



Research paper

ERAS protocol in colorectal surgery is effective in octogenarians: A retrospective cohort study



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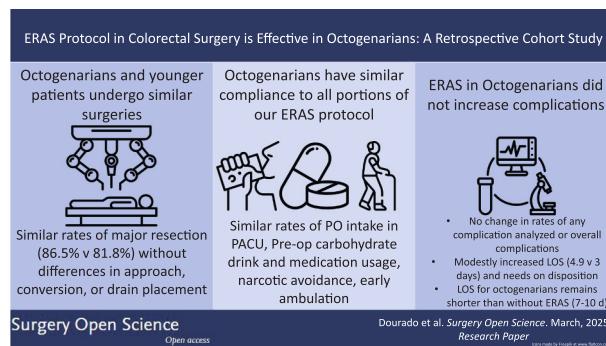
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HIGHLIGHTS

- ERAS protocol is safe and effective in octogenarians without decreased compliance.
- Utilizing ERAS protocol in octogenarians does not lead to increased complications.
- Increased LOS, care on discharge, and readmission are likely related to frailty.

GRAPHICAL ABSTRACT



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ABSTRACT

Purpose: Evaluate the effectiveness of implementing an ERAS protocol in octogenarians.

Methods: This retrospective cohort study analyzed patients undergoing colorectal surgery under the ERAS protocol at Boca Raton Regional Hospital from December 1, 2019 to October 30, 2021. Patients under the age of 18, undergoing emergency surgery, and with incomplete data were excluded. A $p < 0.05$ was considered statistically significant and analyses were done using EZR and R software.

Results: 299 patients met inclusion criteria with 60 (20.1 %) over the age of 80 and 239 (79.9 %) younger than 80. 140 (46.8 %) of the cohort were male. When comparing octogenarians with younger patients there were no differences in compliance with ERAS protocols such as pre-operative medication ($p = 1$) and oral carbohydrate drink consumption ($p = 0.574$), oral intake in PACU ($p = 0.832$), PACU sit and dangle ($p = 0.619$), or adherence to a narcotic sparing regimen ($p = 0.365$). Additionally, there were no differences in complications ($p = 1$), time until bowel function ($p = 0.401$), or time to first ambulation ($p = 0.883$). Octogenarians were more likely to have

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a longer LOS (4.89 v 3.0 days; $p = 0.006$), disposition requiring either home health care or a skilled nursing facility (SNF) (52.5 % v 28.3 %; $p = 0.008$), and readmission (42.3 % v 20.8 %; $p = 0.042$).

Conclusion: The ERAS protocol is safe and effective when used in the octogenarian without decreased compliance or increased complications. Increased LOS, care needed on disposition, and readmission are in-line with other published data of all patients and are likely related to increased frailty among this group and not to the addition of the ERAS protocol.

Background

Enhanced Recovery After Surgery (ERAS) is a multidisciplinary approach designed to minimize the surgical stress response and improve overall postoperative outcomes [1,2]. The methodology has been applied to patients undergoing colorectal surgery and has demonstrated a reduction in length of hospital stay and postoperative complications in both open and laparoscopic operations [1,2].

The average length of stay after colorectal surgery without implementing the ERAS protocol is 7 days to 10 days [3,4]. Several trials have shown that there is a reduction in the length of stay (LOS) and lower readmission rates for patients while utilizing the ERAS protocol without affecting patient outcome. While some studies indicate that length of stay is reduced to four days [2], others show that discharge within two days after surgery can be achieved and does not increase readmission or complication rates [5,6].

Additionally, complication rates have been shown to decrease from 30.3 % to 25.2 % when the ERAS protocol was adhered to and applied in patients undergoing colorectal surgery [7]. An increase in compliance of the components of the ERAS protocol is associated with a reduction in complication rates [7]. A study by Sato et al. demonstrated that in the ERAS protocol for elective colorectal cancer surgery, perioperative fluid management had a significant impact on the patient outcomes. Discontinuation of continuous intravenous infusion on post operative day 1 and avoidance of fluid overload (intraoperative fluid <2000 mL) was associated with a significantly shorter length of hospital stay and fewer incidences of paralytic ileus [8].

A systematic review by Bagnall et al. shows that ERAS can be implemented in elderly patients safely (age 65 and above) [9]. It is estimated that by 2050, the number of older adults is expected to reach up to 89 million [10]. As the geriatric population is rises and the number of older individuals requiring surgery increases, it is critical to ascertain the benefits elderly patients might receive when utilizing an ERAS protocol. Many older patients have multiple co-morbidities and are at higher risk to develop postoperative complications and require a longer hospital stay. Additionally, previous reports have demonstrated that an age of 80 or higher is an independent risk factor for increased morbidity and mortality [10–12]. Therefore, further investigation is required, prior to implementing an ERAS protocol for this patient population. A study by Liu et al. showed that with the application of ERAS protocols in patients undergoing colorectal surgery was beneficial in both older and younger patients. They demonstrated similar LOS for both groups and there were no increased rates of complications in the elderly population [12]. However, a study by Studniarek et al. reviewed patients undergoing colectomies with an ERAS protocol and found that elderly patients were associated with an increase in LOS, readmissions, and emergency department visits [13].

This study aims to assess whether implementation of an ERAS protocol in patients over the age of 80 achieves similar outcomes in length of stay and complications rates when compared to younger patients. It additionally aims to assess if any components of the ERAS protocol have lower compliance within this patient population.

Methods

Study design and setting

This retrospective cohort study took place at a community center. The data within the records of all consecutive patients who underwent any colorectal surgery at Boca Raton Regional Hospital between December 1, 2019, and October 30, 2021, were reviewed. Data was included for multiple surgeons. Patients were compared based on age with an age of ≥ 80 years being considered geriatric. Prior to medical record review, institutional approval and ethics consent was obtained from the Institutional Review Board (IRB) with study number 1812440-3. This observational study was reported in line with the STROBE guideline [14].

Study population

The inclusion criteria for the study were adult patients who underwent any surgery for any colorectal pathology at Boca Raton Regional Hospital in the inclusion period. Exclusion criteria were patients ages <18 years, patients with no data on compliance with ERAS protocols, or patients with incomplete data. Cases were patients ≥ 80 years of age and controls were patients <80 years of age. The ERAS protocol was used in all patients regardless of age and without modification by surgeon preference for the data points studied. This protocol is outlined in Supplementary Table 1.

Data collected

The following data points were collected and included in the analyses:

- Demographic: age, date of birth, biological sex, body mass index (BMI), and American Society of Anesthesia (ASA) classification.
- Operative details: procedure performed, approach (i.e. open, laparoscopic, robotic), conversion to open, classification as emergent, length of surgery (minutes), type of drain placed, use of a Foley catheter, use of a rectal tube, type of anesthesia used, and use of a clean closing table.
 - o Of note, usage of drains and rectal tubes were at surgeon discretion and not part of our institutional ERAS protocol.
- Complications: presence of any complication, presence of an infectious complication, presence of urinary retention, presence of post-operative nausea or emesis, and specific complication experienced.
- Compliance to the ERAS protocol: pre op carbohydrate drink, ERAS medications given pre op, per os (PO) intake in the post-anesthesia recovery unit (PACU), PACU sit and dangle compliance, opioids used in PACU, avoidance of post-op narcotics, time until first ambulation in hours.
 - o Compliance was based on adherence to individual components in to attempt to identify any areas where octogenarians needed modification of the protocol.
- Postoperative details: pain goal met (yes or no), use of narcotics during hospital stay (yes or no), time until first bowel movement (BM) in hours, readmission (yes or no), discharge disposition, and LOS (days).

This data is collected by nursing staff utilizing the attached protocol from Supplementary Table 1. This form is maintained in the patient's chart during their hospitalization and completed by all nursing staff caring for the patient. After their admission, the form is given to a dedicated quality improvement nursing staff who enters it into an encrypted, password protected, HIPAA compliant database for further quality improvement study. This database may only be accessed with IRB approval as outlined above.

Outcomes

The primary outcome of the study was the compliance with ERAS protocols among octogenarians. Secondary outcomes were complications, length of stay, operative outcomes, and readmission rates.

Statistical analysis

Statistical analysis was conducted utilizing EZR (version 1.61) and R (version 4.3.1) software [15]. Categorical data was expressed in absolute numbers and percentages, analyzed employing either the Fisher-exact test or Chi-square test as deemed appropriate. Continuous data distribution underwent normality evaluation and was presented as either mean and standard deviation or median and inter-quartile range (IQR). Continuous variables were analyzed using either the Student's *t*-test or Mann-Whitney test pending normality. For comparisons involving greater than two groups, a one-way Anova test was utilized. Significance was considered at $p < 0.05$. Missing data was handled by utilizing pairwise deletion via an available case analysis method.

Results

Description of cohort

A total of 71 patients were excluded due to these records having a high rate of missing data. After exclusions, 299 patients met inclusion criteria with 60 (20.1 %) over the age of 80 and 239 (79.9 %) younger than 80. A total of 140 (46.8 %) patients were male. Overall, the cohort of patients who were octogenarians were similar in terms of gender and American Society of Anesthesiology (ASA) class. The octogenarians had a lower BMI (24 v 27, $p < 0.001$) (Table 1).

Operative factors by age

When octogenarians were compared to younger patients, they had a shorter operative time (170.5 v 219 min, $p = 0.008$) and were less likely to have a rectal tube placed (0 % v 6.8 %, $p = 0.049$). Among younger patients 81.8 % underwent a major colonic resection compared to 86.5 % of octogenarians indicating a similar rate of major surgery between groups ($p = 0.389$). Utilization of adjunctive anesthesia, robotic surgery, conversion rates, clean closing table, ureteral stents, Foley catheters, nasogastric tubes, and placement of drains were similar between groups (Table 2).

Table 1

Demographic features of the cohort.

Factor	Group	Age $\geq 80^a$		p-Value
		No	Yes	
N (%)		239	60	
Gender	F	132 (55.2)	27 (45.0)	0.193
	M	107 (44.8)	33 (55.0)	
ASA status	2	114 (47.7)	25 (41.7)	0.314
	3	124 (51.9)	34 (56.7)	
	4	1 (0.4)	1 (1.7)	
BMI		27.00 [14.00, 44.00]	24.00 [17.00, 37.00]	<0.001

^a Continuous variables represented as median [IQR]. Bold text indicates statistical significance.

Table 2

Operative factors by age.

Factor	Group	Age $\geq 80^a$		p-Value
		No	Yes	
N (%)		239	60	
Anesthesia type	TAP	55 (31.8)	14 (33.3)	0.379
	Spinal	69 (39.9)	21 (50.0)	
	TAP + spinal	8 (4.6)	0 (0.0)	
Procedure performed	General only	41 (23.7)	7 (16.7)	N/a
	Robotic right hemicolectomy	48 (20.4)	21 (35.6)	
	Robotic left hemicolectomy	89 (37.9)	16 (27.1)	
	Ostomy closure	27 (11.5)	4 (6.8)	
	Robotic low-anterior resection	22 (9.4)	4 (6.8)	
	Robotic ileocolic resection	5 (2.1)	1 (1.7)	
	Other open colectomy	20 (8.5)	7 (11.9)	
	Open Hartmann's reversal	5 (2.1)	0 (0.0)	
	Robotic rectopexy	2 (0.9)	3 (5.1)	
	Robotic sigmoid resection	6 (2.6)	2 (3.4)	
	Robotic rectopexy	1 (0.4)	0 (0.0)	
	Robotic parastomal hernia repair	2 (0.9)	0 (0.0)	
	Robotic abdominoperineal resection	2 (0.9)	0 (0.0)	
	Diagnostic laparoscopy	2 (0.9)	1 (1.7)	
	Laparoscopic colostomy creation	2 (0.9)	0 (0.0)	
	Open colostomy creation	2 (0.9)	0 (0.0)	
Major colectomy	Yes	192 (81.8)	51 (86.5)	0.389
	No	47 (18.2)	9 (13.5)	
Robotic	No	56 (23.9)	13 (21.7)	0.865
	Yes	178 (76.1)	47 (78.3)	
Conversion to open	No	156 (84.3)	40 (83.3)	0.828
	Yes	29 (15.7)	8 (16.7)	
Length of surgery (mins)		219.00 [19.00, 1372.00]	170.50 [45.00, 969.00]	0.008
Clean closing table used	No	50 (23.9)	14 (25.9)	0.726
	Yes	159 (76.1)	40 (74.1)	
Ureteral stents used	No	113 (47.3)	36 (60.0)	0.085
	Yes	126 (52.7)	24 (40.0)	
Drain type	None	189 (79.7)	56 (93.3)	0.122
	Penrose	14 (5.9)	1 (1.7)	
	Intra-abdominal	30 (12.7)	3 (5.0)	
	Penrose and intra-abdominal	4 (1.7)	0 (0.0)	
Foley used	No	44 (18.6)	13 (21.7)	0.585
	Yes	193 (81.4)	47 (78.3)	
NGT used	No	236 (99.6)	59 (98.3)	0.364
	Yes	1 (0.4)	1 (1.7)	
Rectal tube used	No	221 (93.2)	60 (100.0)	0.049
	Yes	16 (6.8)	0 (0.0)	

^a Continuous variables represented as median [IQR]. Bold text indicates statistical significance.

ERAS compliance and complications

Octogenarians were found to have similar compliance to all measured components of the ERAS protocol including PO intake in PACU, limited narcotic use, time until ambulation, and time until first bowel movement (Table 3). When postoperative outcomes were analyzed, octogenarians had a longer LOS (4.89 v 3 days, $p = 0.006$), higher rates of readmission (42.3 % v 20.8 %, $p = 0.042$), and were more likely to have a discharge requiring either home health care or a skilled nursing facility (SNF) (52.5 % v 28.3 %; $p = 0.008$). There were no differences in any complications examined (Table 4).

Table 3

ERAS compliance by age.

Factor	Group	Age $\geq 80^a$		p-Value
		No	Yes	
N (%)		239	60	
Carbohydrate drink given	No	52 (31.9)	15 (37.5)	0.574
	Yes	111 (68.1)	25 (62.5)	
ERAS meds given pre-op	No	49 (30.8)	12 (30.0)	1
	Yes	110 (69.2)	28 (70.0)	
PO in PACU	No	53 (51.0)	13 (48.1)	0.832
	Yes	51 (49.0)	14 (51.9)	
PACU sit and dangle	No	88 (75.9)	23 (82.1)	0.619
	Yes	28 (24.1)	5 (17.9)	
Pain goal met	No	9 (16.7)	2 (12.5)	1
	Yes	45 (83.3)	14 (87.5)	
Narcotics used during admission	No	104 (60.8)	27 (69.2)	0.365
	Yes	67 (39.2)	12 (30.8)	
Opioids used in PACU	No	107 (67.3)	26 (72.2)	0.693
	Yes	52 (32.7)	10 (27.8)	
Time until ambulation (hrs)		24.00 [0.00, 96.00]	24.00 [0.00, 48.00]	0.883

^a Continuous variables represented as median [IQR].**Table 4**

Postoperative outcomes by age.

Factor	Group	Age $\geq 80^a$		p-Value
		No	Yes	
N (%)		239	60	
Complications	No	211 (88.3)	53 (88.3)	1
	Yes	28 (11.7)	7 (11.7)	
Infectious complications	No	231 (96.7)	58 (96.7)	1
	Yes	8 (3.3)	2 (3.3)	
Urinary retention	No	226 (97.0)	58 (100.0)	0.352
	Yes	7 (3.0)	0 (0.0)	
Specific complication	None	211 (88.3)	53 (88.3)	0.169
	Urinary retention	7 (2.9)	0 (0.0)	
	Bladder injury	1 (0.4)	0 (0.0)	
	C.Diff infection	1 (0.4)	0 (0.0)	
	Small bowel perforation	2 (0.8)	0 (0.0)	
	Hypotension	1 (0.4)	2 (3.3)	
	Ileus	3 (1.3)	1 (1.7)	
	Superficial SSI	2 (0.8)	1 (1.7)	
	Deep SSI	1 (0.4)	0 (0.0)	
	Anastomotic leak	5 (2.1)	0 (0.0)	
	Anastomotic leak and SBO	0 (0.0)	1 (1.7)	
	A. Fib exacerbation	0 (0.0)	1 (1.7)	
	Spinal headache	1 (0.4)	0 (0.0)	
	Stricture	3 (1.3)	0 (0.0)	
	SBO	1 (0.4)	1 (1.7)	
	Mortality	0 (0)	0 (0)	
Post-operative nausea or emesis	No	88 (61.1)	25 (73.5)	0.235
	Yes	56 (38.9)	9 (26.5)	
Time until BM (hrs)		1.34 [0.11, 43,918.27]	1.68 [0.21, 43,909.59]	0.401
LOS (d)		3.00 [1.00, 20.29]	4.89 [1.25, 19.00]	0.006
Discharge disposition	Home	109 (71.7)	19 (47.5)	0.008
	Home with home health	35 (23.0)	17 (42.5)	
	Home with PT	0 (0.0)	1 (2.5)	
	Skilled nursing facility	8 (5.3)	3 (7.5)	
Readmission	No	95 (79.2)	15 (57.7)	0.042
	Yes	25 (20.8)	11 (42.3)	

^a Continuous variables represented as median [IQR]. Bold text indicates statistical significance.

Discussion

The present study evaluated the compliance of octogenarians with an ERAS protocol and its effect on outcomes. There were no differences between octogenarians and the general population in terms of compliance to any of the outcomes within our institution's ERAS protocol. Additionally, there were no increases in overall complications, infectious complications, or specific complications with increasing age. The only differences found between the groups were an increased LOS of 1.89 days, increased needs upon discharge, and increased readmission. Overall, the high level of readmission is an area where the ERAS protocol was not effective in improving outcomes among the octogenarian population. The differences in operative time and usage of rectal tubes are likely related to confounding factors and not the patient's age. The shorter operative times in the older cohort are likely due to the increased pressures to decrease time under anesthesia in these individuals and not a result of ERAS protocols. Prolonged operative times have been associated with as much as a 14 % increase in complications per 30 additional minutes of general anesthesia [16]. This decreased time under anesthesia is a confounding factor, however, and may be a source of additional confounding.

The similar compliance to ERAS with no increased complications among octogenarians is an important finding of the present study. Increased compliance with ERAS was shown in a large European cohort to decrease complications further [17]. This effect combined with the equal compliance among older patients in the present study implies the generalizability of ERAS protocols to this population and its additional benefits.

In the general population, average LOS after colectomy ranges from 7 to 10 days [3,4] which decreases to 2–4 days when an ERAS protocol is utilized [2,6]. The present finding of a LOS of 4.9 days among octogenarians shows that, while the benefit of ERAS is not as pronounced as in the general population (LOS 3d), it is still improved significantly from the data without ERAS (7–10 days). Additionally, it is in line with a study of elderly colorectal surgery patients undergoing ERAS protocol which showed a LOS of 4–6 days [18]. Due to the inability to perform subgroup and multivariable analysis, it cannot be said with certainty that the reduction in LOS from baseline is due to the ERAS protocol, however, no other major changes to perioperative care at our institution were undertaken prior to the study period making the ERAS protocol the likely cause of this reduction.

Within elderly patients undergoing colectomy under an ERAS protocol, Studniarek et al. demonstrated with a higher frailty index correlated with readmission and increased LOS [13]. This is in line with the present study showing increased readmission and longer LOS among this group of patients. The present study evaluates extremes of age (>80 years), and this factor likely contributes to the similar results even though ASA status, a correlate for comorbidities, did not differ between groups. Evaluating frailty as a predictor of disposition, readmission, and LOS among patients undergoing colorectal surgical intervention could be an area of future study.

Additionally, our study did not evaluate the effects of prehabilitation or early engagement of case management and social services in the care of elderly patients undergoing colectomy. Prehabilitation has been shown in some studies to reduce complications in colorectal surgery [19]. When combined with nutritional optimization preoperatively it has also been shown to reduce LOS as much as 2 days [20]. However, in a recent Cochrane review, prehabilitation was not shown to have a solid effect on complications, ED visits, or readmission [21]. Given the potential for benefit in this population, the addition of prehabilitation to ERAS protocols could be utilized for elderly patients and would be an interesting future area of study.

Overall, the octogenarian appears to be able to tolerate an ERAS protocol without modification leading to the same reduction in complications and a smaller, but clinically relevant reduction in LOS when compared to younger patients. The increases in LOS and readmission are

in line with published literature and likely relate to increased frailty among this population and not the institution of an ERAS protocol specifically.

The study has some important limitations to be aware of. The retrospective design and conduction at a single center limit the data. Additionally, the low outcome rate and presence of missing data among some data points limits the ability for subgroup analyses. The rate of missing data was relatively consistent between the two groups which lessens the chance that the impact of missing data is due to age. Additionally, the present study does not include comparative data to before the initiation of ERAS protocols as the purpose of the present study was to compare the protocol based on the age group to which it was applied. This is an area of future study. However, there is limited evidence for ERAS protocols among the geriatric and the present study includes a high number ($n = 60$) of octogenarians. This expands the robustness of available literature regarding this growing patient population.

Conclusion

The ERAS protocol is safe and seems to be effective when used in the octogenarian without decreased compliance or increased complications. Increased LOS, care needed on disposition, and readmission are in-line with other published data of all patients and are likely related to increased frailty among this group and not to the addition of the ERAS protocol.

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.sopen.2025.03.004>.

CRediT authorship contribution statement

Justin Dourado: Writing – review & editing, Writing – original draft, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Ariel Wolf:** Writing – review & editing, Writing – original draft, Formal analysis, Data curation. **Maria Herrera Rodriguez:** Writing – review & editing, Writing – original draft, Formal analysis, Data curation. **Shruti Agarwal:** Writing – review & editing, Writing – original draft, Formal analysis, Data curation. **Karin Blumofe:** Writing – review & editing, Writing – original draft, Formal analysis. **Jordan Moseson:** Writing – review & editing, Writing – original draft, Formal analysis. **Jose Yeguez:** Writing – review & editing, Writing – original draft, Formal analysis. **Andrew Ross:** Writing – review & editing, Writing – original draft, Formal analysis. **Avraham Belizon:** Writing – review & editing, Writing – original draft, Formal analysis, Conceptualization.

Ethics approval

Prior to medical record review, institutional approval and ethics consent was obtained from the Institutional Review Board (IRB) with study number 1812440-3.

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Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Avraham Belizon, MD reports a relationship with Intuitive Surgical Inc. that includes: consulting or advisory. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The datasets analyzed during this study are maintained on an encrypted and password protected drive. They are not publicly available, but are available in a deidentified fashion on reasonable request from the corresponding author.

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