Original Article

Enhanced recovery after surgery reduces length of stay after colorectal surgery in a small rural hospital in Ontario

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Abstract

Introduction: Enhanced recovery after surgery (ERAS) programmes include pre-operative, intraoperative and post-operative clinical pathways to improve quality of patient care while reducing length of stay (LOS) and readmission. This study assessed the feasibility and outcomes of an ERAS protocol for colorectal surgery implemented over 2 years in a small, resource-challenged rural hospital.

Methods: A prospective cohort study used retrospectively matched controls to assess the effect of ERAS on LOS in patients undergoing colorectal surgery in a small rural hospital in northern Ontario, Canada. ERAS patients were matched to two patients in the control group based on diagnosis, age and gender. Patients had open or laparoscopic colorectal surgeries, with those in the intervention group treated per ERAS protocol and given instructions on pre- and post-operative self-care.

Results: Most of the 47 ERAS patients recruited to the study reported adherence to ERAS protocols before surgery. Adherence to protocol was strongest for chewing gum in the days after surgery. Most patients were sitting in a chair for their afternoon meal by the 1st day and most were walking down the hallway by the 2nd day. The control group had significantly higher ($P < 0.001$) malignant neoplasm of the colon (C18, 69% vs. 35%) and significantly lower malignant neoplasm of the rectum (C20, 0% vs. 5%). The control group had an average ln-transformed LOS that was significantly longer (exponentiated as 1.7 days) than ERAS patients (t-test, $P < 0.001$).

Conclusion: This study found that ERAS could be implemented in a small rural hospital and provided evidence for a reduced LOS of approximately 2 days.

Keywords: Colorectal surgery, enhanced recovery after surgery, hospitals, length of stay, Ontario, perioperative care, rural

Résumé

Introduction: Les programmes de réhabilitation améliorée après chirurgie (RAAC) comprennent des itinéraires cliniques préopératoires, peropératoires et postopératoires visant à améliorer la qualité des soins aux patients tout en réduisant la durée du séjour et les réadmissions. Cette étude a évalué la faisabilité et les

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résultats d'un protocole de RAAC pour la chirurgie colorectale mis en œuvre pendant deux ans dans un petit hôpital rural aux ressources limitées.
Méthodes: Une étude de cohorte prospective a utilisé des témoins appariés pour évaluer l'effet de la RAAC sur la durée du séjour des patients subissant une chirurgie colorectale dans un petit hôpital rural du nord de l'Ontario, au Canada. Les patients RAAC ont été appariés à deux patients du groupe témoin sur la base du diagnostic, de l'âge et du sexe. Les patients ont subi une chirurgie colorectale ouverte ou laparoscopique, et ceux du groupe d'intervention ont été traités selon le protocole de RAAC et ont reçu des instructions sur les soins auto-administrés pré et postopératoires.
Résultats: La plupart des 47 patients RAAC recrutés pour l'étude ont déclaré adhérer aux protocoles de RAAC avant l'intervention chirurgicale. L'adhésion au protocole a été la plus forte pour la gomme à mâcher dans les jours qui ont suivi l'opération. La plupart des patients étaient assis sur une chaise pour le repas de l'après-midi dès le premier jour et la plupart marchaient dans le couloir dès le deuxième jour. Le groupe témoin présentait un taux significativement plus élevé ($P < 0{,}001$) de néoplasme malin du côlon (C18, 69% contre 35%) et un taux significativement plus faible de néoplasme malin du rectum (C20, 0% contre 5%). Le groupe de contrôle avait une durée moyenne de séjour transformée en Ln significativement plus longue (exponentielle de 1,7 jours) que les patients RAAC (test t, $P < 0{,}001$).
Conclusion: Cette étude a montré que la RAAC pouvait être mise en œuvre dans un petit hôpital rural et a fourni des preuves d'une réduction de la durée de séjour d'environ deux jours.

Mots-clés: Réhabilitation améliorée après chirurgie (RAAC); durée du séjour; hôpitaux ruraux; chirurgie colorectale; Ontario; soins périopératoires

INTRODUCTION

Enhanced recovery after surgery (ERAS) programmes consist of pre-operative, intraoperative and post-operative clinical pathways to improve the quality of patient care while reducing the length of stay (LOS), readmission rates and reduce the economic impact on the institution.[1-6] By following the 15–20 interventions defined by ERAS, many large centres have shown significant improvement in patient outcomes, fewer surgical site infections and lower rates of hospital-acquired infection.[2-4] However, evidence is sparse for the effectiveness of ERAS in smaller, rural hospitals.[7] This study reports on the feasibility and selected outcomes of implementing the ERAS programme in a small rural hospital located in an underserved region of Ontario, Canada.

ERAS programmes use evidence-based medicine to challenge traditional surgical practices; strict fasting protocols are replaced by carbohydrate loading, control and optimal goal-directed fluid therapy during surgery. Advances in anaesthesia allow catered approaches to minimise opioid use, and early mobilisation after surgery is encouraged.[6-9]

ERAS also highlights the need for patient engagement in their own healing. Patients appreciated playing a role in their recovery and were highly satisfied with all aspects of their procedure such as physician skill level (technical and interpersonal), pre-operative patient education and availability of staff to the patients.[6,10,11]

Patient education is a key component from the pre-operative stage through to post-operative follow-up.[6,12] Patients are encouraged to take some responsibility for their post-surgical outcomes,[13] particularly related to smoking cessation. Smoking increases risk factors for wound healing, anastomotic leak, perioperative stroke and myocardial infarction. Consistent and correct information is crucial, as demonstrated by previous research where 90% of older adults adhere more strongly to ERAS protocols when time is taken to ensure the patients understand the guidelines.[10,11,13]

Conventionally, patients preparing to undergo gastrointestinal surgery would be in a fasting state for a minimum of 8 h to reduce the risk of aspiration pneumonia.[14,15] In addition, patients would undergo a bowel preparation, which may increase the risk of dehydration, particularly in the elderly.[6,14] Patients who smoke, have functional dyspepsia, psychological stress or have an increase in female hormones are at increased risk for delayed gastric emptying.[14]

ERAS pre-operative procedures focus on patient engagement and optimal preparation for their surgical procedure in four key areas: breathing

(smoking cessation), movement (exercise), nutrition and expectations (clear surgery date).[8,12] Intraoperatively, the patient is maintained at the ideal anaesthesia depth, has active warming and goal-directed fluid therapy, particularly for high-risk patients.[11] Patients are risk-stratified for nausea and vomiting and are given pre-emptive medication accordingly. Postoperatively, pain is managed with multi-modal therapy, minimising opioid use; narcotic use is a rate-limiting step in patients regaining bowel function, which directly influences LOS and can result in further complications.[5,8,9] Epidural anaesthesia is often part of this approach. Nasal gastric tubes, bladder catheters, drains and intravenous fluid are used sparingly and removed as soon as possible.[8] Enteral feeding and early mobility are introduced as soon as feasible after surgery and routine screening for delirium is conducted for older adults.[11]

Studies overwhelmingly suggest that adherence to the entire pathway produces the best patient outcomes[1,7,8] and highlight the need for health-care professionals to work as a multidisciplinary team.[2,7,11] The programme requires input and support from all layers within the facility: hospital administrators and senior leadership, clinicians including surgeons, anaesthesiologists and nurses, and allied health professionals such as physiotherapists and dietitians.[3,16,17]

Successful execution of ERAS requires substantial changes from the traditional methodologies for gastrointestinal surgeries. While ERAS protocols have been in place in urban centres for several years, this may be a challenge in rural hospitals, which have fewer resources.[7] The goal of this project was to determine the feasibility of implementing an ERAS protocol for gastrointestinal procedures over 2 years in a small rural hospital and to evaluate its impact on patient outcomes, LOS, morbidity and readmission rate.

METHODS

Study design and setting

A prospective cohort study, using retrospectively matched controls was used to assess the effect of ERAS on LOS in patients undergoing colorectal surgery. The setting was a small rural community hospital situated in northern Ontario. Huntsville has a stable population of 6482 and a catchment area of just under 20,000 permanent residents quadrupling seasonally with tourists. Seniors represent 27% of the population as it is also a retirement destination (Statistics Canada, 2016). The local hospital, Huntsville District Memorial Hospital (HDMH) (one site of Muskoka Algonquin Health Care (MAHC), has 37 acute care beds, dedicated to adult care.

This study received ethics approval from the Laurentian University Research Ethics Board (file number 2015-02-02) on 10 April 2015.

The surgical team involved the primary investigator HR, and two other surgeons, JM and RK. The study educator and surgical assistant is a Registered Nurse First Assistant (RNFA). Anaesthesia for all surgeries was overseen by AB.

All patients undergoing routine colorectal surgery, either benign or malignant disease, were eligible for the ERAS project. Consent for patients undergoing colorectal surgery was attained as per normal procedure in the surgeon's office. Patients were educated regarding the surgical procedure and expectations after which they had the opportunity to ask questions and have any aspect clarified. Family members were included when possible. Smoking cessation was mandatory 4 weeks before all ERAS procedures with patients receiving support aids if necessary. Patients were provided an ERAS handbook which contained education and instructions about the specific ERAS protocols. Patients were asked to fill in their handbook for each protocol they were required to complete before their day of surgery (e.g. carbohydrate consumption on the night before and morning of surgery and bowel preparation).

Enhanced recovery after surgery protocol

The RNFA and, when required, the on-call anaesthetist conducted patient education sessions in the day surgery unit. These visits lasted 1–2 h. ERAS patients received detailed information about how to prepare for surgery, and what they would need in the hospital and at home for their post-surgical care. Patients were sent home with the ERAS Patient Education Booklet.

Conventionally, patients would only attend the hospital pre-surgically if a consult was required. Surgical instructions and pre-surgical medications

would be provided by their surgeon when the procedure was booked.

ERAS patients were advised to consume two carbohydrate drinks before their surgery (the night before and 4 h before surgery). They were asked to chew gum as soon after recovery as possible and were encouraged to start eating solid food and drinking immediately after surgery. Mobility was promoted the night immediately following surgery by having patients sit and dangle their legs over their bed. Short walks were encouraged the day after surgery.

When ERAS patients were seen by their surgeon 2–4 weeks before their surgery, they were instructed to optimise their nutrition and improve their cardiovascular activity. Prescriptions were provided for oral antibiotics and bowel preparation at the surgeon's discretion. Upon completion of their pre-surgical appointment, patients could be referred for a pre-operative anaesthesia and/or internal medicine consultation if not already done. Patients were asked to bring their ERAS patient handbook to the hospital with them on the day of their surgery with the pre-operative questionnaire completed in advance.

On the day of surgery, patients were instructed to fast after midnight, except for clear fluids as desired and a mandated liquid carbohydrate load 4 h before surgery. Once in the operating room, a surgical checklist was completed as per routine hospital procedure. Intravenous antibiotics, to help prevent surgical site infection, were initiated 1 h before surgery, and deep vein thrombosis prophylaxis treatment, including compression stockings and sequential compression devices, was used. Patients were warmed during surgery with an air blanket device to maintain their body temperature while actively monitoring their temperature throughout.

Each ERAS patient received thoracic epidural anaesthesia before anaesthetic induction. Induction of general anaesthesia was done through the usual technique with opioids, propofol and rocuronium dosed individually by the attendant physician. Immediately after induction, an oesophageal Doppler probe, which generates individualised, estimated real-time cardiac output, was placed to facilitate intraoperative goal-directed fluid therapy. Patients were monitored in the usual fashion during surgery and transferred to the intensive care unit for monitoring and care after surgery.

After surgery, while still in hospital, patients tracked their progress in their patient handbook. Many wrote additional notes and comments in the margins of their handbook about their experience, interaction with staff or how they were feeling. The patient handbook was left with the nursing staff to be collected by the research team when the patient was discharged. ERAS post-operative recommendations included early mobilisation after surgery, chewing gum daily, early return to normal diet and the optimal use of pain management.

Data collection and analyses

Patients were asked to complete the ERAS patient handbook pre- and postoperatively. Questions were asked about the patient's role and expectations for recovery. Patients were also asked to report their perceived pain using a 10-point Visual Analogue Scale with 0 being no pain and 10 being the highest pain they had experienced. Data were also collected from the hospital's EMR including sex, age (years), most responsible diagnosis (coded by International Statistical Classification of Diseases and Related Health Problems, 10th Revision, Canada, [ICD-10-CA]), principal surgical procedure (coded by the Canadian Classification of Health Interventions [CCI]), and LOS, in days. Additional data were collected for patients who were enrolled in the ERAS programme from November 2015 to November 2017. These data included the presence of ileus, vomiting/nausea, urinary retention, wound infection or dehiscence, deep vein thrombosis, pneumonia, anastomotic leak and readmission.

The choice of statistical procedures was informed by Chazard *et al*. (2017)[18] who recommended Student's *t*-test on logarithmically transformed data or the Mann–Whitney (Wilcoxon) test for two independent groups. Chazard's recommendations, developed for equal sample size, were assumed to apply to this study with twice as many patients in the control group than in the ERAS group. We also used Student's *t*-test and Fisher's test (using exact methods or Monte Carlo methods based on 10,000 randomly sampled tables) to look for differences in patients' age and sex, as well as ICD-10-CA and CCI codes between the control and ERAS group. We used McNemar tests to look for differences in self-reported pain scores from the night following

the surgery to days 1, 2 and 3 post-surgery. All analyses were conducted with IBM SPSS Statistics for Windows, Version 24.0 (Armonk, NY, USA: IBM Corp.). This study is registered with ISRCTN as ISRCTN39272581.

RESULTS

Enhanced recovery after surgery patients, protocol and outcomes

Participation was offered to all eligible patients between 1 November 2015 and 1 November 2017. All patients who were invited to participate enrolled in the study and consented. Forty-seven patients were recruited for the study. Fifty-five per cent were male and were somewhat older, though not statistically significant, compared to female patients [Chi-squared test, $P = 0.57$, Table 1]. At least 57% of patients adhered to pre-operative instructions to drink bowel preparation and bring chewing gum with them [Table 2]. Patients' recall of what was expected of them and their expected LOS was 65% or higher with one exception; only 48% (19 of 40) of patients recalled being informed that they would be able to consume solid foods the day after surgery.

Of the 47 patients recruited to the study, seven patients were removed at the discretion of the attending surgeon due to significant post-operative complications including complicated ileus, substantial nausea and vomiting and a case of abdominal dehiscence that required re-suturing. These complications were outlined in the ERAS order set at the beginning of the study. An initial control group was obtained from the EMR for 2 years before implementation of the ERAS programme. Patients were matched on diagnosis, age and sex. A total of 11 patients were removed from the control group because they experienced similar complications to those patients that were excluded from the study (significant ileus, vomiting and diarrhoea and surgical site complications).

Table 1: Age-sex distribution of 40 enhanced recovery after surgery patients

Age (years)	Male, *n* (%)	Female, *n* (%)	All patients, *n* (%)
<60	6 (27)	8 (44)	14 (35)
60–69	4 (18)	4 (22)	8 (20)
70–79	7 (32)	4 (22)	11 (28)
80–89	5 (23)	2 (11)	7 (18)
Sub-total	22 (100)	18 (100)	40 (100)

The primary outcome was LOS, measured in whole days, with 80 patients in the control group and 40 patients in the ERAS group.

On the night following surgery, 45% of the patients dangled their legs from the bed with help, 55% completed their breathing exercises and 73% were offered clear fluids [Table 2]. The day after surgery between 38% and 53% of patients consumed breakfast or lunch while sitting in their chair, 73% reported consuming liquids and 78% chewed gum at least once. Only 23% indicated they were 'peeing on their own', while 40% reported they were passing gas. On day two post-surgery, 56% of patients ate one meal in their chair and reported walking down the hall at least once, 45% were consuming solid food, 73% were chewing gum, 47% were 'peeing on their own' and 47% were passing gas. Day 3 findings were like day 2.

The night of the surgery, 25% of patients reported moderately high pain (6–7) and 12% reported high pain (8–10) [Table 3]. On the day following surgery, 20% of patients reported moderately high pain and 25% reported high pain. On days 2 and 3 after surgery, patients indicated a trend towards lower pain, though these day-to-day trends were not statistically significant (McNemar test, $P > 0.27$).

Overall, up to 87% (40) of patients completed the surveys in the ERAS patient handbooks, though response rates for some questions were as low as 20%. Recalculating percentages by excluding missing data, particularly for discharged patients, showed increased adherence to ERAS recommendations or achievement of desirable outcomes.

Enhanced recovery after surgery patient complications

The most common complications included urinary retention or nausea and vomiting (23%, 9/40 patients) and ileus (18%, seven patients) [Table 4]. Readmission was rare (8%, 3/40 patients), with one patient readmitted for general weakness, a second for myocardial infarction and a third for pneumonia and surgical-related complications.

Enhanced recovery after surgery patient comments

Many patients added notes to their handbooks

Table 2: Enhanced recovery after surgery procedural compliance as reported by patients pre- and post-operatively

Question	Yes, n (%)	No, n (%)	No answer, n (%)
Did you drink bowel preparation?	28 (70)	3 (8)	9 (23)
Did you bring chewing gum with you?	24 (57)	1 (2)	17 (40)
Were you informed that you are expected to dangle your legs out of bed within 4 h of surgery?	26 (65)	0	14 (35)
Were you informed that you are expected to chew gum after surgery to help you pass gas?	26 (65)	0	14 (35)
Were you informed that you are expected to eat your meals in a chair, out of bed?	26 (65)	0	14 (35)
Were you informed that you are able to consume solid foods the day after surgery?	19 (48)	5 (13)	16 (40)
Were you informed that your LOS is expected to be 3 days (colon) or 4 days (rectal)?	30 (75)	0	10 (25)
Were you encouraged to drink a high carbohydrate drink the night before your surgery?	31 (78)	0	9 (23)
Were you encouraged to drink a high carbohydrate drink 2 h before your surgery?	31 (78)	0	9 (23)
Night of surgery (with help)			
I sat at the side of my bed for 10–15 min (with help)	18 (45)	9 (23)	13 (33)
I did deep breathing exercises 10 times per hour when I was awake	22 (55)	10 (25)	8 (20)
I was offered sips of clear fluids	29 (73)	3 (8)	8 (20)

Days after surgery	Day 1			Day 2			Day 3		
Question	Yes, *n* (%)	No, *n* (%)	No answer, *n* (%)	Yes, *n* (%)	No, *n* (%)	No answer, *n* (%)	Yes, *n* (%)	No, *n* (%)	No answer, *n* (%)
I sat in the chair for my morning meal	15 (38)	13 (33)	12 (30)	23 (58)	6 (15)	11 (28)	23 (58)	7 (18)	10 (25)
I sat in the chair for my afternoon meal	21 (53)	9 (23)	10 (25)	22 (55)	6 (15)	12 (30)	22 (56)	5 (13)	12 (30)
I sat in my chair at other times throughout the day	16 (40)	9 (23)	15 (38)	23 (58)	4 (10)	13 (33)	15 (38)	4 (10)	21 (53)
I walked down the hall at least once	17 (41)	9 (22)	15 (37)	23 (58)	2 (5)	15 (38)	23 (58)	2 (5)	15 (37)
I had nothing to eat or drink	0	30 (75)	10 (25)	3 (8)	6 (15)	31 (78)	2 (5)	6 (15)	32 (80)
I had liquids to eat/drink	29 (73)	0	11 (28)	26 (65)	1 (3)	13 (33)	23 (58)	0	17 (43)
I had solid food	17 (43)	4 (10)	19 (48)	18 (45)	3 (8)	19 (48)	19 (38)	3 (8)	28 (70)
I chewed gum in the morning	28 (72)	2 (5)	9 (23)	28 (72)	3 (8)	8 (21)	25 (63)	3 (8)	12 (31)
I chewed gum in the afternoon	31 (78)	1 (3)	8 (20)	29 (73)	2 (5)	9 (23)	22 (55)	3 (8)	15 (38)
I chewed gum in the evening	27 (68)	2 (5)	11 (28)	29 (73)	3 (8)	8 (20)	19 (48)	3 (8)	18 (45)
My catheter came out today	13 (33)	16 (40)	11 (28)	14 (35)	11 (28)	15 (38)	11 (28)	11 (28)	18 (45)
I am peeing on my own	9 (23)	20 (50)	11 (28)	19 (48)	10 (25)	11 (28)	22 (55)	4 (10)	14 (35)
I am passing gas	16 (40)	14 (35)	10 (25)	21 (53)	9 (23)	10 (25)	24 (60)	3 (8)	13 (33)

LOS: Length of stay

Table 3: Number of enhanced recovery after surgery patients and their self-reported daily pain measurement score*,†

Time relative to surgery	Pain level 0, *n* (%)	Pain level 1–3, *n* (%)	Pain level 4–5, *n* (%)	Pain level 6–7, *n* (%)	Pain level 8–10, *n* (%)	No answer, *n* (%)
First night after surgery	5 (12)	4 (10)	9 (22)	10 (24)	5 (12)	8 (20)
Day 1 after surgery	2 (5)	3 (8)	6 (15)	8 (20)	10 (25)	11 (28)
Day 2 after surgery	2 (5)	7 (18)	8 (20)	8 (20)	5 (13)	10 (25)
Day 3 after surgery	2 (5)	6 (15)	8 (20)	6 (15)	4 (10)	14 (35)

*McNemar tests did not find any evidence of a difference from one night or day to any of the next subsequent days ($P>0.27$), †Pain was reported using a Visual Analog Scale

Table 4: Complications of 40 enhanced recovery after surgery patients*

Complication	Yes, *n* (%)	No, *n* (%)
Nausea or vomiting	9 (23)	31 (78)
Urinary retention	9 (23)	31 (78)
Ileus	7 (18)	33 (83)
Wound dehiscence	1 (3)	39 (98)
Deep vein thrombosis	1 (3)	39 (98)
Pneumonia	1 (3)	39 (98)
Wound infection	0	40 (100)
Anastomotic leak	0	40 (100)
Number of patients with	*n* (Total number)	
No complications	24 (60)	
1 complication	7 (18)	
2 complications	7 (18)	
3 or 4 complications†	2 (5)	

*Three patients (8%) were re-admitted, †One of these two patients had ileus, nausea or vomiting and urinary retention, while the second patient had these three complications plus wound dehiscence

that included comments on the reasons for their responses and about their experience. Retrospective feedback from staff indicated that early removal of catheters was not well-received, particularly in patients that required multiple re-catheterisations. Patients did report that they were highly satisfied with the ERAS procedures, staff and being able to take part in their recovery. Written notes and comments were unanimously positive with respect to patient education and the commitment demonstrated by the RNFA.

Patient comments

'Very helpful to have meeting prior to surgery, Useful information on recovery', 'Great to meet JR (RNFA) before surgery – put me at ease', 'Amazed by how quickly I felt good. Day 7 and no pain meds needed', 'I feel good going home day 4', 'After my surgery I ate food and passed gas', 'ERAS – amazing', 'I was happy to participate in the program', 'Great care in hospital', 'The program was helpful and informative'.

Control versus enhanced recovery after surgery patients

Average age of patients was 70.0 years (standard deviation [SD] =12.5) in the control group and 65.4 years (SD = 14.0) in the ERAS patient group; this difference was not statistically significant (*t*-test, $P=0.07$, mean difference =4.7, 95% confidence interval of the difference –0.3–9.6). There was no statistically significant difference in the percentage of females (or males) between the Control group (50.0%) and the ERAS group (45.0%) (Fisher's exact test, two-sided $P = 0.70$).

The control group had a significantly higher percentage (69% vs. 35%, Fisher's exact test, $P < 0.001$) of ICD-10-CA code C18 (malignant neoplasm of colon), and significantly lower percentage (0% vs. 5%) of C20 (malignant neoplasm of rectum), relative to the ERAS group [Table 5]. There were no significant differences between control and ERAS groups for 5-character CCI codes [$P = 0.503$, Table 6].[19]

For logarithm-transformed LOS data, Levene's test of equal variances was significant ($f = 4.44$, $P = 0.045$) and therefore the independent samples Student's *t*-test that assumed unequal variances was used. This test found that control patients had a LOS that was significantly longer than ERAS patients [$P < 0.001$, Table 7]. The Kolmogorov–Smirnov Test found a significant difference in the distribution of untransformed or transformed LOS between pre- and Post-ERAS patient groups ($P < 0.001$). The mean difference in logarithm-transformed LOS was 0.548, which was reverse transformed (exponentiated) as a difference of 1.73 days. A test of medians found that the median of the control patient group (median LOS = 6) was significantly higher than that of the ERAS patient group (median LOS = 4) ($P = 0.001$). Removing 6 cases in the control group with extreme LOS [≥21 days,

Table 5: International statistical classification of diseases and related health problems, 10th revision, Canada (ICD-10-CA) 3-character code for control and enhanced recovery after surgery patient groups

ICD-10-CA*		Patient group†		Total
		Control	ERAS	
C18	*n*	55‡	14§	69
Malignant neoplasm of colon	Percentage within patient group	68.8	35.0	57.5
C19	*n*	3	0	3
Malignant neoplasm of rectosigmoid junction	Percentage within patient group	3.8	0.0	2.5
C20	*n*	0§	2‡	2
Malignant neoplasm of rectum	Percentage within patient group	0.0	5.0	1.7
D12	*n*	9	8	17
Benign neoplasm of colon, rectum, anus and anal canal	Percentage within patient group	11.3	20.0	14.2
K55	*n*	0	1	1
Vascular disorders of intestine	Percentage within patient group	0.0	2.5	0.8
K56	*n*	3	1	4
Paralytic ileus and intestinal obstruction without hernia	Percentage within patient group	3.8	2.5	3.3
K57	*n*	4	6	10
Diverticular disease of intestine	Percentage within patient group	5.0	15.0	8.3
K62	*n*	1	2	3
Other diseases of anus and rectum	Percentage within patient group	1.3	5.0	2.5
N32	*n*	1	2	3
Other disorders of bladder	Percentage within patient group	1.3	5.0	2.5
Z43	*n*	4	4	8
Attention to artificial openings	Percentage within patient group	5.0	10.0	6.7
Total	*n*	80	40	120
	Percentage within patient group	100	100	100

*The 23 full ICD-10-CA codes were collapsed to ten 3-character codes. Source: CIHI (2015a), †Fisher's test (two-sided), Monte Carlo method: P=0.004 (95% CI for P: 0.002–0.005), ‡The observed count was significantly higher than predicted by marginal totals, §The observed count was significantly lower than predicted by marginal totals. CI: Confidence interval, ERAS: Enhanced recovery after surgery, ICD: International Classification of Disease, CIHI: Canadian institute for health information

Table 6: Canadian classification of health interventions 5-character code for control and enhanced recovery after surgery patient groups

CCI code*		Patient group†		Total
		Control	ERAS‡	
1.NM.82	*n*	4	4	8
Reattachment, large intestine	Percentage within patient group	5.0	10.8	6.8
1.NM.87	*n*	75	33	108
Excision partial, large intestine	Percentage within patient group	93.8	89.2	92.3
1.NQ.74	*n*	1	0	1
Fixation, rectum	Percentage within patient group	1.3	0.0	0.9
Total	*n*	80	37	117
	Percentage within patient group	100	100	100

*The full CCI codes were collapsed to three 5-character codes. Source: CIHI (2015b), †Fisher's test (two-sided), Monte Carlo method: P=0.503, ‡CCI codes were missing for 3 ERAS patients. CCI: Canadian Classification of Health Interventions, ERAS: Enhanced recovery after surgery, CIHI: Canadian institute for health information

Figure 1] yielded similar statistical test results. A detailed comparison of LOS is provided in Table 8.

All statistical tests on natural logarithm-transformed LOS consistently found that control LOS differed from ERAS LOS. The best available evidence suggests that control LOS was significantly longer (by 2 days) than ERAS LOS.

DISCUSSION

ERAS programmes using pre-operative and

Table 7: Independent samples t-test of the difference of the mean ln (length of stay) between control and enhanced recovery after surgery patient groups

Patient group		*n*	Mean ln (LOS)	SD	SEM	
Control		80	1.93	0.611	0.0683	
ERAS		40	1.38	0.463	0.0732	
			t-test for equality of means			
t	df	*P* (two-tailed)	Mean difference ln (LOS)	SE of the difference	95% CI of the difference	
					Lower	Upper
5.62	97.9	<0.001	0.55	0.10	0.36	0.74
Reverse-transformed*			1.73	1.10	1.43	2.10

*Values were reverse transformed as e^x, with e=~2.718, and x=ln (days). LOS: Length of stay, SD: Standard deviation, SEM: Standard error of mean, CI: Confidence interval, SE: Standard error, ERAS: Enhanced recovery after surgery

Table 8: Length of stay (categories) by sex for control and enhanced recovery after surgery patients

LOS (days)	Control			ERAS		
	Male, *n* (%)	Female, *n* (%)	All control patients, *n* (%)	Male, *n* (%)	Female, *n* (%)	All ERAS patients, *n* (%)
≤3	2 (5)	5 (13)	7 (9)	11 (50)	8 (44)	19 (48)
4–6	16 (40)	23 (58)	39 (49)	8 (36)	7 (39)	15 (38)
7–10	9 (23)	5 (13)	14 (18)	3 (14)	1 (6)	4 (10)
>10	13 (33)	7 (18)	20 (25)	0	2 (11)	2 (5)
Total	40 (100)	40 (100)	80 (100)	22 (100)	18 (100)	40 (100)
Percentile	LOS (days)			LOS (days)		
25th	3			4		
50th (median)*	4			6		
75th	5			10		
Minimum	2			2		
Maximum	13			34		
Mean (SD)	8.44 (6.278)			4.45 (2.407)		

*Difference between medians (median test) *P*=0.001. LOS: Length of stay, ERAS: Enhanced recovery after surgery, SD: Standard deviation

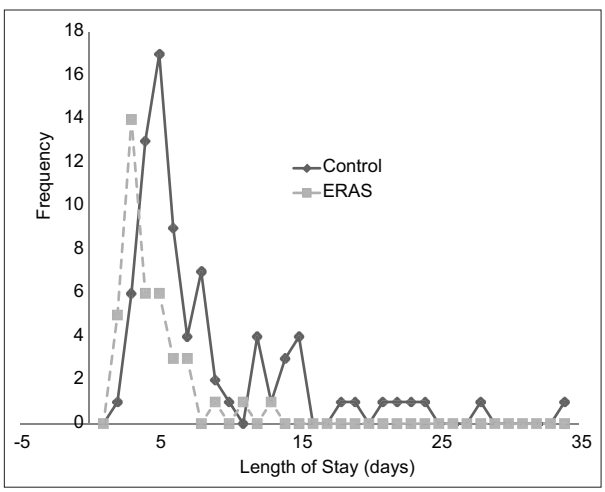

Figure 1: Frequency of LOS (days) for 80 control patients and 40 ERAS patients. LOS: Length of stay, ERAS: Enhanced recovery after surgery.

postoperative clinical pathways to improve patient outcomes were introduced more than two decades ago, however, they are almost exclusively implemented in large urban centres and associated with teaching hospitals. Studies have shown that incorporating ERAS protocols can enhance patient outcomes, reduce the LOS for patients and offer cost savings for the institution (1–7). However, implementing these protocols requires significant multidisciplinary teamwork. Many of the ERAS protocols conflict with traditional practice, which can make uptake difficult. The goal of this project was to demonstrate that ERAS can be performed in a small rural hospital and positively impact patient outcomes.

Over the 2-year study, 40 patients were included in the ERAS procedures for colon or rectal surgery. Patients were asked to report on which of the ERAS protocols they were informed about and which they complied with. It was found that most patients (75%) consumed the pre-surgical

carbohydrate and chewed gum consistently after surgery. Patient mobility immediately after surgery was also noted, as patients made efforts to both walk in the hallway and take their meals in their chair. Early consumption of food postoperatively was not reported frequently and feedback from patients indicated that the use of an anti-emetic may have improved this. Patients frequently reported feeling nauseous (23%), some to the point of vomiting.

Urinary retention was also high among patients (28%). Comments indicated that early withdrawal of catheters was not well-received, particularly when patients required multiple re-catheterisations. Patients did, however, report that they were highly satisfied with the ERAS procedures and staff and taking part in their recovery. Feedback in the form of written notes and comments was unanimously positive, particularly with respect to patient education and the commitment demonstrated by the RNFA.

Huntsville, Ontario is a community with an aging population, which was evident in this study. Of the 40 patients treated, the average age was 65 years, equally represented by female and male patients. Demonstrating improved patient outcomes and a reduced LOS is of importance in this age group as they are predisposed to chronic conditions and susceptible to nosocomial infections.

Limitations

While all patients were provided the ERAS patient handbook and were asked to complete the handbook throughout their hospital stay, approximately one-quarter did not. Tasking hospital staff, volunteers or research assistants to help patients complete these questionnaires would likely improve response rates, perhaps improve adherence to protocols, and would help identify which ERAS procedures have a higher impact on outcomes.

There are limitations to interpretation based on a matched case study design that uses historical controls. For example, the matching process was conducted on three variables (age, gender and diagnosis) and the effect on LOS of differences between the control and ERAS of these and other variables is unknown. LOS was not adjusted by any method such as the National Surgical Quality Improvement Program risk calculator (ACS 2020). To simplify analyses, the study used unadjusted LOS.

The study was conducted at a single site and results may not necessarily be applicable to other rural hospitals. However, it is worth noting that the ERAS programme was successfully implemented in a low-resourced rural hospital, with an aging patient population and compounded by a strong seasonal influx of tourists. Evidence of a reduction in LOS complements success in implementation.

Future direction

Creating and implementing pre-surgical, surgical and post-surgical electronic order sets for the ERAS pathway is underway at the HDMH. The order sets and training developed through this study are being shared and implemented at the sister site of MAHC, South Muskoka Memorial Hospital.

CONCLUSION

ERAS consists of a series of pre-operative, intraoperative and post-operative clinical pathways aimed at improving clinical care to improve the quality of patient care with patients as active partners in their care. Patient compliance was highest for chewing gum and drinking carbohydrate liquids. Patient outcomes were lowest for 'peeing on their own' with several patients requiring re-catheterisation. Similarly, the highest complications found in 20%–30% of patients were urinary retention, nausea and vomiting and ileus. Pain scores were generally well controlled and overall patient feedback was positive, appreciating that their participation impacted their post-operative recovery. This study found that ERAS could be implemented in a small rural hospital and that LOS could be reduced by 2 days.

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REFERENCES

1. Arrick L, Mayson K, Hong T, Warnock G. Enhanced recovery after surgery in colorectal surgery: Impact of protocol adherence on patient outcomes. J Clin Anesth 2019;55:7-12.
2. Altman AD, Helpman L, McGee J, Samouëlian V, Auclair MH, Brar H, *et al*. Enhanced recovery after surgery: Implementing a new standard of surgical care. CMAJ 2019;191:E469-75.
3. Gianotti L, Beretta S, Luperto M, Bernasconi D, Valsecchi MG, Braga M. Enhanced recovery strategies in colorectal surgery: Is the compliance with the whole program required to achieve the target? Int J Colorectal Dis 2014;29:329-41.
4. Gonzalez-Ayora S, Pastor C, Guadalajara H, Ramirez JM, Royo P, Redondo E, *et al*. Enhanced recovery care after colorectal surgery in elderly patients. Compliance and outcomes of a multicenter study from the Spanish working group on ERAS. Int J Colorectal Dis 2016;31:1625-31.
5. Rosenberg K, Kayyali A. Enhanced recovery after surgery in a community hospital. AJN Am J Nurs 2014;114:69.
6. Philp S, Carter J, Pather S, Barnett C, D'Abrew N, White K. Patients' satisfaction with fast-track surgery in gynaecological oncology. Eur J Cancer Care (Engl) 2015;24:567-73.
7. Tebala GD, Keane S, Osman A, Ip M, Khan AQ, Perrone L. Early discharge after colorectal resection: The positive impact of an enhanced recovery program on a rural colorectal surgery service. Surg Laparosc Endosc Percutan Tech 2016;26:e137-44.
8. Soeters PB. The enhanced recovery after surgery (ERAS) program: Benefit and concerns. Am J Clin Nutr 2017;106:10-1.
9. Gómez-Izquierdo JC, Trainito A, Mirzakandov D, Stein BL, Liberman S, Charlebois P, *et al*. Goal-directed fluid therapy does not reduce primary postoperative ileus after elective laparoscopic colorectal surgery: A randomized controlled trial. Anesthesiology 2017;127:36-49.
10. Gillis C, Gill M, Marlett N, MacKean G, GermAnn K, Gilmour L, *et al*. Patients as partners in enhanced recovery after surgery: A qualitative patient-led study. BMJ Open 2017;7:e017002.
11. Hegarty A, Shah N. Enhanced recovery: Pathways to better care. Br J Hosp Med (Lond) 2017;78:597.
12. Nicolescu TO. Perioperative surgical home. Meeting tomorrow's challenges. Rom J Anaesth Intensive Care 2016;23:141-7.
13. Schatz C. Enhanced recovery in a minimally invasive thoracic surgery program. AORN J 2015;102:482-92.
14. Pogatschnik C, Steiger E. Review of preoperative carbohydrate loading. Nutr Clin Pract 2015;30:660-4.
15. Bozzetti F, Mariani L. Perioperative nutritional support of patients undergoing pancreatic surgery in the age of ERAS. Nutrition 2014;30:1267-71.
16. Aarts MA, Rotstein OD, Pearsall EA, Victor JC, Okrainec A, McKenzie M, *et al*. Postoperative ERAS interventions have the greatest impact on optimal recovery: Experience with implementation of ERAS across multiple hospitals. Ann Surg 2018;267:992-7.
17. Watson DJ. Nurse coordinators and ERAS programs. Nurs Manage 2018;49:42-9.
18. Chazard E, Ficheur G, Beuscart J-B, Preda C. How to Compare the Length of Stay of Two Samples of Inpatients? A Simulation Study to Compare Type I and Type II Errors of 12 Statistical Tests. Value in Health 2017;20:992-8.
19. ACS Risk Calculator – Home Page. Available from: https://riskcalculator.facs.org/RiskCalculator/. [Last accessed on 2022 Jan 05].