components) adherence group, respectively. There was no increase in the 30-day readmissions, even in the group with the shortest LOS. Estimated odds ratios for postoperative complications were 0.62 [95\% CI: 0.33–1.17], 0.19 [95\% CI: 0.09–0.43], and 0.14 [95\% CI: 0.05–0.39] for medium, high, and very high protocol adherence.

DISCUSSION
This multicenter study, over 5 years, showed that higher adherence to ERAS components significantly improved the postoperative outcomes. A progressive and significant increase in adherence to ERAS components was observed over the different assessment periods and across the different institutions. At baseline, an important variation in adherence to ERAS components was observed. This finding is rather unexpected as participating hospitals are located in a distinct geographic area with the same financial incentives and participating physicians share the same training background. At the time of the start of the study only 2 hospitals had an ERAS protocol running, which could be explained by the absence of (financial) incentives to reduce postoperative hospital stay within our healthcare system.

This further emphasizes the role of a peer organized BIC to implement a complex pathway as ERAS. Despite CRC surgery not being centralized, improvements were achieved across all institutions, with low-volume centers improving equally.

A major finding of this study was the significant increase in overall and component-specific adherence over the different assessment periods. The components: avoidance of epidural anesthesia, urinary catheters, and early postoperative mobilization showed the largest improvements. The use of abdominal drains dropped over time, but are still placed in 40\% of the cases, despite evidence.\textsuperscript{28} Furthermore, there was a limited decrease in opioid use...
(81%–68%), indicating the difficulty of creating an opioid-free environment. Non steroidal anti inflammatory drugs (NSAIDs) are a key opioid-sparing component in multimodal analgesia.26 Current evidence shows that the use of NSAIDS in the early postoperative setting after surgical resection for CRC is safe.31 However, at the time of development of our ERAS protocol there was ongoing debate on the safety of the use of NSAIDs in the postoperative setting (risk for bleeding, increased risk for anastomotic leakage). This explains why only 28% of patients received NSAIDs post-operatively, and the persistent need for the use of opioids. This finding emphasizes the importance of refining a multimodal post-operative pain protocol according to newest insights.

Overall, there was a gradual increase in adherence to ERAS components from 42.8% in 2017 to 58.4% in 2019 and

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**TABLE 2. Descriptives**

| Characteristic                      | Mean (SD) or N (%) | Period 1   | Period 2   | Period 3   | Overall * | P Period 2 vs. 1* | P Period 3 vs. 2* | P Period 3 vs. 1* |
|-------------------------------------|--------------------|------------|------------|------------|-----------|-----------------|-----------------|-----------------|
| Age (y)                             |                    | Period 1 (N = 219) | Period 2 (N = 252) | Period 3 (N = 269) | Overall P* | P Period 2 vs. 1* | P Period 3 vs. 2* | P Period 3 vs. 1* |
| Male                                | 123 (56.2)         | 137 (54.4) | 144 (53.5) | 0.841      | 0.695     | 0.849           | 0.561           |
| Female                              | 96 (43.8)          | 115 (45.6) | 125 (46.5) | 0.539      | 0.277     | 0.526           | 0.609           |
| BMI†                                | 26.0 (4.4)         | 26.5 (4.5) | 26.2 (4.2) | 0.001      | 0.001     | 0.001           | 0.001           |
| ASA                                 |                    |             |             |            |           |                 |                 |
| I                                   | 11 (5.0)           | 21 (8.3)   | 18 (6.7)   | <0.001     | <0.001    | 0.019           | 0.001           |
| II                                  | 68 (31.1)          | 123 (48.8) | 104 (38.7) | 0.001      | 0.094     | 0.048           | <0.001          |
| III                                 | 45 (20.6)          | 64 (25.4)  | 76 (28.3)  | 0.001      | 0.001     | 0.001           | 0.001           |
| IV                                  | 11 (5.0)           | 6 (2.4)    | 3 (1.1)    | 0.001      | 0.001     | 0.001           | 0.001           |
| Missing                             | 54 (23.4)          | 38 (15.1)  | 68 (25.3)  | 0.001      | 0.001     | 0.001           | 0.001           |
| Type of surgery                     |                    |             |             |            |           |                 |                 |
| Open                                | 37 (16.9)          | 29 (11.5)  | 21 (7.8)   | 0.001      | 0.094     | 0.048           | <0.001          |
| Laparoscopic or robot               | 161 (73.5)         | 208 (82.5) | 241 (89.6) | 0.001      | 0.094     | 0.048           | <0.001          |
| Conversion to laparotomy            | 20 (9.1)           | 15 (6.0)   | 7 (2.6)    | 0.001      | 0.094     | 0.048           | <0.001          |
| Missing                             | 1 (0.5)            |             |             |            |           |                 |                 |
| Overall ERAS performance (number of guidelines adhered to) | 12 (5.5) | 27 (10.0) | <0.001      | 0.001     | 0.001     | 0.001           | 0.001           |
| Low (<6)                            | 122 (55.7)         | 72 (28.6)  | 27 (10.0)  | <0.001     | 0.001     | 0.001           | 0.001           |
| Medium (6–7)                        | 62 (28.3)          | 62 (24.6)  | 57 (21.2)  | 0.001      | 0.001     | 0.001           | 0.001           |
| Low (8–9)                           | 24 (11.0)          | 76 (30.2)  | 99 (36.8)  | 0.001      | 0.001     | 0.001           | 0.001           |
| High (10–12)                        | 11 (5.0)           | 42 (16.7)  | 86 (32.0)  | 0.001      | 0.001     | 0.001           | 0.001           |
| Length of stay                      | 9.4 (7.4)          | 8.6 (7.6)  | 6.3 (5.2)  | <0.001     | 0.249     | <0.001          | <0.001          |
| Complications                       | 21 (9.6)           | 29 (11.5)  | 23 (8.6)   | 0.520      | 0.500     | 0.260           | 0.690           |
| Clavien-Dindo grade I–II            | 14 (6.4)           | 24 (9.5)   | 16 (5.9)   | 0.001      | 0.082     | <0.001          | <0.001          |
| Clavien-Dindo grade III–IV          | 7 (3.2)            | 5 (2.0)    | 7 (2.7)    | 0.001      | 0.082     | <0.001          | <0.001          |
| Readmissions                        | 16 (7.5)           | 12 (4.8)   | 9 (3.4)    | 0.133      | 0.244     | 0.412           | 0.048           |

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**TABLE 3. Description of and Adherence to Each of the 12 ERAS Components**

| Characteristic                        | Period 1   | Period 2   | Period 3   |
|--------------------------------------|------------|------------|------------|
| PONV screening                       | 41.6       | 54.8       | 75.5       |
| No sedative medication               | 71.7       | 88.5       | 87.0       |
| Antibiotics prophylaxis               | 202        | 219        | 267        |
| Carbohydrate loading                 | 15.5       | 55         | 39.0       |
| No epidural (laparoscopic/robotic) or removed the day after surgery (open/conversion) | 77.3       | 67.9       | 81.4       |
| No drain                             | 75         | 142        | 56.4       |
| No nasogastric (NG) tube or NG removed on day of surgery | 116        | 186        | 224        |
| No opioids postoperatively            | 41         | 51         | 87         |
| No urinary catheter or catheter removed the day after surgery | 56         | 154        | 75         |
| Fluid nutrition on day of surgery or day after when surgery after 12 AM | 94         | 143        | 194        |
| Walking 5 m day after surgery         | 22.1       | 36.9       | 46.8       |

Bold represents statistical significance (after Bonferroni correction for pairwise period comparisons).

*Number of patients (%) for which the guideline was adhered to.

†Because of missing data, results presented are based on N = 211, N = 244, and N = 251 patients in period 1, 2 and 3, respectively.
69.2% in 2021. Participating hospitals differed in size and patient caseload. Despite those differences, implementation of and increased adherence to ERAS components was achieved at the different sites.

The effect of an ERAS protocol on postoperative hospital stay is well established. MIS is a key component of ERAS. However, the increase in MIS cannot explain as a sole reason the obtained reduction in LOS. Despite the progressive and near total implementation of MIS in all Belgian hospitals, the “acceptable” LOS, what reflects the mean LOS within our system remained high (10.6 days in 2017 and 8.8 days in 2021, according to federal data).

Our data corroborate the data on a dose relation between protocol adherence and postoperative outcomes. Increased adherence to ERAS components was associated with decreased incidence of postoperative complications and a shorter LOS. These findings are consistent with previous studies showing that increased adherence is associated with better short-term clinical outcomes and shorter length of stay.32–34 A recent systematic review showed that reduced compliance to ERAS components increases LOS, morbidity and readmission. This underscores the importance of an ERAS bundle rather than the implementation of a limited number of components (“cherry picking”).

One of the strengths of this study was peer-review of a predefined protocol in a multicenter setting. Moreover, the adherence to a bundle of 12 predefined ERAS components that are relevant to the care process of colon cancer surgery was assessed over different time periods. The results show that adherence to these predefined components was not uniform. Components with the highest adherence rates were antibiotic prophylaxis, MIS, and avoidance of preoperative sedative medication. In contrast, the ERAS components with the lowest adherence across the three measurement periods were early postoperative mobilization, carbohydrate loading, and opioid avoidance. This is in line with previous research showing that adherence to ERAS guidelines remains challenging and results in persistent high variation in delivered care across hospitals.3

This study has several important limitations. One could criticize the retrospective nature of the assessments. However, this reflects better the actual practice of an institution. There was no specific focus possible to the protocol as caregivers were not aware of the “sampling” periods, and data recording was a requirement to participate. The BIC intends to continue its monitoring and reflects on the use of prospective data recording of all consecutive patients in the future.

In this study, no control group was assessed. However, the “acceptable” LOS for elective colectomy reflects current practice in Belgium, and this could substitute a control arm.

Third, there was no formal assessment of the reasons for nonadherence. All hospitals, except one, improved significantly, 

| Table 4. Relation of Period and ERAS Performance With Patient Outcomes |
|------------------|------------------|------------------|
|                  | LOS Mean ± SD    | 30-Day Complications N (%) OR* (95% CI) P | 30-Day Readmissions N (%) OR* (95% CI) P |
| Period           |                  |                  |                  |
| First            | 9.4 ± 7.4        | Reference        | 21 (9.6) Reference 0.121 | 16 (7.3) Reference 0.3748 |
| Second           | 8.6 ± 7.6        | 0.8 (−0.4; 2.0)  | 36 (14.3) 1.76 (0.89; 3.45) | 12 (4.8) 0.63 (0.25; 1.60) |
| Third            | 6.3 ± 5.2        | −0.6 (−1.8; 0.7) | 28 (10.4) 2.14 (1.01; 4.53) | 9 (3.4) 0.46 (0.15; 1.41) |
| ERAS performance (number of guidelines adhered to) |                  |                  |                  |
| Low (<6)         | 11.6 ± 8.2       | Reference        | <.0001 | 34 (15.4) Reference <.0001 | 17 (7.7) Reference 0.4616 |
| Medium (6–7)     | 9.0 ± 7.3        | −1.3 (−2.5; 0.0) | 30 (16.6) 0.62 (0.33; 1.17) | 7 (3.9) 0.51 (0.17; 1.53) |
| High (8–9)       | 5.6 ± 4.6        | −3.6 (−4.9; −2.2) | 14 (7.0) 0.19 (0.09; 0.43) | 9 (4.5) 1.27 (0.42; 3.86) |
| Very high (10–12) | 4.5 ± 1.9        | −4.4 (−6.1; −2.7) | 7 (5.0) 0.14 (0.05; 0.39) | 4 (2.9) 0.95 (0.23; 4.00) |

*Estimates (with 95% confidence intervals) represent the difference in number of days for LOS and OR for complications and 30-day readmission and are adjusted for age, sex, ASA classification, and type of surgery. Estimates for LOS and 30-day readmissions are additionally adjusted for complications.
but reasons for the lack of change for some aspects could not be retrieved. In addition, there was a higher adherence to some ERAS components, but no additional analyses were performed to elucidate this observation.

The peer collaborative will review the ERP components and adjust where needed according to new insights (eg, the role of oral antibiotics in the prevention of surgical site infection; the use of NSAIDs in the multimodal postoperative pain control) and further allow other institutions to participate.

The group further explores the possibility to prospective data recording of all consecutive cases to assess differences between high-volume and low-volume hospitals.

Currently, a registration tool has been developed to continuously follow-up care and to evaluate the possible retention of improvement initiatives. Therefore, a timely critical evaluation of ERAS components is necessary, to keep pace with actual insights.

CONCLUSIONS

This BIC shows that timely feedback and peer knowledge sharing results in an improved adherence to ERAS components. This improvement can be obtained across a healthcare system. There is a dose-response effect between adherence to ERAS components and length of stay.

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DISCUSSANTS

Fabrizio Michelassi (New York, United States)

I would like to congratulate Dr. Coeckelberghs and Prof. D’Hoore on their clear presentation and well-written manuscript.
The study they conducted aimed to assess the effect of their improvement collaborative on adherence to ERAS components after elective colectomies for cancer, with a subsequent improvement in patient outcomes. This study confirms that “collaboratives” work.

The authors recognize that their study is based on a retrospective data collection methodology and lacks a control group. The latter precludes the inference that the improvement in outcomes is entirely due to the improvement in adherence to the ERAS protocol. As one can expect, other changes occurred during the study period which may have contributed to the improved outcomes, e.g., an increase in the penetration of minimally invasive techniques from 73% in the first period to 90% in the last period is one obvious factor. Are the authors able to distinguish the contribution of the increased minimally invasive approach from the contribution of the increased adherence to the ERAS protocol?

During the duration of the study, the overall adherence to the ERAS protocol increased from 42.8% to 69.2%, and LOS decreased from 9.4 days to 6.3 days. Reassuringly, there was no increase in the 30-day readmission rates; surprisingly, complication rates did not decrease significantly between periods. Many similar studies have found that complications improve with standardization, though this was not the case in this study. How can the authors explain this?

Do the authors have any data on the incidence of postoperative ileus in the low-, medium-, high- and very high adherence hospitals? It would be reassuring to show that in high-adherence hospitals patients achieved recovery milestones earlier in the aggregate, with return of bowel function, tolerance of diet and oral pain control much sooner than in low-adherence hospitals.

It is interesting that compliance was still low (<50%) in several areas, including carbohydrate loading, opioid-free analgesia, and early mobilization after surgery. Why was compliance still low in Period 3, after several years of the improvement effort?

I would like to congratulate Prof. D’Hoore for yet another valuable contribution to the literature, and to thank the ESA for the honor of commenting on this paper.

Response from André D’Hoore (Leuven, Belgium)

I thank Prof. Michelassi for these valuable comments. After all these years, we agree that there is still room for improvement. Carbohydrate loading was more difficult to achieve from an organizational point of view and physicians were not convinced of its clinical relevance (as the evidence for it is also limited). In contrast, there is agreement on the relevance of obtaining an opioid-free environment. At the time of the development of the protocol, there was ongoing debate on the safety of using NSAIDs in the early postoperative period (especially in view of the risk of anastomotic leakage and postoperative bleeding). Therefore, many participating centers did not routinely use NSAIDs in their multimodal pain protocol. Only one center systematically used NSAIDs and nearly achieved the ultimate goal of avoiding opioids. The collaborative will rediscuss this and adapt to the current insights.

In this report, we looked at overall postoperative complications and did not separately report on postoperative ileus. Indeed, postoperative ileus is a common complication, which occurs in about 11% of elective colectomies and hampers early discharge. However, in our raw data, there was no significant difference in the occurrence of postoperative ileus between the different groups of adherence.

Minimally invasive surgery is a main pillar for the Enhanced Recovery Protocol (ERP). Indeed, over time, it was used significantly more. However, this was not the single significant factor that impacted hospital stay. Therefore, this study again underscores the importance of adhering to the complete package of ERP components, rather than promoting a cherry-picking attitude.

Antonio D. Pinna (Weston, United States)

Thank you for a very nice presentation. You mentioned that your centers did not have financial pressure to force adherence to the project. In view of this, did you evaluate patient satisfaction?

Response from André D’Hoore (Leuven, Belgium)

That’s a very good question. In this regard, we added questionnaires at the ultimate assessment (period 3) on patient experience of ERP (PREM), early discharge and whether this imposed more stress on their environment. Overall, patient satisfaction increased with earlier discharge, but this was not incorporated in the manuscript, as we only had limited data available.

Martin Hübner (Lausanne, Switzerland)

Congratulations on this paper. My question is whether the primary outcome that links to hospital stay is multi-factorial and not specific. Is it due to standardization or really an improvement in care? Did you change the discharge criteria to shorten hospital stay? Did you then optimize logistics because we know that patients typically stay 1-2 days longer in hospital than is necessary?

Response from André D’Hoore (Leuven, Belgium)

No specific change of discharge criteria was imposed. Indeed, some hospitals provided more appropriate ERP information to patients. This includes the criteria for early discharge, and this could have influenced patient willingness and readiness to leave the hospital.

Frederic Ris (Geneva, Switzerland)

Thank you very much for this interesting paper. You observed that antibiotic prophylaxis needed improvement over time; what is your view on introducing an oral preoperative antibiotic and do you think you will do this?

Response from André D’Hoore (Leuven, Belgium)

There is increasing evidence that adding oral antibiotics to the intravenous prophylaxis could reduce the risk of postoperative infections. This will be discussed within the collaborative and could be one of the new components that will be proposed.

Nicolas Demartines (Lausanne, Switzerland)

I just have a short question. You did not observe an impact on complications. However, did you assess the complications better during the collaborative, which could explain this?

Response from André D’Hoore (Leuven, Belgium)

There was no significant decrease in observed complications between the different groups. I do agree that there is a steady improvement in the assessment of postoperative morbidity, and there is increased reporting using the Clavien-Dindo and cumulative complication index. Larger data sets are needed to observe changes in postoperative complications.