

# Five-item Modified Frailty Index in Elderly Patients Undergoing Laparoscopic Colorectal Surgery Predicts Postoperative Complications

SATOMI OKADA<sup>1,2</sup>, YUSUKE INOUE<sup>1</sup>, TOSHIYUKI ADACHI<sup>1</sup>, SHINICHIRO ITO<sup>1</sup>, TOMOHIKO ADACHI<sup>1</sup>, AKIHIKO SOYAMA<sup>1</sup>, KAZUMA KOBAYASHI<sup>1</sup>, MASAOKI HIDAKA<sup>1</sup>, KENGO KANETAKA<sup>1</sup> and SUSUMU EGUCHI<sup>1</sup>

<sup>1</sup>Department of Surgery, Nagasaki University Graduate School of Biomedical Sciences Center, Nagasaki, Japan;

<sup>2</sup>Department of Surgery, Nagasaki Harbor Medical Center, Nagasaki, Japan

**Abstract.** *Background/Aim:* Owing to underlying diseases and decreased physiological functions, frailty in elderly patients may be associated with adverse postoperative complications and mortality. To date, there are various frailty assessment methods, with the five-item modified frailty index (mFI-5) being an objective and concise evaluation tool. This study aimed to clarify whether mFI-5 scoring, a measure of frailty, can predict postoperative outcomes in elderly patients undergoing laparoscopic colorectal surgery. *Patients and Methods:* A total of 107 patients aged over 80 years who underwent laparoscopic colorectal surgery at Nagasaki University Hospital between 2011 and 2018 were included in this study. The mFI-5 was used to assess the preoperative condition of each patient, with scores compared against various postoperative outcome measures. Univariate analysis was used to determine between-group differences for pre- and post-operative variables. *Results:* Of the 107 patients [median age, 83 (80-99) years], 44.9% were male. The mFI-5 score was calculated and patients were divided into three groups: 0 (n=36, 33.6%); 1 (n=44, 41.1%); and 2+ (n=27, 25.3%). The groups were significantly associated with the American

Society of Anesthesiology (ASA) classification ( $p<0.001$ ). Postoperative complications occurred in 43 patients (40.2%), and a higher mFI-5 score was significantly associated with postoperative complications of Clavien–Dindo grade  $\geq$ III and duration of hospital stay. *Conclusion:* The mFI-5 is an objective and useful tool for predicting postoperative complications of laparoscopic surgery in elderly patients with colorectal cancer.

Colorectal cancer is the most common cancer in Japan. It is the third leading cause of cancer-related deaths in men and the leading cause of cancer-related deaths in women. Surgical resection is an established curative treatment option for colorectal cancer that contributes to improved prognosis and quality of life (1, 2). With the rapidly aging global population, the rate of surgeries performed on elderly colorectal cancer patients is also growing incrementally.

The benefits of laparoscopic colorectal resections over open surgery have been well described in the general population, regardless of age (3, 4). In addition, elective laparoscopic resection for elderly colorectal cancer patients has been demonstrated as feasible and safe (5). Laparoscopic colorectal resections in older adults have thus become increasingly common; however, there is a direct correlation between age and risk of morbidity and mortality (6, 7). Elderly patients have accompanying co-morbidities, such as cardiovascular and pulmonary issues, that place them at a significantly higher risk of postoperative mortality, morbidity, and a longer hospital stay after surgery (8, 9). Therefore, it is important to assess the level of physical independence of frail elderly patients.

Frailty is defined as an objective measure of increased vulnerability and decreased physiological reserves resulting from the age-associated accumulation of physiological deficits in multiple systems.

To assess frailty, various frailty predictive models have been developed, such as the Physiological and Operative

*Correspondence to:* Satomi Okada, Department of Surgery, Nagasaki University Graduate School of Biomedical Sciences, 1-7-1 Sakamoto, Nagasaki 852-8501, Japan. Tel: +81 958197316, Fax: +81 958197319, e-mail: okada\_s\_1107@yahoo.co.jp

**Key Words:** Elderly, frailty, laparoscopic colorectal surgery, mFI-5.

©2024 The Author(s). Published by the International Institute of Anticancer Research.



This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY-NC-ND) 4.0 international license (<https://creativecommons.org/licenses/by-nc-nd/4.0>).

Scoring System for Enumeration of Morbidity and Mortality, Estimation of Physiologic Ability and Surgical Stress Score, and Comprehensive Geriatric Assessment; however, these models are often complex or time-consuming (10-12). The Canadian Study of Health and Aging introduced a 70-item frailty index (CSHA-FI) based on the accumulated deficits (symptoms, signs, functional impairments, and laboratory abnormalities) (13). Subsequently, a modified frailty index (mFI) was derived by matching the CSHA-FI to the 11 variables collected by the American College of Surgeons National Surgical Quality Improvement Program (14). This 11-item mFI (mFI-11) has been proven to reflect frailty adequately and is a valid predictor of postoperative outcomes in several surgical populations (15-17). In 2015, an even simpler and more time-efficient five-item mFI (mFI-5) was developed. The mFI-5 has proven equally as predictive of 30-day outcomes as the mFI-11 (18-20). However, to our knowledge, the predictive ability of the mFI-5 has not been shown in a cohort consisting of elderly patients who have undergone laparoscopic colorectal surgery exclusively. Our study aimed to clarify the accuracy of the mFI-5 score on predicting postoperative outcomes in elderly patients undergoing laparoscopic colorectal surgery.

**Patients and Methods**

*Patient population.* A total of 107 patients, aged over 80 years, who underwent laparoscopic surgery for colorectal cancer at Nagasaki University Hospital between 2011 and 2018 were included in this study. Data were collected retrospectively from their hospital charts. This study was conducted in accordance with the 1975 Declaration of Helsinki and was approved by the clinical research ethics committee of Nagasaki University Hospital (approval number: 19102141). Acquisition of informed consent from patients was waived owing to the retrospective nature of this study.

*Five-item modified frailty index.* The mFI-5 was assessed based on the following co-morbidities: congestive heart failure; diabetes mellitus; chronic obstructive pulmonary disease, or diagnosis of pneumonia within 30 days; functional status (partially dependent or completely dependent); and hypertension requiring medication (Table I). The mFI-5 score was calculated by adding the number of frailty variables present (scored 1 point per variable), resulting in a score range from 0 to 5 points. The patients were grouped into three categories corresponding to the mFI-5 scores of 0, 1, and 2+.

*Perioperative variables and outcomes.* Patient demographics and perioperative and postoperative outcomes, including age, sex, body mass index (BMI), American Society of Anesthesiology (ASA) classification, functional status, tumor location, surgical approach, operation time, bleeding, reoperation, duration of hospital stay, discharge status, and postoperative complications, were collected and compared between the three mFI-5 groups. Postoperative complications were evaluated according to the Clavien–Dindo classification (21).

*Statistical analysis.* Data were collected as medians for continuous variables and frequencies for categorical variables. Patient demographics

Table I. *Co-morbidities included in the five-item modified frailty index (mFI-5).*

1	Congestive heart failure
2	Diabetes mellitus
3	Chronic obstructive pulmonary disease or diagnosis of pneumonia within 30 days
4	Functional status (partially dependent or totally dependent)
5	Hypertension requiring medication

Table II. *Population demographics.*

	All patients (n=107)
Age (median, range) (years)	83 (80-99)
Sex	
Male	48 (44.9%)
Female	59 (55.1%)
BMI (median, range) (kg/m <sup>2</sup> )	21.4 (14.9-31.9)
Tumor location	
Cecum	14 (13.1%)
Ascending colon	25 (23.4%)
Transvers colon	8 (7.5%)
Descending colon	4 (3.7%)
Sigmoid colon	25 (23.4%)
Rectum	31 (29.0%)
Pathological stage	
Stage 0	5 (4.7%)
Stage I	24 (22.4%)
Stage II	37 (34.6%)
Stage III	33 (30.8%)
Stage IV	7 (6.5%)
Emergency surgery	3 (2.8%)
Converted to open surgery	9 (8.4%)

BMI: Body mass index.

and perioperative and postoperative outcomes across the mFI-5 groups were compared using univariate analyses. Categorical variables were compared using the chi-square test, and continuous variables were compared using the Mann–Whitney *U*-test. Statistical significance was defined as a *p*-value <0.05. All statistical analyses were performed using the SPSS statistical software (version 22.0; SPSS Inc., Chicago, IL, USA).

**Results**

*Patient demographics.* The results of the demographic analysis are presented in Table II. The median age was 83 years (range=80-99 years), and the median BMI was 21.4 (range=14.9-31.9) kg/m<sup>2</sup>. Males represented 44.9% of the patients in the sample. Of the enrolled patients, 29.0% were diagnosed with rectal cancer, while 71.0% were diagnosed with colon cancer. The pathological stages of the 107 patients were as follows: pStage 0, 4.7%; pStage I, 22.4%;

Table III. Demographics and perioperative factors of the mFI-5 group.

	Group 0 (n=36)	Group 1 (n=44)	Group 2+ (n=27)	p-Value
Age (years)	83 (80-95)	83 (80-97)	83 (80-99)	0.810
Sex				0.165
Male	12 (33.3%)	24 (54.5%)	12 (44.4%)	
Female	24 (66.7%)	20 (45.5%)	15 (55.6%)	
BMI (kg/m <sup>2</sup> )	21.2 (16.0-31.9)	21.9 (14.9-26.8)	21.5 (18.5-27.0)	0.344
Tumor location				0.712
Colon	26 (72.2%)	31 (70.5%)	17 (63.0%)	
Rectum	10 (27.8%)	13 (29.5%)	10 (37.0%)	
Emergency surgery	2 (5.6%)	0 (0%)	1 (3.7%)	0.309
ASA classification				<0.001
I-II	31 (86.1%)	24 (54.5%)	8 (29.6%)	
III	4 (11.1%)	15 (34.1%)	16 (59.3%)	
IV-V	1 (2.8%)	5 (11.4%)	3 (11.1%)	
Ischemic heart disease	2 (5.6%)	8 (18.2%)	6 (22.2%)	0.137
Cerebrovascular disorder	1 (2.8%)	7 (15.9%)	5 (18.5%)	0.102
Renal dysfunction	1 (2.8%)	1 (2.3%)	0 (0%)	0.699
Antithrombotic therapy	10 (27.8%)	16 (36.4%)	7 (25.9%)	0.579
Steroid	1 (2.8%)	2 (4.5%)	0 (0%)	0.530
Intestinal obstruction	5 (13.9%)	11 (25.0%)	7 (25.9%)	0.424
Anemia	15 (41.7%)	14 (31.8%)	10 (37.0%)	0.582
Serum Albumin <3.5 g/dl	7 (19.4%)	12 (27.3%)	10 (37.0%)	0.298
PNI $\leq$ 40	8 (22.2%)	9 (20.5%)	8 (29.6%)	0.536
mFI-5 categories				
Congestive heart failure	0 (0%)	3 (6.9%)	5 (18.5%)	0.021
Diabetes mellitus	0 (0%)	5 (11.4%)	16 (59.3%)	<0.001
COPD and pneumonia	0 (0%)	4 (9.1%)	4 (14.8%)	0.075
Functional status	0 (0%)	4 (9.1%)	12 (44.4%)	<0.001
Hypertension	0 (0%)	28 (63.6%)	22 (81.5%)	<0.001

ASA classification: American Society of Anesthesiologists Physical Status Classification System; COPD: chronic obstructive pulmonary disease; PNI: Prognostic Nutritional Index= $[10 \times \text{serum albumin (g/dl)}] + [0.005 \times \text{total lymphocyte count (/mm}^3\text{)}]$ .

pStage II, 34.6%; pStage III, 30.8%; and pStage IV, 6.5%. Three patients (2.8%) underwent emergency colorectal surgery, and in nine cases (8.4%), it was necessary to convert from laparoscopic to open surgery.

*Univariate analysis of demographics and perioperative factors by mFI-5 group.* Of the 107 patients, 33.6% were classified as mFI-5=0; 41.1% were classified as mFI-5=1; and 25.3% were classified as mFI-5=2+. We compared the three groups' demographics and perioperative factors (Table III). There were no significant differences in age, sex, BMI, or tumor location. ASA classification correlated with the mFI-5 score ( $p<0.001$ ). Higher mFI-5 scores were associated with a significantly higher rate of congestive heart failure, diabetes mellitus, functional dependence, and hypertension; however, there was no significant trend for chronic obstructive pulmonary disease (COPD). Moreover, the three groups showed no significant differences regarding other co-morbidities.

*Univariate analysis of outcomes by mFI-5 group.* We compared the postoperative outcomes of the three groups

(Table IV). Forty-three patients (40.2%) had postoperative complications, with no significant differences among the three groups. Postoperative ileus was the most common complication in Groups 0 and 1, whereas wound infection and pneumonia were more common in Group 2+. Thirteen patients (12.1%) had Clavien–Dindo classification grade III or higher complications. As the mFI-5 scores increased, the percentage of complications of Clavien–Dindo classification  $\geq$  grade III was higher, with significant differences ( $p=0.02$ ).

The duration of postoperative hospital stay was longer in Group 2+ ( $p=0.039$ ). In mFI-5 Group 1, 61.1% were discharged home, and in mFI-5 Group 2+, 59.2% were transferred to another hospital.

## Discussion

This study focused on the correlation between frailty and postoperative complications in elderly patients. With the rapidly aging population, the number of surgeries for elderly colorectal cancer is increasing. For elderly patients, it is necessary to develop a treatment strategy based on a

Table IV. Postoperative outcomes of the mFI-5 group.

	Group 0 (n=36)	Group 1 (n=44)	Group 2+ (n=27)	p-Value
Postoperative complication	13 (36.1%)	18 (40.9%)	12 (44.4%)	0.794
Anastomotic leakage	1 (2.8%)	0	0	
Anastomotic bleeding	0	1 (2.3%)	0	
Intraperitoneal abscess	0	1 (2.3%)	1 (3.7%)	
Intraperitoneal bleeding	0	0	2 (7.4%)	
Wound infection	2 (5.6%)	4 (9.1%)	3 (11.1%)	
Ileus	5 (13.9%)	6 (13.6%)	1 (3.7%)	
Pneumonia	1 (2.8%)	0	3 (11.1%)	
Heart failure	1 (2.8%)	0	0	
Enterocolitis	0	1 (2.3%)	0	
Delirium	3 (8.3%)	4 (9.1%)	1 (3.7%)	
Other	0	1 (2.3%)	1 (3.7%)	
Postoperative complication (CD≥Grade III)	1 (2.8%)	5 (11.4%)	7 (25.9%)	0.020
Anastomotic leakage	1 (2.8%)	0	0	
Anastomotic bleeding	0	1 (2.3%)	0	
Intraperitoneal abscess	0	1 (2.3%)	1 (3.7%)	
Intraperitoneal bleeding	0	0	2 (7.4%)	
Wound infection	0	2 (4.5%)	2 (7.4%)	
Ileus	0	1 (2.3%)	0	
Pneumonia	0	0	2 (7.4%)	
Reoperation	1 (2.8%)	0	1 (3.7%)	0.473
Duration of hospital stay (days)	13.5 (7-32)	14 (8-43)	17 (8-40)	0.039
Discharge status				0.109
Home	22 (61.1%)	28 (63.6%)	10 (37.0%)	
Nursing facility	0	0	1 (3.7%)	
Another hospital	14 (38.9%)	16 (36.4%)	16 (59.2%)	

CD: Clavien–Dindo classification.

comprehensive assessment of not only age but also physical function, mental function, cognitive function, co-morbidities, social environment, and nutritional status. It is also important to adequately assess their preoperative condition using predictive tools for adverse events and prognosis, and to plan preoperative preparation and postoperative management while considering perioperative risks. There are a variety of frailty assessments, some of which have been reported to be associated with complications and prognosis (22, 23). However, owing to the complexity of the evaluation methods and the large number of items per index, these are not widely used. Therefore, to determine whether it is possible to evaluate frailty in a simpler and more convenient manner, we focused on the mFI-5. In addition to being time-saving, the mFI-5 shows inter-rater reliability due to its objective nature, making it an attractive tool.

In the existing literature, Weaver *et al.* (20) concluded that the mFI-5 score was associated with postoperative complications in elective posterior lumbar fusion. Simon *et al.* (24) found that the mFI-5 predicted higher morbidity and mortality in elderly patients needing emergency colorectal surgery. Therefore, we hypothesized that the mFI-5 could be useful for predicting postoperative outcomes in elderly patients undergoing laparoscopic colorectal surgery.

In this study, we examined the association between the mFI-5 score and postoperative outcomes of laparoscopic colorectal surgery in elderly patients. Of the 107 patients, a mFI-5 score of 1 was the most common, accounting for approximately 40% of the cohort, and the highest score was 3. In the univariate analysis of preoperative factors, COPD and pneumonia were the only co-morbidities that were not significantly different among the five mFI-5 score items, reflecting the small number of patients. From this analysis, a significant between-group difference was found in the ASA classification, suggesting that the mFI-5 is useful for assessing the general clinical status and surgical risk factors.

In terms of postoperative factors, patients with higher mFI-5 scores also had higher rates of postoperative complications of Clavien–Dindo classification grade III or higher. In particular, the mFI-5 Group 2+ had a higher incidence of pneumonia, wound infection, and intraperitoneal bleeding, with longer hospital stays and higher rates of hospital transfer. These results suggest that patients with higher preoperative frailty require prolonged postoperative care and rehabilitation.

There were no significant differences in the 5-year survival rates or disease-specific 5-year survival rates

among the three groups (Median observation period: 810 days; 5-year survival rates: Group 0, 62.1%; Group 1, 64.7%; and Group 2+, 59.7%; Disease-specific 5-year survival rates: Group 0, 87.7%; Group 1, 82.8%; and Group 2+, 79.8%). These results show that even patients with a high mFI-5 score have a good disease-specific prognosis. Thus, it is necessary to develop treatment strategies, including surgical intervention, based on adequate risk management, which includes predictive tools such as the mFI-5.

The results of this study demonstrate that for laparoscopic colorectal resection in elderly patients, the mFI-5 is a useful and simple scale for predicting the occurrence of severe postoperative complications and prolonged postoperative treatment. Therefore, when the preoperative mFI-5 score is high, aggressive therapeutic interventions should be performed during the waiting period before surgery to maximally improve postoperative recovery. Examples include respiratory and physical rehabilitation, preoperative oral care, and intensified diabetes therapies. It is also important to provide early release and rehabilitation after surgery to prevent postoperative complications.

The mFI-5 is a simple tool with only five items. However, because it is based on the presence or absence of the included co-morbidities, it does not adequately reflect the severity of each disease. Additionally, the mFI-5 is limited in that it only evaluates physical frailty and does not assess cognitive, mental, psychological, and social frailty.

## Conclusion

In conclusion, the mFI-5 is an objective tool that can accurately predict postoperative complications in elderly patients undergoing colorectal cancer surgery. In the future, it is necessary to develop a simple tool that can assess frailty in a composite manner, by including psychological, cognitive, and social dimensions.

## Conflicts of Interest

The Authors have no conflicts of interest to declare in relation to this study.

## Authors' Contributions

SO participated in the study concept and design, collected data, performed a literature review, and drafted the manuscript. YI, TA, SI, TA, AS, KK, MH, KK, and SE reviewed the manuscript.

## Acknowledgements

The Authors thank their colleagues in the Department of Surgery, Graduate School of Biomedical Sciences, Nagasaki University for their kind cooperation and support.

## Funding

The Authors received no funding for this work.

## References

- Richards CH, Platt JJ, Anderson JH, McKee RF, Horgan PG, McMillan DC: The impact of perioperative risk, tumor pathology and surgical complications on disease recurrence following potentially curative resection of colorectal cancer. *Ann Surg* 254(1): 83-89, 2011. DOI: 10.1097/sla.0b013e31821fd469
- Chang GJ, Kaiser AM, Mills S, Rafferty JF, Buie WD: Practice parameters for the management of colon cancer. *Dis Colon Rectum* 55(8): 831-843, 2012. DOI: 10.1097/dcr.0b013e3182567e13
- Kitano S, Inomata M, Mizusawa J, Katayama H, Watanabe M, Yamamoto S, Ito M, Saito S, Fujii S, Konishi F, Saida Y, Hasegawa H, Akagi T, Sugihara K, Yamaguchi T, Masaki T, Fukunaga Y, Murata K, Okajima M, Moriya Y, Shimada Y: Survival outcomes following laparoscopic versus open D3 dissection for stage II or III colon cancer (JCOG0404): a phase 3, randomised controlled trial. *Lancet Gastroenterol Hepatol* 2(4): 261-268, 2017. DOI: 10.1016/s2468-1253(16)30207-2
- Tjandra JJ, Chan MKY: Systematic review on the short-term outcome of laparoscopic resection for colon and rectosigmoid cancer. *Colorectal Dis* 8(5): 375-388, 2006. DOI: 10.1111/j.1463-1318.2006.00974.x
- Devoto L, Celentano V, Cohen R, Khan J, Chand M: Colorectal cancer surgery in the very elderly patient: a systematic review of laparoscopic *versus* open colorectal resection. *Int J Colorectal Dis* 32(9): 1237-1242, 2017. DOI: 10.1007/s00384-017-2848-y
- Longo WE, Virgo KS, Johnson FE, Oprian CA, Vernava AM, Wade TP, Phelan MA, Henderson WG, Daley J, Khuri SF: Risk factors for morbidity and mortality after colectomy for colon cancer. *Dis Colon Rectum* 43(1): 83-91, 2000. DOI: 10.1007/bf02237249
- Jafari MD, Jafari F, Halabi WJ, Nguyen VQ, Pigazzi A, Carmichael JC, Mills SD, Stamos MJ: Colorectal cancer resections in the aging US population. *JAMA Surg* 149(6): 557, 2014. DOI: 10.1001/jamasurg.2013.4930
- Lin HS, Watts JN, Peel NM, Hubbard RE: Frailty and post-operative outcomes in older surgical patients: a systematic review. *BMC Geriatr* 16(1): 157, 2016. DOI: 10.1186/s12877-016-0329-8
- Robinson TN, Wu DS, Pointer L, Dunn CL, Cleveland JC Jr, Moss M: Simple frailty score predicts postoperative complications across surgical specialties. *Am J Surg* 206(4): 544-550, 2013. DOI: 10.1016/j.amjsurg.2013.03.012
- Deyle S, Banz VM, Wagner M, Becker K, Inderbitzin D, Gloor B, Candinas D: Estimation of physiologic ability and surgical stress score does not predict immediate outcome after pancreatic surgery. *Pancreas* 40(5): 723-729, 2011. DOI: 10.1097/mpa.0b013e318212c02c
- Hashimoto D, Takamori H, Sakamoto Y, Ikuta Y, Nakahara O, Furuhashi S, Tanaka H, Watanabe M, Beppu T, Hirota M, Baba H: Is an estimation of physiologic ability and surgical stress able to predict operative morbidity after pancreaticoduodenectomy? *J Hepatobiliary Pancreat Sci* 17(2): 132-138, 2010. DOI: 10.1007/s00534-009-0116-4
- Wagner D, DeMarco MM, Amini N, Buttner S, Segev D, Gani F, Pawlik TM: Role of frailty and sarcopenia in predicting outcomes among patients undergoing gastrointestinal surgery. *World J Gastrointest Surg* 8(1): 27-40, 2016. DOI: 10.4240/wjgs.v8.i1.27

- 13 Mitnitski AB, Mogilner AJ, Rockwood K: Accumulation of deficits as a proxy measure of aging. *ScientificWorldJournal* 1: 323-336, 2001. DOI: 10.1100/tsw.2001.58
- 14 Velanovich V, Antoine H, Swartz A, Peters D, Rubinfeld I: Accumulating deficits model of frailty and postoperative mortality and morbidity: its application to a national database. *J Surg Res* 183(1): 104-110, 2013. DOI: 10.1016/j.jss.2013.01.021
- 15 Chimukangara M, Frelich MJ, Bosler ME, Rein LE, Szabo A, Gould JC: The impact of frailty on outcomes of paraesophageal hernia repair. *J Surg Res* 202(2): 259-266, 2016. DOI: 10.1016/j.jss.2016.02.042
- 16 Louwers L, Schnickel G, Rubinfeld I: Use of a simplified frailty index to predict Clavien 4 complications and mortality after hepatectomy: analysis of the National Surgical Quality Improvement Project database. *Am J Surg* 211(6): 1071-1076, 2016. DOI: 10.1016/j.amjsurg.2015.09.015
- 17 Vermillion SA, Hsu FC, Dorrell RD, Shen P, Clark CJ: Modified frailty index predicts postoperative outcomes in older gastrointestinal cancer patients. *J Surg Oncol* 115(8): 997-1003, 2017. DOI: 10.1002/jso.24617
- 18 Subramaniam S, Aalberg JJ, Soriano RP, Divino CM: New 5-factor modified frailty index using American College of Surgeons NSQIP data. *J Am Coll Surg* 226(2): 173-181e8, 2018. DOI: 10.1016/j.jamcollsurg.2017.11.005
- 19 Chimukangara M, Helm MC, Frelich MJ, Bosler ME, Rein LE, Szabo A, Gould JC: A 5-item frailty index based on NSQIP data correlates with outcomes following paraesophageal hernia repair. *Surg Endosc* 31(6): 2509-2519, 2017. DOI: 10.1007/s00464-016-5253-7
- 20 Weaver DJ, Malik AT, Jain N, Yu E, Kim J, Khan SN: The modified 5-item frailty index: a concise and useful tool for assessing the impact of frailty on postoperative morbidity following elective posterior lumbar fusions. *World Neurosurg* 124: e626-e632, 2019. DOI: 10.1016/j.wneu.2018.12.168
- 21 Dindo D, Demartines N, Clavien PA: Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. *Ann Surg* 240(2): 205-213, 2004. DOI: 10.1097/01.sla.0000133083.54934.ae
- 22 Ruiz M, Reske T, Cefalu C, Estrada J: Management of elderly and frail elderly cancer patients: the importance of comprehensive geriatrics assessment and the need for guidelines. *Am J Med Sci* 346(1): 66-69, 2013. DOI: 10.1097/maj.0b013e31826d59aa
- 23 Huisingh-Scheetz M, Walston J: How should older adults with cancer be evaluated for frailty? *J Geriatr Oncol* 8(1): 8-15, 2017. DOI: 10.1016/j.jgo.2016.06.003
- 24 Simon HL, Paula T, Luz MM, Nemeth SK, Moug SJ, Keller DS: Frailty in older patients undergoing emergency colorectal surgery: USA National Surgical Quality Improvement Program analysis. *Br J Surg* 107(10): 1363-1371, 2020. DOI: 10.1002/bjs.11770

*Received June 6, 2024*  
*Revised July 14, 2024*  
*Accepted July 16, 2024*