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Research

Using the Hospital Frailty Risk Score to assess mortality risk in older medical patients admitted to the intensive care unit

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Abstract

Background: Prognostic information at the time of hospital discharge can help guide goals-of-care discussions for future care. We sought to assess the association between the Hospital Frailty Risk Score (HFRS), which may highlight patients' risk of adverse outcomes at the time of hospital discharge, and in-hospital death among patients admitted to the intensive care unit (ICU) within 12 months of a previous hospital discharge.

Methods: We conducted a multicentre retrospective cohort study that included patients aged 75 years or older admitted at least twice over a 12-month period to the general medicine service at 7 academic centres and large community-based teaching hospitals in Toronto and Mississauga, Ontario, Canada, from Apr. 1, 2010, to Dec. 31, 2019. The HFRS (categorized as low, moderate or high frailty risk) was calculated at the time of discharge from the first hospital admission. Outcomes included ICU admission and death during the second hospital admission.

Results: The cohort included 22 178 patients, of whom 1767 (8.0%) were categorized as having high frailty risk, 9464 (42.7%) as having moderate frailty risk, and 10 947 (49.4%) as having low frailty risk. One hundred patients (5.7%) with high frailty risk were admitted to the ICU, compared to 566 (6.0%) of those with moderate risk and 790 (7.2%) of those with low risk. After adjustment for age, sex, hospital, day of admission, time of admission and Laboratory-based Acute Physiology Score, the odds of ICU admission were not significantly different for patients with high (adjusted odds ratio [OR] 0.99, 95% confidence interval [CI] 0.78 to 1.23) or moderate (adjusted OR 0.97, 95% CI 0.86 to 1.09) frailty risk compared to those with low frailty risk. Among patients admitted to the ICU, 75 (75.0%) of those with high frailty risk died, compared to 317 (56.0%) of those with moderate risk and 416 (52.7%) of those with low risk. After multivariable adjustment, the risk of death after ICU admission was higher for patients with high frailty risk than for those with low frailty risk (adjusted OR 2.86, 95% CI 1.77 to 4.77).

Interpretation: Among patients readmitted to hospital within 12 months, patients with high frailty risk were similarly likely as those with lower frailty risk to be admitted to the ICU but were more likely to die if admitted to ICU. The HFRS at hospital discharge can inform prognosis, which can help guide discussions for preferences for ICU care during future hospital stays.

Medical patients discharged from acute care hospitals are at increased risk for a myriad of adverse events, including hospital readmission.[1] Medical patients admitted to the intensive care unit (ICU) during a hospital readmission are at increased risk for death or survival with new or worsening disabilities,[2] especially those with a life-limiting illness or impaired baseline function.[3–5] Understanding the prognosis of a patient admitted to the ICU can be coupled with a patient's values and preferences in order to engage in shared decision-making to determine the appropriateness of the ICU admission.[6]

Identifying patients who would benefit from goals-of-care discussions is challenging[7] but feasible with the use of electronic medical records.[8] The Hospital Frailty Risk Score (HFRS) is a tool that uses diagnostic codes at the time of hospital discharge to determine the patient's risk of adverse outcomes after discharge.[9] The HFRS uses administrative data that is routinely collected in health care systems; collection of detailed clinical

Competing interests: Amol Verma and Fahad Razak are employees of Ontario Health (Quality), which had no role in this work. Katherine Courtright receives funding from the National Institutes of Health. Jacqueline Kruser's time was supported, in part, by the National Heart, Lung, and Blood Institute (grant K23HL146890). No other competing interests were declared.

This article has been peer reviewed.

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***CMAJ Open* 2023 July 4. DOI:10.9778/cmajo.20220094**

data is not required. This tool could potentially identify, at the time of hospital discharge, patients who would be at risk for adverse events including death if admitted to the ICU on a subsequent hospital admission.

We sought to assess the association between HFRS at the time of hospital discharge and in-hospital mortality for patients admitted to the ICU on a subsequent hospital admission. Our goal was to determine whether the HFRS could quantify, at the time of initial hospital discharge, patients' prognosis on future hospital admissions and ICU admissions. This could inform discussions regarding goals of care, including decisions regarding ICU admission in the future.

Methods

Study design and setting

We conducted a multicentre retrospective cohort study that included patients admitted at least twice over a 12-month period to the general medicine service at 7 hospitals participating in the General Medicine Inpatient Initiative (GEMINI) from Apr. 1, 2010, to Dec. 31, 2019.[10] The hospitals included academic centres and large community-based teaching hospitals in Toronto and Mississauga, Ontario, Canada.

Participants

The cohort included medical patients aged 75 years or older who were admitted from the emergency department and were transferred to the general medical ward from the ICU, or vice versa. Because data were included only for patients who were admitted to the general medicine service at some point during their hospital stay, patients who were admitted directly from the emergency department to the ICU and either died in the ICU or were discharged directly from the ICU are not included. We also excluded interhospital transfers and patients who did not have an Ontario Health Insurance Plan number.

Data collection

The GEMINI database includes clinical and administrative data extracted from hospitals and linked at the individual patient level. The data have 98%–100% accuracy compared to detailed manual review of medical records for more than 23 000 data points; the accuracy rate for both ICU admission and in-hospital death is 100%.[11] As there are no missing data on patient characteristics, we used complete case analysis. We used the GEMINI database to collect the following baseline patient characteristics: age, sex, residence before hospital admission and comorbidities, including the Charlson Comorbidity Index score (using *International Statistical Classification of Diseases and Related Health Problems, 10th Revision* [ICD-10] codes). We also collected hospital-based data including laboratory test results, ICU admission, diagnostic imaging and invasive procedures, including dialysis, endoscopy (sigmoidoscopy, colonoscopy, esophagogastroduodenoscopy, endoscopic retrograde cholangiopancreatography, bronchoscopy) and interventional radiology.

Hospital Frailty Risk Score

The HFRS is calculated with the use of ICD-10 codes at the time of hospital discharge.[9] It was originally developed and validated in patients aged 75 years or older. The HFRS was designed to identify patients at increased risk for adverse events, including death and hospital readmission, within 30 days of hospital discharge.[9] In its initial description, the HFRS was trichotomized to categorize patients as having high (score > 15), moderate (score 5–15) or low (score < 5) frailty risk. This tool has been validated in Ontario,[12] where the present study was performed. We calculated the HFRS using discharge diagnoses, as reported by hospitals to the Canadian Institute for Health Information for the Discharge Abstract Database and National Ambulatory Care Reporting System, at the time of discharge from the first hospital admission, between Apr. 1, 2010, and Dec. 31, 2019.

Outcomes

We assessed outcomes during the second hospital admission within 12 months of the first hospital admission. The primary outcome was in-hospital death among patients admitted to the ICU. Secondary outcomes included in-hospital death among patients not admitted to the ICU, ICU admission and measures of resource use, including ICU and hospital length of stay, diagnostic imaging, dialysis, endoscopy and interventional radiology procedures.

Statistical analysis

We summarized descriptive statistics using counts with percentages or medians with interquartile ranges where appropriate. We compared differences in outcomes based on the 3 categories of frailty risk described by Gilbert and colleagues:[9] high, moderate and low. We reported 95% confidence intervals (CIs) for the absolute risk difference in outcomes between patients with high frailty risk versus those with moderate or low frailty risk. We obtained the risk differences in outcomes using adjusted standard errors from a 2-tailed independent proportions test for clustered data to account for clustering of observations at the hospital level.[13] We used the χ^2 test to determine significant differences in categoric variables and the Kruskal–Wallis test to determine significant differences in continuous variables. We constructed 3 multivariable logistic regression models for the outcome variables of ICU admission, in-hospital death among patients admitted to the ICU and in-hospital death among patients not admitted to the ICU. We used these models to calculate the adjusted odds ratio (OR) and assess whether death and ICU admission were associated with HFRS when we controlled for other clinically important covariates, including patient age, patient sex, hospital, weekday admission (v. weekend admission), daytime admission (v. night admission) and Laboratory-based Acute Physiology Score.[14] To illustrate the selection effects resulting from the study design, we also compared the HFRS and baseline characteristics of the cohort of patients who were excluded because they were not readmitted to hospital within 12 months.

Our primary analysis included all patients in the cohort who had at least 2 admissions to a medical ward within 12 months. Analyses were done in R version 4.0.2 (R Foundation for Statistical Computing).

Ethics approval

GEMINI received research ethics board approval at each participating site to conduct this research.

Results

The cohort included 22 178 patients aged 75 years or older who had at least 2 admissions to a medical ward within 12 months at 1 of the participating GEMINI hospitals (Table 1; Appendix 1, Figure S1, available at www.cmajopen.ca/content/11/4/E607/suppl/DC1). We excluded 769 patients because they did not have an Ontario Health Insurance Plan number. The patients in the study cohort were slightly older, had a higher Charlson Comorbidity Index score and were more likely to be from a nursing home than those who did not have a hospital readmission within 12 months (n = 125 369) (Appendix 1, Table S1).

Of the 22 178 patients in the study cohort, 1767 (8.0%) were categorized as having high frailty risk, 9464 (42.7%) as having moderate frailty risk, and 10 947 (49.4%) as having low frailty risk. Among the patients who were not included in the cohort because they were not readmitted to hospital within 12 months, the corresponding values were 5239 (7.4%), 28 671 (40.3%) and 37 280 (52.4%).

In the study cohort, the mortality rate during the subsequent hospital admission was 26.1% (n = 461) among patients with high frailty risk, 22.9% (n = 2167) among those with moderate frailty risk and 20.1% (n = 2205) among those with low frailty risk (Table 2).

Table 1: Baseline characteristics of patients aged 75 years or older who were admitted at least twice over a 12-month period to the general medicine service, stratified by Hospital Frailty Risk Score category

Characteristic	Hospital Frailty Risk Score category;* no. (%) of patients†		
	High n = 1767	Moderate n = 9464	Low n = 10 947
Age, yr, median (IQR)	86 (82–90)	86 (81–90)	84 (80–89)
Sex, male	739 (41.8)	4327 (45.7)	5061 (46.2)
From nursing home	662 (37.5)	2560 (27.0)	1689 (15.4)
ICU admission before hospital admission	110 (6.2)	393 (4.2)	351 (3.2)
Charlson Comorbidity Index score			
0	322 (18.2)	2135 (22.6)	2485 (22.7)
1	146 (8.3)	1231 (13.0)	1726 (15.8)
≥ 2	1299 (73.5)	6098 (64.4)	6736 (61.5)
LAPS, median (IQR)	22 (11–36)	22 (11–35)	21 (10–33)
Admitted on weekend	464 (26.3)	2421 (25.6)	2803 (25.6)
Admitted in evening or overnight‡	1341 (75.9)	7218 (76.3)	8181 (74.7)
Discharge diagnosis			
Heart failure	79 (4.5)	778 (8.2)	1330 (12.1)
COPD	37 (2.1)	319 (3.4)	775 (7.1)
Pneumonia	99 (5.6)	509 (5.4)	593 (5.4)
Urinary tract infection	134 (7.6)	684 (7.2)	334 (3.1)
Cognitive disorder§	225 (12.7)	697 (7.4)	342 (3.1)
Sepsis	113 (6.4)	497 (5.3)	336 (3.1)
Aspiration pneumonitis	169 (9.6)	575 (6.1)	354 (3.2)
Gastrointestinal bleed	33 (1.9)	203 (2.1)	314 (2.9)
Renal failure	38 (2.2)	250 (2.6)	219 (2.0)

Note: COPD = chronic obstructive pulmonary disease, ICU = intensive care unit, IQR = interquartile range, LAPS = Laboratory-based Acute Physiology Score.
*High = score > 15, moderate = score 5–15, and low = score < 5.
†Except where noted otherwise.
‡Between 1700 and 0800.
§Includes "delirium" and "dementia."

Table 2: Patient outcomes and resource use stratified by Hospital Frailty Risk Score category

Variable	Hospital Frailty Risk Score category; no. (%) of patients*			p value†
	High n = 1767	Moderate n = 9464	Low n = 10 947	
ICU admission	100 (5.7)	566 (6.0)	790 (7.2)	< 0.001
Hospital length of stay, d, median (IQR)	7.4 (3.6–15.5)	6.9 (3.5–14.1)	6.1 (3.9–12.2)	< 0.001
Discharge disposition				
Died	461 (26.1)	2167 (22.9)	2205 (20.1)	< 0.001
With ICU admission	75 (4.2)	317 (3.3)	416 (3.8)	0.09
Without ICU admission	386 (21.8)	1850 (19.5)	1789 (16.3)	< 0.001
Inpatient chronic care‡	487 (27.6)	2034 (21.5)	1371 (12.5)	< 0.001
Inpatient rehabilitation facility	81 (4.6)	479 (5.1)	555 (5.1)	0.7
Home	638 (36.1)	4244 (44.8)	6227 (56.9)	< 0.001
Acute care institution	72 (4.1)	413 (4.4)	466 (4.3)	0.8
Other§	28 (1.6)	127 (1.3)	123 (1.1)	0.2
Endoscopy	73 (4.1)	603 (6.4)	1014 (9.3)	< 0.001
Dialysis	16 (0.9)	197 (2.1)	238 (2.2)	0.002
Interventional radiology procedures	124 (7.0)	814 (8.6)	945 (8.6)	0.07
Imaging				
Computed tomography	990 (56.0)	5241 (55.4)	5554 (50.7)	< 0.001
Magnetic resonance imaging	77 (4.4)	596 (6.3)	735 (6.7)	0.001
Ultrasonography	455 (25.7)	2508 (26.5)	2866 (26.2)	0.8

Note: ICU = intensive care unit, IQR = interquartile range.
*Except where noted otherwise.
†Comparing differences across all groups.
‡Nursing home or complex continuing care institution.
§Includes ambulatory care, acute detoxification centre, mental health unit, Ontario Ministry of Health internally used classification, health care service organization (family health organization) and addiction treatment centre.

Intensive care unit admission and mortality

Of the 22 178 patients, 1456 (6.6%) were admitted to the ICU during their second hospital admission, with the majority being admitted to the ICU within the first 2 days of the hospital stay (Appendix 1, Figure S2). A total of 100 patients (5.7%) with high frailty risk were admitted to the ICU, compared to 566 (6.0%) of those with moderate frailty risk (risk difference –0.3%, 95% CI –2.5% to 1.9%) and 790 (7.2%) of those with low frailty risk (risk difference –1.6%, 95% CI –4.2% to 1.1%) (Table 2). After multivariable adjustment, the odds of ICU admission were not significantly different for patients with high (adjusted OR 0.99, 95% CI 0.78 to 1.23) or moderate (adjusted OR 0.97, 95% CI 0.86 to 1.09) frailty risk compared to those with low frailty risk (Figure 1; Appendix 1, Table S2).

Of the 1456 patients admitted to the ICU during their second hospital admission, 800 (54.9%) died in hospital; the rate was 75.0% (n = 75) among those with high frailty risk. The risk of death for patients with high frailty risk was greater than that for patients with moderate (56.0% [n = 317], risk difference 19.0%, 95% CI 7.4% to 30.6%) or low (52.7% [n = 416], risk difference 22.3%, 95% CI 12.4% to 32.3%) frailty risk. After multivariable adjustment, the odds of death after ICU admission were significantly higher for patients with high frailty risk than for those with low frailty risk (adjusted OR 2.86, 95% CI 1.77 to 4.77) (Figure 1; Appendix 1, Table S3).

Death among patients not admitted to intensive care unit

Of the 20 722 patients not admitted to the ICU during their second hospital admission, 4025 (19.4%) died in hospital, accounting for 83.3% (4025/4833) of the total deaths in hospital. The proportion of patients at high frailty risk who died without being admitted to the ICU was 23.2% (n = 386/1667), compared to 20.8% (n = 1850/8898; risk difference –2.4%, 95% CI –0.8 to 5.5) of those with moderate frailty risk and 17.6% (n = 1789/10 157; risk difference –5.5%, 95% CI 2.2 to 8.9) of those with low frailty risk (Table 2). After multivariable adjustment, among patients not admitted to the ICU, the odds of in-hospital death were significantly higher for those with high (adjusted OR 1.23, 95% CI 1.07 to 1.41) or moderate (adjusted OR 1.15, 95% CI 1.06 to 1.24) frailty risk than for those with low frailty risk (Figure 1; Appendix 1, Table S4).

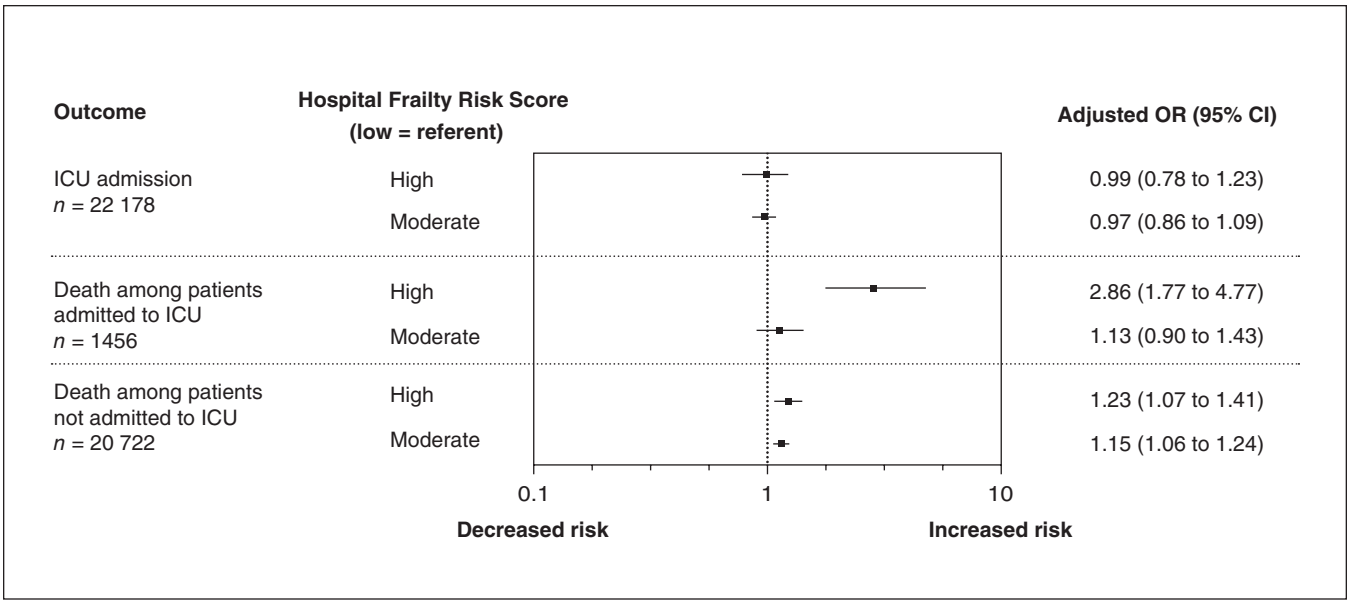

Figure 1: Adjusted odds ratios (ORs) and 95% confidence intervals (CIs) for outcomes by Hospital Frailty Risk Score category (high = score > 15, moderate = score 5–15, and low = score < 5). Adjusted for age, sex, hospital, day of admission, time of admission and Laboratory-based Acute Physiology Score. Note: ICU = intensive care unit.

Table 3: Patient outcomes and resource use for patients admitted to the intensive care unit, stratified by Hospital Frailty Risk Score category

Variable	Hospital Frailty Risk Score category; no. (%) of patients*†			
	High *n* = 100	Moderate *n* = 566	Low *n* = 790	*p* value‡
ICU length of stay, d, median (IQR)	4.0 (2.0–8.8)	3.3 (1.6–7.0)	3.2 (1.4–7.0)	0.1
Hospital length of stay, d, median (IQR)	14.99 (6.9–27.4)	13.9 (6.9–30.8)	13.6 (6.6–26.5)	0.4
Discharge disposition				
Death	75 (75.0)	317 (56.0)	416 (52.7)	< 0.001
Inpatient chronic care§	8 (8.0)	66 (11.7)	59 (7.5)	0.03
Inpatient rehabilitation facility	≤ 5	33 (5.8)	40 (5.1)	0.5
Acute care hospital	≤ 5	27 (4.8)	52 (6.6)	0.3
Home	8 (8.0)	119 (21.0)	217 (27.5)	< 0.001
Other¶	≤ 5	≤ 5	6 (0.8)	1.0
Endoscopy	10 (10.0)	106 (18.7)	150 (19.0)	0.08
Dialysis	6 (6.0)	47 (8.3)	69 (8.7)	0.6
Interventional procedures	26 (26.0)	151 (26.7)	170 (21.5)	0.08
Imaging				
Computed tomography	68 (68.0)	372 (65.7)	502 (63.5)	0.5
Magnetic resonance imaging	12 (12.0)	53 (9.4)	68 (8.6)	0.5
Ultrasonography	49 (49.0)	255 (45.1)	326 (41.3)	0.2

Note: IQR = interquartile range.
*Except where noted otherwise.
†Cells with fewer than 5 cases were suppressed to reduce risk of patient reidentification, in line with local privacy policies.
‡Comparing differences across all groups.
§Nursing home or complex continuing care institution.
¶Health care service organization (family health organization).

Table 4: Patient outcomes and resource use for patients not admitted to the intensive care unit, stratified by Hospital Frailty Risk Score category

Variable	Hospital Frailty Risk Score category; no. (%) of patients*			
	High *n* = 1667	Moderate *n* = 8898	Low *n* = 10 157	*p* value†
Hospital length of stay, d, median (IQR)	7.03 (3.56–14.86)	6.63 (3.42–13.55)	5.77 (2.86–11.31)	< 0.001
Discharge disposition				
Death	386 (23.2)	1850 (20.8)	1789 (17.6)	< 0.001
Inpatient chronic care‡	479 (28.7)	1968 (22.1)	1312 (12.9)	< 0.001
Inpatient rehabilitation facility	78 (4.7)	446 (5.0)	515 (5.1)	0.8
Acute care institution	67 (4.0)	386 (4.3)	414 (4.1)	0.6
Home	630 (37.8)	4125 (46.4)	6010 (59.2)	< 0.001
Other§	27 (1.6)	123 (1.4)	117 (1.2)	0.2
Endoscopy	63 (3.8)	497 (5.6)	864 (8.5)	< 0.001
Dialysis	10 (0.6)	150 (1.7)	169 (1.7)	0.003
Interventional procedures	98 (5.9)	663 (7.5)	775 (7.6)	0.04
Imaging				
Computed tomography	922 (55.3)	4869 (54.7)	5052 (49.7)	< 0.001
Magnetic resonance imaging	65 (3.9)	543 (6.1)	667 (6.6)	< 0.001
Ultrasonography	406 (24.4)	2253 (25.3)	2540 (25.0)	0.7

Note: IQR = interquartile range.
*Except where noted otherwise.
†Comparing differences across all groups.
‡Nursing home or complex continuing care institution.
§Includes ambulatory care, acute detoxification centre, mental health unit, Ministry of Health internally used classification, health care service organization (family health organization) and addiction treatment centre.

Resource use

Resource use for patients according to HFRS is summarized in Table 2. Among patients admitted to the ICU during their second hospital admission, there were no significant differences across HFRS categories in resource use, including hospital and ICU length of stay, medical imaging, interventional radiology procedures, endoscopy and dialysis (Table 3). Among patients not admitted to the ICU during their second hospital admission, compared to patients with moderate or low frailty risk, those with high frailty risk had a longer hospital stay, were more likely to be discharged to a nursing home and received computed tomography scans more frequently, and received magnetic resonance imaging scans, interventional procedures and endoscopy less frequently (Table 4).

Interpretation

In this large multicentre cohort study of older patients admitted to a general medical service, the HFRS calculated at hospital discharge provided useful prognostic information for those who were admitted to the ICU on a subsequent hospital admission within 12 months. Although the proportion of patients admitted to the ICU was similar across HFRS categories, patients with high frailty risk were more likely to die than those with lower frailty risk. This suggests there is an opportunity to use the HFRS to identify patients who would benefit from goals-of-care discussions after hospital discharge.

Discussions of goals of care should focus on aligning patients' values and preferences with their prognosis to ensure that their goals are realistically achievable given the clinical scenario.[15] Ideally, these discussions include appropriate stakeholders. This includes patients and their surrogate decision-maker(s) to ensure that the patient's perspective is shared should they become unable to express these considerations. Other partners should include clinicians who have a longitudinal relationship with the patient, including a primary care physician and/or a specialist who has been involved in treating the patient's chronic medical condition and understands the expected trajectory. Ideally, these discussions would also include an ICU physician, who has the expertise to help patients make an informed decision about the risks of ICU admission, including delirium,[16] impaired sleep[17] and exposure to bacteria with increased antimicrobial resistance.[18] A randomized controlled trial comparing systematic ICU admission to usual care for high-functioning older patients showed that patients admitted to the ICU were at increased risk of dying within 6 months.[19] This highlights the challenges of making

an informed decision about the appropriateness of ICU admission for patients at risk for adverse outcomes.

We found that patients admitted to the ICU within 12 months of a previous discharge were at high risk of dying in hospital: they had a probability of dying of more than 50%, and this number increased to 75% for patients with high frailty risk. This finding is consistent with prior work identifying that older patients admitted to the ICU, especially those categorized as frail, were at high risk for death.[4,5,20–24]

Traditional measures of frailty, such as the Clinical Frailty Scale, and the HFRS are different scales with different intended uses that are ultimately used to try to assess a patient's risk of experiencing adverse outcomes. Although the HFRS can be used to predict this risk, it may have variable correlation with traditional measures of frailty such as the Clinical Frailty Scale.[25] The advantage of using the latter is that it incorporates different quantitative and qualitative elements of a patient's clinical and functional status to summarize their overall clinical status; however, this requires time and expertise.[26] The advantage of the HFRS is that it uses administrative data that can be collected automatically from electronic medical records.[9]

In general, ICU care often includes continuous monitoring, procedures and the use of invasive life support. In our study, patients admitted to the ICU received invasive investigations and interventions (i.e., endoscopy, dialysis, interventional radiology procedures) in similar proportions regardless of their HFRS. This is consistent with prior work showing that frail older patients in the ICU had similar imaging costs as nonfrail older patients in the ICU.[27] This suggests that the care received in the ICU is uniformly intense. In our study, among patients not admitted to the ICU, a smaller proportion of those with higher frailty risk than those with lower frailty risk received procedures, and a higher proportion received computed tomography scans. This suggests that care on the medical wards may have focused more on noninvasive diagnostic testing and possibly limiting more invasive investigations.

The impact of understanding a patient's risk for death and informing decisions about ICU care are unknown. Our findings can help inform future directions of care with the use of the HFRS to identify patients who may benefit from discussions about ICU admission on future hospital admissions. Prior work has shown that these opportunities are frequently missed.[28] Other potential interventions addressing goals-of-care discussions in the outpatient setting may include palliative care consultation or advanced care planning, or both; these can reduce unwanted ICU admissions and ICU length of stay.[29] The potential interruptions in hospital that can limit the quality of these discussions are avoided in the ambulatory setting.[30] In our study, the majority of ICU admissions occurred within the first 2 days of the patient's hospital admission, when there may be limited time and opportunity to have high-quality discussions about care preferences. Furthermore, patients admitted to hospital often lack the capacity to engage in these discussions,[31] possibly secondary to delirium related to the underlying reason for hospital admission.[32]

Limitations

We used the HFRS as a measure of prognosis. Although this tool has been validated against patient outcomes in several settings, including our own province,[12] there is potential misclassification of prognosis owing to the limited sensitivity of most administrative diagnostic codes. Nevertheless, in our study, the HFRS was clearly associated with increased in-hospital mortality, particularly among patients admitted to the ICU. In addition, although the proportion of older patients who died without an ICU admission was comparable to that in earlier work,[31] we lacked data on patient values and preferences and on clinical decision-making, and therefore draw no conclusions about the appropriateness of ICU admission. We also lacked detailed information on the degree of ICU care delivered and whether limitations to care were implemented. Detailed qualitative data are needed to understand the relation between prognosis, patient preferences, informed decision-making and the invasive nature of ICU care. Furthermore, roughly 1 of every 4 patients categorized as having high frailty risk at the time of hospital discharge was readmitted within 12 months (data not shown). This underscores the challenge in predicting hospital readmission. It is possible that some of the remaining patients died without a hospital readmission or were readmitted to nonparticipating hospitals within 12 months. Future work should focus on identifying risk factors for hospital readmission. Finally, we were unable to include hospital as a random effect term in our regression analyses owing to convergence issues, and this may further limit the generalizability of our results beyond our 7 participating hospitals.

Conclusion

Older medical patients categorized with the HFRS as having high frailty risk who were admitted to the ICU were more likely to die during the study period than patients with lower frailty risk. Calculating the HFRS at hospital discharge can help identify patients who would benefit from discussions about future ICU care. The HFRS can provide prognostic estimates that can be used to engage in shared decision-making between patients and clinicians to help ensure delivery of care that is concordant with the patient's values and preferences in the case of future hospital readmission.

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Contributors: All of the authors contributed to the study conception and design. The site leads for data collection included Lauren Lapointe-Shaw, Terence Tang, Shail Rawal, Janice Kwan, Adina Weinerman, Fahad Razak and Amol Verma. Michael Detsky drafted the manuscript, and all coauthors revised it for important intellectual content. All of the authors analyzed and interpreted the data, approved the final version to be published and agreed to be accountable for all aspects of the work. Amol Verma and Fahad Razak were co–senior authors of this work.

Data sharing: Data from this manuscript can be accessed on request to the corresponding author, to the extent that is possible in compliance with local research ethics board requirements and data-sharing agreements.

Funding: There was no specific funding for this study. The development of the General Medicine Inpatient Initiative (GEMINI) data platform has been supported with funding from the Canadian Cancer Society, the Canadian Frailty Network, the Canadian Institutes of Health Research, the Canadian Medical Protective Association, the Digital Research Alliance of Canada, the Green Shield Canada Foundation, the Natural Sciences and Engineering Research Council of Canada, Ontario Health, the St. Michael's Hospital Association Innovation Fund and the University of Toronto Department of Medicine, and in-kind support from partner hospitals and the Vector Institute.

Supplemental information: For reviewer comments and the original submission of this manuscript, please see www.cmajopen.ca/content/11/4/E607/suppl/DC1.