Compliance with enhanced recovery protocols in elderly patients undergoing colorectal resection

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ABSTRACT

INTRODUCTION Enhanced recovery after surgery (ERAS) is associated with reduced length of stay (LOS) and improved outcomes in colorectal surgery. It is unclear whether ERAS can be safely implemented in elderly patients undergoing complex colorectal resections. The aim of this study was to evaluate the feasibility of ERAS in patients of all ages undergoing colorectal surgery.

METHODS A prospective database of a consecutive series of patients undergoing colorectal resections with ERAS between August 2012 and December 2014 was evaluated. Patients were divided into four age groups. Outcomes studied were compliance with ERAS elements, LOS, morbidity and mortality.

RESULTS Of the 294 patients in the study cohort, 79 were <60 years, 81 were 60–69 years, 86 were 70–79 years and 48 were ≥80 years of age. There was no significant difference between age groups in compliance with ERAS elements. Age was not predictive of delayed discharge (LOS >6 days) or morbidity. Factors that were predictive of delayed discharge on multivariate analysis were open surgery (odds ratio [OR]: 2.23, $p=0.003$), conversion to open surgery (OR: 3.23, $p=0.017$), stoma formation (OR: 2.10, $p=0.019$) and chronic obstructive pulmonary disease (OR: 4.12, $p=0.038$). Factors predictive of morbidity on multivariate analysis comprised conversion to open surgery (OR: 7.72, $p=0.004$), high creatinine (OR: 1.03 per unit increase in creatinine, $p=0.008$) and stoma education (OR: 0.31, $p=0.030$).

CONCLUSIONS ERAS can be successfully implemented in older patients. There was equal compliance with the ERAS programme across the four age groups and no significant effect of age on LOS or morbidity.

KEYWORDS

Colorectal cancer – Enhanced recovery

Accepted 18 March 2018

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Enhanced recovery after surgery (ERAS) protocols were first introduced by Kehlet *et al.*¹ ERAS aims to reduce the surgical stress response, postoperative complications and recovery time by combining evidence-based elements of care into standardised protocols for patients undergoing elective surgery.

Colorectal resection results in significant surgical stress and prolonged recovery of gastrointestinal function. Complication rates are traditionally 20–30% with a length of stay (LOS) of 6–12 days.² Mortality for elderly patients following colorectal resection is up to 9 times higher than for patients under 65 years of age.³

ERAS programme implementation is cost effective,^{4,5} and reduces LOS,^{5–12} morbidity^{6–11} and postoperative ileus.^{5,7} Readmission and mortality rates are not significantly reduced.^{7,8} The majority of studies on ERAS either excluded elderly patients or the numbers were too small to allow subgroup analysis.^{5–7,9} Studies where age has been addressed have defined the elderly as ≥65 years.¹³ In an ageing population, this definition no longer reflects physiological old age, meaning findings may not be applicable to the elderly. The literature suggests that complete ERAS protocol compliance

is rare but that greater compliance is associated with improved postoperative outcomes.¹⁴

Despite the potential benefits of ERAS in elderly patients, there exists little high quality evidence to support its use. In addition, few studies have looked at compliance with ERAS protocols in the elderly. The aim of this study was to evaluate the feasibility of ERAS and compliance with the protocol in elderly patients undergoing colorectal surgery, and to assess outcomes such as LOS, readmission, reoperation, morbidity and mortality.

Methods

A prospective database of consecutive patients undergoing colorectal resections with ERAS between August 2012 and December 2014 at our institution was evaluated. The database is maintained by a full-time data clerk.

Patients were divided into four age groups: <60 years, 60–69 years, 70–79 years and ≥80 years. Epidemiological variables analysed included age, sex, ASA (American Society of Anesthesiologists) grade, operation type and whether the operation was laparoscopic or open. Outcomes studied

comprised LOS, readmission, reoperation, morbidity, mortality and compliance with all aspects of the ERAS programme. Morbidity was stratified according to the Clavien–Dindo classification.¹⁵

Statistical analysis

The impact of age on ERAS compliance was assessed by linear regression. Predictors of delayed discharge (defined as greater than the median LOS) and morbidity (Clavien–Dindo grade) were assessed using a logistic regression model. Only factors with a *p*-value of <0.1 on univariate analysis were entered into the logistic regression model for multivariate analysis.

Ethical approval

All procedures performed were in accordance with the Declaration of Helsinki. This project was approved by the University Hospitals Bristol NHS Foundation Trust audit committee. As a retrospective study, formal consent was not required.

Results

A total of 294 patients (165 men [56%] and 129 women [44%]) undergoing colorectal resection were included in the

study. Of these, 79 were <60 years, 81 were 60–69 years, 86 were 70–79 years and 48 were ≥80 years of age. Patients classed as ASA grade 1 comprised 15% of the study cohort, those with ASA grade 2 comprised 62% and those with ASA grade 3 comprised 23%. Right colonic resection was performed in 35% of cases, left colonic resection in 23%, rectal resection (anterior resection or abdominoperineal excision) in 35% and subtotal or total colectomy in 6%. Over half (52%) of the operations were completed laparoscopically and 8% required conversion to open surgery.

A full-time enhanced recovery nurse specialist lead the implementation of the ERAS programme for the first 18 months of the study period. All patients were provided with patient diaries, directing them towards their daily goals (daily walks, oral intake, breathing exercises etc). Patients were reviewed daily by a physiotherapist. Compliance with individual elements of the ERAS programme was unaffected by age (Table 1). Compliance was <70% for avoidance of bowel preparation, use of epidural or regional anaesthesia, use of goal directed fluid therapy, avoidance of drains, avoidance of postoperative systematic opiates and mobilisation within 24 hours.

The median LOS was 6 days (range: 3–81 days) and so delayed discharge was defined as LOS >6 days. Factors that were associated with delayed discharge on univariate

Table 1 The effect of age on compliance with individual ERAS elements

ERAS element	<60 years (<i>n</i> =79)	60–69 years (<i>n</i> =81)	70–79 years (<i>n</i> =86)	≥80 years (<i>n</i> =48)	<i>p</i> -value
Preoperative visit	77 (97.5%)	81 (100%)	86 (100%)	48 (100%)	0.067
Preoperative assessment	79 (100%)	81 (100%)	86 (100%)	48 (100%)	1.0
Preoperative explanation	67 (84.8%)	80 (98.8%)	74 (86.1%)	45 (93.8%)	0.470
Preoperative stoma education	32/46 (69.6%)	35/46 (76.1%)	36/41 (87.8%)	14/18 (77.8%)	0.123
Avoidance of bowel preparation	49 (62.0%)	39 (48.2%)	39/85 (45.9%)	28 (58.3%)	0.374
Admission on the day of surgery	76 (96.2%)	80 (98.8%)	83 (96.5%)	47 (97.9%)	0.783
Preoperative carbohydrate loading	67/77 (87.0%)	70/76 (92.1%)	60/74 (81.1%)	42/47 (89.4%)	0.686
Avoidance of preoperative sedation	78 (98.7%)	79 (97.5%)	86 (100%)	48 (100%)	0.255
Antibiotics before incision	78 (98.7%)	80 (98.8%)	86 (100%)	48 (100%)	0.249
Regional anaesthesia	51 (64.6%)	57 (70.4%)	57 (66.3%)	36 (75.0%)	0.364
Goal directed fluid therapy	22 (27.9%)	28 (34.6%)	27 (31.4%)	13 (27.1%)	0.949
Intraoperative warming	78 (98.7%)	81 (100%)	86 (100%)	48 (100%)	0.196
Avoidance of abdominal drains	25/33 (75.8%)	17/26 (65.4%)	25/30 (83.3%)	7/12 (58.3%)	0.763
Intraoperative nasogastric tube removal	7/8 (87.5%)	10/11 (90.9%)	7/7 (100%)	3/3 (100%)	0.308
Postoperative avoidance of IV fluid overload	79 (100%)	80 (98.8%)	85 (98.8%)	47 (97.9%)	0.280
Postoperative avoidance of opiates	5 (6.3%)	8 (9.9%)	12 (14.0%)	7 (14.6%)	0.080
Postoperative resumption of solid diet	71 (89.9%)	71 (87.7%)	76 (88.4%)	42 (87.5%)	0.716
Prophylactic antiemetic therapy	73 (92.4%)	72 (88.9%)	74 (86.1%)	44 (91.7%)	0.569
Postoperative mobilisation	45 (57.0%)	49 (60.5%)	46 (53.5%)	26 (54.2%)	0.562

ERAS = enhanced recovery after surgery; IV = intravenous

Table 2 Factors associated with delayed discharge on univariate analysis

Characteristic	Category	Total	LOS >6 days	OR (95% CI)	p-value
Sex	Male	165	94 (57.0%)	1	0.001
	Female	129	48 (37.2%)	0.45 (0.28–0.72)	
Operation	Right colonic resection	104	35 (33.7%)	1	0.002
	Left colonic resection	67	35 (52.2%)	2.16 (1.14–4.10)	
	Rectal resection	104	61 (58.7%)	2.80 (1.56–5.01)	
	Subtotal/proctocolectomy	18	11 (61.1%)	3.10 (1.08–8.92)	
Approach	Laparoscopic	130	46 (35.4%)	1	<0.001
	Converted to open	24	16 (66.7%)	3.65 (1.41–9.45)	
	Open	140	80 (57.1%)	2.43 (1.47–4.03)	
Age group (4 groups)	<60 years	79	38 (48.1%)	1	0.934
	60–69 years	81	43 (53.1%)	1.22 (0.65–2.28)	
	70–79 years	86	35 (40.7%)	0.74 (0.40–1.38)	
	≥80 years	48	26 (54.2%)	1.28 (0.62–2.63)	
Age group (2 groups)	<80 years	246	116 (47.2%)	1	0.375
	≥80 years	48	26 (54.2%)	1.32 (0.71–2.47)	
Stoma formed	No	181	70 (38.7%)	1	<0.001
	Yes	113	72 (63.7%)	2.78 (1.69–4.60)	
ASA grade	1	43	21 (48.8%)	1	0.299
	2	182	82 (45.1%)	0.86 (0.44–1.67)	
	3	69	39 (56.5%)	1.36 (0.63–2.94)	
IDDM	No	290	139 (47.9%)	1	0.356
	Yes	4	3 (75.0%)	3.26 (0.33–32.0)	
Ischaemic heart disease	No	263	125 (47.5%)	1	0.441
	Yes	31	17 (54.8%)	1.34 (0.63–2.84)	
Stroke	No	273	129 (47.3%)	1	0.195
	Yes	21	13 (61.9%)	1.81 (0.73–4.54)	
Heart failure	No	292	140 (48.8%)	–	0.232
	Yes	2	2 (100%)	–	
COPD	No	279	130 (46.6%)	1	0.012
	Yes	15	12 (80.0%)	4.58 (1.25–16.9)	
Mean preoperative serum creatinine in µmol/l	LOS ≤6 days	80.1 (SE: 1.51)			0.017
	LOS >6 days	86.1 (SE: 2.03)			
Mean preoperative haemoglobin in g/dl	LOS ≤6 days	14.1 (SE: 0.98)			0.194
	LOS >6 days	12.8 (SE: 0.16)			
Preoperative visit	No	2	1 (50.0%)	1	0.734
	Yes	292	141 (48.3%)	0.93 (0.06–15.1)	
Preoperative assessment	No	0	0 (0%)	–	–
	Yes	294	142 (48.3%)	–	
Preoperative explanation	No	28	13 (46.4%)	1	0.835
	Yes	266	129 (48.5%)	1.09 (0.50–2.37)	

Characteristic	Category	Total	LOS >6 days	OR (95% CI)	p-value
Preoperative stoma education	No	34	15 (44.1%)	1	0.766
	Yes	117	55 (47.0%)	1.12 (0.52–2.43)	
Avoidance of bowel preparation	No	138	67 (48.6%)	1	0.890
	Yes	155	74 (47.7%)	0.97 (0.61–1.53)	
Regional anaesthesia	No	93	44 (47.3%)	1	0.818
	Yes	201	98 (48.8%)	1.06 (0.65–1.73)	
Admission on the day of surgery	No	8	4 (50.0%)	1	1.0
	Yes	286	138 (48.3%)	0.93 (0.23–3.81)	
Preoperative carbohydrate loading	No	35	21 (60.0%)	1	0.122
	Yes	239	110 (46.0%)	0.57 (0.27–1.18)	
Goal directed fluid therapy	No	204	100 (49.0%)	1	0.710
	Yes	90	42 (46.7%)	0.91 (0.55–1.50)	
Intraoperative warming	No	1	0 (0%)	–	1.0
	Yes	293	142 (48.5%)	–	
Avoidance of abdominal drain	No	27	15 (55.6%)	1	0.893
	Yes	74	40 (54.1%)	0.91 (0.55–1.50)	
Intraoperative nasogastric tube removal	No	2	1 (50.0%)	1	1.0
	Yes	27	13 (48.2%)	0.93 (0.05–17.3)	
Postoperative avoidance of IV fluid overload	No	3	1 (33.3%)	1	1.0
	Yes	291	141 (48.5%)	1.88 (0.17–21.1)	
Postoperative avoidance of opiates	No	262	126 (48.1%)	1	0.838
	Yes	32	16 (50.0%)	1.08 (0.52–2.25)	
Postoperative resumption of solid diet	No	34	20 (58.8%)	1	0.192
	Yes	260	122 (46.9%)	0.62 (0.30–1.28)	
Prophylactic antiemetic therapy	No	31	16 (51.6%)	1	0.696
	Yes	263	126 (47.9%)	0.86 (0.41–1.82)	
Postoperative mobilisation	No	128	64 (50.0%)	1	0.609
	Yes	166	78 (47.0%)	0.89 (0.56–1.41)	
Protocol compliance	≤90%	285	138 (48.4%)	1	0.815
	>90%	9	4 (44.4%)	0.85 (0.22–3.25)	

ASA = American Society of Anesthesiologists; CI = confidence interval; COPD = chronic obstructive pulmonary disease; IDDM = insulin dependant diabetes mellitus; IV = intravenous; LOS = length of stay; OR = odds ratio; SE = standard error

Table 3 Factors associated with delayed discharge (length of stay >6 days) on multivariate analysis

Characteristic	Category	OR (95% CI)	p-value
Sex	Male	1	0.128
	Female	0.65 (0.38–1.13)	
Operation	Right colonic resection	1	0.212
	Left colonic resection	1.55 (0.78–3.10)	
	Rectal resection	1.70 (0.84–3.45)	
	Subtotal/proctocolectomy	1.94 (0.63–6.02)	
Approach	Laparoscopic	1	0.017
	Converted to open	3.23 (1.23–8.49)	
Open	2.23 (1.31–3.80)	0.003	
Stoma formed	No	1	0.019
	Yes	2.10 (1.13–3.92)	
COPD	No	1	0.038
	Yes	4.12 (1.08–15.7)	
Preoperative serum creatinine in $\mu\text{mol/l}$		1.01 (0.99–1.02) per unit increase in creatinine	0.355
CI = confidence interval; COPD = chronic obstructive pulmonary disease; OR = odds ratio			

Table 4 Frequency of complications by age groups

Age group	Total	Clavien–Dindo grade			
		IIIa	IIIb	IV	V
<60 years	11 (14%)	3	7	1	0
60–69 years	6 (7%)	2	3	1	0
70–79 years	6 (7%)	0	4	2	0
≥80 years	2 (4%)	0	1	1	0

analysis included type of resection (left colonic odds ratio [OR]: 2.16, 95% confidence interval [CI]: 1.14–4.10; rectal OR: 2.80, 95% CI: 1.56–5.01; subtotal or total colectomy OR: 3.10, 95% CI: 1.08–8.92; $p=0.002$), approach (conversion to open surgery OR: 3.65, 95% CI: 1.41–9.45; open surgery OR: 2.43, 95% CI: 1.47–4.03; $p<0.001$), stoma formation (OR: 2.78, 95% CI: 1.69–4.60, $p<0.001$), past medical history of chronic obstructive pulmonary disease (COPD) (OR: 4.58, 95% CI: 1.25–16.9, $p=0.012$) and increased preoperative creatinine ($86.1\mu\text{mol/l}$ [standard error (SE): $2.03\mu\text{mol/l}$] vs $80.1\mu\text{mol/l}$ [SE: $1.51\mu\text{mol/l}$], $p=0.017$). Details of the univariate analysis for delayed discharge are given in Table 2.

On multivariate analysis, factors that remained statistically significant predictors of delayed discharge were conversion to open surgery (OR: 3.23, 95% CI: 1.23–8.49, $p=0.017$), open surgery (OR: 2.23, 95% CI: 1.31–3.80, $p=0.003$), stoma formation (OR: 2.10, 95% CI: 1.73–3.92, $p=0.019$) and past medical history of COPD (OR: 4.12, 95% CI: 1.08–15.7, $p=0.038$). The results of the multivariate analysis for delayed discharge are summarised in Table 3.

Twenty-three patients (8%) were readmitted within twenty-eight days and seventeen patients (6%) required reoperation. The small numbers precluded statistical analysis according to age.

Overall morbidity was observed in 14% of patients. Complications classed as Clavien–Dindo grade IIIb or above were experienced by 6% of patients (Table 4). Factors associated with morbidity on univariate analysis included type of resection (left colonic OR: 1.17, 95% CI: 0.50–2.73; rectal OR: 1.59, 95% CI: 0.77–3.29; subtotal or total colectomy OR: 3.78, 95% CI: 1.22–11.7; $p=0.082$), approach (conversion to open surgery OR: 3.83, 95% CI: 1.36–10.8; open surgery OR: 2.27, 95% CI: 1.16–4.47; $p=0.009$), stoma formation (OR: 1.72, 95% CI: 0.95–3.11, $p=0.072$), increased preoperative creatinine ($87.9\mu\text{mol/l}$ [SE: $3.50\mu\text{mol/l}$] vs $81.8\mu\text{mol/l}$ [SE: $1.32\mu\text{mol/l}$], $p=0.058$) and preoperative stoma education (OR: 0.35, 95% CI: 0.14–0.90, $p=0.022$). The findings from the univariate analysis for morbidity are listed in Table 5.

On multivariate analysis, factors remaining statistically significant predictors of morbidity were conversion to open

Table 5 Factors associated with morbidity (all Clavien–Dindo grades combined) on univariate analysis

Characteristic	Category	Total	Morbidity	OR (95% CI)	p-value
Sex	Male	165	38 (23.0%)	1	0.032
	Female	129	17 (13.2%)	0.51 (0.27–0.95)	
Operation	Right colonic resection	104	15 (14.4%)	1	0.082
	Left colonic resection	67	11 (16.4%)	1.17 (0.50–2.73)	
	Rectal resection	104	22 (21.2%)	1.59 (0.77–3.29)	
	Subtotal/proctocolectomy	18	7 (38.9%)	3.78 (1.22–11.7)	
Approach	Laparoscopic	130	15 (11.5%)	1	0.009
	Converted to open	24	8 (33.3%)	3.83 (1.36–10.8)	
	Open	140	32 (22.9%)	2.27 (1.16–4.47)	
Age group (4 groups)	<60 years	79	13 (16.5%)	1	0.910
	60–69 years	81	17 (21.0%)	1.34 (0.60–3.01)	
	70–79 years	86	16 (18.6%)	1.16 (0.52–2.60)	
	≥80 years	48	9 (18.8%)	1.17 (0.46–3.00)	
Age group (2 groups)	<80 years	246	46 (18.7%)	1	0.993
	≥80 years	48	9 (18.8%)	1.00 (0.45–2.22)	
Stoma formed	No	181	28 (15.5%)	1	0.072
	Yes	113	27 (23.9%)	1.72 (0.95–3.11)	
ASA grade	1	43	9 (20.9%)	1	0.134
	2	182	26 (14.3%)	0.63 (0.27–1.47)	
	3	69	20 (29.0%)	1.54 (0.62–3.82)	
IDDM	No	290	54 (18.6%)	1	0.565
	Yes	4	1 (25.0%)	1.46 (0.15–14.3)	
Ischaemic heart disease	No	263	47 (17.9%)	1	0.284
	Yes	31	8 (25.8%)	1.60 (0.67–3.81)	
Stroke	No	273	49 (18.0%)	1	0.229
	Yes	21	6 (28.6%)	1.83 (0.67–4.97)	
Heart failure	No	292	55 (18.8%)	–	1.0
	Yes	2	0 (0%)	–	
COPD	No	279	52 (18.6%)	1.09 (0.24–4.37)	0.895
	Yes	15	3 (20.0%)		
Mean preoperative serum creatinine in µmol/l	No morbidity	81.8 (SE: 1.32)			0.058
	Morbidity	87.9 (SE: 3.50)			
Mean preoperative hae-moglobin in g/dl	No morbidity	13.6 (SE: 0.63)			0.501
	Morbidity	12.7 (SE: 0.28)			
Preoperative visit	No	2	0 (0%)	–	1.0
	Yes	292	55 (18.8%)	–	
Preoperative assessment	No	0	0 (0%)	–	–
	Yes	294	55 (18.7%)	–	
Preoperative explanation	No	28	8 (28.6%)	1	0.159
	Yes	266	47 (17.7%)	0.54 (0.22–1.30)	

Characteristic	Category	Total	Morbidity	OR (95% CI)	p-value
Preoperative stoma education	No	34	10 (29.4%)	1	0.022
	Yes	117	15 (12.8%)	0.35 (0.14–0.90)	
Avoidance of bowel preparation	No	138	30 (21.7%)	1	0.220
	Yes	155	25 (16.1%)	0.69 (0.38–1.25)	
Regional anaesthesia	No	93	17 (18.3%)	1	0.898
	Yes	201	38 (18.9%)	1.04 (0.55–1.97)	
Admission on the day of surgery	No	8	3 (37.5%)	1	0.167
	Yes	286	52 (18.2%)	0.37 (0.09–1.61)	
Preoperative carbohydrate loading	No	35	8 (22.9%)	1	0.451
	Yes	239	42 (17.6%)	0.72 (0.30–1.70)	
Goal directed fluid therapy	No	204	42 (20.6%)	1	0.213
	Yes	90	13 (14.4%)	0.65 (0.33–1.29)	
Intraoperative warming	No	1	0 (0%)	–	1.0
	Yes	293	55 (18.8%)	–	
Avoidance of abdominal drains	No	27	5 (18.5%)	1	0.845
	Yes	74	15 (20.3%)	1.12 (0.36–3.46)	
Intraoperative nasogastric tube removal	No	2	0 (0%)	–	1.0
	Yes	27	5 (18.5%)	–	
Postoperative avoidance of IV fluid overload	No	3	0 (0%)	–	1.0
	Yes	291	55 (18.9%)	–	
Postoperative avoidance of opiates	No	262	47 (17.9%)	1	0.334
	Yes	32	8 (25.0%)	1.52 (0.52–2.25)	
Postoperative resumption of solid diet	No	34	9 (26.5%)	1	0.192
	Yes	260	46 (17.7%)	0.60 (0.26–1.37)	
Prophylactic antiemetic therapy	No	31	7 (22.6%)	1	0.559
	Yes	263	48 (18.3%)	0.77 (0.31–1.88)	
Postoperative mobilisation	No	128	29 (22.7%)	1	0.127
	Yes	166	26 (15.7%)	0.63 (0.35–1.15)	
Protocol compliance	≤85%	259	50 (19.3%)	1	0.476
	>85% (too few outcomes for 90% cut-off)	35	5 (14.3%)	0.70 (0.26–1.89)	
ASA = American Society of Anesthesiologists; CI = confidence interval; COPD = chronic obstructive pulmonary disease; IDDM = insulin dependent diabetes mellitus; IV = intravenous; LOS = length of stay; OR = odds ratio; SE = standard error					

Table 6 Factors associated with morbidity on multivariate analysis

Characteristic	Category	OR (95% CI)	p-value
Sex	Male	1	0.784
	Female	0.84 (0.25–2.88)	
Operation	Right colonic resection	1	0.683
	Left colonic resection	1.34 (0.33–5.35)	
	Rectal resection	1.05 (0.24–4.60)	
	Subtotal/proctocolectomy	0.83 (0.07–10.2)	
Approach	Laparoscopic	1	0.004
	Converted to open	7.72 (1.89–31.5)	
	Open	1.15 (0.38–3.47)	
Stoma formed	No	1	0.537
	Yes	1.46 (0.44–4.82)	
Preoperative serum creatinine in $\mu\text{mol/l}$		1.03 (1.01–1.06) per unit increase in creatinine	0.008
Preoperative stoma education	No	1	0.030
	Yes	0.31 (0.11–0.90)	

CI = confidence interval; OR = odds ratio

surgery (OR: 7.72, 95% CI: 1.89–31.5, $p=0.004$), preoperative creatinine (OR: 1.03 per unit increase in creatinine, 95% CI: 1.01–1.06, $p=0.008$) and preoperative stoma education (OR: 0.31, 95% CI: 0.11–0.90, $p=0.030$). Details of the multivariate analysis for morbidity are given in Table 6.

Two patients died within 30 days of their admission. One was an 80-year-old patient (ASA grade 3) with a background of ischaemic heart disease, stroke and COPD. He developed an anastomotic leak following anterior resection, and required relaparotomy with washout and a defunctioning colostomy. The second patient (also ASA grade 3) was 78 years old with a background of heart failure. He died following abdominoperineal excision of the rectum complicated by postoperative collection, which required relaparotomy and washout.

Discussion

Elderly patients undergoing major gastrointestinal tract resection have increased LOS, perioperative morbidity, mortality and readmission, even after adjustment for co-morbidities.¹⁶ Evidence suggests that ERAS implementation reduces LOS and morbidity but there is no evidence to support its use in elderly patients.^{5–7,9}

The impact of ERAS compliance on patient outcomes has been reported widely but there is very little information on compliance and its effects in elderly patients.^{5–11} Our study found no significant variation in compliance with ERAS according to age. Overall, poor compliance was noted for avoidance of bowel preparation, use of epidural or regional anaesthesia, use of goal directed fluid therapy, avoidance of drains, avoidance of postoperative systematic opiates and

mobilisation within 24 hours. Compliance with ERAS elements is not commonly reported in the literature but where it is reported, categories with poor compliance (<75%) are similar to those in our study (goal directed fluid therapy,^{14,17,18} avoidance of drains,^{14,17,18} use of preoperative carbohydrate drinks,^{14,17,18} medication regimes to avoid PONV,^{14,17} avoidance of preoperative bowel preparation,¹⁷ use of regional anaesthesia¹⁴ and early mobilisation).¹⁸

Hesitance regarding implementation of ERAS elements clearly still exists but these elements have a strong evidence base. Systematic review and meta-analysis show routine drains placement does not reduce anastomotic leak or mortality.^{19,20} Regional anaesthesia extends the duration of post-operative analgesia and decreases stress induced organ dysfunction.²¹ The omission of bowel preparation is not associated with increased risk of anastomotic dehiscence; indeed, the administration of bowel preparation increases dehydration as well as cardiac and renal complications.²² Gianotti *et al* found that following an ERAS programme resulted in a 23% risk reduction in morbidity and an average reduction in LOS of 2.48 days.¹⁷ This was achieved regardless of the number and type of elements in the protocol, suggesting it may be possible to simplify the ERAS programme to increase overall compliance. Likewise, Ahmed *et al* also noted similar outcomes despite variation in the elements of ERAS protocols.²³

Our median LOS of 6 days is equivalent to reports in the literature.^{18,24} Meta-analysis by Zhuang *et al* showed a significant reduction in LOS with ERAS implementation.⁷ In our study, LOS was equivalent across the age groups and age was not predictive of delayed discharge (defined as LOS above the median of 6 days). On the other hand, open

surgery and conversion from laparoscopic to open surgery were both strongly associated with delayed discharge. Conversion to open surgery was also strongly associated with morbidity, and this may be reflective of the increased operative duration and technical challenges that are often encountered in these cases.

Stoma formation is typically undertaken following low anterior resection, in cases where intraoperative difficulties have been encountered or where patient frailty precludes the risks associated with performing a primary anastomosis. Furthermore, patients require ward-based stoma education in the postoperative period and cannot be discharged until they are competent to manage their stoma independently. All of these factors (either individually or in combination) are likely to contribute to the delay in discharge associated with stoma formation. Patient education and expectation setting is an important foundation for the success of ERAS,²⁵ with evidence suggesting that improvements in preoperative stoma education can lead to reductions in LOS.²⁶

COPD is a significant co-morbidity that limits a patient's physical functioning; it is therefore unsurprising that COPD was associated with delayed discharge in our study. While not shown to increase morbidity in our cohort, COPD is a well characterised risk factor for postoperative respiratory complications. The concept of pulmonary prehabilitation as an adjunct to existing ERAS pathways with targeted postoperative physiotherapy in high risk COPD patients should be the focus of future studies in this area as well as determining the optimum anaesthetic regimen and mode of regional anaesthesia. This is of particular relevance to patients with COPD in whom a minimally invasive approach may not be feasible.

Readmission occurred in 8% of our cohort, which lies well within the range of 2.7–22% that is quoted in the literature.^{18,25,27} Ahmed *et al* reported that decreased LOS was predictive of increased readmission although their systematic review incorporated studies where LOS as low as 2 days was reported²⁵ so it may not be representative of our own cohort. The low number of readmissions in our patients precluded any meaningful analysis of impact of LOS or age but no readmissions were noted in patients aged >80 years.

The 30-day mortality rate of <1% in our cohort compares favourably with what has been reported previously in the literature.¹⁸ There were two deaths. These occurred in an 80-year-old man with COPD, ischaemic heart disease and a previous history of a cerebrovascular event who experienced an anastomotic leak and in a 78-year-old man who required reoperation for a pelvic collection.

Morbidity was experienced by 14% of our patients. Complications of Clavien–Dindo grade IIIb or above developed in 6%. Age was not predictive of morbidity. In addition to conversion to open surgery, worsening renal function (as demonstrated by an increase in serum creatinine) and a lack of preoperative stoma education were the only other factors that were predictors of morbidity on multivariate analysis. While the decision to convert to open surgery may not be modifiable, optimising renal function through preoperative hydration, avoiding nephrotoxic medications and minimising prolonged duration of nil by mouth due to institutional

constraints are all factors that can be addressed at the preoperative assessment. The protective effect of preoperative stoma education on morbidity is not readily explainable but may be related to knowledge of dietary modifications preventing high stoma output or being better able to manage/avoid stoma bag leakage, which could lead to wound contamination.

Conclusions

This study shows that compliance with ERAS elements and LOS are unaffected by age. Nevertheless, reluctance still exists in terms of fully implementing the ERAS protocol in elderly patients. Delayed discharge and morbidity were more likely with planned open surgery, conversion to open surgery, stoma formation and the presence of respiratory or renal disease but they were not predicted by age.

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