Limited preoperative physical capacity continues to be associated with poor postoperative outcomes within a colorectal ERAS programme

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ABSTRACT

AIM Enhanced recovery after surgery (ERAS) programmes aim to standardise perioperative care leading to optimal patient outcomes. Despite these programmes, variation in outcomes still persists. This study aimed to assess the influence of lifestyle factors on short-term outcomes after colorectal surgery within this optimal recovery programme.

METHODS Consecutive patients enrolled on an ERAS pathway who underwent elective colorectal surgery (June 2013 to July 2014) at one site were included. We used data routinely collected by ERAS nurse specialists and during preassessment to analyse association between patient and lifestyle factors and likelihood of developing postoperative complications or having an increased length of stay.

RESULTS A total of 199 patients were included: mean age 61.8 years (range 17–90 years) and 53.8% male. Age, sex, deprivation, smoking status, alcohol intake, body mass index or level of comorbidity were not associated with postoperative complications. Patients reporting limited preoperative physical capacity (unable to climb two flights of stairs) were more than four times as likely to have a postoperative complication on univariate analysis and were found to still have increased risk of postoperative complications on multivariate analysis. Patients reporting limited preoperative physical capacity were shown to have significantly longer hospital stay on univariate analysis. In the multivariate analysis, limited physical capacity was not associated with prolonged length of stay due to confounding factors of age and deprivation.

CONCLUSIONS Limited physical capacity was the only patient and lifestyle factor associated with poorer postoperative complications and prolonged hospital stay after elective colorectal surgery within an ERAS programme. Consideration should be given to individualised prehabilitation that aims to increase physical capacity pre-operatively to improve patient outcomes.

KEYWORDS

General surgery – Outcomes – Colorectal surgery – Lifestyle

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Introduction

Since being first described by Kehlet and Mogensen,¹ there has been widespread adoption by colorectal surgeons of enhanced recovery after surgery (ERAS) programmes.^{1–4} ERAS consists of multimodal components including shorter fasting times, carbohydrate preloading, preoperative counselling, appropriate fluid therapy, early initiation of oral diet and early mobilisation, which aimed to standardise and subsequently optimise postoperative care.^{5,6} The latter has been achieved with several meta-analyses confirming that ERAS programmes result in reduced length of hospital stay, without accompanying increases in readmissions, and significant reductions in postoperative complication rates.^{7,8} However, despite this standardisation of perioperative care, there remains

significant published variation in outcomes in patients undergoing elective colorectal surgery, suggesting other influencing factors that need to be identified for further improved surgical outcomes.⁹

Before widespread integration of ERAS programmes, patient-related factors and lifestyle factors were proven to strongly influence perioperative outcomes. Patient-related factors included increasing age, presence of increasing number of comorbidities and socioeconomic deprivation.^{10–15} It can be seen that most of these are non-modifiable except for the presence of comorbidities, which is assessed preoperatively with onward referrals and investigations made to ensure optimisation prior to surgery. In contrast, lifestyle factors are modifiable and include smoking, excess alcohol, excess weight/obesity and physical inactivity. Prior to the integration of ERAS programmes, all these lifestyle

factors had individually or collectively been shown to increase the risk of postoperative complications, including wound infection/dehiscence; cardiorespiratory deterioration/critical care admission; conversion from laparoscopic to open surgery, delirium and, in some circumstances, postoperative death.^{16–18}

In the era of ERAS being considered the optimal perioperative care pathway, not only do these modifiable lifestyle factors still persist, but several have now become major public health issues.^{19–22} In relation to diet and obesity, the Health Survey for England reported in 2016 that 58% of women and 68% of men in England were at least overweight, with 26% obese.²³ The next generation are following, with National Child Measurement Programme England reporting over one-third of children are overweight or obese by the time they leave primary school.²⁴ After smoking, which is reducing in incidence with the smoking ban and e-cigarettes,²⁵ excess weight and obesity are the most important known avoidable causes of several cancers, including colorectal cancer.²⁶ Alcohol has also been found to cause 3% of cancer cases in the UK.²⁷ In 2017, the Office for National Statistics found that 27% of people in the UK who had drunk alcohol the week before interview were classed as binge drinkers (men drinking more than 8 units of alcohol in one sitting and women drinking over 6 units).²⁸ The recommended physical activity is only 150 minutes of moderate level of activity over one week but only 61% of UK adults were achieving this in 2017.^{29,30}

The continuing presence of these modifiable lifestyle factors could potentially explain the variation in documented perioperative outcomes despite patients undergoing optimal perioperative care in the form of an ERAS programme. This study therefore had two aims: first, to document the prevalence of lifestyle factors in a colorectal patient population undergoing elective surgery, and second to analyse any influence that lifestyle factors might have on perioperative outcomes within an established ERAS programme.

Methods

A dedicated ERAS nurse in a single-centre colorectal department prospectively collected details of consecutive patients undergoing elective colorectal surgery within an established ERAS programme over a 12-month period (June 2013 to July 2014). All patients admitted for elective colorectal surgery (benign or malignant pathology; resectional or non-resectional) were included in the ERAS programme. Any patient undergoing emergency or expedited colorectal surgery was excluded.

All data were entered into a clinical database that was established early 2013 and is part of the Whole System Patient Flow Improvement Programme initiated and led by the Scottish Government.³¹ Briefly, this programme has Caldicott approval and requires monthly data

submission from all elective colorectal surgery departments across Scotland with central and individual interpretation of key ERAS performance indicators, allowing departmental feedback and maintenance of standards. Details of the multimodal ERAS programme are detailed in Appendix 1.

From this database, age, gender, laparoscopic versus open procedure and comorbidity were analysed using the Charlson comorbidity score.³² Additional data regarding socioeconomic circumstances were calculated using patients' postcode of residence linked to the Scottish Index of Multiple Deprivation (SIMD): an area-based measure of deprivation.³³ Lifestyle factors were routinely recorded at each patient's surgical preassessment visit as part of hospital standard care. These were smoking status (defined as current, ex-smoker, non-smoker), alcohol intake (excess: over 14 units/week; within guidelines: equal to or less than 14 units/week or none);³⁴ body mass index (BMI: underweight < 20: healthy 20–24.9; overweight 25–29.9; obese 30 and above) and physical capacity. Physical capacity was divided into two groups: moderate and limited, according to whether the patient self-reported that they could (moderate) or could not complete (limited) two flights of stairs without stopping.

Postoperative complications, including mortality, were defined as any complication or death occurring within 30 days of surgery. For the purposes of binary analysis, all grades of complications were included and compared with patients without complications.³⁵

Statistical analysis

To determine the influence of modifiable lifestyle factors on postoperative complications (any Clavien–Dindo grading) and increased length of stay (greater than median cohort length of stay), univariate and multivariate logistic regression models were developed. Odds ratios (OR) are presented with 95% confidence intervals (CI); *P*-value less than 0.05 was considered statistically significant. Analysis was performed using STATA software package version 11(IC).

Results

A total of 199 consecutive patients were included: 46% female (*n* = 92); mean age 61.8 years (range, 17–90 years) and 63.8% (*n* = 127) scoring at least 3 on the Charlson Index. Of these patients, 43% (*n* = 85) were classified as deprived (SIMD 1 and 2; Table 1).

In relation to modifiable lifestyle factors, 44.7% (*n* = 89) of patients were current or former smokers, 10.6% (*n* = 21) reported excess alcohol consumption, 55.8% (*n* = 111) were overweight or obese and 6% (*n* = 12) reported limited physical capacity.

There were 112 open procedures cases (56.3%) with the rest recorded as laparoscopic. Overall, 65 patients (32.7%)

Table 1 Demographics and characteristics of patients undergoing elective colorectal surgery.

Demographic	Patients (N =)199
Sex:	
Male	107 (53.8)
Female	92 (46.2)
Age, mean years (SD)	61.8 (14.4)
Deprivation (SIMD 2012):	
1 (most deprived)	50 (25.1)
2	35 (17.6)
3	47 (23.6)
4	31 (15.6)
5 (least deprived)	36 (18.1)
Smoking status:	
Current	33 (16.6)
Ex-smoker	56 (28.1)
Non-smoker	74 (37.2)
Unknown	36 (18.1)
Alcohol intake:	
< Recommended limit	140 (70.4)
> Recommended limit	21 (10.6)
Unknown	38 (19.1)
Body mass index:	
Normal (18–25)	50 (25.1)
Overweight (25–30)	60 (30.2)
Obese (30–40)	51 (25.6)
Unknown (> 40)	38 (19.1)
Physical capacity:	
< 2 flights of stairs	12 (6.0)
≥ 2 flights of stairs	152 (76.4)
Unknown	35 (17.6)
Charlson comorbidity score:	
0	30 (15.1)
1	17 (8.5)
2	25 (12.6)
≥ 3	127 (63.8)
Length of stay, mean days (SD)	8.4 (4.5)
Postoperative complications (Clavien–Dindo):	
0	134 (67.3)
1	31 (15.6)
2	21 (10.6)
3	11 (5.5)
4	2 (1.0)

Table 1 (Continued)

Surgery:	
Open	112 (56.3)
Laparoscopic	87 (43.7)

SD, standard deviation from the mean; SIMD, Scottish Index of Multiple Deprivation.

developed any grade of postoperative complication and the mean length of postoperative hospital stay was 8.4 days (range, 3–32 days). There was no recorded 30-day mortality.

Lifestyle factors associated with postoperative complications (any Clavien–Dindo score) are shown in Table 2. On univariate analysis, the only patient or modifiable lifestyle factor associated with the development of a postoperative complication was limited physical capacity. Patients who were unable to climb two flights of stairs were more than four times more likely to develop a postoperative complication than patients who could climb two flights of stairs (OR 4.2; 95% CI 1.21, 14.6; $P = 0.024$). Limited physical capacity remained independently associated with postoperative complication on multivariable analysis (OR 6.64; 95% CI 1.51, 29.13; $P = 0.012$).

Lifestyle factors associated with prolonged postoperative length of stay (length of stay more than the cohort mean) are shown in Table 3. Both limited physical capacity and the development of a postoperative complication were associated with a prolonged inpatient stay on univariate analysis. Patients who were unable to climb two flights of stairs were more than four times more likely to have a prolonged postoperative inpatient stay than patients who could climb two flights of stairs (OR 4.47; 95% CI 1.28, 15.57; $P = 0.019$). In the multivariate analysis, limited physical capacity was no longer associated with prolonged length of stay due to an interaction between age (patients over 75 years more likely to stay in hospital longer (OR 5.69; 95% CI 1.04, 31.18; $P = 0.045$) and deprivation (least deprived patients less likely to stay in hospital longer (OR 0.24; 95% CI 0.06, 0.92; $P = 0.038$)). Postoperative complications remained associated with increased length of stay (OR 20.95; 95% CI 7.99, 54.95; $P < 0.001$).

Patients who underwent open surgery were more than twice as likely to develop a postoperative complication than those who underwent laparoscopic surgery (OR 2.03; 95% CI 1.09, 3.78; $P = 0.025$). In the multivariate analysis, open surgery remained associated with an increased risk of postoperative complications compared with laparoscopic surgery (OR 2.21; 95% CI 1.09, 4.48; $P = 0.028$). Likewise, patients undergoing open procedures were three times as likely to have prolonged hospital stay when compared with those who underwent laparoscopic surgery (OR 3.21; 95% CI 1.66, 6.21; $P = 0.001$). In the multivariate analysis this also remained significant (OR 4.05; 95% CI 1.60, 10.25; $P = 0.003$).

Table 2 Univariate and multivariate logistic regression model examining patient and modifiable lifestyle factors associated with postoperative complications.

Patient/lifestyle factor	Univariate		Multivariate	
	OR (95% CI)	P-value	OR (95% CI)	P-value
Sex:				
Male	1.00		1.00	
Female	0.99 (0.55, 1.80)	0.988	1.10 (0.55, 2.23)	0.784
Age (years):				
< 60	1.00		1.00	
60–74	0.91 (0.47, 1.76)	0.781	0.92 (0.34, 2.45)	0.861
≥ 75	0.85 (0.37, 1.96)	0.710	0.48 (0.14, 1.68)	0.249
Deprivation (SIMD 2012):				
1 (most deprived)	1.00		1.00	
2	0.85 (0.35, 2.10)	0.726	0.81 (0.29, 2.24)	0.681
3	0.50 (0.21, 1.21)	0.123	0.40 (0.15, 1.07)	0.068
4	0.57 (0.21, 1.52)	0.260	0.69 (0.23, 2.02)	0.498
5 (least deprived)	1.17 (0.49, 2.79)	0.732	1.34 (0.51, 3.55)	0.558
Smoking status:				
Non-smoker	1.00		1.00	
Ex-smoker	1.45 (0.71, 2.99)	0.311	1.50 (0.65, 3.46)	0.348
Smoker	0.91 (0.37, 2.20)	0.827	0.83 (0.29, 2.34)	0.722
Unknown	0.60 (0.24, 1.50)	0.271	1.51 (0.11, 20.50)	0.756
Alcohol intake:				
< Recommended limit	1.00		1.00	
> Recommended limit	1.44 (0.57, 3.65)	0.445	1.65 (0.55, 5.00)	0.373
Unknown	0.51 (0.22, 1.20)	0.124	0.62 (0.04, 8.70)	0.721
Body mass index:				
Normal	1.00		1.00	
Overweight	0.96 (0.44, 2.10)	0.913	0.88 (0.37, 2.11)	0.772
Obese	0.97 (0.43, 2.19)	0.941	0.63 (0.24, 1.68)	0.356
Unknown	0.47 (0.18, 1.25)	0.132	0.56 (0.11, 2.75)	0.475
Physical capacity:				
2 flights stairs	1.00		1.00	
< 2 flights stairs	4.20 (1.21, 14.64)	0.024	6.64 (1.51, 29.13)	0.012
Unknown	0.62 (0.26, 1.47)	0.280	1.37 (0.30, 6.20)	0.686
Charlson comorbidity score:				
0	1.00		1.00	
1	2.07 (0.61, 7.11)	0.246	2.36 (0.60, 9.21)	0.217
2	0.58 (0.17, 2.04)	0.399	0.47 (0.09, 2.31)	0.350
≥ 3	1.19 (0.50, 2.83)	0.687	1.41 (0.40, 4.93)	0.590
Surgery:				
Laparoscopic	1.00		1.00	
Open	2.03 (1.09, 3.78)	0.025	2.21 (1.09, 4.48)	0.028

CI, confidence interval; OR, odds ratio; SIMD, Scottish Index of Multiple Deprivation.

Table 3 Univariate and multivariate logistic regression model examining patient and modifiable lifestyle factors associated with prolonged postoperative length of stay^a

Patient/lifestyle factor	OR (95% CI)	P-value	OR (95% CI)	P-value
Sex:				
Male	1.00		1.00	
Female	0.62 (0.33, 1.13)	0.118	0.61 (0.25, 1.53)	0.296
Age (years):				
< 60	1.00			
60–74	0.77 (0.39, 1.53)	0.453	1.00	
≥ 75	1.67 (0.75, 3.71)	0.205	1.63 (0.40, 6.60)	0.495
Deprivation (SIMD 2012):				
1 (most deprived)	1.00		5.69 (1.04, 31.18)	0.045
2	0.32 (0.12, 0.86)	0.025	0.25 (0.06, 1.08)	0.062
3	0.44 (0.18, 1.03)	0.059	0.67 (0.20, 2.23)	0.510
4	0.83 (0.32, 2.00)	0.639	1.74 (0.44, 6.77)	0.428
5 (least deprived)	0.49 (0.20, 1.23)	0.127	0.24 (0.06, 0.92)	0.038
Smoking status:				
Non-smoker	1.00		1.00	
Ex-smoker	1.09 (0.53, 2.26)	0.819	0.96 (0.34, 2.73)	0.936
Smoker	0.85 (0.35, 2.06)	0.723	1.40 (0.36, 5.40)	0.624
Unknown	0.56 (0.22, 1.41)	0.218	3.08 (0.17, 57.46)	0.451
Alcohol intake:				
< Recommended limit	1.00		1.00	
> Recommended limit	0.74 (0.27, 2.04)	0.563	0.25 (0.06, 1.09)	0.064
Unknown	0.50 (0.21, 1.16)	0.107	0.20 (0.01, 4.09)	0.293
Body mass index:				
Normal	1.00		1.00	
Overweight	0.83 (0.37, 1.86)	0.654	0.36 (0.11, 1.19)	0.094
Obese	1.25 (0.56, 2.82)	0.587	1.17 (0.33, 4.13)	0.810
Unknown	0.52 (0.20, 1.37)	0.186	0.41 (0.06, 3.01)	0.383
Physical capacity:				
2 flights stairs	1.00		1.00	
< 2 flights stairs	4.47 (1.28, 15.57)	0.019	1.65 (0.27, 10.08)	0.586
Unknown	0.66 (0.28, 1.57)	0.347	1.23 (0.21, 7.24)	0.818
Charlson comorbidity score:				
0	1.00		1.00	
1	2.07 (0.61, 7.11)	0.246	2.46 (0.46, 13.25)	0.296
2	0.44 (0.12, 1.67)	0.230	0.41 (0.05, 3.34)	0.408
≥ 3	1.15 (0.49, 2.74)	0.747	0.58 (0.12, 2.91)	0.508
Surgery:				
Laparoscopic	1.00		1.00	
Open	3.21 (1.66, 6.21)	0.001	4.05 (1.60, 10.25)	0.003

Table 3 (Continued)				
Post-operative complication:				
No	1.00		1.00	
Yes	12.68 (6.23, 25.83)	<0.001	20.95 (7.99, 54.95)	<0.001

^a Prolonged = length of stay more than the cohort mean.
CI, confidence interval; OR, odds ratio; SIMD, Scottish Index of Multiple Deprivation.

Discussion

This study has shown that lifestyle factors are prevalent in elective colorectal surgical patients. In addition, limited physical capacity resulted in poorer perioperative outcomes despite patients undergoing optimal perioperative care within an ERAS programme. The inability of a patient to climb two flights of stairs was associated with an increase in postoperative complications that resulted in a longer length of hospital stay. These results support a potential role for physical capacity prehabilitation in surgical patients prior to undergoing elective surgery within an ERAS programme, especially in those undergoing an open approach, which carry a higher risk of poorer postoperative complications.^{36–39}

Prehabilitation, or pretreatment intervention, is currently an area of research interest which, like ERAS programmes, can be multimodal, including physical activity/exercise, lifestyle reduction advice including diet and weight, pharmacy rationalising or optimising and patient counselling, both about pathology and perioperative pathways. With many components to choose from, published prehabilitation programmes vary, making comparisons between the small number of studies difficult. However, a 2016 systematic review found that prehabilitation decreased the incidence of postoperative complications, especially pulmonary, after major abdominal surgery (OR 0.59; 95% CI 0.38–0.91).⁴⁰

In addition, in one of the first randomised controlled studies including only high-risk patients (age over 70 years and/or American Society of Anesthesiologists score III or IV) undergoing major abdominal surgery, a significant reduction in postoperative complications was recorded: 31% in prehabilitation group compared with 62% in standard care group ($P = 0.001$).⁴¹ With these potential improvements in perioperative outcomes reported after a mean intervention time of only six weeks, it can be seen that treatment targets would not need to be significantly altered to potentially reduce complications in this vulnerable patient group.

Although the evidence for prehabilitation is in evolution and has focused, like this study, on short-term outcomes, all members of the perioperative care team should be aware of the growing evidence that preoperative limited physical capacity influences long-term survival outcome in a range of different cancers, including colorectal cancers.^{42–46} The CHALLENGE study from Canada is currently underway both in Northern America and Europe and is the first trial to try to provide level one evidence in this area.⁴⁹

Strengths

One of the strengths of this work is the use of a prospective cohort that allowed us to measure multiple patient-related variables and outcomes contemporaneously. Analysing this prospectively collected dataset retrospectively also reduced the potential for collection bias during data collection. The cohort nature of this study also led to all patients being included for analysis leading to a representative dataset of typical colorectal patients within our ERAS programme. This is evident from the wide range of patient factors and lifestyle factors documented.

Limitations

The main limitation of the study design was that it relied on patient self-reporting of lifestyle factors. Although this is easy to apply and a non-invasive approach, unlike cardiopulmonary exercise testing for exercise capacity or serum cotinine to establish smoking status, patients may under- or overestimate their consumption and physical capacity.^{48,49} Further work is needed to focus on a direct comparison between self-reported physical capacity and an objective measurement of such. A further limitation is that, although all data were collected prospectively, the authors acknowledge that some are missing, reflecting the pragmatic nature of this study.

Conclusion

In conclusion, the present study has shown that despite undergoing an elective colorectal ERAS programme, a patient with limited preoperative physical capacity remains at higher risk of poorer short-term outcomes. Identifying this high-risk patient group preoperatively could lead to targeted prehabilitation strategies aimed at optimising patient outcomes within an ERAS programme.

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