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Abstract

Screening colonoscopy is beneficial in screening for colorectal cancer, though it is not without risks, which increase with increasing age. The objectives of this prospective feasibility and outcomes study was to assess the effectiveness of the upper-extremity frailty (UEF) test to risk stratify adults ≥ 50 years of age undergoing routine screening colonoscopy. Socio-demographic data, the Charlson Comorbidity Index (CCI), and UEF clinical frailty syndrome classification (non-frail versus pre-frail/frail) were assessed prior to colonoscopy, and acute colonoscopy outcomes were stratified into three severity categories. Logistic regression and ANOVA/ANCOVA were employed.

41% of non-frail had one or more complications, versus 70% of pre-frail/frail group. Those in the pre-frail/frail group had nearly three times the number of acute colonoscopy complications (OR 2.84, p = 0.01) when compared to the non-frail. Chronological age, and comorbidity score (CCI) failed to predict complication outcomes. UEF frailty was useful in predicting acute complications in screening colonoscopy.

Keywords
Colonoscopy, Screening, Frailty, UEF, Outcomes

Introduction

Screening recommendations become more complex with increasing age. Colorectal cancer (CRC) is second in cancer deaths in the United States (US cancer stats), and lifetime risk of CRC is 1/22 [1]. Screening and early treatment prevent an estimated 10,000 additional deaths each year in comparison with late-stage diagnosis [2]. The United States Preventive Services Task Force recommends screening for colorectal cancer starting at age 50 years and continuing until age 75 years, with those 76 to 85 years screened based on overall health and prior screening history [3]. However, screening colonoscopy is not without serious adverse events in asymptomatic persons including hypotensive events, perforations and major bleeds; and these increase with age [5]. Frailty syndrome has been demonstrated to be a robust predictor of falls, incident disability, hospitalization, surgical complications and mortality [6], and the integration of frailty measures in clinical practice is crucial to inform the recommendation regarding geriatric screening and intervention [7]. The purpose of this feasibility/outcome study was to assess the effectiveness of the validated upper-extremity frailty (UEF) test [8,9] as a risk stratification tool in routine screening colonoscopy in adults.

Methods

Participants included adults undergoing routine CRC screening colonoscopy (June 2016 to July 2017) from a major integrated Academic Medical Center. Inclusion...
criteria included: 1) ≥ 50 years; and 2) Capacity to understand instructions. Exclusion criteria included: 1) Mobility impairment preventing performance of UEF; non-English speaking. The study was approved by the University of Arizona Institutional Review Board, and informed written consent was obtained by trained coordinators according to the principles expressed in the Declaration of Helsinki from all participants [10].

Socio-demographic data, and the Charlson Comorbidity Index (CCI) [11] were assessed before the UEF assessment, just prior to undergoing colonoscopy [8,9]. The Anesthesia Society of America’s “ASA Physical Status Classification System a I (normal healthy patient) to VI (declared brain dead) Anesthesia risk classification system was assigned prior to anesthesia.

Upper Extremity Frailty (UEF) test

The validated UEF test was used to assess frailty using wearable motion sensors (BioSensics LLC, Cambridge, MA) during a 20-second trial of rapid elbow flexion and extension while in a seated position. Several outcomes representing kinematics and kinetics of elbow flexion were derived, based on physical frailty features including: slowness (speed of elbow flexion), weakness (strength of upper-extremity muscles), exhaustion (muscle fatigue), and flexibility (upper-extremity range of motion). Standard frailty categories (non-frail, pre-frail, and frail) were derived. UEF model development and validation processes have been explained comprehensively within our previous work, and demonstrate a 99% sensitivity and 97% specificity when compared to the Fried Frailty Index [12].

Colonoscopy procedure and complications

Acute complications during and immediately following the colonoscopy were recorded. Blood pressure, heart rate, and oxygenation status were measured every two minutes during the procedure, and every five minutes following the procedure until discharge. Complications were stratified into three categories according to severity. Major complications required hospitalization or blood transfusion. Minor complications, included changes in cardiovascular status including systolic ≤ 90 or ≥ 180 mmHg, heart rate < 40 or > 100, and desaturation (SpO₂ < 90). Medication reversal agents (e.g., atropine and metoprolol) and increased oxygen, changes in cardiac rhythm, myocardial infarction, colon perforation, rectal hemorrhage, and colonoscopy completion rates were recorded, as well as post-procedure difficult arousal or ongoing pain.

Statistical analysis

Pre-frail and frail participants were combined due to our small sample size (frail subjects n = 5). The association between frailty and colonoscopy complication occurrence was assessed using multinomial logistic regression, considering complication occurrence (yes or no) as the dichotomous dependent variable. Frailty group and the covariate of age were considered as independent variables. Sociodemographic and clinical variable group comparisons were performed with chi² (proportions) and t-tests (means), and CCI score among frailty groups were assessed using one-way analysis of variance (ANOVA) model. Differences in number of complications between the frailty groups were assessed using analyses of covariates (ANCOVA), considering age as a covariate. The above analyses were repeated separately by assigning either major complications, minor complications requiring intervention, or minor complication requiring no intervention as the dependent variable. Similarly, we assessed the association between CCI score and colonoscopy complication (or the number of complications) as the dependent variable. All analyses were done using JMP (Version 11, SAS Institute Inc., Cary, NC), and statistical significance was concluded when p < 0.05.

Results

Participants

Ninety-nine participants were enrolled: 49 were non-frail (mean age: 60.8 ± 7.8 years) and 50 were pre-frail/fail (mean age: 64.8 ± 9.2 years) (Table 1). Pre-frail/fail participants differed from non-frail participants, as they were older (6%, p = 0.02); and male sex (63% compared to 34%) in the non-frail group (p < 0.01). Ninety-four percent of pre-frail/fail and 92% of non-frail participants received propofol (Diprivan) during the colonoscopy; the remainder received fentanyl (Fenilate) and midazolam (Versed).

Clinical measures

Charlson Comorbidity Index measure did not differ between frailty groups (Table 1).

Table 1: Demographic data, complications, comorbidity and ASA scores for non-frail and pre-frail/fail groups.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Non-frail Group</th>
<th>Pre-frail/Frail Group</th>
<th>p-value</th>
<th>CI</th>
<th>Effect Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number, n (% of total)</td>
<td>49 (49%)</td>
<td>50 (51%)</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Male, n (% of the group)</td>
<td>31 (63%)</td>
<td>17 (34%)</td>
<td>&lt; 0.01*</td>
<td>-1.07 - (-0.24)</td>
<td>0.23</td>
</tr>
<tr>
<td>Mean age, years (SD)</td>
<td>60.82 (7.81)</td>
<td>64.76 (9.17)</td>
<td>0.02</td>
<td>-3.67 - (-0.27)</td>
<td>0.03</td>
</tr>
<tr>
<td>Mean stature, cm (SD)</td>
<td>173.18 (8.29)</td>
<td>167.36 (10.32)</td>
<td>&lt; 0.01*</td>
<td>1.04 - (4.78)</td>
<td>0.31</td>
</tr>
<tr>
<td>Mean body mass, kg (SD)</td>
<td>82.38 (16.83)</td>
<td>81.39 (19.35)</td>
<td>0.79</td>
<td>-3.13 - (-4.11)</td>
<td>0.03</td>
</tr>
<tr>
<td>Mean BMI, kg/m² (SD)</td>
<td>27.49 (5.77)</td>
<td>28.99 (6.00)</td>
<td>0.21</td>
<td>-1.92 - (0.43)</td>
<td>0.13</td>
</tr>
<tr>
<td>Adverse outcomes, n (SD)</td>
<td>0.72 (0.94)</td>
<td>1.51 (1.72)</td>
<td>0.01</td>
<td>-0.69 - (-0.08)</td>
<td>0.30</td>
</tr>
<tr>
<td>Comorbidity Score, (0-35)</td>
<td>3.07 (2.05)</td>
<td>3.80 (2.37)</td>
<td>0.11</td>
<td>-0.82 - (0.08)</td>
<td>0.17</td>
</tr>
</tbody>
</table>

* p-value is adjusted with age; CI: confidence interval; SD: standard deviation; BMI: body mass index.
Comorbidity score (OR 0.87, p = 0.19, CI -0.36-0.07) was not statistically significant (not shown). No significant association was observed between age or CCI score and number of complications. Of note, pre-frail/frail group assignment was the only measure to predict adverse outcomes both during and immediately after the procedure (data not shown).

When stratifying minor complications, frailty spectrum was significantly associated with occurrence of minor complications that required intervention (p < 0.01); however, frailty was not significantly associated with minor complications requiring no intervention (p = 0.15). All three major complications and the two aborted colonoscopies occurred in the pre-frail/frail group.

Discussion

In our prospective feasibility and outcomes study of patients undergoing routine screening colonoscopy, we found the UEF assessment a simple and time efficient (one to two minutes) tool allowing implementation in a busy academic medical center setting. Where chronological age and comorbidity score (CCI) failed to predict acute colonoscopy outcomes. Our results indicate that when compared to age or comorbidity index, frailty more accurately reflects acute complications during and immediately following colonoscopy. Despite guidelines, neither patient chronological age nor comorbidities
proved sufficient in predicting colonoscopy outcomes. Our results were consistent in predicting outcomes throughout the procedure, as pre-frailty/frailty was the only measure to predict adverse outcomes both during and immediately after the procedure.

Our study has several strengths. The UEF proved easily performed and feasible and is a useful instrument in assessing risk of patients undergoing screening colonoscopy, and importantly does not require gait. Our analysis reveals that UEF frailty screening performs better than patient age or comorbidity status in predicting acute screening colonoscopy outcomes. Additional prospective studies evaluating various frailty measurements in endoscopy will be helpful in clarifying its role in forecasting endoscopic outcomes.

Limitations include our younger cohort, small sample size and our single institution. Our study was designed to examine the effectiveness of frailty in predicting acute complications of screening colonoscopy in aging adults; further studies are needed to evaluate longer-term outcomes, and in patients undergoing colonoscopy for non-screening purposes. We grouped frail and pre-frail patients in our analyses due to the small sample (n = 5) of frail individuals. Despite our small sample of pre-frail/frail subjects, and despite our relatively young age of participants within this study, we still found statistical significance in the primarily pre-frail group, indicating that even they are at significantly increased risk of complication, thereby strengthening the clinical relevance of our findings.

Conclusions and Clinical Recommendations

Older adult screening recommendations become increasingly complex with increasing age. Despite colorectal cancer screening guidelines, patient age and comorbidities do not adequately account for older adult heterogeneity, and proved insufficient in predicting poor colonoscopy outcomes in this study. These measures should not be relied upon to fully inform CRC screening decisions. The prospective nature of this study allowed for more accurate and precise assessment of outcomes. Providers should risk stratify with frailty measurement when making colorectal cancer screening recommendations in older patients.

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References