Gynecologic Oncology 166 (2022) 379–388

Contents lists available at ScienceDirect

Gynecologic Oncology

journal homepage: www.elsevier.com/locate/ygyno

Preoperative assessment using the five-factor modified frailty index: A call for standardized preoperative assessment and prehabilitation services in gynecologic oncology

Mariam M. AlHilli [a,*], Jesse D. Schold [b,c], Johanna Kelley [a], Anne S. Tang [b,c], Chad M. Michener [a]

[a] Department of Obstetrics and Gynecology, Division of Gynecologic Oncology, Cleveland Clinic, Cleveland, OH, USA
[b] Department of Quantitative Health Sciences, Cleveland Clinic, Cleveland, OH, USA
[c] Center for Populations Health Research, Lerner Research Institute, Cleveland Clinic, Cleveland, OH, USA

HIGHLIGHTS

- The 5 factor mFI is a simple tool for perioperative assessment of frailty in gynecologic cancer patients.
- Older age, African American race, laparoscopic surgery and obesity are associated with higher mFI score.
- Patients with higher 5-factor mFI score account for the majority of readmissions and 30-day complications.

ARTICLE INFO

Article history:
Received 27 February 2022
Received in revised form 26 June 2022
Accepted 4 July 2022
Available online 19 July 2022

Keywords:
Frailty
Gynecologic oncology
Readmissions
Prehabiliation

ABSTRACT

Objective. To evaluate if the 5-factor modified frailty index (mFI) is associated with postoperative complications, readmissions or non-home discharge in gynecologic cancer patients undergoing surgery.

Methods. Patients with a diagnosis of gynecologic cancer (cervical, uterine, or ovarian cancer) who underwent surgery between 2014 and 2018 were identified through the National Surgical Quality Improvement Program (NSQIP) database. The 5-factor mFI was applied and patients classified into 6 categories (mFI groups 0,1,2, 3, 4 and 5). The incidence of 30-day complications, readmissions and non-home discharge was evaluated. Multivariable logistic regression models were used to determine the association between mFI category and readmissions/complications. Adjusted probabilities of events were calculated based on patient characteristics.

Results. At total of 31,181 gynecologic cancer cases were included in the analysis: N = 2968 (9.4%) cervical, N = 20,862 (66.4%) uterine, and N = 7351 (23.4%) ovarian cancers. Of all patients, 46.1% were in category 0, 36.5% category 1, and 1% category 3–5. Factors associated with increased mFI included older age, African American race, laparoscopic surgery and obesity. A significant dose-response relationship between higher mFI and readmission and 30-day complications was noted on adjusted multivariable analysis (adjusted OR 2.37 (1.65–3.45) and 2.10 (1.59–2.75) for readmissions and complications, respectively, in mFI category 3–5). These associations were consistent within each cancer type.

Conclusions. The 5-factor mFI universally predicts postoperative readmissions, 30-day complications and non-home discharge in patients with gynecologic cancer. Incorporation of mFI into routine preoperative assessment can identify patients for non-surgical treatments, prehabiliatation and short term home assessments.

Published by Elsevier Inc.

1. Introduction

Frailty is a condition characterized by a generalized decrease in physiologic reserve accompanied by multisystem impairment that is separate from the process of aging [1,2] . Frailty is a well-established independent predictor of adverse postoperative outcomes and increased mortality among surgical patients across various disciplines [3–5]. It has a significant negative influence on several healthcare metrics and social outcomes including length of hospitalization, readmissions, non-home discharge, health-related quality of life and time to return to work [6–11]. A multitude of risk assessment tools have been developed to evaluate frailty and identify patient at high risk for surgical

* Corresponding author at: Obstetrics, Gynecology and Women's Health Institute, 9500 Euclid Avenue/ A81, Cleveland, OH 44115, USA.
E-mail address: alhillm@ccf.org (M.M. AlHilli).

https://doi.org/10.1016/j.ygyno.2022.07.003
0090-8258/Published by Elsevier Inc.

morbidity [2,11–14]. However, to date, there is no gold standard for the preoperative evaluation of frailty.

Frailty assessments generally measure key domains of physical performance, mobility, nutrition, comorbidities, mental health and cognition, and include a geriatric assessment [14,15]. The vast majority of frailty assessment tools available are resource-intensive, and do not allow for rapid and cost-effective preoperative screening in surgical patients. For example, the Canada Study of Health and Aging Frailty Index (CSHA-FI), is a 70-item scale based on the cumulative deficit model that includes factors that are difficult to measure and are not uniformly available [12]. The modified frailty index (mFI) was developed through the American College of Surgeons National Surgical Quality Improvement Program (NSQIP) database and includes 11 factors. The mFI has been shown to accurately reflect frailty and predict morbidity and mortality in surgical patients [15] .

Frailty has been described to be prevalent in up to 60% of gynecologic oncology patients, although rates as low as 6% have been reported with the majority of studies focusing on cancer patients [8]. Women with gynecologic cancers are unique due to the diversity of age at presentation, nutritional status levels and need for preoperative and/or postoperative systemic and localized therapies which may further impair performance status. A systematic review of the literature on frailty in gynecologic oncology identified the 11 factor mFI as the most widely adopted tool [8]. However, the approach of uniformly screening all gynecologic oncology patients for frailty indicators has not been widely adopted. There is strong clinical need to implement accurate, standardized, and easily accessible frailty assessment tools in patients undergoing gynecologic oncology surgery that would inform decisions regarding surgical versus medical treatments and guide targeted to optimize preoperative physical function.

In this study, we retrospectively apply a brief and targeted frailty assessment (5-factor mFI) to patients with cervical, uterine and ovarian managed surgically in the NSQIP database. We aim to determine the predictive ability of the 5-factor mFI on postoperative complications, readmissions and non-home discharge.

2. Methods

The observational data for the study were derived from American College of Surgeons (ACS) National Surgical Quality Improvement Program (NSQIP), where under the ACS data use agreement, participant use files from years of 2014 to 2018 were reviewed. Hysterectomy Procedure Targeted Participant Use Data File was used to identify patients undergoing oncologic procedures by cancer type. Exclusion criteria were cases with invalid current procedural terminology (CPT) codes and/or with more than one type of gynecologic cancer listed. CPT codes were used to determine open vs. laparoscopic surgical approach. Thirty-day readmission status included unplanned hospital readmissions only. The 5-factor modified frailty index was determined from the following variables: dependent functional status, diabetes mellitus, history of COPD, history of congestive heart failure within 30 days of surgery, and hypertension requiring medication (Table 1). mFI was calculated as number of frailty factors present divided by the number of non-missing frailty factors. For the purpose of statistical analyses, MFI categories were used with the following ranges: 0 = (mFI = 0), 1 = (0 < mFI ≤ 0.2), 2 = (0.2 < mFI ≤ 0.4), 3 = (0.4 < mFI ≤ 0.6), 4 = (0.6 < mFI ≤ 0.8), 5 = (0.8 < mFI ≤ 1). Comorbidities included and used for risk adjustment were superficial surgical site infection (SSI), deep SSI, organ space SSI, wound disruption, pneumonia, deep venous thrombosis (DVT), pulmonary embolism (PE), ventilator requirement >48 h, sepsis, renal insufficiency, acute renal failure, urinary tract infection (UTI), cerebrovascular accident (CVA)/ stroke, cardiac arrest, myocardial infarction, transfusion, intestinal obstruction, prolonged postoperative nil per oral (NPO) status, anastomotic leak, ureteral obstruction, ureteral fistula, and bladder fistula.

2.1. Statistical analysis

Descriptive statistics (Chi-square, Kruskal-Wallis, Fisher's exact tests and ANOVA) were used to compare patient characteristics, complications and thirty-day outcomes by the four categories of mFI. Multivariable logistic regression models were used to evaluate the independent association of mFI category with 30-day complications and readmissions. These models were also used to calculate adjusted probabilities of events based on the average patient characteristics in the study population. Interaction effects between a priori selected variables including age, cancer type and race were tested with mFI category. Forest plots were used to display results of the multivariable models. Time to complications within 30-days was displayed with Kaplan-Meier plots and compared using Log-Rank p-values. A two-sided type-I error probability of 0.05 was used as a threshold for all statistical tests. All analyses were performed in SAS (v.9.4, Cary, N.C.).

3. Results

The final study population included 31,181 gynecology cancer cases with one of three cancer types: cervical cancer (N = 2968; 9.5%), uterine cancer (N = 20,862, 66.8%) and ovarian cancer (N = 7351, 23.6%), Fig. 1**.** The mFI was applied to all patients retrospectively to determine the distribution of mFI categories 0–5 within the study population. As shown in Fig. 2**,** the vast majority of patients were in mFI category 0 (46.9%), 36.5% were in category 1 (0 < mFI ≤ 0.2), 15.6% in category 2 (0.2 < mFI ≤ 0.4), and only 1% in category 3, 4, and 5 combined (mFI ≥ 0.4). Due to small numbers, category 3–5 was combined into a single group. The demographic characteristics of the study population by mFI category are displayed in Table 1. Increasing mFI category was associated with older age, African American race and obesity ($p < 0.001$). Patients undergoing laparoscopic procedures had a modestly higher mFI category than those undergoing open procedures (17% vs. 14% for category 2 and 38% vs. 35% for category 3–5 $p < 0.001$). Lower albumin levels were associated higher mFI category, but weight loss within the prior 6 months was not associated with mFI category. With regard to cancer type, 1% of patients with each of the three gynecologic cancers were classified in category 3–5. Patients with cervical cancer were more likely than patients with ovarian or uterine cancer to be in category 0. Notably, 40% of patients with uterine cancer were in mFI category 0 and 1 each in contrast to cervical cancer patients (67% and 23%, respectively in category 0 and 1) and ovarian cancer patients (58% and 32%, respectively in category 0 and 1). The distribution of patients with each cancer type and mFI category is displayed in Fig. 2.

The proportion of patients with unplanned readmission at 30 days increased with each higher mFI category (Table 2). The proportion of patients with 30-day unplanned readmissions ranged from 5.2% within the lowest mFI category to 11.7% in the highest mFI group ($p < 0.01$). Similarly, 30-day complications increased from 14.1% to 25.0% from the lowest to highest MFI category ($p < 0.01$). The individual complications codified in the data categorized by MFI are displayed in Table 2S. The most significant complications associated with higher mFI were superficial and deep incisional SSIs ($p < 0.001$ and $p = 0.03$, respectively), postoperative pneumonia (p ⟨0001), postoperative ventilator requirement >48 h ($p < 0.001$), acute renal failure and progressive renal insufficiency ($p < 0.001$ and < 0.001 respectively), postoperative stroke with neurological deficit ($p < 0.001$), cardiac arrest requiring CPR ($p < 0.001$), myocardial infarction ($p < 0.001$), bleeding with transfusion need ($p < 0.001$) and intestinal obstruction (p 0.02). As indicated, 30-day complication rates increased in a dose-response manner by MFI category. More specifically, in a subgroup multivariable analysis (including age, cancer type, race and ethnicity) to calculate adjusted odds of 30-day readmission for each cancer type, the odds ratio for 30 day readmission was 2.72 (1.80–4.12) for uterine cancer, 0.77 (0.10–6.12) for cervical cancer and 1.78 (0.78–4.06) for ovarian cancer. Patients aged 75 years and older had the highest odds of readmission (OR 3.04

Table 1
Demographic and clinical characteristics by patient modified frailty index.

Variable	Level	Modified frailty index category				
		0	1	2	3–5	p-value**
Age	18–44 (n = 3194)	79%	15%	6%	<1%	<0.001
	45–54 (n = 5060)	63%	26%	11%	<1%	
	55–64 (n = 10,208)	47%	35%	17%	1%	
	65–74 (n = 8725)	35%	44%	19%	2%	
	75+ (n = 3994)	26%	53%	19%	2%	
Race	White (n = 21,687)	46%	37%	15%	1%	<0.001
	Black (n = 2348)	29%	45%	24%	2%	
	Asian (n = 1095)	54%	30%	15%	<1%	
	Other/missing (n = 6051)	55%	31%	14%	1%	
BMI (kg/m^2)	13–19 (n = 996)	71%	23%	5%	<1%	<0.001
	20–24 (n = 5384)	69%	25%	6%	<1%	
	25–29 (n = 6985)	54%	35%	10%	<1%	
	30–34 (n = 6365)	43%	40%	16%	1%	
	35+ (n = 11,317)	32%	42%	24%	2%	
	Missing (n = 134)	55%	31%	14%	0%	
Surgical approach	Open (n = 12,140)	50%	35%	14%	1%	<0.001
	Laparoscopic (n = 19,041)	45%	38%	17%	1%	
Cancer type	Corpus Uterus (n = 20,862)	40%	40%	19%	1%	<0.001
	Cervical (n = 2968)	67%	23%	9%	1%	
	Ovarian (n = 7351)	58%	32%	9%	1%	
Smoker	No (n = 27,811)	46%	37%	16%	1%	<0.001
	Yes (n = 3370)	52%	32%	14%	2%	
Cancer stage	I (n = 18,670)	45%	37%	17%	1%	<0.001
	II (n = 3132)	45%	37%	17%	1%	
	III (n = 5963)	50%	36%	13%	1%	
	IV (n = 1116)	47%	38%	14%	1%	
	Missing (n = 2300)	56%	33%	11%	1%	
Weight Loss > 10% last six months	No (n = 30,582)	47%	37%	16%	1%	0.66
	Yes (n = 599)	47%	37%	15%	2%	
Ascites	No (n = 29,815)	46%	37%	16%	1%	<0.001
	Yes (n = 1366)	58%	31%	10%	1%	
Preoperative serum albumin	< 3.5 (n = 2248)	43%	34%	19%	3%	<0.001
	≥ 3.5 (n = 16,955)	45%	37%	16%	1%	
	Missing (n = 11,978)	49%	36%	14%	1%	
Operation time (mins)	Median (q1/q3)	156 (114/211)	152 (114/204)	156 (116/205)	154 (112 / 200)	<0.001
Overall	% (n)	46.9% (14,608)	36.5% (11,383)	15.6% (4868)	1.0% (n = 322)	

(1.48–6.24)) compared to those <45 years of age (Table 3). Median length of stay after the initial procedure was 2 days among the highest mFI group, and non-home discharge was also highest in the highest mFI category (OR 19.6% for category 3 vs. 5.7%, 4.3% and 2.1 for categories 2, 1 and 0, respectively, $p < 0.01$).

The adjusted probabilities of 30-day readmissions and 30-day complications are displayed in Figs. 1S and 2S**,** respectively. There is a statistically significant association between mFI with complications and readmissions after adjusting for other patient characteristics. The full multivariable models for these associations with mFI category are displayed in Forest plots (Fig. 3a–c). For 30-day readmissions, in addition to mFI category, a more advanced cancer stage, African American race, cervical cancer and lowest BMI level were associated with higher adjusted risk of readmission. Conversely, middle age groups, surgery after 2015, non-smokers, and laparoscopic procedures were associated with decreased likelihood of readmissions. These risk factors were similar for 30-day complications. We further assessed the adjusted odds of readmission and complications for each of the three gynecologic cancer types as shown in Fig. 3a–cS. For uterine cancer, ovarian cancer and cervical cancer, advanced cancer stage and higher mFI were significantly associated with increased odds of 30-day readmission.

Multivariate analysis results for likelihood of non-home discharge are displayed in Table 3C. In addition to mFI category, several factors were associated with non-home discharge including cancer stage, race, age, body mass index, year of surgery and laparoscopic procedures. Time to 30-day complication is displayed in Fig. 4. As indicated, rates of 30 day complications were significantly higher in mFI category 3–5 and they accelerated immediately after discharge ($p < 0.01$).

Table 3S displays results of models testing interactions of mFI by preselected patient characteristics. In general, increased mFI category was associated with increased risk for adjusted complications and readmission in each subgroup. For the outcome of readmission, the only statistically significant interaction was age and mFI category, but there was no consistent direction of the interaction effect.

4. Discussion

In this study, we demonstrate that the abbreviated 5-factor mFI predicts global postoperative morbidity (30-day readmission, 30- day complications and non-home discharge) in patients with cervical cancer, uterine cancer and ovarian cancer. Although the majority of patients were low risk (category 0 or 1 mFI), and only 1% of patients in each cancer group in the highest risk category (category 3–5), high risk patients accounted for the significant majority of patients with 30-day postoperative complications and readmissions.

The mFI utilizing 11 factors from the NSQIP database is one of the most widely reported frailty assessment tools in the surgical literature. Recent modifications of the NSQIP database variables have led to the 5 factor mFI which is adapted from the original NSQIP mFI and has shown high correlation with the 11-factor mFI across surgical subspecialties [15]. The updated 5-factor mFI has not yet been evaluated in the gynecologic oncology literature. As shown in this study, applying the 5-factor mFI to the gynecologic oncology patient population reveals a differential effect of frailty (by mFI score) on postoperative complications and readmission. Thus, the 5-factor mFI represents a simple tool for clinicians to utilize in the perioperative period. Similar to other studies, the score was predictive of perioperative outcomes reinforcing its excellent validity.

The gynecologic oncology literature is rich in studies pertaining to frailty in ovarian cancer given the complex surgical and perioperative

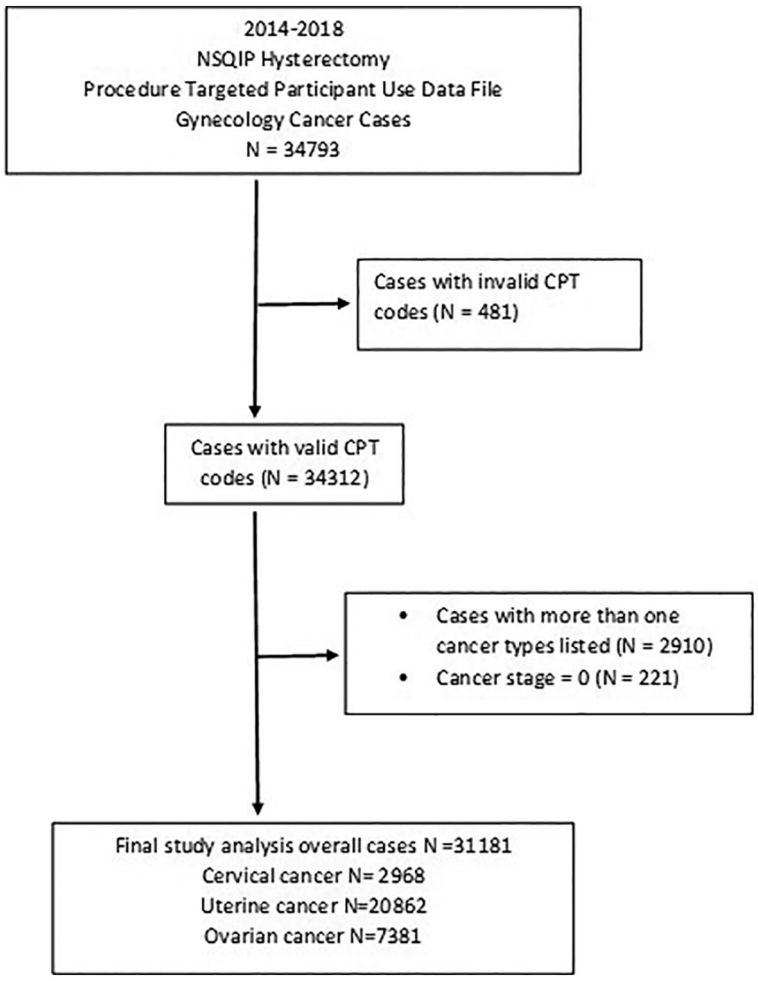

Fig. 1. Consort diagram.

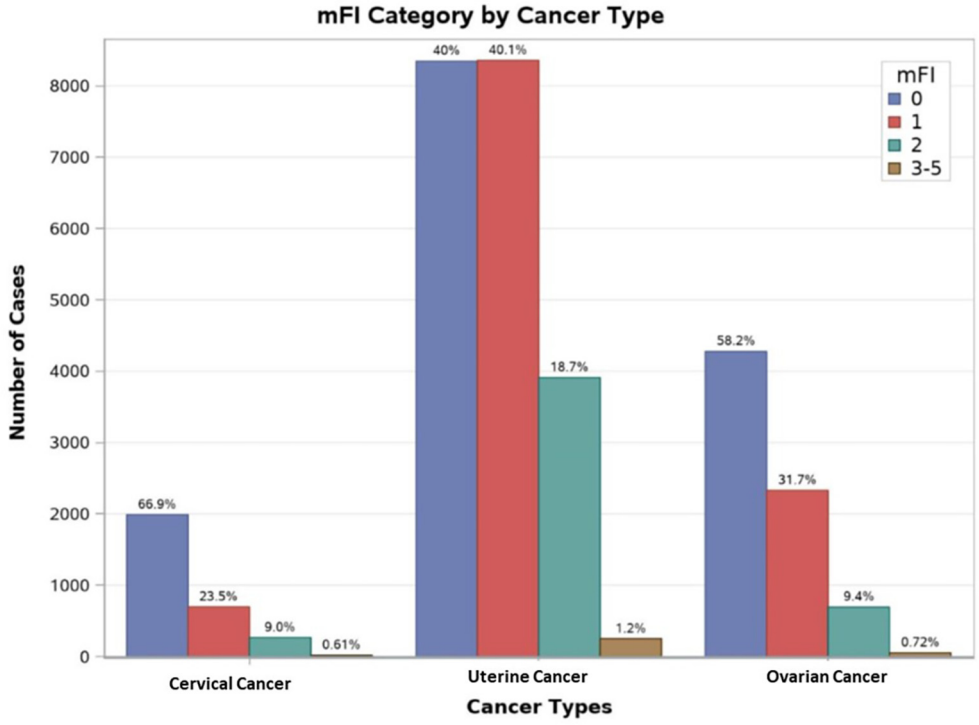

Fig. 2. Distribution of patients by mFI category and cancer type.

Table 2
Unadjusted outcome measured by modified frailty index category.

	Modified frailty index category			
	0	1	2	3–5
30-day Readmission (%)*	5.2	5.8	6.6	11.7
30-day Complication (%)*	14.1	14.5	16.4	25.0
Median LOS (Q1 / Q3)*	1 (1/3)	1 (1/3)	1 (1/3)	2 (1/5)
Non-home discharge (%)*	2.1	4.3	5.7	19.6

* Unadjusted associations of outcome measures all statistically significantly associated ($p < 0.01$) with modified frailty index category.

care these patients require [8,16–18]. Frail ovarian cancer patients are significantly more likely to die within 30 and 90 days after surgery compared to non-frail patients; one study reported a 30% mortality rate during the 90-day readmission period [16,17]. Additionally, these patients were less likely to undergo adjuvant chemotherapy after primary debulking surgery or receive chemotherapy within 42 days compared to non-frail patients, and longer time to adjuvant chemotherapy has been associated with decreased overall survival in patients with ovarian cancer and microscopic Stage IV or Stage III with residual disease after debulking surgery [19,20]. Interestingly, patients with uterine cancer had the highest odds of 30 day readmission in our study. These patients were also less likely to be in the lowest frailty category (category 0) compared to ovarian and cervical cancer patients, which is a reflection of higher rate of related comorbidities for patients with endometrial cancer. Studies pertaining to frailty in uterine cancer have explored the outcome of disease-free survival, complications and non-home discharge and found a direct correlation with higher frailty index and adverse postoperative outcomes and non-home discharge [21,22]. Reports on frailty measures in cervical cancer patients specifically have not been performed to date. As our data shows, it is important to widely apply preoperative frailty assessment to all gynecologic oncology patients regardless of surgical complexity or type of cancer with the goal of preoperative risk stratification, optimization of modifiable risk factors, counseling and tailoring of treatment strategies [8].

Uppal et al. evaluated the value of the 11-factor mFI in predicting 30-day postoperative complications using the NSQIP database between the years 2008–2011. They found higher mFI scores were associated with severe postoperative morbidity, and that mFI along with albumin were predictive of ICU admissions. However, there was no description of outcomes within each cancer type in the Uppal stud, and that data was obtained form a time period where "enhanced recovery" surgical care guidelines had not been adopted, compared to our study period of 2014–2018. Additionally other outcomes such as readmissions and non-home discharge were not reported by Uppal et al.

We acknowledge the availability of multiple risk prediction tools for frailty and geriatric assessment, some of which have been endorsed by international societies such as the International Society of Geriatric Oncology (SIOG), American Society of Clinical Oncology (ASCO) and Eastern Cooperative Oncology Group (ECOG). According to systematic reviews and panel consensus guidelines by the SIOG in 2015 and ASCO in 2018, it was recommended that a geriatric assessment be utilized in patients older than 65 to "identify vulnerabilities" including assessment of function, comorbidities, falls, cognition and nutrition [11,23]. A multidisciplinary team approach including geriatric specialists certainly allows for an individualized plan for the management of medical issues that may complicate surgery and chemotherapy [23]. Unfortunately, a survey administered to 1277 cancer providers reported that only 53% were aware of the ASCO Geriatric Oncology guidelines and utilized a geriatric assessment tool in their elderly patients. Reported barriers were lack of resources (time and staff), lack of knowledge or awareness, and uncertainly about the use of tools [24]. This highlights the need for education about geriatric assessments and the use of risk assessment tools to triage patients to comprehensive geriatric assessment or routine assessment. In a busy clinical practice, screening tools, such as the 5-factor mFI can be an effective method to assess frailty. Filippova et al. reported favorable outcomes for geriatric co-management of patients undergoing surgical cytoreduction for ovarian cancer with the median age in their cohort of 79 (range 74–88) [25]. Further efforts are needed to integrate geriatric co-management into perioperative care are of all gynecologic oncology patients.

Table 3
Adjusted odds ratios of modified frailty index category with outcomes by patient subgroups.

Outcome	Variable	Patient subgroup	Modified frailty index category (reference level = 0)		
			1	2	3–5
30-day Readmission	Cancer Type	Uterine cancer	1.27 (1.08–1.48)	1.46 (1.21–1.76)	2.72 (1.80–4.12)
		Cervical	1.33 (0.91–1.94)	1.12 (0.62–2.03)	0.77 (0.10–6.12)
		Ovarian	1.05 (0.85–1.30)	1.41 (1.06–1.88)	1.78 (0.78–4.06)
	Age*	18- < 45	1.48 (1.00–2.21)	0.60 (0.25–1.44)	**
		45- < 55	1.05 (0.78–1.41)	1.39 (0.94–2.04)	2.18 (0.48–10.04)
		55- < 65	1.50 (1.21–1.85)	1.69 (1.30–2.19)	2.39 (1.16–4.94)
		65- < 75	1.01 (0.81–1.26)	1.44 (1.11–1.86)	1.96 (1.11–3.46)
		75+	1.07 (0.77–1.49)	0.95 (0.63–1.45)	3.04 (1.48–6.24)
	Race/Ethnicity	White	1.18 (1.02–1.36)	1.50 (1.26–1.79)	2.80 (1.84–4.26)
		Black	0.94 (0.64–1.38)	0.95 (0.61–1.49)	1.30 (0.47–3.60)
		Asian	1.46 (0.78–2.73)	1.35 (0.56–3.23)	**
		Other	1.30 (0.98–1.72)	1.25 (0.86–1.83)	1.60 (0.56–4.58)
30-day Complications	Cancer Type	Uterine	1.21 (1.08–1.35)	1.40 (1.23–1.60)	2.01 (1.43–2.82)
		Cervical	1.12 (0.84–1.50)	1.72 (1.16–2.55)	5.73 (2.11–15.52)
		Ovarian	1.00 (0.88–1.13)	1.48 (1.23–1.78)	1.71 (0.96–3.06)
	Age	18- < 45	1.14 (0.85–1.54)	0.96 (0.59–1.56)	**
		45- < 55	1.17 (0.96–1.42)	1.61 (1.24–2.09)	3.48 (1.15–10.53)
		55- < 65	1.13 (0.98–1.31)	1.41 (1.18–1.68)	1.34 (0.75–2.40)
		65- < 75	1.00 (0.87–1.17)	1.33 (1.10–1.60)	2.29 (1.50–3.48)
		75+	1.30 (1.04–1.62)	1.58 (1.20–2.08)	2.81 (1.55–5.07)
	Race/Ethnicity	White	1.13 (1.03–1.25)	1.48 (1.31–1.68)	2.23 (1.48–3.13)
		Black	1.03 (0.78–1.36)	1.31 (0.94–1.82)	1.78 (0.80–3.94)
		Asian	0.89 (0.56–1.41)	1.14 (0.62–2.08)	**
		Other	1.14 (0.96–1.36)	1.29 (1.02–1.62)	2.00 (1.07–3.74)

* Interaction p-value<0.05.
** No sufficient sample size to estimate adjusted odds ratio.

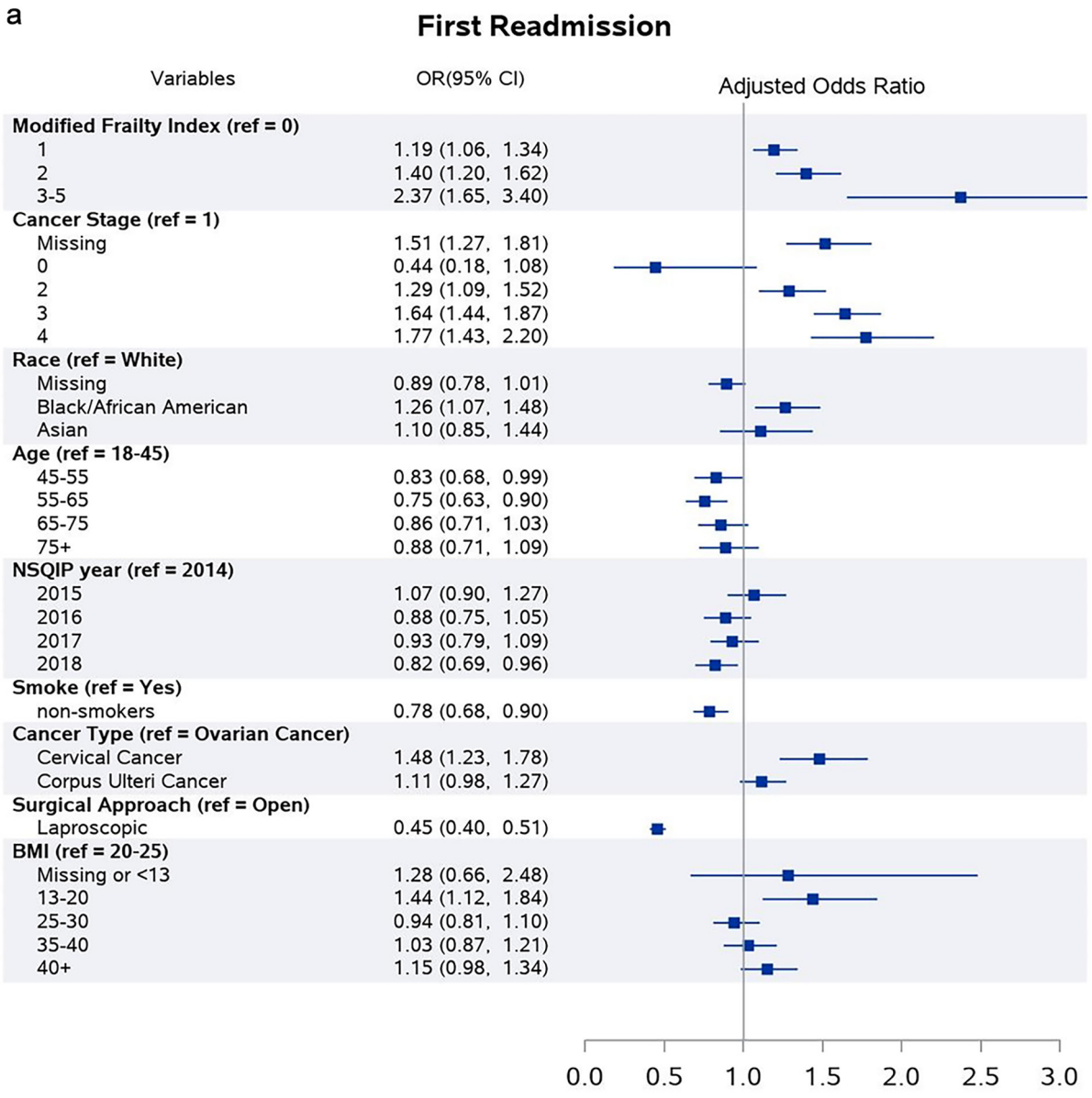

Fig. 3. a: Forest plot of the adjusted odds of likelihood of readmission. b: Forest plot of the adjusted odds of likelihood of complications. c: Forest plot of multivariable models for non-home discharge.

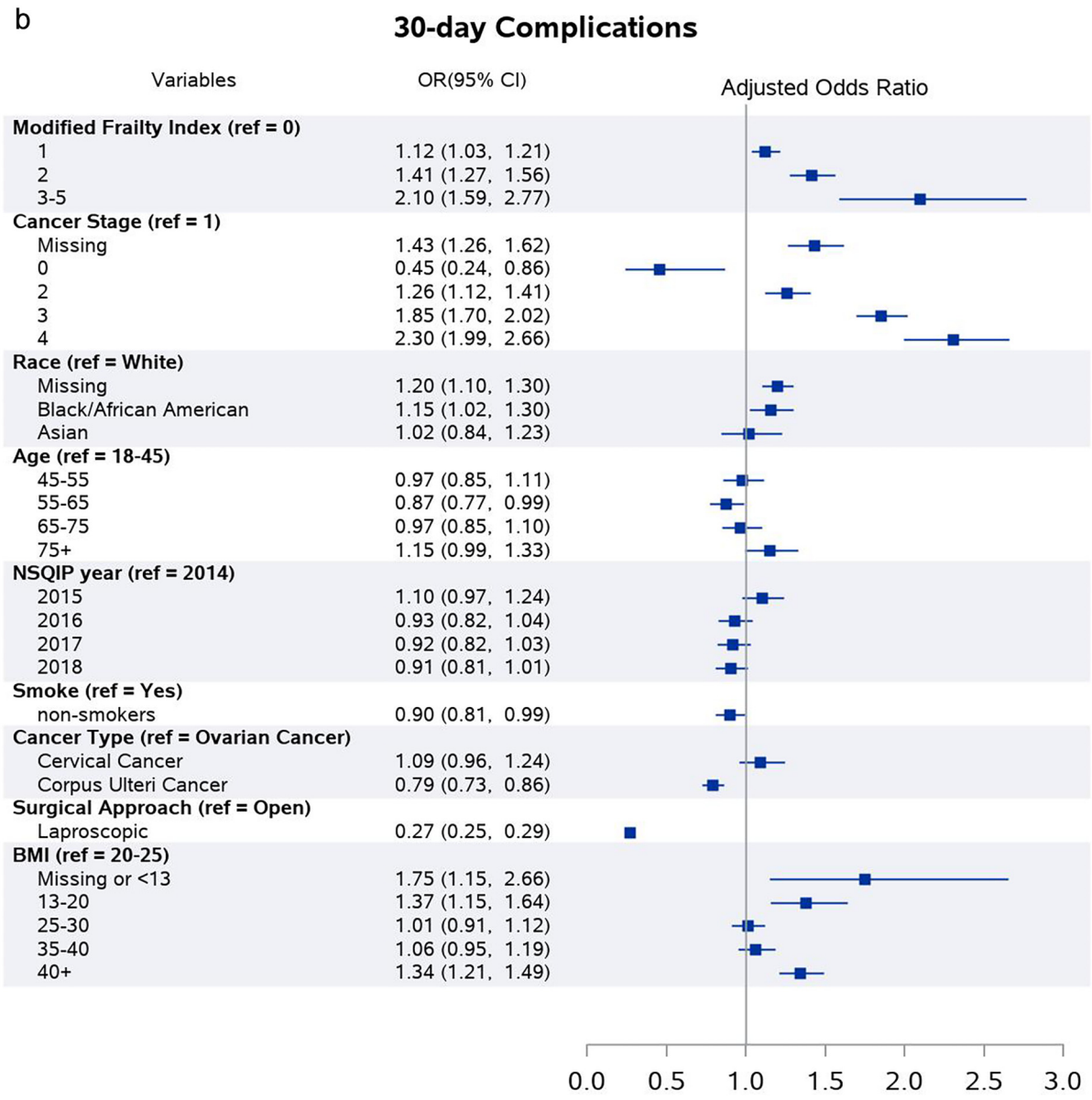

Fig. 3 (*continued*).

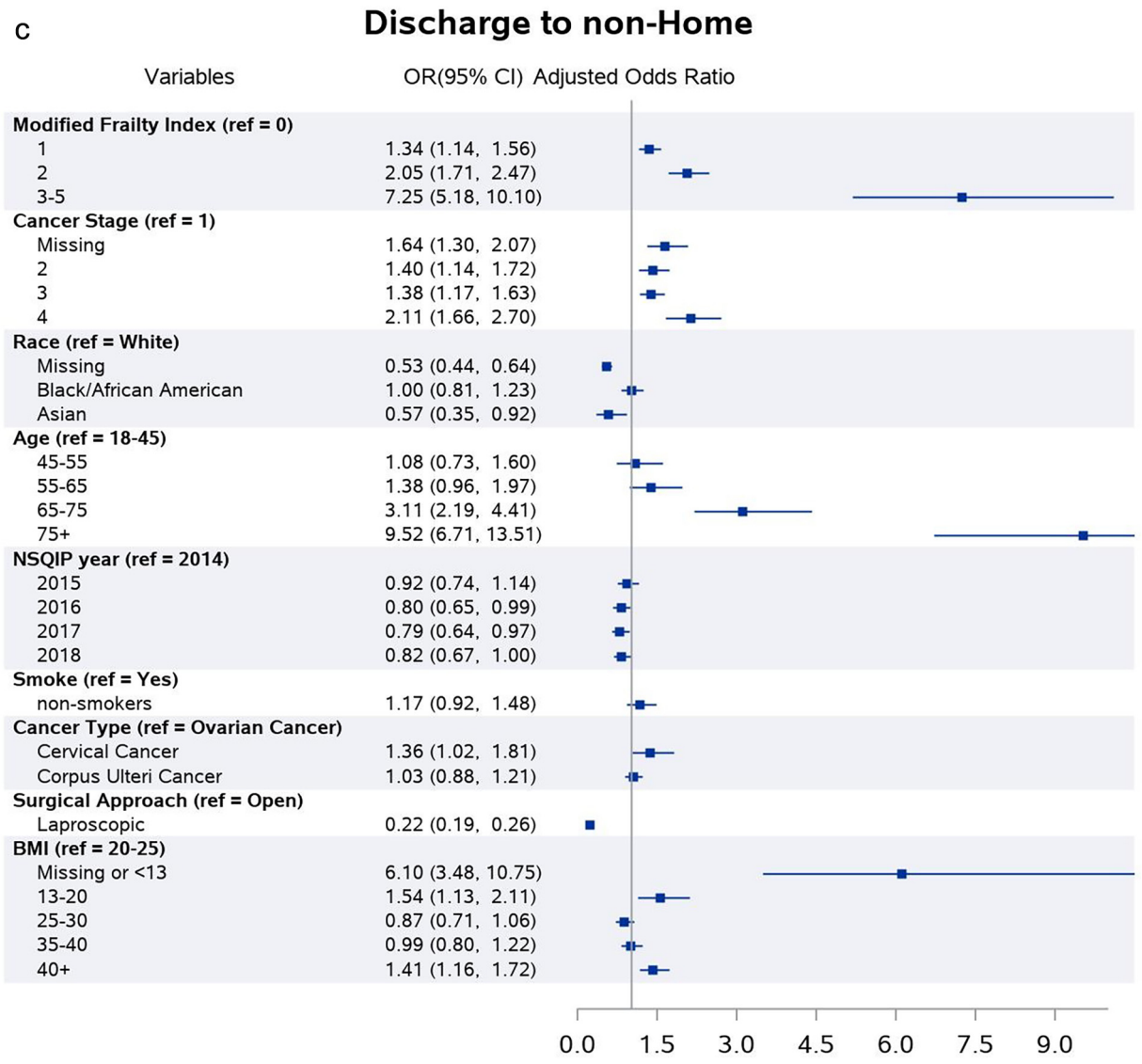

Fig. 3 (*continued*).

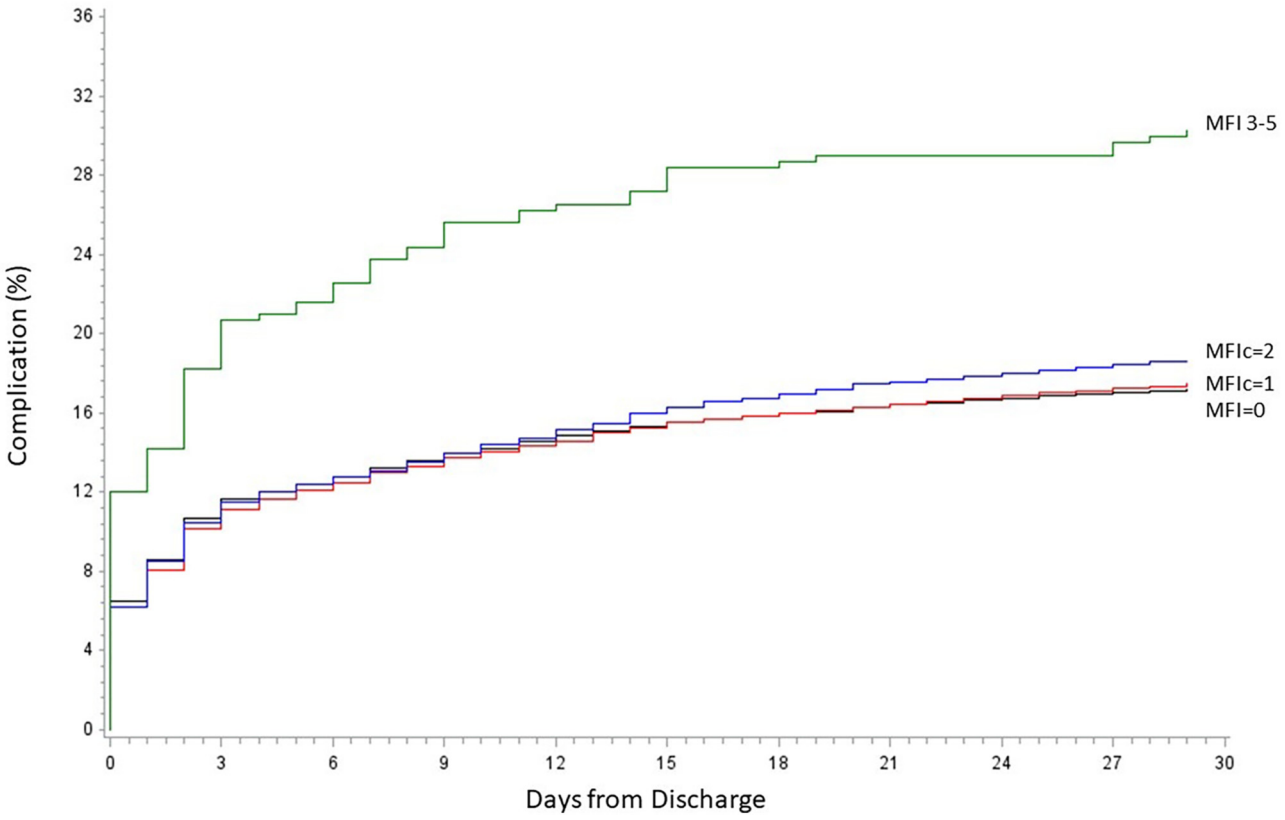

Fig. 4. Time to complication from discharge by modified frailty index category**. (* Log-rank p-value <0.01 for association of time to complication with modified frailty index level/ **Modified Frailty Index (MFI) categories: 0 = (MFI = 0), 1 = (0.2 ≤ MFI ≤ 0.25), 2 = (MFI = 0.4), 3–5 = (MFI ≥ 0.5).)

Use of the mFI could identify patients who may benefit from prehabilitation services. Multimodal prehabilitation is an evolving practice in surgical specialties that focuses on enhancing functional capacity prior to surgery by incorporating physical conditioning with nutrition support and psychological preparation [26–28]. This concept has been applied to patients undergoing complex abdominal surgery, but has not yet been fully integrated into the care of gynecologic oncology patients. Studies reported to date have been heterogeneous but have nevertheless reported improvements in physical and psychological outcomes after prehabilitation [29]. Miralpeix et al. described a multimodal prehabilitation program for gynecologic oncology patients that can be integrated into Enhanced Recovery after Surgery (ERAS) guidelines [28]. It is plausible that prehabiliation could have an impact that extends beyond improving physical capacity to reducing inflammation and boosting immunity that warrant further translational evaluation.

Limitations of this study include the retrospective nature of data obtained from a large surgical database such as NSQIP. Relevant outcomes that could not be assessed through this study are overall survival, disease free survival and delays in chemotherapy. In addition, patients included in the study were identified according to “hysterectomy” as the primary procedure performed. We acknowledge the variability in extent of surgery performed and its associated surgical decision making may have been influenced by age, comorbidities and frailty factors. Nevertheless, we were able to identify a group of highly vulnerable surgical patients through the 5-factor mFI. Prospective studies utilizing the mFI that triage patients to geriatric assessment, geriatric co-management and prehabilitation are urgently needed to identify knowledge gaps and serve the needs of the aging patient population. In addition, early postoperative follow up utilizing telemedicine services is likely to be improve postoperative outcomes and quality of care. Ultimately, this is an important step toward mitigation of morbidity associated with surgery and cancer therapies and improving patient-reported outcomes.

Author contribution

MAH: Conceptualization and design of study, data curation, formal analysis, methodology, writing - original draft.

JS: Conceptualization and design of study, data curation, formal analysis, methodology, interpretation of results, writing, writing-original draft, writing - review.

AT: Data curation, formal analysis, methodology

JK and CM: Review and editing of manuscript.

Declaration of Competing Interest

The authors have no conflicts of interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ygyno.2022.07.003.

References

[1] A. Clegg, J. Young, S. Iliffe, M.O. Rikkert, K. Rockwood, Frailty in elderly people, Lancet 381 (2013) 752–762.
[2] M. Cesari, G. Gambassi, G. Abellan van Kan, B. Vellas, The frailty phenotype and the frailty index: different instruments for different purposes, Age Ageing 43 (2014) 10–12.
[3] M.A. Makary, et al., Frailty as a predictor of surgical outcomes in older patients, J. Am. Coll. Surg. 210 (2010) 901–908.
[4] A. Kumar, et al., Inflammatory and nutritional serum markers as predictors of perioperative morbidity and survival in ovarian cancer, Anticancer Res. 37 (2017) 3673–3677.
[5] M.C. Shinall, et al., Association of preoperative patient frailty and operative stress with postoperative mortality, JAMA Surg. 155 (2020) e194620.
[6] J.S.L. Partridge, D. Harari, J.K. Dhesi, Frailty in the older surgical patient: a review, Age Ageing 41 (2012) 142–147.

[7] F.N. de Arruda, et al., Determinants of health-related quality of life in elderly ovarian cancer patients: the role of frailty and dependence, Gynecol. Oncol. 153 (2019) 610–615.
[8] V. Di Donato, et al., Preoperative frailty assessment in patients undergoing gynecologic oncology surgery: a systematic review, Gynecol. Oncol. 161 (2021) 11–19.
[9] N. Geessink, et al., Frailty and quality of life among older people with and without a cancer diagnosis: findings from TOPICS-MDS, PLoS One 12 (2017) e0189648.
[10] J.G. Wilkes, et al., Frailty cost: economic impact of frailty in the elective surgical patient, J. Am. Coll. Surg. (2019) https://doi.org/10.1016/j.jamcollsurg.2019.01.015.
[11] L. Decoster, et al., Screening tools for multidimensional health problems warranting a geriatric assessment in older cancer patients: an update on SIOG recommendations†, Ann. Oncol. Off. J. Eur. Soc. Med. Oncol. 26 (2015) 288–300.
[12] K. Rockwood, M. Andrew, A. Mitnitski, A comparison of two approaches to measuring frailty in elderly people, J. Gerontol. A Biol. Sci. Med. Sci. 62 (2007) 738–743.
[13] D.E. Hall, et al., Development and initial validation of the risk analysis index for measuring frailty in surgical populations, JAMA Surg. 152 (2017) 175–182.
[14] H. Wildiers, et al., International Society of Geriatric Oncology consensus on geriatric assessment in older patients with cancer, J. Clin. Oncol. 32 (2014) 2595–2603.
[15] S. Subramaniam, J.J. Aalberg, R.P. Soriano, C.M. Divino, New 5-factor modified frailty index using American College of Surgeons NSQIP data, J. Am. Coll. Surg. 226 (2018) 173–181.e8.
[16] A. Kumar, et al., Functional not chronologic age: frailty index predicts outcomes in advanced ovarian cancer, Gynecol. Oncol. 147 (2017) 104–109.
[17] T.Y. Sia, T. Wen, S. Cham, A.M. Friedman, J.D. Wright, Effect of frailty on postoperative readmissions and cost of care for ovarian cancer, Gynecol. Oncol. 159 (2020) 426–433.
[18] T. Yao, et al., Frailty in ovarian cancer identified the need for increased postoperative care requirements following cytoreductive surgery, Gynecol. Oncol. 153 (2019) 68–73.
[19] K.S. Tewari, J.J. Java, R.N. Eskander, B.J. Monk, R.A. Burger, Early initiation of chemotherapy following complete resection of advanced ovarian cancer associated with improved survival: NRG Oncology/Gynecologic Oncology Group study, Ann. Oncol. Off. J. Eur. Soc. Med. Oncol. 27 (2016) 114–121.
[20] D.M. Narasimhulu, et al., Frailty is a determinant of suboptimal chemotherapy in women with advanced ovarian cancer, Gynecol. Oncol. 158 (2020) 646–652.
[21] P. Adedayo, K. Resnick, S. Singh, Preoperative frailty is a risk factor for non-home discharge in patients undergoing surgery for endometrial cancer, J. Geriatr. Oncol. 9 (2018) 513–515.
[22] J.A. Driver, A.N. Viswanathan, Frailty measure is more predictive of outcomes after curative therapy for endometrial cancer than traditional risk factors in women 60 and older, Gynecol. Oncol. 145 (2017) 526–530.
[23] S.G. Mohile, et al., Practical assessment and Management of Vulnerabilities in older patients receiving chemotherapy: ASCO guideline for geriatric oncology, J. Clin. Oncol. 36 (2018) 2326–2347.
[24] W. Dale, et al., How is geriatric assessment used in clinical practice for older adults with Cancer? A survey of Cancer providers by the American Society of Clinical Oncology, JCO Oncol. Pract. 17 (2021) 336–344.
[25] O.T. Filippova, et al., Geriatric co-management leads to safely performed cytoreductive surgery in older women with advanced stage ovarian cancer treated at a tertiary care cancer center, Gynecol. Oncol. 154 (2019) 77–82.
[26] F. Carli, R. Brown, S. Kennepohl, Prehabilitation to enhance postoperative recovery for an octogenarian following robotic-assisted hysterectomy with endometrial cancer, Can. J. Anaesth. 59 (2012) 779–784.
[27] D.Z.H. Levett, M. Edwards, M. Grocott, M. Mythen, Preparing the patient for surgery to improve outcomes, Best Pract. Res. Clin. Anaesthesiol. 30 (2016) 145–157.
[28] E. Miralpeix, G. Mancebo, S. Gayete, M. Corcoy, J.-M. Solé-Sedeño, Role and impact of multimodal prehabilitation for gynecologic oncology patients in an enhanced recovery after surgery (ERAS) program, Int. J. Gynecol. Cancer 29 (2019) 1235–1243.
[29] S. Schneider, R. Armbrust, C. Spies, A. du Bois, J. Sehouli, Prehabilitation programs and ERAS protocols in gynecological oncology: a comprehensive review, Arch. Gynecol. Obstet. 301 (2020) 315–326.