Gynecologic Oncology 152 (2019) 304–309

Contents lists available at ScienceDirect

Gynecologic Oncology

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

Chemotherapy in older adult gynecologic oncology patients: Can a phenotypic frailty score predict tolerance?

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HIGHLIGHTS

- Chronologic age is a poor predictor of chemotherapy tolerance or completion, thus new tools to predict outcomes are needed.
- Frailty predicts inability to complete standard adjuvant chemotherapy, thus may help direct less aggressive treatment.
- Frailty does not have utility for predicting ability to complete neoadjuvant chemotherapy.
- Among frailty domains, walk time is most associated with ability to complete chemotherapy.
- Frailty does not predict chemotherapy tolerance as measured by transfusion, admission, cycle delay, or dose reduction.

ARTICLE INFO

Article history:
Received 3 October 2018
Received in revised form 21 November 2018
Accepted 23 November 2018
Available online 28 November 2018

Keywords:
Frailty
Chemotherapy tolerance
Elderly
Older adult

ABSTRACT

Objective. Evaluate the ability of an office-administered phenotypic frailty assessment to predict chemotherapy tolerance in older adult gynecologic oncology patients, and describe practice patterns for chemotherapy administration in this population.

Methods. Prospective, single-institution cohort study of gynecologic oncology patients 65 or older initiating chemotherapy. Phenotypic frailty testing at an office visit encompassed components of two validated frailty assessments: Fried Score (physical testing and patient response) and FRAIL Scale (patient response only). Patients were followed through three cycles of neoadjuvant chemotherapy or six cycles of adjuvant chemotherapy. Standard statistics examined the relationship of frailty to chemotherapy regimen, ability to complete chemotherapy, and complications.

Results. Eighty patients were included, 65% with ovarian and 34% with endometrial cancer. On average 57% of patients were fit, 32% intermediately frail, and 11% frail. 68% received adjuvant chemotherapy versus 32% neoadjuvant. The majority (81%) received IV chemotherapy on a 21-day cycle and 81% initially received a regimen consistent with standard-of-care chemotherapy (SOCC). Age was not associated with receiving SOCC, or tolerance or completion of chemotherapy. Frailty was associated with non-initiation of SOCC in all patients and inability to complete SOCC in adjuvant patients. Complications and regimen alterations were common but were not associated with frailty.

Conclusions. There is a need to develop tools to help physicians predict chemotherapy tolerance among older adult gynecologic oncology patients in order to prevent both under- and over-treatment while minimizing morbidity. However, in this study phenotypic frailty assessment had limited predictive utility. Among adjuvant chemotherapy patients, frailty was associated with inability to complete SOCC and thus may be helpful in selecting patients appropriate for less aggressive chemotherapy regimens.

1. Introduction

Ovarian and endometrial cancer are the two most common gynecologic malignancies, with an estimated 76,160 new cancer cases and 24,350 deaths in the United States in 2015 [1]. These diseases

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https://doi.org/10.1016/j.ygyno.2018.11.031
0090-8258/

disproportionately affect older women, with 40–45% of new diagnoses and 65% of deaths occurring in women over the age of 65 [2]. Older patients have lower overall survival even when corrected for stage, residual disease and performance status [3,4], however they are also less likely to receive standard chemotherapy [5–7]. Older adult cancer patients are also underrepresented in the clinical trials upon which much standard-of-care is based [8,9], making treatment decisions more challenging.

There is speculation that worse survival in this group could in part be the result of inadequate treatment reflecting clinician hesitancy towards aggressive treatment in older adults. Physician assessment of patient ability to tolerate treatment often relies heavily on patient age [10], however, emerging evidence suggests that age alone is a poor predictor of chemotherapy tolerance [4,11–13] and that older adults receiving standard chemotherapy have outcomes similar to their younger counterparts [11,14,15].

Frailty is a complex biologic syndrome of decreased reserve and inability to tolerate stressors that causes vulnerability to adverse health outcomes [16,17]. It is related to, but distinct from, disability and comorbidity [18]. In the general population the prevalence of frailty among women over the age of 65 is about 25%, and this increases to about 45% in women over 85 [19]. In studies within the gynecologic oncology population the prevalence of frailty has been 16–25% [20,21]. A systematic review of frailty among older cancer patients found that frail cancer patients had an increased risk of mortality, postoperative complications, and chemotherapy intolerance [22]. In advanced ovarian cancer patients who underwent primary debulking, frailty was associated with postoperative complications, postoperative death, and worse overall survival [21]. Frailty has been suggested as a tool to help guide chemotherapy treatment decisions in older adults [23]. Recent studies in both colorectal cancer [24] and lung cancer [25] have examined this approach as a way to decrease toxicity and increase chemotherapy adherence, with promising results.

There are three common and validated approaches to assessing frailty: the phenotype model, the cumulative deficit model, and the comprehensive geriatric assessment (CGA) [22]. The comprehensive geriatric assessment (CGA) is a complex multi-domain geriatric evaluation and treatment process that has been shown to predict chemotherapy toxicity risk as well as improve chemotherapy tolerance [26]. Both the NCCN and ASCO recommend the incorporation of a geriatric assessment into chemotherapy counseling and decision-making [27,28]. However, both the CGA and the cumulative deficit model require significant time and expertise, which presents a barrier to effective implementation. Numerous tools are currently being investigated to more efficiently predict chemotherapy tolerance in older adults. In gynecologic oncology, the Chemotherapy Risk Assessment Scale for High-Age Patients (CRASH) score incorporates various functional, nutritional, and lab values and has been shown to predict risk of severe chemotherapy toxicity [29]. In broader groups of older adult cancer patients, the Cancer and Aging Research Group (CARG) tool incorporates clinical information, lab values, and patient questions and has also been shown to predict the risk of severe chemotherapy toxicity [30]. Utilization of a purely phenotypic frailty assessment has not been prospectively examined in gynecologic oncology and is appealing because it is easy to perform, does not require extensive expertise or lab work, and has been shown to be both acceptable to patients and feasible to perform in a busy gynecologic oncology clinic [20].

This research aims to test the ability of phenotypic frailty assessment to predict older adult tolerance of chemotherapy in order to improve the effectiveness and quality of cancer treatment for gynecologic cancer patients over the age of 65. In this study we prospectively assess the ability of two phenotypic frailty assessments administered during an office visit to predict older adult patient tolerance of platinum and taxane-based chemotherapy. We assess the original phenotypic model, the Fried Score which requires both physical testing and patient responses, as well as the FRAIL Scale, which requires only patient responses. We examine the various components that make up these two well-validated phenotypic frailty assessments to better understand which components are predictive of tolerance in our unique population. We also describe the patterns of chemotherapy administration for this population at our institution.

2. Materials and methods

We conducted a prospective, single-institution, cohort study of older adult gynecologic oncology patients planning to initiate chemotherapy. Eligibility criteria included age 65 or older, chemotherapy naïve (may have received radiation in the past), and plan to receive neoadjuvant or adjuvant chemotherapy with a platinum and/or taxane. Bevacizumab was permitted but was not considered in the assessment of drug or dose changes. Patients were excluded if they had a medical condition that could invalidate the frailty assessment, such as a history of Parkinson's disease, stroke, current use of Carbidopa/Levodopa, or neurologic disorder affecting grip strength or ambulation [17]. Enrollment occurred at a large academic medical center between 1/2016 and 1/2018. Chemotherapy was administered by a gynecologic oncologist or a medical oncologist. This study was approved by the University of Pittsburgh Institutional Review Board and all participants gave informed, written consent.

Participants were consented and screened by a study investigator and then asked to answer a series of questions as well as perform physical tests of grip strength and walking speed (see Appendix A). Physicians were blinded to the results of the frailty assessments. Dominant hand maximal grip strength was measured by averaging three separate grasps of a hand-held JAMAR dynamometer. Walking speed was measured by averaging three trials of walking 15 ft at a normal pace. Testing encompassed the components of two validated frailty assessments: the Fried Score [17] and the FRAIL Scale [31,32]. The Fried Score uses both questions and physical testing to evaluate frailty in five domains: weight loss, exhaustion, grip strength, walk time, and physical activity. The FRAIL scale uses only questions answered by the patient to evaluate frailty in five domains: loss of weight, fatigue, resistance, ambulation, and illnesses. In both assessments each domain receives a dichotomous score of 0 or 1, which are summed to give a final score. Patients with final score of 0–1 are considered fit, score of 2–3 are considered intermediately frail, and score of 4–5 are considered frail. Details of each domain are listed in Table 1.

Charts were reviewed for age, race, date of diagnosis, cancer type and stage, and surgery performed. Patients were then followed prospectively from enrollment through three cycles of neoadjuvant chemotherapy (NACT) or six cycles of adjuvant chemotherapy (ACT). Completion of NACT was defined as three cycles based on the standard timing for consideration of interval debulking and thus the clinical relevance of ability to complete three cycles. Chemotherapy drug(s), dose(s), and date(s) received were recorded for each cycle. Drug changes, dose changes, and cycle delays were also recorded. Information was collected regarding receipt of blood transfusion, need for hospitalization, death during chemotherapy, and reason for discontinuation of chemotherapy when applicable.

For the purposes of this study we defined Standard-of-Care Chemotherapy (SOCC) as one of the following regimens: 1) Standard IV - IV Carboplatin AUC 5 or 6 + IV Paclitaxel 175 mg/m2 every 21 days [33,34] *or* 2) Dose Dense - IV Carboplatin AUC 5 or 6 every 21 days + IV Paclitaxel 80 mg/m2 days 1, 8, 15 [35] *or* 3) IV/IP - any intraperitoneal regimen with a platinum and taxane on a 21 day cycle. *Completion of SOCC* was defined as receiving either three cycles of neoadjuvant SOCC or six cycles of adjuvant SOCC. *Completion of any regimen chemotherapy* was defined as receiving either three cycles of any neoadjuvant chemotherapy or six cycles of any adjuvant chemotherapy regardless of drug choice, dosing, or route of administration. *Completion of initial regimen of chemotherapy* was defined as receiving the same chemotherapy

Table 1
Frailty assessments with brief descriptions of included domains [18,28,29].

Fried score		FRAIL scale	
Weight loss	Self report of unintentional weight loss >10 pounds over the prior year	Loss of weight	Self-report of current weight compared to weight one year prior
Exhaustion	Self report of often feeling everything is an effort and/or inability to "get going"	Fatigue	Self-report of feeling tired over the preceding 4 weeks
Grip strength	Average of 3 trials of grip strength using a hand held dynamometers	Resistance	Self-report of difficulty walking up 10 steps
Walk time	Average of 3 trials of walking 15 ft at a normal pace	Ambulation	Self-report of difficulty walking several hundred yards
Physical activity	Kcals of energy expended weekly based on patient report of physical activities over prior 2 weeks	Illnesses	Self-report of presence of a diagnosis of 11 possible health conditions

regimen for all three cycles neoadjuvant or all six cycles adjuvant chemotherapy.

Descriptive statistics using means and standard deviations for continuous variables and frequency and proportions for categorical variables were conducted to describe demographic characteristics, chemotherapy regimens, and completion of chemotherapy by frailty category. Fisher's Exact or Pearson's Chi-square tests were conducted for associations across categorical variables. As the focus of this study is largely exploratory, we make no corrections for multiple comparisons. P value <0.05 was considered significant. All analyses were conducted in SPSS software (IBM Corp. Released 2016. IBM SPSS Statistics for Windows, Version 24.0. Armonk, NY: IBM Corp).

3. Results

Eighty-four patients were enrolled and 80 were included in the analysis. Reasons for exclusion included two patients ultimately deciding against adjuvant chemotherapy (ACT), one electing to transition to hospice prior to receiving any neoadjuvant chemotherapy (NACT), and one with a history of chemotherapy that was missed on screening. No patients were lost to follow-up. Mean age was 72 (range 65–87, SD = 6) and the majority of patients were white (99%) and had ovarian cancer (65%). Using the FRAIL scale, 60% of the patients were fit, 28% intermediately frail, and 13% frail. Using the Fried Score 54% of the patients were fit, 36% intermediately frail, and 10% frail. Please see Table 2 for demographics and breakdown by frailty categories. Of note, one patient undergoing adjuvant standard IV treatment died unexpectedly during the study period and no cause of death was identified.

Table 3 shows information on the receipt of chemotherapy and frailty category. ACT was given to 68% of participants. By the FRAIL scale 67% of these patients were fit, 20% intermediately frail, and 13% frail. By the Fried Score 59% of these patients were fit, 33% intermediately frail, and 7% frail. NACT was given to 33% of participants. By the FRAIL scale 46% of these patients were fit, 42% intermediately frail, and 12% were frail. By the Fried Score 42% of these patients were fit, 42% intermediately frail, and 15% were frail. Chemotherapy regimens varied, with the majority of patients (81%) receiving IV chemotherapy on a 21-day cycle. Of all patients, 81% were initially started on SOCC including 73% of the NACT group and 85% of the ACT group. Among the 15 patients not started on SOCC, six (40%) received decreased weekly dosing of carboplatin and paclitaxel consistent with the MITO 7 protocol [36], seven (47%) received carboplatin AUC 5 or 6 with reduced dose paclitaxel, one (7%) received reduced dose carboplatin and paclitaxel given on a 21-day cycle, and one (7%) received single-agent carboplatin AUC 4. Within the NACT group 46% completed at least 3 cycles of SOCC, 89% completed at least 3 cycles of any chemotherapy, and 65% completed at least 3 cycles of the chemotherapy started initially. Within the ACT group 67% completed at least 6 cycles of SOCC, 89% completed at least 6 cycles of any chemotherapy, and 69% completed at least 6 cycles of the chemotherapy started initially.

Demographics and frailty categories were examined to identify factors associated with physician decision not to initiate SOCC. Age was

Table 2
Participant demographics and frailty categories.

Characteristic		FRAIL scale category, n(%)			Fried score category (n,%)		
Total participants, n = 80		Frail	Intermediate frailty	Fit	Frail	Intermediate frailty	Fit
		10	22	48	8	29	43
Age	Mean 72, SD6						
65–70	40 (50)	4 (40)	11 (50)	25 (52)	2 (25)	12 (41)	26 (60)
71–80	29 (36)	5 (50)	7 (32)	17 (35)	5 (63)	10 (34)	14 (33)
>80	11 (14)	1 (10)	4 (18)	6 (13)	1 (13)	7 (24)	3 (7)
Cancer site							
Ovarian/FT/PPC	52 (65)	6 (60)	18 (82)	28 (58)	5 (63)	23 (79)	24 (56)
Endometrial	27 (34)	4 (40)	4 (18)	19 (40)	3 (38)	5 (17)	19 (44)
Dual primary	1 (1)	0 (0)	0 (0)	1 (2)	0 (0)	1 (3)	0 (0)
Race							
White	79 (99)	10 (100)	22 (100)	47 (98)	8 (100)	29 (100)	42 (98)
Black	1 (1)	0 (0)	0 (0)	1 (2)	0 (0)	0 (0)	1 (2)
Surgery type							
Open	32 (40)	7 (70)	8 (36)	17 (35)	3 (38)	15 (52)	14 (33)
Minimally invasive	25 (31)	0 (0)	4 (18)	21 (44)	1 (13)	5 (17)	19 (44)
None	23 (29)	3 (30)	10 (45)	10 (21)	4 (50)	9 (31)	10 (23)
Surgery extent							
Standard[a]	46 (58)	6 (60)	10 (45)	30 (63)	4 (50)	12 (42)	30 (74)
Radical[b]	11 (14)	1 (10)	2 (9)	8 (17)	0 (0)	8 (28)	3 (7)
None	23 (29)	3 (30)	10 (45)	10 (21)	4 (50)	9 (31)	10 (23)

FT: fallopian tube; PPC: primary peritoneal cancer.
[a] Any procedures not identified as radical below.
[b] Identified as bowel resection, ureteral resection, diaphragmatic stripping, splenectomy.

Table 3
Receipt of chemotherapy and frailty categories.

		FRAIL scale category, n(%)				Fried score category, n(%)			
		Frail	Intermediately frail	Fit	*p* value	Frail	Intermediately frail	Fit	*p* value
Total participants	80 (100)	10 (13)	22 (28)	48 (60)		8 (10)	29 (36)	43 (54)	
Chemo setting									
NACT	26 [33]	3 (12)	11 (42)	12 (46)		4 (15)	11 (42)	11 (42)	
ACT	54 [68]	7 (13)	11 (20)	36 (67)		4 (7)	18 (33)	32 (59)	
Initial regimen									
Any SOCC	65 [81]	6 [60]	15 [68]	44 [92]		2 [25]	24 [83]	39 [91]	
IV q21 day	56 [86]	6 [100]	13 [87]	37 [84]		2 [100]	20 [83]	34 [87]	
Dose dense	6 [9]	0 [0]	2 [13]	4 [9]		0 [0]	4 [17]	2 [5]	
IV/IP	3 [5]	0 [0]	0 [0]	3 [7]		0 [0]	0 [0]	3 [8]	
Reduced dose	15 [19]	4 [40]	7 [32]	4 [8]		6 [75]	5 [17]	4 [9]	
SOCC initially	65 [81]	6 [60]	15 [68]	44 [92]		2 [25]	24 [83]	39 [91]	
NACT, n = 26	19 (73)	3 (16)	5 (26)	11 (58)		2 (11)	9 (47)	8 (42)	
ACT, n = 54	46 (85)	3 (7)	10 (22)	33 (72)		0 (0)	15 (33)	31 (67)	
SOCC non-initially	15 [19]	4 [40]	7 [32]	4 [8]	0.008	6 [75]	5 [17]	4 [9]	<0.001

* () indicates the row percentage, [] indicates the column percentage.

not associated with non-initiation of SOCC (mean 73 ± sd 7 vs. age of initiation SOCC 72 ± 6, $p = 0.656$), while both FRAIL Scale ($p = 0.008$) and Fried Score ($p < 0.001$) categories were associated with non-initiation of SOCC. For both assessments the rates of initiation of SOCC showed greater decrease with increasing frailty (Table 3). The individual components of both assessments were examined to determine if certain components were more strongly associated with physician decision not to initiate SOCC. Components significantly associated with non-initiation of SOCC were Fried Score exhaustion (33% vs. 7%, $p = 0.003$) and walk time (55% vs. 5%, $p < 0.001$) and FRAIL Scale fatigue (39% vs. 11%, $p = 0.009$), resistance (39% vs. 8%, $p = 0.001$), ambulation (37% vs. 9%, $p = 0.003$), and illnesses (60% vs. 16%, $p = 0.043$).

Next, we examined the ability to complete chemotherapy. There was no association between age and any measure of ability to complete chemotherapy: 3 cycles NACT SOCC, 3 cycles NACT any chemotherapy, 3 cycles of initial NACT, 6 cycles of ACT SOCC, 6 cycles of ACT any chemotherapy, or 6 cycles of initial ACT. We examined the association between frailty and ability to complete chemotherapy (see Appendix B). Fit, intermediately frail, and frail were examined as three separate categories. There was no association between frailty category on either assessment tool and ability to complete 3 cycles NACT SOCC, 3 cycles NACT any chemotherapy, or 3 cycles of initial NACT. The ability to complete 6 cycles of ACT SOCC was significantly associated with Fried Score category ($p = 0.003$) but not with FRAIL Scale category; among individual components there was a significant association with Fried Score activity ($p = 0.007$) and walk time ($p \leq 0.001$), and with FRAIL Scale illnesses ($p = 0.033$). There was no association between frailty category on either assessment tool and ability to complete 6 cycles of ACT any chemotherapy or 6 cycles of initial chemotherapy, however Fried Score walk time was significant for both completion of 6 cycles ACT ($p = 0.012$) and 6 cycles initial chemotherapy ($p = 0.025$) as an individual component.

Lastly, we considered chemotherapy complications and need for regimen alteration. Transfusion was required in 10% of participants, hospital admission in 18%, cycle delay in 29%, and dose reduction in 21%. There was no association between age or chemotherapy setting (NACT vs ACT) and need for transfusion, hospital admission, cycle delay, or dose reduction. We examined the association of frailty category with chemotherapy complications and need for regimen alteration. Transfusion was not associated with frailty category or any individual component on either assessment tool. Hospital admission was not associated with frailty category on either assessment tool; among individual components only Fried Score exhaustion (33% vs. 10%, $p = 0.016$) was significantly associated with requiring hospital admission. Neither cycle delay or dose reduction was associated with frailty category or any individual component on either assessment tool.

4. Discussion

The concept of frailty is increasingly being used to predict patient outcomes both in surgical and general medicine settings, but less information exists on the role of frailty assessment in chemotherapy populations. This study examined whether phenotypic assessment of frailty can be used to predict chemotherapy tolerance in older adult gynecologic cancer patients, and thus help physicians to counsel patients as well as decide when it is appropriate to deviate from SOCC.

In this study we found both strengths and limitations to the use of frailty as a predictor of chemotherapy tolerance and completion. We found no association between age and chemotherapy tolerance or ability to complete chemotherapy, reinforcing that age alone should not drive clinical decisions and illustrating the importance of finding novel ways to predict outcomes. Among ACT patients there was an association between Fried Score category and completion of SOCC, but no association between frailty category from either assessment tool and completion of initial regimen or any regimen. This suggests that Fried Score may be a useful predictor of ACT patients who would be unable to complete SOCC, and thus could help select patients for whom it may be appropriate to initiate a less aggressive regimen. Among NACT patients we found no association between frailty and completion of chemotherapy, suggesting that frailty is not an accurate predictor of ability to complete chemotherapy in this population.

In examining individual frailty components, no components were associated with chemotherapy completion among NACT patients. However, among ACT patients Fried Score walk time was associated with all three measures of chemotherapy completion (completion of SOCC, initial chemotherapy, and any chemotherapy). ACT patients were enrolled postoperatively and thus the use of walk time to determine frailty in this population may be confounded by surgical complications and recovery. However, current research supports that postoperative complications are related to frailty and thus the assessment of walk time in the postoperative setting may still function as a proxy for overall frailty [21,22,37,38]. In future attempts to develop a frailty assessment tool appropriate for use in older adult chemotherapy patients the incorporation of walk time in ACT patients is supported by this study, whereas all other components of the FRAIL Scale and Fried Score assessments did not show clinical utility; however, the individual components of frailty assessment should be evaluated in a larger group of patients prior to elimination from a frailty assessment tool.

In addition to completion of chemotherapy we also assessed ability to tolerate chemotherapy without complications; measures of tolerance included need for transfusion, hospital admission, cycle delay, or dose reduction. We found that age alone did not predict ability to tolerate

chemotherapy as none of the examined outcomes varied significantly with age. We found no association of any frailty category in either frailty assessment tool with any measure of chemotherapy tolerance. This suggests that neither age nor phenotypic assessment of patient frailty is a good predictor of ability to tolerate chemotherapy in this population. This parallels findings from a recent retrospective study in older adult ovarian cancer patients that found neither age nor frailty was associated with chemotherapy toxicity [39]. The idea of a phenotypic frailty assessment is appealing as physicians attempt to find simple and efficient ways to move away from relying purely on age to determine when older adult patients cannot tolerate SOCC. However, our data suggests that use of a phenotypic frailty assessment to influence chemotherapy decisions could result in the under- or over-treatment of older adult patients. Tools such as the CRASH Score [29] and CARG tool [30] that combine aspects of phenotypic frailty with other clinical and lab data have shown promise in predicting chemotherapy tolerance. Future research could focus on improving the effectiveness and efficiency of combination tools such as these by incorporating the aspects of phenotypic assessment we have identified as most predictive, and by further defining the subsets within the gynecologic oncology population for which these tools are best utilized

We also describe patterns of chemotherapy administration in our population. In this study physicians chose to forego SOCC and instead initiate decreased dosing in 16% of patients. Physicians did not rely significantly on patient chronologic age when making chemotherapy decisions, as evidenced by the fact that age was not associated with non-initiation of SOCC. Instead, physicians seemed to rely on a personal gestalt related to perception of patient frailty, as is suggested by the significant association between both the FRAIL Scale and Fried Score and physician decision to initiate SOCC (physicians were blinded to the frailty scores when making clinical decisions). In fact, the association was fairly linear, with decreasing rates of SOCC as frailty scores increased. Breakdown of individual frailty score components and the association with non-initiation of SOCC suggests that physician decision-making may rely more heavily on perception of patient factors related to energy and mobility and less heavily on factors related to weight loss or strength. Our data suggests that physicians make treatment decisions in part based on a subjective assessment of patient frailty rather than chronologic age, but it remains unclear if this is an accurate way to predict chemotherapy tolerance. The lack of association between frailty and chemotherapy tolerance in our study suggests that physician use of frailty to guide deviation from SOCC could lead to under-treatment of older adult patients.

Our study has several limitations. The patients were predominantly white, limiting the generalizability to other populations. This was not a randomized trial; there is inherent selection bias in physicians determining the treatment plan, though the physicians were blinded to the results of the frailty assessment. Physician decision to give decreased chemotherapy to frail patients from the outset could have led to an underestimation of the association between frailty and chemotherapy complications and an overestimation of the association between frailty and ability to complete SOCC. While this could have some influence on the data, 80% of patients still received SOCC despite 40–45% being intermediately frail or frail. Additionally, the small number of patients in the frail category limits the strength of the conclusions drawn regarding this group, and the overall number of patients may not be large enough to detect smaller but potentially clinically meaningful differences between frailty groups.

There is a vital need to develop tools to help physicians predict chemotherapy tolerance among older adults in order to prevent both under- and over- while minimizing morbidity; however, in this study frailty assessment had limited predictive utility. Among NACT patients' frailty category did not predict tolerance or completion of chemotherapy. Among ACT patients frailty category did not predict tolerance of chemotherapy, however Fried Score was associated with ability to complete SOCC and thus may be helpful in selecting patients appropriate for less aggressive chemotherapy regimens. Among individual frailty score components, only walk time was associated with completion of chemotherapy and thus may be useful to incorporate into future assessment tools.

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ygyno.2018.11.031.

Conflict of interest statement

The authors listed on this manuscript have no conflicts of interest to disclose.

Author contributions

Casey M. Hay, Madeleine Courtney-Brooks, and Heidi S. Donovan made substantial contributions to the conception, design, data collection, data analysis, and interpretation of this research. Grace B. Campbell, Sarah E. Taylor, and Li Wang made substantial contributions to the data analysis and interpretation of this research.

Sources of funding

This project was supported in part by the National Institutes of Health through Grant Number UL1-TR-001857.

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