The association of peri-operative scores, including frailty, with length of stay after unscheduled surgery[+]

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Summary

Postoperative hospital stay is longer for frail, older patients, who are more likely to experience prolonged postoperative morbidity and reduced long-term survival. We recorded in-hospital mortality, morbidity and length of stay for 164 patients aged at least 65 years after unscheduled surgery. We evaluated pre-operative frailty with the seven-point Clinical Frailty Scale: 81 patients were 'not vulnerable' (frailty score 1-3) and 83 were 'vulnerable or frail' (frailty score $\geq$ 4), with mean (sd) ages of 74.7 (7.5) years vs. 79.4 (8.3) years, respectively, $p < 0.001$. Within 30 postoperative days 8/164 (5%) patients died, all with frailty scores $\geq$ 4, $p = 0.007$. Postoperative morbidity was less frequent in patients categorised as 'not vulnerable' on 4/6 days it was measured (days 3, 5, 8, 14, 23, 28). Median (IQR [range]) postoperative stay was 9 (6-18 [2-221]) days for patients with frailty scores 1-3, and 22 (12-33 [2-270]) days for patients with score $\geq$ 4, $p < 0.001$. Four variables independently associated with hospital discharge, hazard ratio (95% CI): E-POSSUM, 0.74 (0.60-0.92), $p = 0.007$; ASA 2, 0.35 (0.13-0.98), $p = 0.046$, ASA 3, 0.17 (0.06-0.47), $p = 0.001$, and ASA 4/5, 0.08 (0.02-0.28), $p < 0.001$; operative severity 'major +', 0.69 (0.41-1.08), $p = 0.10$; and the Surgical Outcome Risk Tool, 7.75 (0.81-74.40), $p = 0.08$.

Introduction

Frailty can be broadly defined as ‘vulnerability to external stressors’, with increased rates of morbidity and death compared with similar people who are not frail [1]. The rate of frailty increases with age and might affect up to half of older surgical patients [2, 3]. Worldwide there were 461 million people older than 65 years in 2004, which might increase to two billion people by 2050 [4].

Frail patients are more likely to experience postoperative complications, such as pneumonia and delirium, prolonged hospital stay, discharge to care facilities and higher mortality rates [5-8]. Chronological age should be adjusted for frailty, although it is unclear which measures should be used, in both research and clinical practice [9]. An ideal peri-operative frailty score should be quick and easy to administer, and it should be associated with complications and mortality, so that their risks can be predicted, and the level of peri-operative care can be determined, including after hospital discharge [10].

Emergency surgery is associated with particularly poor outcomes. Only half of patients aged 80 years or more at the time of emergency surgery survive three years [11-13]. Previous evaluations of peri-operative frailty have been for scheduled surgery, often using physical tasks that may be impractical for use in acute care [14]. The first prospective study measuring frailty in the emergency surgical population used the seven-point Canadian Study of Health and Ageing Clinical Frailty Scale (CSHA CFS) [15]. The Clinical Frailty Scale is a subjective, deficit-accumulation scoring system based on visual observation combined with a review of the medical records. It is suitable for use before unscheduled surgery as in trained hands it takes a few minutes to complete and it has acceptable reliability and predictive validity [16]. However, the Clinical Frailty Scale was validated only after patients had undergone a comprehensive geriatric assessment by trained researchers, so it may be unsuitable for routine use [17].

This study evaluates the association of frailty, as measured by the Clinical Frailty Scale, as well as more traditional surgical prediction tools, in a population of elderly emergency surgical admissions.

Methods

Our local Research and Development group determined that ethical approval was unnecessary for this non-interventional study of patients at least 65 years old who had unscheduled non-cardiac surgery at University College Hospital June 2012 to January 2013. Research nurses recorded peri-operative patient and surgical data, including the ASA physical status assigned by the surgical team. Specialist care-of-the-elderly trainees reviewed patients and spoke with their relatives postoperatively to categorise their function before hospital admission, using the Clinical Frailty Scale: 1, 'very fit'; 2, 'well'; 3, 'well, with treated comorbid disease'; 4, 'apparently vulnerable'; 5, 'mildly frail'; 6, 'moderately frail'; 7, 'severely frail'. We calculated five other scores: the Surgical Risk Scale [18]; the Charlson Age-Comorbidity Index [19]; two versions of the Physiological and Operative Severity Score for the enUmeration of Mortality and Morbidity, E-POSSUM and P-POSSUM [20, 21]; and the Surgical Outcome Risk Tool (SORT) [22].

We retrospectively determined an adjusted Post-Operative Morbidity Survey (POMS) for days 3, 5, 8, 14, 21 and 28 by reviewing patients' clinical notes, charts and electronic records [23, 24]. We excluded the presence of a urinary catheter from the diagnostic criteria, which in this population might be due to reasons other than renal dysfunction, such as poor mobility [25].

Our primary outcome was length of hospital stay. We did not perform a sample size calculation. Secondary outcomes were POMS-defined morbidity and mortality, in-hospital and at 30 days [23, 24]. We used Excel (Microsoft® Excel for Mac, 2008; Microsoft Corp, Redmond, WA, USA) and Stata (Intercooled version, release 13; StataCorp LP, College Station, TX, USA). We used ANOVA, the Kruskal Wallis test, the Fisher exact test and chi-squared test, as appropriate. We used the area under the receiver operating characteristics (ROC) curve to compare score discrimination [26]. Cox proportional hazards regression was used to evaluate the association between peri-operative risk scores and hospital length of stay [27]. We used the 'swaic' package in Stata to perform automatic multivariate model selection using Akaike information criterion (AIC). We tested the Cox proportional hazards assumption with Schoenfeld residuals.

Results

Table 1 details the characteristics of the 164 patients who required urgent (162) or immediate (2) surgery, most commonly – in 60/164 (37%) – for hip fracture. Age accounted for 7% of the linear variation in frailty score, Pearson's correlation coefficient 0.27, $p < 0.001$. Approximately half the patients (81/164) were 'not vulnerable' (frailty score 1-3) and the other half (83/164) were 'vulnerable or frail' (frailty score $\geq$ 4); the proportions of these frailty subgroups who were ASA physical status < 3 were 62/81 (77%) vs. 19/83 (23%), $p < 0.001$. The mean (sd) ages for these frailty subgroups were 74.7 (7.5) years vs. 79.4 (8.3) years, $p < 0.001$.

Within 30 postoperative days 8/164 (5%) patients died, all of whom had been assessed as 'vulnerable' or 'frail', $p = 0.007$ (Table 2). The rates of postoperative morbidity on days 3, 5, 8, 14, 21, 28 for patients categorised as 'not vulnerable' vs. 'vulnerable or frail' were: 41/81 vs. 62/83, $p = 0.002$; 33/81 vs. 46/83, $p = 0.06$; 19/81 vs. 37/83, $p = 0.005$; 11/81 vs. 23/83, $p = 0.03$; 16/81 vs. 30/83, $p = 0.02$; and 7/81 vs. 10/83, $p = 0.69$ (Table 2). These differences were partly due to patients who were 'not vulnerable' being discharged sooner than patients scored 'vulnerable and frail', with median (IQR [range]) postoperative stays of 9 (6-18 [2-221]) days vs. 22 (12-33 [2-270]) days, $p < 0.001$ (Fig. 1 and Table 2). However, frailty score was not independently associated with postoperative stay, which was accounted for by four other variables: E-POSSUM; ASA physical status; operative severity; and SORT (Table 3).

Discussion

The duration of hospital stay after unscheduled surgery was independently associated with: pre-operative ASA physical status; the surgical severity; and the peri-operative E-POSSUM score and Surgical Outcome Risk Tool. The duration of stay was also associated with the Clinical Frailty Scale, but not independent of these variables.

Frailty scored by seven categories associated only weakly with postoperative morbidity, as well as mortality and re-admission to hospital, perhaps because frailty does not account for surgical type and severity. The POMS was not specifically designed for use in the elderly surgical population, for whom it may not be the most appropriate measure of postoperative adverse out- comes. Some complications are more common in elderly patients, and not all complications develop in the immediate postoperative period [28]. However, frailty was associated with postoperative morbidity if the seven categories of the CFS were amalgamated into two categories, ‘not vulnerable’ (1–3) and ‘vulnerable or frail (≥ 4), which suggests that a larger sample size might differentiate between the seven categories. Two studies have reported an association between frailty and mortality and hospital stay after elective surgery [9, 29]. Models that incorporate frailty may be associated with postoperative outcomes, including mortality, better than models that do not incorporate frailty, particularly those that are based on a single system [30, 31].

Surveys have identified ignorance of frailty as a key barrier to its incorporation into pre-operative assessments [32], but no frailty measure has been identified as the ‘gold standard’ [9]. Performance-based tests and complex assessments may be impractical for patients undergoing unscheduled surgery; different tools to detect frailty may be required for different situations.

Our study is subject to the biases of any single- centre observational study, as well as bias introduced by the postoperative categorisation of pre-operative frailty and too few patients to explore graded associations of frailty scored in seven categories.

In our population of patients undergoing unscheduled surgery, the CFS was not independently associated with hospital stay, postoperative morbidity, mortality and re-admission to hospital. Our study was not powered to explore whether there was a graded association of the seven categories of the CFS with any outcome. Future observational research should measure frailty before surgery and might use our study to adequately power the sample for a particular outcome.

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Competing interests

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Table 1 The characteristics of 164 patients who underwent unscheduled surgery. Values are mean (SD), median (IQR [range]) or number (proportion).

Age; y	77.1 (8.3)
Female	104 (63%)
Ethnicity	
White	121 (74%)
Asian	6 (4%)
Black	2 (1%)
Other	6 (4%)
Not stated	29 (17%)
Surgery	
Orthopaedic	102 (62%)
Colorectal	28 (17%)
Upper gastrointestinal	10 (6%)
Vascular	11 (7%)
Urology	4 (2%)
Other	9 (6%)
CSHA Clinical Frailty Score	4 (3-5 [1-7])
Mortality at one month; %	
SORT	0.04 (0.01-0.09 [0.01-0.56])
P-POSSUM	2.14 (1.22-4.19 [0.19-39.25])
Morbidity at one month; %	
E-POSSUM	0.28 (0.21-0.33 [0.10-0.63])

CHSA, Canadian Study of Health and Ageing; E- and P-POSSUM, Elderly and Portsmouth Physiological and Operative Severity Score for the enUmeration of Mortality and Morbidity

Table 2 Characteristics and outcome measures by frailty score of 164 patients who had unscheduled surgery. Values are number (proportion), mean (SD) or median (IQR [range]).

Characteristic	CSHA Clinical Frailty Scale								p value
	1 (n = 7) 4%	**2 (n = 19)** 12%	**3 (n = 55)** 34%	**4 (n = 23)** 14%	**5 (n = 24)** 15%	**6 (n = 21)** 13%	**7 (n = 15)** 9%	**Total (n = 164)**	
Age; years	68.7 (2.8)	75.2 (8.3)	75.2 (7.4)	77.4 (8.0)	82.8 (8.0)	78.6 (7.5)	78.3 (9.6)	77.1 (8.3)	< 0.001
ASA									
1	1	0	3	0	0	0	0	4 (2%)	
2	5	18	35	7	5	3	4	77 (47%)	
3	0	1	14	14	17	15	11	72 (44%)	< 0.001
4	0	0	3	2	2	3	0	10 (6%)	
5	1	0	0	0	0	0	0	1 (1%)	
Operative severity									
Minor	0	0	0	1	0	0	0	1 (1%)	
Moderate	0	0	9	2	4	0	2	17 (10%)	0.17
Major	2	5	9	1	2	1	1	21 (13%)	
Major+	5	14	37	19	18	20	12	125 (76%)	
Hospital stay; days	7 (3-8 [2-92])	8 (6-10 [2-28])	12 (5-23 [2-221])	23 (13-38 [4-97])	22 (11-33 [2-126])	17 (7-29 [2-270])	21 (14-42 [5-167])	14 (7-28 [2-270])	< 0.001
POMS-defined morbidity									
Day 3	5	6	30	22	15	15	10	103 (63%)	0.002
Day 5	3	4	26	16	12	10	8	79 (48%)	0.12
Day 8	1	1	17	14	8	8	7	56 (34%)	0.009
Day 14	1	0	10	7	5	5	6	34 (21%)	0.12
Day 21	1	2	13	12	9	3	6	46 (28%)	0.022
Day 28	1	0	6	4	3	2	1	17 (10%)	0.69
Mortality									
Inpatient	0	0	2	1	2	3	2	10 (6%)	0.35
30 days	0	0	0	1	2	3	2	8 (5%)	0.032
Planned postoperative critical care	2	2	17	14	9	11	8	63 (38%)	0.014
Discharge to institutional care	0	0	2	2	0	3	2	9 (5%)	0.16

ASA, ASA physical status; CHSA, Canadian Study of Health and Ageing; POMS, Post-Operative Morbidity Survey

Table 3 Multivariate time-to-event analysis (using Cox Proportional Hazards) of risk factors associated with length of hospital stay following unscheduled surgery

Variable	**Hazard ratio (95% CI)**	**p value**
ASA		
2	0.35 (0.13-0.98)	0.046
3	0.17 (0.06-0.47)	0.001
4-5	0.08 (0.02-0.28)	< 0.001
E-POSSUM Morbidity*	0.74 (0.60-0.92)	0.007
Major+ operation	0.69 (0.44-1.08)	0.10
SORT	7.75 (0.81-74.40)	0.08

ASA, ASA physical status; E-POSSUM, Emergency Portsmouth Physiological and Operative Severity Score for the enUmeration of Mortality and Morbidity; SORT, Surgical Outcome Risk Tool.

* 0.1 unit change in morbidity risk.

Figure 1 Kaplan-Meier plot for the proportion (95%) of patients in hospital after surgery, categorised by frailty score ≥ 4 (red) o < 4 (blue).