Association between frailty and 30-day outcomes after discharge from hospital

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ABSTRACT

Background: Readmissions after hospital discharge are common and costly, but prediction models are poor at identifying patients at high risk of readmission. We evaluated the impact of frailty on readmission or death within 30 days after discharge from general internal medicine wards.

Methods: We prospectively enrolled patients discharged from 7 medical wards at 2 teaching hospitals in Edmonton. Frailty was defined by means of the previously validated Clinical Frailty Scale. The primary outcome was the composite of readmission or death within 30 days after discharge.

Results: Of the 495 patients included in the study, 162 (33%) met the definition of frailty: 91 (18%) had mild, 60 (12%) had moderate, and 11 (2%) had severe frailty. Frail patients were older, had more comorbidities, lower quality of life, and higher LACE scores at discharge than those who were not frail. The composite of 30-day readmission or death was higher among frail than among nonfrail patients (39 [24.1%] v. 46 [13.8%]). Although frailty added additional prognostic information to predictive models that included age, sex and LACE score, only moderate to severe frailty (31.0% event rate) was an independent risk factor for readmission or death (adjusted odds ratio 2.19, 95% confidence interval 1.12–4.24).

Interpretation: Frailty was common and associated with a substantially increased risk of early readmission or death after discharge from medical wards. The Clinical Frailty Scale could be useful in identifying high-risk patients being discharged from general internal medicine wards.

Readmissions within 30 days after hospital discharge are common and costly occurrences. Although many studies have attempted to identify patients at highest risk of readmission, neither experienced clinicians nor experienced researchers using rigorously developed administrative data-rich algorithms can accurately predict which patients will not successfully transition back into the community.[1–6] This suggests that currently unrecognized factors likely play a major role in readmission risk. Identification of these factors would be important for future initiatives to reduce readmission rates by targeting resources to those at highest risk.

Frailty is a frequently underdiagnosed condition, with prevalence estimates ranging from 27% to 80% among inpatients[7–9] and from 4% to 59% among older adults living in the community,[10] depending on the frailty measure used and the population evaluated. Frailty is a multidimensional syndrome of decreased reserve and resistance to stressors leading to increased vulnerability to adverse outcomes.[11–14] The 2 models of frailty most commonly used in the literature are the phenotype model (e.g., the approach proposed by Fried and colleagues,[15] which is based on 5 objective variables assessed at one point in time that do not include psychosocial and cognitive variables) and the cumulative deficit model (e.g., the Clinical Frailty Index, which is based on a mix of more than 30 variables capturing function in many domains over time).[16–18]

Although the gold standard for frailty assessment is a comprehensive geriatric assessment by a multidisciplinary team, both the phenotype and cumulative deficit models appear reasonably accurate for identifying frailty. However, both are somewhat cumbersome for routine use at the bedside.[12] For these reasons, the Clinical Frailty Scale was developed and relies on clinical judgment based on history taking and clinical examination. The Clinical Frailty Scale is easy to ad-

minister at the bedside; has been used by physicians, allied health professionals and research assistants; does not require any special equipment; is highly correlated with the Fried frailty index ($r = 0.8$);[17] and appears to be valid, reliable and reproducible.[19] Some risk-prediction models, such as the LACE Index, have tried to incorporate frailty, but they did not find it to be a significant independent variable, possibly owing to the frailty measure used. A systematic review of 30 risk-prediction models for hospital readmission found that only 2 included functional status.[4]

We conducted a study to evaluate whether frailty identified using the Clinical Frailty Scale is an independent predictor of death or readmission within 30 days after discharge from hospital.

Methods

Study design and population
This was a prospective cohort study. We enrolled patients 18 years of age and older who were being discharged from 7 general internal medicine wards at 2 teaching hospitals in Edmonton (University of Alberta and Royal Alexandra hospitals) between October 2013 and November 2014. Patients were excluded if they did not live in the province, had severe cognitive impairment (5 or more errors on the Short Portable Mental Status Questionnaire, on the assumption their ability to answer questionnaires accurately would be compromised),[20] were deemed by their attending physician to have foreshortened life expectancy that would preclude 90-day follow-up, or were transferred to or from a long-term care facility, another inpatient service or another acute care hospital. If a patient was admitted more than once during the study period, we collected data from the first admission. The follow-up period was 30 days after discharge.

All participants provided informed consent. The study design was approved by the Health Research Ethics Board at the University of Alberta.

Determination of frailty
Frailty was defined using the Clinical Frailty Scale derived from the Canadian Study on Health and Aging. This well-validated assessment tool is based on clinical judgment and quantifies frailty on a scale of 1 (very fit) to 9 (terminally ill).[17] Trained research assistants aware of the study hypothesis determined the Clinical Frailty Scale scores by interviewing participants and reviewing each participant's hospital chart. They assigned the score based on the patient's (or proxy's) self-reported best status in the week before becoming ill with the reason for the index hospital admission. We trained our research assistants to calibrate their frailty assessments with those of experienced clini-

cians, and scores were reproducible between examiners. The Clinical Frailty Scale has been previously used by our team.[19]

We considered patients to be frail if their Clinical Frailty Scale score was 5 or higher (which represents mild, moderate, severe or very severe frailty and is consistent with published cut-off points[17,19]). Of note, mild frailty (score of 5) corresponds to difficulty with 1 or more instrumental activities of daily living (e.g., finances, shopping, meal preparation, housework, medications); moderate frailty (score of 6) corresponds to difficulty with 1 or 2 activities of daily living (e.g., bathing, dressing, climbing stairs); and severe frailty (score of 7 or 8) refers to being completely dependent for 3 or more activities of daily living, regardless of whether the cause is physical or cognitive.

Outcome measures
The primary outcome measure was the composite of readmission (to any acute care hospital in the province) or death within 30 days after discharge from the index hospital. Data on these outcomes were collected by study coordinators through telephone interviews with the patients and review of their electronic health records (Alberta Netcare records) 30 days after discharge; the coordinators were unaware of the study hypothesis and the frailty assessments done at discharge. Secondary outcomes included each element of the primary outcome individually, and the frequency of emergency department visits within the 30-day follow-up period.

Other covariates
The research assistants collected data on the participants' sociodemographic characteristics, medical comorbidities and medications from the patients' self-reports, the audits of their hospital charts and electronic health records, and contact with patients' pharmacies. They also captured data on length of stay and calculated each patient's LACE score, which is currently the best risk-prediction model for outcomes within 30 days after discharge.[1] (LACE is a nmemonic derived from variables independently associated with the outcome of death or urgent readmission within the first month after discharge: length of stay ["L"]; acuity of the admission ["A"]; comorbidity of the patient, as measured with the Charlson Comorbidity Index score ["C"]; and emergency department use, measured as the number of visits in the 6 months before admission ["E"].)

Statistical analysis
We compared characteristics and outcomes of patients according to frailty status at the time of discharge using the t test for continuous variables

and the χ^2 test for categorical variables. We used multivariable logistic regression analysis, adjusting for age and sex, to determine the association between frailty and the composite outcome of readmission or death. We used the Hosmer–Lemeshow goodness-of-fit test to assess model fit. To determine whether frailty provided additional prognostic information above the LACE Index, we compared models with and without the LACE Index using the C statistic and the Integrated Discrimination Improvement index. All analyses were performed with the use of SAS software (SAS Institute, Inc.); p values of less than 0.05 were considered to be statistically significant.

Results

Of 1147 potentially eligible patients discharged alive from the medical wards during the study period, 498 were enrolled in our study; 3 patients withdrew, which left 495 (99.4%) with 30-day follow-up data (Figure 1). The mean age was 64 years, 252 (50.6%) were female, the vast majority (485 [97.4%]) were admitted via the emergency department, and the median number of comorbidities was 5 (interquartile range 3–7). The top 5 reasons for hospital admission were heart failure ($n = 50$), pneumonia ($n = 50$), chronic obstructive pulmonary disorder (COPD, $n = 38$), urinary tract infection ($n = 27$) and acute complications of diabetes ($n = 26$). Of note, 163 patients (32.7%) had diabetes.

Of the 495 patients, 162 (32.7%) were considered to be frail (Clinical Frailty Scale score ≥ 5) in the week before becoming unwell (91 had mild, 60 moderate and 11 severe frailty). Compared with nonfrail patients, frail patients were older, were more likely to be female, had more comorbidities, had more hospital admissions in the year before enrolment, were less likely to live independently before and after hospital admission, had lower scores on the EuroQol Health Questionnaire (a standardized measure of health-related quality of life [www.euroqol.org]) and had slower gait speeds (as determined by the timed get-up-and-go test) (Table 1). Serum albumin levels and mean scores on depression and anxiety did not differ between frail and nonfrail patients, nor did the proportion of patients discharged from teaching wards (Table 1).

Overall, 85 patients were readmitted or died within 30 days after discharge (Table 2), with the most responsible diagnoses being congestive heart failure ($n = 11$), pneumonia ($n = 8$), COPD ($n = 6$), malignant disease ($n = 5$) and renal failure ($n = 4$). Frail patients had higher event rates than nonfrail patients (24.1% v. 13.8%; age- and sex-adjusted odds ratio [OR] 2.01, 95% confidence interval [CI] 1.19–3.41). Frailty as defined by the Clinical

Frailty Scale (which included mild frailty) was not independently associated with the composite outcome of readmission or death when we adjusted for age, sex and LACE score (adjusted OR 1.52, 95% CI 0.87–2.62). Patients with moderate or severe frailty ($n = 71$) were more likely than nonfrail patients to be readmitted or to die within 30 days after discharge (31.0% [22/71] v. 13.8%; OR adjusted for age and sex 3.19, 95% CI 1.70–6.00; OR adjusted for age, sex and LACE score 2.19, 95% 1.12–4.24). The Integrated Discrimination Improvement index was statistically significant for all models that incorporated frailty in addition to age, sex and LACE score ($p < 0.001$ for each comparison), which indicated that there was an improvement in the ability of the model both to predict which patients will have an event and to predict which will not. When we looked at frailty as a continuous measure, we found an increased risk of 30-day readmission or death associated with each additional point on the Clinical Frailty Scale, even after we adjusted for age, sex and LACE score (adjusted OR 1.35, 95% CI 1.11–1.64), but this was driven largely by the very high risk among patients with a frailty score of 7 or 8 (adjusted OR 9.92, 95% CI 2.40–40.0).

Frail patients were more likely than nonfrail patients to present to an emergency department during the 30-day follow-up period (32.7% v.
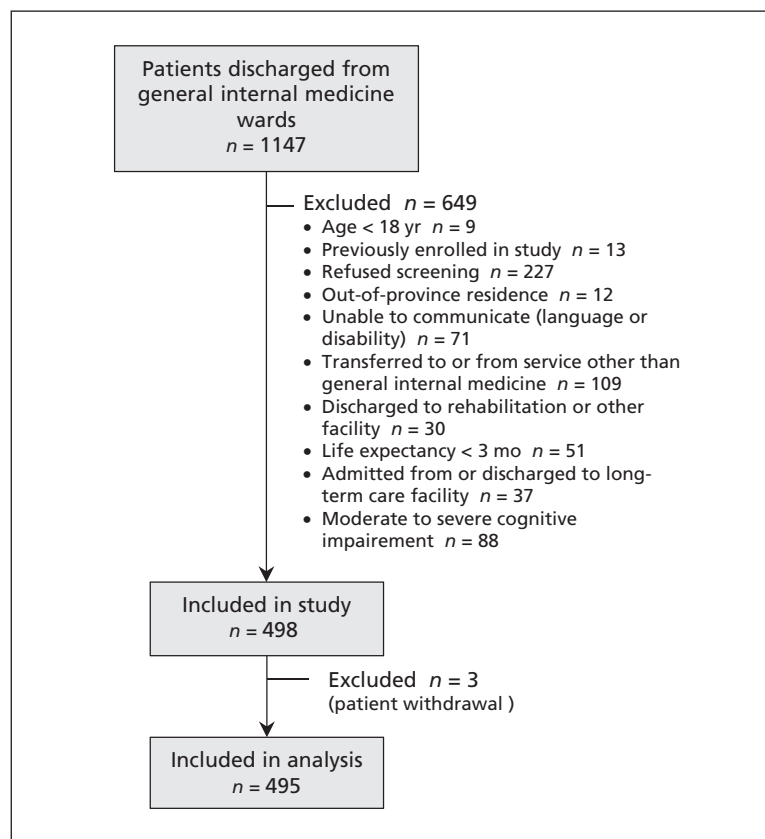

Figure 1: Selection of patients for the study cohort.

23.4%; age- and sex-adjusted OR 1.75, 95% CI 1.10–2.76), but the 2 groups had similar patterns of outpatient physician visits (mean 1.85 v. 1.82; age- and sex-adjusted p value = 0.8). Similar to differences observed before the index admission, frail patients were significantly less likely than

Table 1: Baseline characteristics of patients discharged from hospital who were included in the study			
	Frailty status; mean (95% CI)*		
Characteristic	Frail (CFS score > 4) n = 162	Not frail (CFS score ≤ 4) n = 333	p value†
Age, yr, mean ± SD	72.5 ± 15.0	58.2 ± 18.4	< 0.001
Female sex	105 (64.8)	145 (43.5)	< 0.001
No. of comorbidities	6.3 (5.8–6.7)	4.2 (3.9–4.5)	< 0.001
Charlson Comorbidity Index score	3.6 (3.3–3.9)	2.4 (2.2–2.6)	< 0.001
No. of hospital admissions in past 12 mo	1.2 (1.0–1.4)	0.6 (0.5–0.8)	< 0.001
Discharged from teaching ward	125 (77.2)	264 (79.3)	0.6
Living situation before index admission			< 0.001
Living at home independently	43 (26.5)	246 (73.9)	
Living at home with help	91 (56.2)	78 (23.4)	
Assisted-living facility‡	28 (17.3)	9 (2.7)	
EQ-5D overall score	59.7 (56.5–62.9)	65.2 (63.3–67.1)	0.002
EQ-5D mobility self-report		n = 331	< 0.001
No problems	13 (8.0)	191 (57.7)	
Some problems	132 (81.5)	139 (42.0)	
Confined to bed	17 (10.5)	1 (0.3)	
EQ-5D self-care report		n = 332	< 0.001
No problems	70 (43.2)	284 (85.5)	
Some problems	82 (50.6)	48 (14.5)	
Unable to wash or dress self	10 (6.2)	0 (0.0)	
PHQ-9 score	7.9 (7.0–8.8)	7.1 (6.5–7.7)	0.1
GAD-2 score	1.8 (1.5–2.1)	1.6 (1.4–1.8)	0.2
Goals of care in hospital	n = 148	n = 319	< 0.001
Resuscitation and ICU	70 (47.3)	267 (83.7)	
ICU but no resuscitation	33 (22.3)	22 (6.9)	
No ICU, no resuscitation	45 (30.4)	29 (9.1)	
Comfort care	0 (0.0)	1 (0.3)	
Timed get-up-and-go test, s	24.4 (21.7–27.1)	13.1 (11.8–14.3)	< 0.001
BMI	31.4 (29.5–33.4)	27.8 (27.1–28.6)	< 0.001
eGFR before discharge	65.6 (61.0–70.3)	80.4 (77.21–83.6)	< 0.001
Serum albumin level	34.0 (32.7–35.3)	33.7 (32.5–34.9)	0.8
No. of prescription medications at discharge	8.5 (8.0–9.0)	5.3 (5.0–5.7)	< 0.001
LACE score§ at discharge	12.9 (12.5–13.3)	10.9 (10.6–11.2)	< 0.001

Note: BMI = body mass index, CFS = Clinical Frailty Scale, CI = confidence interval, eGFR = estimated glomerular filtration rate, EQ-5D = EuroQol Health Questionnaire (maximum score 100), GAD-2 = Generalized Anxiety Disorder 2 Questionnaire, ICU = intensive care unit, PHQ-9 = Patient Health Questionnaire, SD = standard deviation.
*Unless otherwise indicated.
†The t test was used for continuous variables and the χ^2 test for categorical variables.
‡Includes independent seniors' apartments with provision of meals with or without supervised medication consumption or on-site nursing support, but not nursing homes.
§LACE is a nmemonic derived from variables independently associated with the outcome of death or urgent readmission within the first month after discharge: length of stay ["L"]; acuity of the admission ["A"]; comorbidity of the patient, as measured with the Charlson Comorbidity Index score ["C"]; and emergency department use, measured as the number of visits in the 6 months before admission ["E"].

nonfrail patients to be discharged home to live independently (16.5% v. 66.4%) and significantly more likely to be discharged home with home care (62.2% v. 30.7%) or discharged to an assisted-living facility (21.3% v. 3.0%) (*p* < 0.001 for each comparison).

Interpretation

There are 3 key findings from our study. First, frailty was common among patients being discharged from the medical wards, even among patients being discharged home. Second, frailty was associated with an increased risk of readmission or death within 30 days after discharge and increased use of health services even after we adjusted for age and sex. Finally, the presence of moderate to severe frailty added prognostic information that improved the ability to predict rates of readmission or death beyond the LACE score, currently the best risk-prediction model.

Our findings are consistent with those from previous studies showing that frailty was common and associated with poorer outcomes after discharge. However, most of the previous studies were limited because of a lack of clinical data, variable definitions of frailty and poor generalizability owing to data being drawn from atypical or narrow patient populations, or because they did not evaluate whether assessment of frailty improved existing readmission risk-prediction rules.[13,14,19,21,22] Mirroring our findings, a recent report from the US Health and Retirement Study found that only patients who were dependent for at least 1 activity of daily living (corresponding to our definition of moderate to severe frailty) were at increased risk of readmission; however, that study used reports of functional status 430 days (median) before the index hospital admission.[23] Although cumulative deficit models such as the Clinical Frailty Scale appear to predict risk of death better than phenotype models,[24] we explored the frailty scale's ability to predict 30-day outcomes after discharge. The extent to which various frailty instruments overlap in their ability to predict the risk of readmission is unknown and is the subject of other research by our group.

Our finding that moderate to severe frailty as defined by the Clinical Frailty Scale added prognostic information beyond that available from the LACE Index is important for clinicians, policymakers and researchers. The LACE Index has been the best means available using administrative data by which to identify patients at highest risk of readmission or death after discharge. However, it is imperfect, with a C statistic of 0.68 in its initial validation study[1] and 0.67 in our study. Use of the simple Clinical Frailty Scale in addition to the LACE Index significantly improved the latter's accuracy and discrimination in our study. This also makes sense clinically, because frailty as defined by the Clinical Frailty Scale has been previously shown to be an independent predictor of length of stay, in-hospital mortality and new placement in a long-term care facility.[25]

Although we focused on frailty in this study, it is only part of the picture for inpatients in general internal medicine services. Numerous studies have shown that hospital admission itself plays a role in subsequent functional deterioration, particularly if patients have prolonged periods of bed rest or cannot take food by mouth during the index admission.[26] Loss of independence, decreased functional ability and restricted activity all seem to bear poorly on recovery after discharge.[27–30] Although frailty or vulnerability before becoming ill may affect outcomes after discharge, patients in hospital may also experience an acquired, transient period of risk for adverse events that is harmful in addition to the stress of the acute illness. This "post-hospital syndrome" is a multidimensional construct that incorporates sleep deprivation, cognitive stress, poor nutrition and physical pain.[26] Patients who are already frail

Table 2: Outcomes within 30 days after discharge, by frailty status

Outcome ≤ 30 d	Frail n = 162	Not frail n = 333	OR for frailty (95% CI)*		
			Crude	Adjusted for age and sex	Adjusted for age, sex and LACE score†
Readmission or death	39 (24.1)	46 (13.8)	1.98 (1.23–3.18)	2.01 (1.19–3.41)	1.52 (0.87–2.62)
Readmission	36 (22.2)	45 (13.5)	1.82 (1.13–2.97)	1.90 (1.11–3.26)	1.42 (0.81–2.49)
Death	7 (4.3)	6 (1.8)	2.46 (0.81–7.45)	2.18 (0.65–7.39)	1.33 (0.37–4.76)
Visit to emergency department	53 (32.7)	78 (23.4)	1.59 (1.05–2.41)	1.75 (1.10–2.76)	1.43 (0.68–2.30)

Note: CI = confidence interval, OR = odds ratio.
*All models showed nonsignificance on the Hosmer–Lemeshow goodness-of-fit test.
†See Table 1 for explanation of LACE Index.

before hospital admission may be more sensitive to the stresses of this syndrome and at higher risk of readmission and poor outcomes. This is likely one of the reasons for the low proportion of readmitted patients whose most responsible diagnosis is the same as the one during their first hospital admission.[31]

Limitations

Although this was a prospective cohort study with objective assessment of outcomes by observers unaware of the patients' frailty scores, the study has some limitations. First, we did not evaluate the functional status of patients after hospital discharge. Changes in functional status are likely to be even more frequent than readmission or death. Second, we included patients discharged from general medical wards at 2 sites (an inner-city hospital and a university campus hospital); therefore, results may not be generalizable to patients admitted for nonmedical reasons, to nonteaching hospitals or in other geographic areas. However, studies involving other inpatient populations have shown similar results to ours.[13,19,21–23] Third, although we were able to determine whether patients were discharged with home care services in place, we could not tell if frail patients received more home care in hours per day than nonfrail patients, and any discrepancy in the provision of home care could have mitigated differences in outcomes between the groups. Fourth, our eligibility criteria decreased the range of the Clinical Frailty Scale (i.e., exclusion of patients with foreshortened life expectancy and those from long-term care facilities resulted in few patients with very high frailty scores) and, therefore, decreased the likelihood of showing an association between frailty and death or readmission within 30 days after discharge. Lastly, the frailty assessment, based on a clinician's overall impression of each patient's premorbid function, may be seen as subjective. However, we have previously shown the Clinical Frailty Scale to be valid and reproducible between examiners at the same hospitals included in this study.[19]

Conclusion

Frailty defined using the Clinical Frailty Scale was common and was an independent predictor of readmission or death within 30 days after discharge from medical wards. However, even with this additional prognostic information, risk prediction remains imperfect. Further research is needed to identify additional predictors of early readmission or death after discharge.

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