Cohort Study

ANNALS OF MEDICINE & SURGERY

OPEN

Relationship between the m-FI 11 score and 2-year survival in octogenarians undergoing colorectal cancer resection

Kaso Ari, MBBS, MRCS[a,*], Muhammad Rafaih Iqbal, BSc, MBBS, MRCS, MFSTEd[b], Jasmine Crane, MBBS, MRCS[d], Joseph Borucki, MBBS, MRCS[e], Ian Nunney, MD[c], James Hernon, MD[b], Adam Stearns, MA, DPhil[b]

Introduction: The modified Frailty Index (m-FI) offers a simple scoring tool, predicting short-term outcomes in elderly colorectal cancer (CRC) patients. However, links between m-FI scores and 2-year postoperative mortality in octogenarian CRC resection patients remain underexplored. A streamlined frailty index can aid in preoperative assessments to identify elderly patients who are likely to live longer after curative resection surgery to then tailor postoperative care. Our study aims to assess the association between m-FI scores and 2-year postoperative mortality in elderly CRC surgery patients.

Methods: A retrospective analysis was conducted on a cohort of consecutive patients aged older than or equal to 80 years who underwent colorectal cancer resection at a tertiary referral centre between 2010 and 2017. The m-FI-11 scores less than or equal to two denoted the non-frail category, whereas m-FI scores equal to or exceeding 3 were categorised as frail. The primary outcome measure was defined as 2-year all-cause mortality.

Results: A total of 337 patients were studied. The 2-year overall survival rate was 83% with an overall median survival time of 84 months (95% CI: 74–94 months). Patients with m-FI scores less than or equal to 2 had a 2-year survival rate of 85% and a median survival time of 94 months (95% CI: 84–104 months). Conversely, patients with m-FI scores greater than or equal to 3 had a 2-year survival rate of 72% and a median survival time of 69 months (95% CI: 59–79 months). An m-FI score greater than or equal to 3 showed a hazard ratio of 1.73 (95% CI: 0.92–3.26, $P = 0.092$) for 2-year mortality compared to an m-FI score less than or equal to 2.

Conclusion: Higher m-FI scores significantly correlate with an increased 2-year mortality risk among octogenarian CRC resection patients. This highlights the potential of the m-FI as a preoperative tool for identifying patients likely to survive longer post-surgery. Its integration aids in tailored postoperative care strategies, ensuring efficient recovery to functional baselines in this cohort.

Keywords: colorectal, frailty, m-FI, outcomes

Introduction

Frailty is defined as a decrease in physiological reserve and multisystem impairments separate from the normal aging process, whereby increasing frailty is associated with a high risk of postoperative morbidity and mortality[1]. This is demonstrated in elective and emergency colorectal cancer operations with readmission rates, postoperative complications, and 30-day and 90-day mortality[2–4]. Furthermore, an association has been demonstrated in elderly colorectal cancer patients with postoperative complications and reduced long-term survival[5]. Approximately 60% of CRC patients are greater than 70 years old at the time of diagnosis, and 43% are greater than 75 years of age[6].

Frailty evaluation in elderly CRC patients is an important part of the preoperative assessment workup required to identify high-risk patients to predict the rate of postoperative complications and mortality. Mounting evidence highlights the harmful impact of frailty-related factors on immediate results, but with the emergence of minimally invasive procedures and better management of associated chronic conditions, elderly patients

HIGHLIGHTS

- A high modified Frailty Index 11 score is associated with increased risk of 2-year postoperative mortality in octogenarians undergoing colorectal cancer resection surgery.
- The modified Frailty Index 11 score can help to identify elderly patients who are likely to live longer postoperatively.
- Therefore, this allows for improved preparation preoperatively to provide more social and functional care allocation to these patients to ensure they return to their normal activities of daily living.

[a]Core Surgical Trainee, Norfolk and Norwich University Hospital, [b]General Surgery, Norfolk and Norwich University Hospital, [c]Norwich Medical School, University of East Anglia, Norwich, [d]Core Surgical Trainee, Basildon Hospital, Basildon and [e]General Surgery, James Paget University Hospital, Yarmouth, UK

Sponsorships or competing interests that may be relevant to content are disclosed at the end of this article.

*Corresponding author. Address: Norfolk and Norwich University Hospital NHS Trust: Norfolk and Norwich University, Hospitals NHS Foundation Trust, Norwich, Norfolk, UK. Tel.: +016 032 862 86 E-mail: kasoari@doctors.org.uk (K. Ari).

Annals of Medicine & Surgery (2024) 86:62–68

Received 16 September 2023; Accepted 22 October 2023

Published online 16 November 2023

http://dx.doi.org/10.1097/MS9.0000000000001453

undergoing colorectal surgery now tend to experience extended lifespans[7]. Therefore, it is important to now look at the lasting consequences of frailty and to identify particular patient groups enduring prolonged unfavourable health effects. As the concept of frailty and its impact on surgical outcomes is relatively new, there is a notable absence of comprehensive data concerning the long-term consequences of frailty characteristics across diverse surgical fields, specifically colorectal cancer surgery[8]. The presence of such data would aid in the more effective allocation of resources to support those individuals facing heightened vulnerability.

Evaluation with a simple frailty index scoring tool could help us identify patients who may be likely to live long after their operations and, therefore, plan our postoperative care[9]. However, using a single tool to assess frailty in an objective and accurate manner to predict long-term postoperative mortality and morbidity has proven difficult[10]. The modified Frailty Index (m-FI) is a simple, objective 11-point scoring tool based on the 70-item Canadian Study of Health and Aging frailty index derived from the existing National Surgical Quality Improvement Program (NSQIP) preoperative variables[9]. Patients are allocated a score for each of the items listed in Table 1, with a cumulative score of 0 representing the absence of frailty, while a score of 11 represents the highest degree of frailty[11].

The m-FI has demonstrated its utility across various surgical specialties, encompassing vascular, gynaecology, head and neck, spine, and colorectal surgery. Consistently, high m-FI scores have been correlated with an elevated likelihood of postoperative complications, prolonged hospital stays, readmissions, as well as augmented risks of 30-day and 90-day postoperative mortality[12–14]. In aggregate, the m-FI tool emerges as a reliable predictor for short-term postoperative complications. Nevertheless, the literature reflects a scarcity of prior investigations focusing on the connection between m-FI scores and 2-year postoperative mortality in octogenarians undergoing colorectal cancer resection surgery[8]. As the elderly population burgeons, the necessity for colorectal cancer (CRC) surgery among this cohort becomes pronounced. Each patient in this context confronts intricate functional challenges compounded by an array of complex co-morbidities[15,16], thereby necessitating resource-intensive preoperative assessment clinics and reviews to facilitate the final decision to operate. With these considerations in mind, we posit that a streamlined frailty index tool could potentially serve as a valuable aid within the preliminary assessment stage, thereby contributing to the arrangement of postoperative care strategies tailored to propel octogenarians toward the restoration of functional baselines, particularly for those expected to experience sustained survival following CRC resection surgery.

We aim to evaluate the association between the m-FI score and 2-year mortality in elderly postoperative colorectal cancer patients. We hypothesise that high m-FI scores are linked to an increased risk of 2-year mortality in octogenarians undergoing colorectal cancer resection.

Table 1

Eleven items of the modified frailty index score.

1) History of diabetes mellitus
2) History of congestive cardiac failure
3) History of hypertension requiring medication
4) History of either transient ischaemic attack of cerebrovascular accident
5) Functional status 2 (not independent)
6) History of myocardial infarction
7) History of peripheral vascular disease or rest pain
8) History of cerebrovascular accident with neurological deficit
9) History of either chronic obstructive pulmonary disease or pneumonia
10) History of either prior percutaneous coronary intervention, prior cardiac surgery or angina
11) History of impaired sensorium

Methods

A retrospective review of prospectively maintained local colorectal cancer database was performed, consisting of consecutive patients diagnosed with primary colorectal cancer between January 2010 and December 2017 at a single high-volume tertiary referral centre. All patients aged 80 years and above, with histopathologically confirmed primary colorectal adenocarcinoma, who underwent elective colorectal cancer resection, were included. All patients included in the study had a total 2-year follow-up to review their survival status. Patients with histopathology other than adenocarcinoma, those undergoing multivisceral resection or exenteration, and emergency operations were excluded from the study.

After screening for inclusion and exclusion criteria, a list of hospital numbers was generated from the database. Each patient was assessed through the relevant electronic care record systems, including general practice and community records, hospital intranet medical records, cancer registry, and hospital surgical operational notes. The use of multiple electronic care records allowed the appropriate identification of each patient's co-morbidities and physical health to ensure the accurate allocation of each item of the m-FI score.

The study gathered demographic and pertinent data, encompassing tumour location, cancer staging, surgical approach, American Society of Anaesthesiologists (ASA) grade, and postoperative complications. The assessment of surgical complications was carried out using the Clavien–Dindo classification system[17]. The m-FI scores were categorised into two groups: m-FI-11 scores less than or equal to two denoted the non-frail category, whereas m-FI scores equal to or exceeding 3 were categorised as frail[18]. The primary focus of this study was to evaluate the 2-year all-cause mortality. Secondary endpoints comprised the length of hospital stay, occurrence of anastomotic leaks, and rate of unplanned admission to the high dependency unit (HDU).

Statistical analysis

A descriptive analysis was performed on the baseline clinical information against 2-year mortality, presenting percentages for the categorical variables and mean with standard deviations for the continuous variables. Two mortality outcomes were analysed: firstly, the binary outcome of death within 2 years, and secondly, time to death. Both outcomes were analysed to determine their association with the m-FI score. The t-test was used to investigate associations between continuous variables and the binary outcome of survival versus mortality, while the χ^2 test of association was used for categorical variables.

For the first outcome, death within 2 years, a logistic regression model was conducted, adjusting for sex, age, operation, cancer stage, tumour location, and length of hospital stay. These

variables were selected for adjustment based on their potential to be confounders in the study. For time to death, a Cox regression model was conducted, adjusting for the same factors used in the logistic regression. Unadjusted and adjusted hazards/odds ratios were used when examining the association between the m-FI score and 2-year mortality. The level of statistical significance was set at $P < 0.05$, and confidence intervals were reported at the 95% level. SPSS version 29 was used for the statistical analysis.

The primary database used to review and collect the data was held under ethical approval (IRAS number 241949). Ethical approval for this study was granted by the East of England—Cambridge East Research Ethics Committee (REC reference 22/EE/0217, IRAS ID 288448). This study was registered on the research registry website with ID number researchregistry9524. This study has been reported in line with the STROCSS criteria[19].

Results

A total of 3051 patients with colorectal cancer resections were reviewed and screened from the database. After application of the inclusion and exclusion criteria, 337 patients were included in the study. There was no difference between the distribution of age, sex, tumour location, operation type, HDU admissions and mean length of stay between the mortality and survival group (Table 2). However, the mortality group had a predominance of patients with Duke's C staging of cancer whilst the survival group consisted of those with Duke's B ($P > 0.05$). Most of the study population underwent colectomy which included hemicolectomy and total colectomy procedures. The maximum m-FI received was five, with most patients scoring a one in both groups. The mortality group had its ASA concentrated at a score of 3 (50%) whereas most of the survival group scored ASA 2 (58%). A significant difference was demonstrated in complication rates between the two groups.

There was no difference between the distribution of age, cancer staging, tumour location operation type postoperative HDU admission rates, leak rates and mean length of stay in the divided study cohorts (Table 3). A significantly high proportion of patients (71%) scored ASA 3 in the m-FI ≥ 3 score cohort. The survival rate of patients with an m-FI score ≥ 3 was at 72% compared to 85% in the those with m-FI of less than or equal to 2 ($P = 0.005$). No statistical difference was demonstrated in 30-day and 90-day mortality between the m-FI score groups.

The overall median survival time was at 84 months (95% CI: 74–94 months). Patients with a score of less than or equal to 2 had a median survival time of 94 months (95% CI: 84–104 months) The median survival time for patients with an m-FI score greater than or equal to 3 was at 69 months (95% CI: 59–79 months). A Pearson's correlation test demonstrated the correlation coefficient between ASA score and m-FI 11 score to be ~0.488, indicating a positive correlation. A log-rank test showed a statistically significant difference between the two survival curves, comparing a score of less than or equal to 2 versus greater than or equal to 3, with a $\chi^2 P$ value of 0.003 (Fig. 1).

Confounders adjusted for 2-year mortality included sex, age, tumour location, operation type, ASA, and tumour staging (Table 4). The odds of mortality between sex, age and tumour location did not change a great amount after adjusting for confounding. Changes in odds ratio were most significant in those with Duke's Stage C and an ASA score of 3 or more ($P < 0.05$).

The most notable and acceptable increase in odds ratio of 2-year mortality is noted at an m-FI score of 3 (Table 5). An m-FI score of 3 after adjusting for potential covariates had an odds ratio of 2.39 (95% CI 0.78–7.33, $P = 0.128$). Overall, a score of greater than or equal to 3 after adjusting gave patients an odds ratio of 1.85 (95% CI 0.87–3.94, $P = 0.108$) compared to a score of less than or equal to 2.

Table 2

Clinical demographics and 2-year survival/mortality rate.

	2-year mortality			
Clinical characteristic	**Survival**	**Mortality**	**Total**	***P***
Mean Age ± SD	83.12 ± 2.72	82.86 ± 2.88		0.458
(Range)	(80–93)	(80–93)		
Sex, *n* (%)				
Female	159 (57)	26 (44)	185 (55)	0.066
Male	119 (43)	33 (56)	152 (45)	
Duke's stage, *n* (%)				
A	50 (18)	6 (10)	56 (17)	0.009
B	148 (53)	23 (39)	171 (51)	
C	77 (28)	28 (48)	105 (31)	
D	3 (1)	2 (3)	5 (1)	
Tumour location, *n* (%)				
Rectum	67 (24)	19 (32)	86 (26)	0.195
Colon	211 (76)	40 (68)	251 (74)	
Operation, *n* (%)				
Hartmann's	23 (8)	9 (15)	32 (9)	0.284
Anterior Resection	78 (28)	13 (22)	91 (27)	
Colectomy	157 (56)	32 (54)	189 (56)	
APR	15 (5)	5 (8)	20 (6)	
Panproctocolectomy	5 (2)	0 (0)	5 (1)	
m-FI score, *n* (%)				
0	59 (21)	9 (15)	68 (20)	0.037
1	93 (33)	17 (29)	110 (33)	
2	79 (28)	15 (25)	94 (28)	
3	26 (9)	13 (22)	39 (12)	
4	17 (6)	2 (3)	19 (6)	
5	4 (1)	3 (5)	7 (2)	
Clavien–Dindo Grade, *n* (%)				
No complications	155 (56)	30 (51)	185 (55)	< 0.001
1	37 (13)	8 (14)	45 (13)	
2	69 (25)	15 (25)	84 (25)	
3	10 (4)	1 (2)	11 (3)	
4	7 (3)	0 (0)	7 (2)	
5	0 (0)	5 (8)	5 (1)	
Post-op HDU admission, *n* (%)				
Planned	48 (81)	12 (70)	60 (79)	0.575
Unplanned	11 (19)	5 (30)	16 (21)	0.138
Postop anastomotic leak, *n* (%)				
Yes	5 (2)	2 (3)	7 (2)	0.436
No	273 (98)	57 (97)	330 (98)	
ASA Score, *n* (%)				
1	22 (8)	5 (9)	27 (8)	0.004
2	161 (58)	23 (40)	184 (55)	
3	93 (34)	29 (50)	122 (37)	
4	0 (0)	1 (2)	1 (0.3)	
Mean length of stay in days ± SD	10.05 ± 8.11	12.07 ± 8.90		0.088
(Range)	(0–80)	(5–44)		

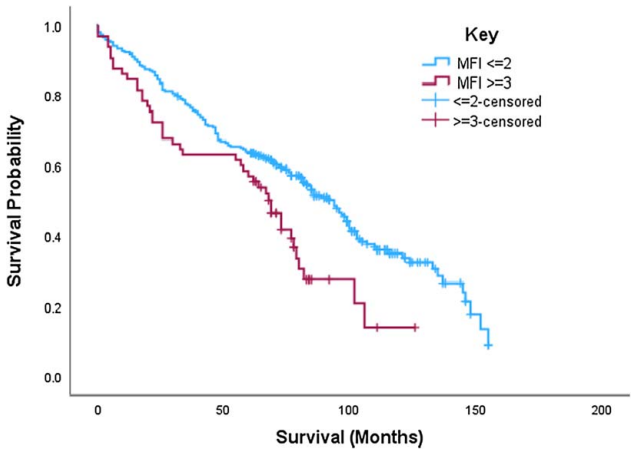
APR, abdominal perineal resection; ASA, American Society of Anaesthesiologists; HDU, high dependency unit; m-FI, modified Frailty Index; Postop, postoperative.

Table 3

Clinical demographics and postop outcomes separated by m-FI score cohorts.

Clinical demographic	Variable	m-FI score ≤2	m-FI score ≥3	Total	P
Mean age ±SD		83.12 ±2.89	83.05 ±2.08		0.844
Sex, *n* (%)	Female	157 (58)	37 (57)	185 (55)	0.033
	Male	115 (42)	28 (43)	152 (45)	
	A	46 (17)	10 (15)	56 (17)	0.699
Duke's stage, *n* (%)	B	136 (50)	35 (54)	171 (51)	
	C	85 (31)	20 (31)	105 (31)	
	D	5 (2)	0 (0.0)	5 (1)	
Tumour location, *n* (%)	Rectum	75 (28)	11 (17)	86 (26)	0.076
	Colon	197 (72)	54 (83)	251 (74)	
	Hartmann's	28 (10)	4 (6)	32 (9)	0.473
Operation, *n* (%)	Anterior Resection	77 (28)	14 (22)	91 (27.0)	
	Colectomy	146 (54)	43 (66)	189 (56)	
	APR	17 (6)	3 (5)	20 (6)	
	Panproctocolectomy	4 (1)	1 (2)	5 (1)	
	No complications	159 (58)	26 (40)	185 (55)	0.047
Clavien–Dindo Grade, *n* (%)	1	37 (14)	8 (12)	45 (13)	
	2	61 (22)	23 (35)	84 (25)	
	3	8 (3)	3 (5)	11 (3)	
	4	4 (1)	3 (5)	7 (2)	
	5	3 (1)	2 (3)	5 (1)	
Postop HDU admission, *n* (%)	Planned	44 (81)	16 (73)	60 (79)	0.110
	Unplanned	10 (19)	6 (27)	16 (21)	0.059
Postop anastomotic leak, *n* (%)		4 (57)	3 (43)	7	0.110
	1	27 (10)	0 (0)	27 (8)	<0.001
ASA Score, *n* (%)	2	167 (61)	17 (27)	184 (55)	
	3	78 (29)	44 (71)	122 (37)	
	4	0 (0)	1 (2)	1 (0.3)	
Mean length of stay (days) ±SD		10.02 ±7.43	12 ±11.06		0.081
Survival, *n* (%)		231 (85)	47 (72)	278 (82)	0.005
2-year mortality, *n* (%)		41 (15)	18 (28)	59 (18)	
30-day mortality, *n* (%)		5 (2)	2 (3)	7 (2)	0.529
90-day mortality, *n* (%)		9 (3)	2 (3)	12 (4)	0.925

ASA, American Society of Anaesthesiologists; HDU, high dependency unit; m-FI, modified Frailty Index; Postop, postoperative.



MFI score	Mean Survival Time (Months)	95% CI	Median Survival Time (Months)	95% CI	p-value
Score <= 2	88	80.9 – 94.2	94	84.1 – 103.9	0.003
Sore >= 3	63	52.0 – 73.4	69	58.9 – 79.0	
Overall	83	77.8 – 89.8	84	74.2 – 93.8	

Figure 1. Survival analysis for modified Frailty Index (m-FI) score ≤2 versus m-FI score ≥3.

The most notable and acceptable increase in hazard ratio of 2-year mortality is noted at an m-FI score of 3 (Table 6). A score of 3 demonstrated a hazard ratio of 2.14 (95% CI: 0.81–5.63, $P = 0.124$) risk of mortality compared to a score of 0. And finally, an m-FI score of greater than or equal to 3 has 1.73 (95% CI 0.92–3.26, $P = 0.092$) hazard ratio risk of 2-year mortality, after adjusting for potential covariates.

Discussion

Increasing frailty is generally considered to be associated with increased risk of postoperative morbidity and mortality. Quantifying frailty in an efficient and accurate manner to help surgeons make clinical decision with regards to postoperative outcomes is difficult. We looked at whether an association exists between the m-FI 11 scores and postoperative 2-year mortality in octogenarians undergoing colorectal cancer resection surgery. Our study demonstrates that an m-FI 11 score of 3 or more was associated with increased risk of 2-year mortality compared to a score of 2 or less. Minimal association was demonstrated in postopeartive HDU admission rates, length of stay and anastomotic leak rates between the m-FI 11 scores.

There is a well-established association between the m-FI tool and its ability to predict 30 and 90-day mortality in various surgical operations[2,3,12]. Moreover, increasing frailty in

Table 4

Unadjusted and adjusted OR of 2-year mortality according to clinical/demographic variables.

Variable	Category	Unadjusted odds ratio	95% CI	*P*	Adjusted odds ratio	95% CI	*P*
Sex	Male: Female	1.69	0.96–2.99	0.067	1.55	0.85–2.82	0.152
Age	Continuous	0.96	0.86–1.07	0.457	0.96	0.85–1.08	0.495
Operation	Hartmanns	1.00		0.433	1.00		0.826
	Anterior resection	0.43	0.16–1.12	0.084	0.61	0.21–1.74	0.353
	Colectomy	0.52	0.22–1.23	0.137	0.98	0.31–3.05	0.965
	APR	0.85	0.24–3.04	0.805	0.83	0.19–3.57	0.803
	Panproctocolectomy	< 0.001	Not estimable		Not estimable	Not estimable	
Duke's stage	A	1.00		0.012	1.00		0.017
	B	1.29	0.49–3.36	0.595	1.19	0.44–3.23	0.729
	C	3.03	1.17–7.84	0.022	2.85	1.08–7.56	0.035
	D	5.56	0.77–40.22	0.090	5.31	0.68–41.21	0.110
Tumour location	Rectum	1.00			1.00		
	Colon	0.67	0.36–1.23	0.197	0.70	0.27–1.82	0.466
ASA	ASA ≥ 3 vs ≤ 2	2.11	1.19–3.74	0.011	1.99	1.09 to 3.63	0.024

APR, abdominal perineal resection; ASA, American Society of Anaesthesiologists; OR, odds ratio.

Table 5

Adjusted and unadjusted OR of 2-year mortality according to m-FI score.

m-FI score	Unadjusted odds ratio	95% CI	*P*	Adjusted odds ratio	95% CI	*P*
0	1.00		0.053	1.00		0.354
1	1.19	0.50–2.86	0.684	1.08	0.43–2.69	0.871
2	1.25	0.51–3.04	0.631	1.04	0.39–2.75	0.940
3	3.28	1.25–8.62	0.016	2.39	0.78–7.33	0.128
4	0.77	0.15–3.91	0.754	0.69	0.12–3.85	0.671
5	4.91	0.94–25.68	0.059	3.43	0.56–20.83	0.180
Score ≤ 2 versus ≥ 3	2.16	1.14–4.08	0.018	1.85	0.87–3.94	0.108

m-FI, modified Frailty Index; OR, odds ratio.

Table 6

Adjusted and Unadjusted HR of 2-year mortality according to m-FI score.

m-FI score	Unadjusted hazards ratio	95% CI	*P*	Adjusted hazards ratio	95% CI	*P*
0	1.00		0.036			0.251
1	1.17	0.52–2.63	0.699	1.08	0.47–2.49	0.862
2	1.23	0.54–2.81	0.624	0.99	0.40–2.43	0.978
3	2.79	1.19–6.53	0.018	2.14	0.81–5.63	0.124
4	0.79	0.17–3.63	0.756	0.71	0.15–3.50	0.678
5	4.05	1.09–14.97	0.036	3.29	0.77–14.08	0.108
Score ≤ 2 versus ≥ 3	1.97	1.13 to 3.43	0.017	1.73	0.92–3.26	0.092

m-FI, modified Frailty Index; HR, hazards ratio.

colorectal operations, according to the m-FI score, has been linked with increased length of hospital stay, complication rates and 30-day mortality[14,20]. However, few studies have looked at long-term mortality risk with regards to the m-FI score in colorectal cancer resection surgery within the elderly population. While prior research has established the m-FI's efficacy in predicting short-term outcomes, our study delves into the less explored territory of its association with 2-year mortality in colorectal cancer resection among the elderly.

CRC stands as one of the prevailing malignant afflictions affecting the elderly population, particularly octogenarians, with its primary management focused on resection surgery for curative intent[21]. Given the heightened prevalence of frailty within this demographic and the consequential significance of long-term dependency among older adults, comprehending the correlation between frailty and sustained dependency post-cancer surgery becomes an imperative consideration[5]. As the longevity of octogenarians following CRC procedures continues to extend due to improvements in operative techniques and minimally invasive procedures[22,23], possessing a pre-existing understanding of patients more likely to endure in the long-term holds potential for enhanced preoperative planning and informed shared decision-making, particularly in the allocation of tailored supportive care to facilitate the restoration of functional baselines within specific patient cohorts. This notion is underscored by a cohort study wherein frailty was linked to an augmented utilisation and intensity of homecare after cancer surgery, emphasising the pivotal role of identifying frailty[15]. The m-FI 11

emerges as a potential tool for such endeavours, serving as a rapid and objective preoperative assessment instrument[24].

Our study findings underscore a notable association between elevated m-FI scores and the 2-year mortality rate among elderly patients who undergo colorectal cancer resection surgery. Specifically, patients bearing m-FI scores of three or higher exhibited a reduction in survival rates, accompanied by a median survival time of 69 months, as contrasted with those presenting scores of two or lower. Subsequent adjusted analyses provided reinforcement to these outcomes, highlighting minimal changes in odds and hazard ratio of 2-year mortality for patients boasting elevated m-FI scores. Hence, the m-FI 11 emerges as a potential means to identify octogenarians with a greater likelihood of protracted survival following CRC operations. This holds significance as it could facilitate preoperative strategizing and precise allocation of postoperative functional care, encompassing elements such as rehabilitation, social support, nursing home provisions, and comprehensive care packages[15,25].

There are numerous reasons for this potential association of high m-FI 11 scores and 2-year mortality. First, frailty, as assessed by the m-FI score, encompasses a range of physiological deficits and health vulnerabilities, including impaired mobility, nutrition, and immune function, which collectively reduce an individual's capacity to withstand the physiological stressors of surgery[1]. Secondly, frail individuals are known to be at higher risk of postoperative complications, including infections and cardiovascular events, which can directly impact survival within the 2-year timeframe[17]. Moreover, frailty status often influences treatment decisions, impacting the choice of surgical approach, adjuvant therapies, and postoperative care strategies, which can, in turn, affect survival outcomes[15]. Patient-centred factors, such as adherence to postoperative care plans, social support, and access to healthcare services, also play a role and can be influenced by frailty subsequently impacting survival[25]. This study underscores the significance of exploring these aspects in future research to provide a more nuanced understanding of how frailty interacts with surgery and postoperative outcomes.

Our study limitations included the finite available data on patients scoring more than 5 points for the m-FI tool in this study. This meant for a lack of comparison of patients with low m-FI scores against those with potentially very high scores. One likely explanation for this may have been due to the inherent exclusion of patients, by the surgical multi-disciplinary team selection process, with high co-morbidities and therefore would have scored a high value for the m-FI score. Nonetheless, new studies have been investigating a further modified m-FI 5-item scoring tool and its link with postoperative mortality[26,27], which could be even more efficient and accurate in quantifying frailty and its link with postoperative survival. Given the select study population, confounders where very much adjusted for to reduce bias however certain characteristics around lifestyle, culture and ethnicity may have reduce the generalisability of this study. We only looked at all-cause mortality as opposed to cancer related mortality or other related causes. This information would provide better insight into ways to further identify high-risk patients of postoperative complications that could occur in the long term and better plan for them. Finally, our study acknowledges the limitation of not directly comparing neoadjuvant and adjuvant therapies in the context of colorectal cancer treatment due to clinical complexities, unmeasured variables, and data constraints. This underscores the need for future research to explore these treatment modalities comprehensively. We also did not use the TNM staging model to compare the study groups comprehensively but opted to use the Duke's staging model instead.

Our study provides evidence that higher m-FI 11 scores are linked to an increased risk of 2-year mortality in octogenarians who have undergone CRC resection surgery. Very few studies have explored the m-FI score in the context of this extreme age group (80 years and older), and the impact of frailty on long-term outcomes remains poorly described in the existing literature. Assessing a patient's level of frailty in an objective manner is complex, and it's recommended to combine thorough clinical assessments with scoring tools to better estimate the risk of postoperative mortality[28]. With elderly CRC resection patients now experiencing extended survival after their operations[7], it becomes crucial to look beyond short-term outcomes and consider the enduring complications associated with surgical procedures. This perspective emphasises the importance of the preoperative assessment phase, allowing the identification of patients who may be likely to live longer after the cancer resection surgery by using such tools such as the m-FI 11 score. These specific patients would benefit from targeted postoperative care to facilitate a quicker return to their baseline functional status.

Ethical approval

The primary database used to review and collect the data was held under ethical approval (IRAS number 241949). Ethical approval for this study was granted by the East of England—Cambridge East Research Ethics Committee (REC reference 22/EE/0217, IRAS ID 288448). As no human subjects were formally involved in this study. No patient or public involvement were used in this study.

Consent

No patient consent was required as this study did not involve any human subjects as part of a clinical trial, this study was purely a retrospective database review study. This database has previously been held under ethical approval for purposes of research and analysis. All patient data on this database have provided previous consent for their anonymous data to be used in research.

Source of funding

No sources of funding were used for this study.

Author contribution

K.A.: designed the research protocol, created the study concept and study design, helped with data collection, analysis and writing the paper. M.I.: helped with data analysis, data interpretation, writing the paper, reviewing the paper and its final draft. J.C.: helped with data collection. J.B.: helped with data analysis and data interpretation. I.N.: helped with data analysis. J.H.: helped with study design and study concept. A.S.: project supervisor, helped with study design, study concept, data interpretation and writing the paper.

Conflicts of interest disclosure

No conflict of interest declared.

Research registration unique identifying number (UIN)

This study did not involve any human subjects as part of a clinical trial, this study was purely a retrospective database review study. Nonetheless, we have registered the trial with UIN researchregistry9524.

Guarantor

Kaso Ari.

Data availability statement

No dataset is publicly available; however, upon reasonable request and through our main standard operation procedures for data access a data request application can be made.

Provenance and peer review

Not invited.

Acknowledgement

Kaso Ari and Muhammad Rafaih Iqbal contributed equally to the manuscript and are joint first authors. The study did not receive any financial support from any source. No conflicts of interests were introduced. We would like to acknowledge the Norfolk and Norwich University Hospital library staff for their help and support.

References

[1] Hewitt J, Long S, Carter B, *et al*. The prevalence of frailty and its association with clinical outcomes in general surgery: a systematic review and meta-analysis. Age Ageing 2018;47:793–800.
[2] Titar C, Benlice C, Delaney C, *et al*. Modified frailty index predicts high-risk patients for readmission after colorectal surgery for cancer. Am J Surg 2019;220:187–90.
[3] Robinson TN, Wu DS, Pointer L, *et al*. Simple frailty score predicts postoperative complications across surgical specialties. Am J Surg 2013;206:544–50.
[4] Sudlow A, Tuffaha H, Stearns A, *et al*. Outcomes of surgery in patients aged ≥90 years in the general surgical setting. Ann R Coll Surg Engl 2018;100:172–7.
[5] Weerink LBM, Gant CM, van Leeuwen BL, *et al*. Long-term survival in octogenarians after surgical treatment for colorectal cancer: prevention of postoperative complications is key. Ann Surg Oncol 2018;25:3874–82.
[6] Papamichael D, Audisio R, Horiot JC, *et al*. Treatment of the elderly colorectal cancer patient: SIOG expert recommendations. Ann Oncol 2009;20:5–16.
[7] Ogata T, Yoshida N, Sadakari Y, *et al*. Colorectal cancer surgery in elderly patients 80 years and older: a comparison with younger age groups. JAMA 2022;13:137–48.
[8] Chen S, Ma T, Cui W, *et al*. Frailty and long-term survival of patients with colorectal cancer: a meta-analysis. Aging Clin Exp Res 2022;34:1485–94.
[9] Rockwood K, Song X, MacKnight C, *et al*. A global clinical measure of fitness and frailty in elderly people. CMAJ 2005;173:489–95.
[10] Feng MA, McMillan DT, Crowell K, *et al*. Geriatric assessment in surgical oncology: a systematic review. J Surg Res 2015;193:265–72.
[11] Kim S, Brooks AK, Groban L, *et al*. Preoperative assessment of the older surgical patient: honing in on geriatric syndromes. Clin Interv Aging 2014;10:13–27.
[12] Wachal B, Johnson M, Burchell A, *et al*. Association of modified frailty index score with perioperative risks for patients undergoing total laryngectomy. JAMA Otolaryngol Head Neck Surg 2017;143:818–23.
[13] Uppal S, Igwe E, Rice LW, *et al*. Frailty index predicts severe complications in gynecologic oncology patients. Gynecol Oncol 2015;137:98–101.
[14] Keller DS, Bankwitz B, Nobel T, *et al*. Using frailty to predict who will fail early discharge after laparoscopic colorectal surgery with an established recovery pathway. Dis Colon Rectum 2014;57:337–42.
[15] Chesney TR, Haas B, Coburn N, *et al*. Association of frailty with long-term homecare utilization in older adults following cancer surgery: retrospective population-based cohort study. Eur J Surg Oncol 2021;47:888–95.
[16] Elabbas E, Sharma A, Thu K, *et al*. Functional outcome and frailty in colorectal surgery patients. ANZ J Surg 2023;93:2664–8. Advance online publication.
[17] lavien PA, Barkun J, de Oliveira ML, *et al*. The Clavien-Dindo classification of surgical complications: five-year experience. Ann Surg 2009;250:187–96.
[18] Congiusta DV, Palvannan P, Merchant AM. The impact of frailty on morbidity and mortality following open emergent colectomies. Biomed Res Int 2017;2017:5126452.
[19] Mathew G, Agha R. for the STROCSS Group. STROCSS 2021: Strengthening the Reporting of cohort, cross-sectional and case-control studies in Surgery. Int J Surg 2021;96:106165.
[20] Obeid NM, Azuh O, Reddy S, *et al*. Predictors critical care related complications in colectomy patients using the national surgical improvement program: exploring frailty and aggressive laparoscopic approaches. J Trauma Acute Care Surg 2012;72:878–83.
[21] Simmonds PD, Best L, George S, *et al*. Surgery for colorectal cancer in elderly patients: a systematic review. Lancet 2000;356:968–74.
[22] Schiffmann L, Ozcan S, Schwarz F, *et al*. Colorectal cancer in the elderly: surgical treatment and long-term survival. Int J Colorectal Dis 2008;23:601–10.
[23] Sheridan J, Walsh P, Kevans D, *et al*. Determinants of short- and long-term survival from colorectal cancer in very elderly patients. J Geriatr Oncol 2014;5:376–83.
[24] Simon HL, Paula T, Luz MM, *et al*. Frailty in older patients undergoing emergency colorectal surgery: USA National Surgical Quality Improvement Program analysis. Br J Surg 2020;107:1363–71.
[25] Cheema FN, Abraham NS, Berger DH, *et al*. Novel approaches to perioperative assessment and intervention may improve long-term outcomes after colorectal cancer resection in older adults. Ann Surg 2011;253:867–74.
[26] Al-Khamis A, Warner C, Park J, *et al*, Modified frailty index predicts early outcomes after colorectal surgery: An ACS-NSQIP study. Colorectal Dis 2019;21:1192–205.
[27] Subramaniam S, Aalberg JJ, Soriano RP, *et al*. New 5-factor modified frailty index using American College of Surgeons NSQIP data. J Am Coll Surg 2018;226:173–181.e8.
[28] Mitnitski AB, Mogilner AJ, Rockwood K, *et al*. Accumulation of deficits as a proxy measure of aging. Sci World J 2001;1:323–36.