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Trends in prevalence and outcomes of frailty in a Swiss university hospital: A retrospective observational study

THESE

préparée sous la direction du Professeur Gérard Waeber
avec la collaboration du Professeur Pedro-Manuel Marques-Vidal

et présentée à la Faculté de biologie et de médecine de
l'Université de Lausanne pour l'obtention du grade de

DOCTEUR EN MEDECINE

par

Thierry BONJOUR

Médecin diplômé de la Confédération Suisse
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RESEARCH PAPER

Trends in prevalence and outcomes of frailty in a Swiss university hospital: a retrospective observational study

Thierry Bonjour, Gérard Waeber, Pedro Marques-Vidal

Department of Medicine and Internal Medicine, Lausanne University Hospital (CHUV), Lausanne, Switzerland

Address correspondence to: Pedro Marques-Vidal, Office BH 10-642, Service de médecine interne, Centre hospitalier universitaire vaudois, Rue du Bugnon 46, 1011 Lausanne, Switzerland. Tel: (+41) 21 314 09 34; Email: Pedro-Manuel.Marques-Vidal@chuv.ch

Abstract

Background: Frailty complicates management and worsens outcomes. We assessed the prevalence, determinants and consequences of frailty among elderly patients in a hospital setting.
Design: Retrospective observational study in a Swiss university hospital.
Methods: 22,323 patients aged ≥65 years hospitalized between January 2009 and December 2017 at the internal medicine ward were included. Frailty was defined by the Hospital Frailty Risk Score (HFRS) and patients were categorized as low (HFRS<5), intermediate (HFRS 5–15) and high (HFRS>15) risk.
Results: Overall prevalence of intermediate and high risk of frailty was 43% and 20%, respectively; prevalence was higher in women and increased with age. Prevalence of high risk of frailty increased from 11.4% in 2009 to 31% in 2012, and decreased to 19.2% in 2017. After multivariable adjustment, frailty was associated with increased length of stay: average and (95% confidence interval) 11.9 (11.7–12.1), 15.6 (15.4–15.8) and 19.7 (19.3–20.1) days for low, intermediate and high risk, respectively, and increased likelihood of ICU stay: odds ratio (OR) and (95% CI) 1.57 (1.41–1.75) and 2.10 (1.82–2.42) for intermediate and high risk, respectively, p for trend <0.001. Frailty was associated with increased likelihood of hospital costs >70,000 CHF: OR and (95% CI) 3.46 (2.79–4.29) and 10.7 (8.47–13.6) for intermediate and high risk, respectively, p for trend <0.001, and with a lower likelihood of complete cost coverage: OR and (95% CI) 0.70 (0.65–0.76) and 0.52 (0.47–0.58) for intermediate and high risk, respectively, *p* for trend<0.001.
Conclusions: Frailty is a frequent condition among hospitalized patients and is associated with higher costs.

Keywords: frailty, patients, health costs, Switzerland, retrospective study, older people

Key Points

- Frailty trends is a retrospective study on 22,323 patients aged ≥65 years.
- Of these patients, 43% were at intermediate and 20% at high risk of frailty.
- High risk of frailty increased length of stay, hospital costs and risk of intensive care unit stay.

Introduction

It is estimated that by year 2050 circa two billion people aged over 65 years will populate the world [1]. In some parts of Switzerland, the number of people aged over 65 is expected to double, representing one-quarter of the total population [2]. This increase poses a considerable pressure in the hospital setting, where increasingly older and more frail patients are admitted. Frailty can be defined by a state of vulnerability following a stress and is a consequence of cumulative decline in multiple physiological systems eroding homeostatic reserve until relative minor stressor events trigger disproportionate changes in health status [3]. In 2005, Rockwood *et al*. [4] published the Clinical Frailty Scale (CFS), grading frailty

on a 7-point scale ranging from 1 (very fit) to 7 (severely frail). Although many other tools to assess frailty have been described since, there is still no gold standard for frailty detection [5]. This multiplicity of available tools has led to widely differing values for the prevalence of frailty, ranging from 10 to 23% among patients aged over 65 [6,7].

Frailty is an important and independent risk factor for mortality [8], lower quality of life [9], increased hospital length of stay (LOS) [10] and costs [11], increased risk of nursing home admission [10] and rehospitalisation [12]. This high burden of frailty on the health system raises the issue of a systematic screening of frailty in older people, the effectiveness of which is currently debated [13]. Indeed, the effectiveness of such a screening is dependent on the screening tool used, which should be easy to apply and with a high sensitivity and specificity. The tools cited earlier do not fulfil these criteria, for instance, the frailty phenotype [14] is time consuming and includes measurements not routinely used for patient assessment like gait speed or grip strength; the Clinical Frailty Scale [4] is dependent on clinical appreciation, and the Frailty Index [15] has not been validated in hospital settings. Recently, Gilbert *et al*. [16] proposed the Hospital Frailty Risk Score (HFRS) to assess frailty in the acute care setting. To our knowledge, the HFRS is the only tool developed for a hospital setting. Recently, the prognostic value of the HFRS has been validated on an independent patient population and confirmed the ability of the score to identify patients at risk of adverse outcomes [17].

Hence, we aimed to (1) evaluate the prevalence and the 9-year evolution of frailty (as defined by the HFRS) in patients aged ≥65 years hospitalised on the internal medicine ward of the Lausanne University Hospital (CHUV) and (2) study the association between frailty and LOS, in-hospital mortality, intensive care unit (ICU) stay, early readmissions and hospital costs. We hypothesised that the prevalence of frailty would increase and would be associated with all deleterious outcomes and increased costs.

Patients and methods

Setting

This is a retrospective study using medical information from of the Department of Internal Medicine of the CHUV. The CHUV is one of the Swiss university hospitals (www.chuv.ch), and the internal medicine unit of the CHUV is the largest in Switzerland, with over 4,000 admissions per year. The CHUV serves both as an end-stage hospital and as a general hospital for the population of canton Vaud.

Participants

We included all patients aged 65 or more, hospitalised between January 2009 and December 2017. Over four out of five admissions to the internal medicine ward transit via the emergency department.

Methods

Coded data was extracted from the hospital medical records by an independent office in charge of data extraction and coding at the CHUV. The following information was extracted: gender, age, number of diagnoses at discharge (coded according to the 10th International Classification of Diseases of the World Health Organization—ICD-10), LOS (in days), stay in an ICU (yes/no), status at discharge (death, return home or institutionalised), 30-day, 90-day and 1-year mortality, and total and reimbursable costs. Mortality data was obtained from the population registries, which record the vital status of a person (i.e. alive/death) but not the cause of death.

We computed the Charlson risk score according to an algorithm optimised for Switzerland [18] and categorised the participants into 0, 1–2, 3–4 and 5+ as suggested in the original publication [19].

The rate of readmission was computed taking into account the 1st admission for each patient within the 2004–17 period, admissions occurring 30 days after the 1st one were considered.

Due to changes in the Swiss reimbursement system by the introduction of the Diagnosis Related Groups (DRG), reimbursable costs were obtained only for years 2012 onwards. Total costs were categorised into <70,000 and ≥70,000 Swiss franc (CHF); this limit was chosen as it is the approximated cost of 1 year of chronic haemodialysis in Switzerland [20]. The difference between total and reimbursed costs was computed and categorised as fully covered if the difference was ≥0. Cost of stay was further categorised according to the DRG criteria into lowlier (LOS below the low margin of LOS for the corresponding DRG), inlier (within the low and high margins of LOS for the corresponding DRG) or highlier (above the high margin of LOS for the corresponding DRG).

Risk of frailty

Risk of frailty was defined according to HFRS proposed by Gilbert *et al*. [16]. The HFRS is a sum of different ICD-10 codes, which are weighted according to their clinical impact. The weight for each condition is provided in Supplementary Table S1. For each admission, the HFRS was computed based on ICD codes and categorised into low (<5), intermediate (5–15) and high (>15) risk.

Ethical statement

The Ethics Commission of Canton de Vaud (www.cer-vd.ch) approved the study protocol (decision No. 2018-01689 of 11 October 2018). The full decision of the CER-VD can be obtained from the authors upon request. The study was performed in agreement with the Helsinki declaration and its former amendments, and in accordance with the applicable Swiss legislation. No individual informed consent was deemed necessary.

Statistical analysis

Statistical analysis was performed using Stata version 16.1 for windows (Stata Corp, College Station, TX, USA). Descriptive results were expressed as number of participants (percentage) or as average ± standard deviation (SD). Bivariate analyses were performed using chi-square test for qualitative variables and analysis of variance or Kruskal–Wallis test for continuous variables.

Trends in prevalence of intermediate and high risk of frailty were assessed using multinomial logistic regression and the results were expressed as multivariable-adjusted relative risk ratios and 95% confidence interval (95% CI). For categorical variables, multivariable analysis was conducted using logistic regression and results were expressed as odds ratio and 95% CI. For continuous variables, multivariable analysis was conducted using analysis of variance and results were expressed as multivariable-adjusted average and 95% CI. Due to the skewed distribution of LOS and health costs, negative binomial regression was performed. Survival analysis was conducted using Cox regression and results were expressed as hazard ratios and 95% CI. All multivariable models were adjusted on gender (man, woman), age group (65–74, 75–84, 85+), number of previous hospitalisations (continuous) and Charlson index categories (0, 1–2, 3–4, 5+). Further adjustments on year of discharge, ICU stay (yes, no) and LOS (quartiles) were performed whenever necessary. Trends within the different frailty groups were tested using the 'contrast p.' command of Stata.

As participants could be hospitalised several times during the study period, a 1st sensitivity analysis was performed considering only the 1st hospitalisation. As the HFRS uses data from the previous 2 years, a 2nd sensitivity analysis was performed considering only the period 2011–17. Due to the number of tests performed, statistical significance was assessed for a two-sided test with $P < 0.001$.

Results

Characteristics of patients admitted according to frailty categories

Overall, 22,323 admissions were included (52% women, mean ± SD age 80.2 ± 8.2 years). Prevalence of frailty, defined as an intermediate or high HFRS, was 63% (95% CI: 62.7–64.0), with 43% (N = 9,656) in the intermediate-risk and 20% (N = 4,485) in the high-risk groups.

The characteristics of the patients admitted overall and according to frailty category are summarised in Table 1. Patients at intermediate or high risk of frailty were more frequently women, were older, presented more frequently with a main diagnosis of gait problems, delirium and sepsis, and less frequently with a main diagnosis of acute myocardial infarction and chronic obstructive pulmonary disease than patients at low risk. Regarding types of disease, patients at intermediate or high risk of frailty presented more frequently with pneumonia, gait problems, delirium, sepsis, chronic kidney disease, diabetes and hypertension, and less frequently with a main diagnosis of acute myocardial infarction and chronic obstructive pulmonary disease than patients at low risk. Finally, patients at intermediate or high risk of frailty had a higher number of comorbidities and were more frequently in the 3–4 and 5+ categories of the Charlson index (Table 1).

Evolution of frailty between 2009 and 2017

The trends between 2009 and 2017 for prevalence of the intermediate- and the high-risk categories of frailty are represented in Figure 1. There was an increase in the prevalence of high-risk patients from 2009 to 2012, followed by a sharp decrease afterwards. This evolution was further confirmed after multivariable adjustment (Figure 2).

Association between frailty and LOS, ICU stay, mortality and costs

The bivariate associations between frailty categories and destination after hospitalisation, ICU stay, LOS, readmission, hospital costs, and 30-, 90-day and 1-year mortality are summarised in Table 2. Patients at intermediate or high risk of frailty were more frequently admitted to the ICU, spent more time in the ICU and were more frequently institutionalised after discharge than patients at low risk. Patients at high risk of frailty had a higher 30-day, 90-day and 1-year mortality than patients at low risk. Patients at intermediate or high risk had higher total and reimbursed costs, their stay was less frequently fully covered and they were more frequently highliers than patients at low risk.

The multivariable associations between frailty categories and ICU stay, LOS, readmission, hospital costs, and 30-, 90- and 1-year mortality are summarised in Supplementary Table S2. Overall, the results were similar to those from the bivariate analyses, except that the associations with 30-day mortality were no longer significant. Further adjusting on ICU stay and LOS led to similar findings, except that the differences regarding cost coverage were no longer significant (Supplementary TableS3). Finally, adjusting for number of previous hospitalisations showed frailty levels to be positively associated with 30-, 90- and 1-year mortality (Table 3).

Sensitivity analysis

The results of the analyses using only 1st admissions are summarised in Supplementary Tables S4–S6. On bivariate analysis, patients at intermediate or high risk of frailty were more frequently admitted to the ICU, spent more time in the ICU and were more frequently institutionalised after discharge than patients at low risk. No differences were found regarding 30- and 90-day mortality, whereas patients at intermediate or high risk of frailty had a higher 1-year mortality than patients at low risk. Patients at intermediate or high risk had a higher total and reimbursed costs, their stay was less frequently fully covered and they were more frequently

Table 1. Clinical characteristics overall and according to the different frailty risk categories, Lausanne University Hospital, Lausanne, Switzerland, 2009–17

	Total	Low	Intermediate	High	*P*-value
N	22,323	8,182	9,656	4,485	
Women (%)	11,579 (51.9)	4,000 (48.9)	5,139 (53.2)	2,440 (54.4)	<0.001
Age (years)	80.2 ± 8.2	78.2 ± 8.1	81.0 ± 8.1	82.2 ± 7.8	<0.001
Age group (%)					<0.001
65–74	6,121 (27.4)	2,950 (36.1)	2,340 (24.2)	831 (18.5)	
75–84	8,621 (38.6)	3,170 (38.7)	3,699 (38.3)	1,752 (39.1)	
85+	7,581 (34.0)	2,062 (25.2)	3,617 (37.5)	1,902 (42.4)	
Main diagnosis (%)					<0.001
Heart failure	2,123 (9.5)	822 (10.1)	857 (8.9)	444 (9.9)	
Pneumonia	1,643 (7.4)	633 (7.7)	709 (7.3)	301 (6.7)	
Gait problems	922 (4.1)	61 (0.8)	501 (5.2)	360 (8.0)	
Delirium	800 (3.6)	34 (0.4)	364 (3.8)	402 (9.0)	
Sepsis	755 (3.4)	110 (1.3)	377 (3.9)	268 (6.0)	
Acute myocardial infarction	656 (2.9)	327 (4.0)	256 (2.7)	73 (1.6)	
COPD	642 (2.9)	315 (3.9)	244 (2.5)	83 (1.9)	
Diabetes	179 (0.8)	73 (0.9)	73 (0.8)	33 (0.7)	
Other	14,603 (65.4)	5,807 (71.0)	6,275 (65.0)	2,521 (56.2)	
Presence of (%)					
Heart failure	3,840 (17.2)	1,243 (15.2)	1,699 (17.6)	898 (20.0)	<0.001
Pneumonia	1,817 (8.1)	472 (5.8)	870 (9.0)	475 (10.6)	<0.001
Gait problems	4,013 (18.0)	261 (3.2)	2,103 (21.8)	1,649 (36.8)	<0.001
Delirium	2,281 (10.2)	128 (1.6)	1,140 (11.8)	1,013 (22.6)	<0.001
Sepsis	854 (3.8)	114 (1.4)	428 (4.4)	312 (7.0)	<0.001
Acute myocardial infarction	525 (2.4)	159 (1.9)	234 (2.4)	132 (2.9)	0.002
COPD	2,051 (9.2)	718 (8.8)	885 (9.2)	448 (10.0)	0.077
Chronic kidney disease	5,334 (23.9)	1,126 (13.8)	2,597 (26.9)	1,611 (35.9)	<0.001
Diabetes	3,819 (17.1)	1,214 (14.8)	1,683 (17.4)	922 (20.6)	<0.001
Hypertension	6,395 (28.7)	2,409 (29.4)	2,826 (29.3)	1,160 (25.9)	<0.001
Number of ICD-10 codes	12 [7; 17]	8 [5; 14]	12 [8; 18]	16 [11; 21]	<0.001‡
Charlson index	2 [0; 4]	2 [0; 4]	2 [0; 3]	2 [1; 4]	<0.001‡
Charlson index categories (%)					<0.001
0	5,796 (26.0)	2,284 (27.9)	2,507 (26.0)	1,005 (22.4)	
1–2	8,384 (37.6)	3,045 (37.2)	3,695 (38.3)	1,644 (36.7)	
3–4	3,953 (17.7)	1,229 (15.0)	1,725 (17.9)	999 (22.3)	
5+	4,190 (18.8)	1,624 (19.9)	1,729 (17.9)	837 (18.7)	

COPD, chronic obstructive pulmonary disease. Results are expressed as number of patients (column percentage) for categorical variables and as average ± standard deviation or median [interquartile range] for continuous variables. Between-group comparisons performed using chi-square for categorical variables and analysis of variance or Kruskal–Wallis test (‡) for continuous variables.

highliers than patients at low risk (Supplementary Table S4). Most associations were confirmed after multivariable analysis (Supplementary Table S5). Further adjusting on ICU stay and LOS led to similar findings, except that 1-year mortality and the differences between total and reimbursed costs and cost coverage were no longer significant (Supplementary Table S6).

The results of the sensitivity analysis focussing on period 2011–17 are summarised in Supplementary Tables S7–S10. Prevalence of intermediate and high risk of frailty

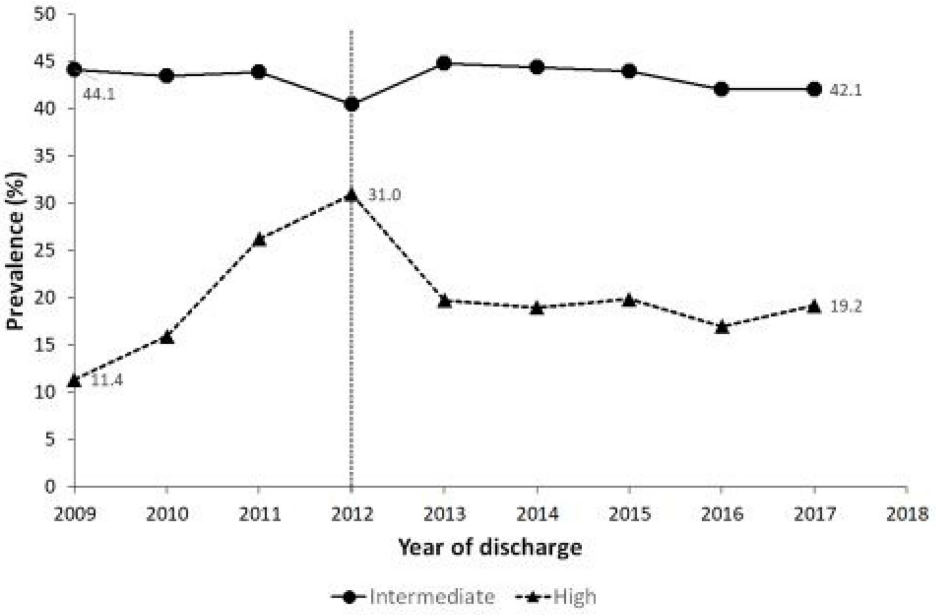

Figure 1. Trends in the prevalence of intermediate and high risk of frailty in the Department of Internal Medicine of the Lausanne University Hospital, 2009–17. Results are expressed as percentage.

Table 2. Bivariate analysis of the associations between frailty risk categories and different outcomes, Lausanne University Hospital, Lausanne, Switzerland, 2009–17

	Low	Intermediate	High	*P*-value
N	8,182	9,656	4,485	
Length of stay (days)	9.5 [6.0; 15.0]	12 [7.9; 18.8]	13.9 [9.0; 21.9]	<0.001‡
ICU stay (%)	663 (8.1)	984 (10.2)	537 (12.0)	<0.001
ICU stay (hours)[a]	68 [28; 120]	97 [48; 184]	143 [61; 308]	<0.001‡
Destination at discharge (%)				<0.001
Deceased	655 (8.0)	783 (8.1)	486 (10.8)	
Returned home	5,413 (66.2)	4,351 (45.1)	1,403 (31.3)	
Institutionalised	2,111 (25.8)	4,517 (46.8)	2,595 (57.9)	
Mortality (%)				
30-day	911 (11.1)	1,066 (11.0)	628 (14.0)	<0.001
90-day	1,474 (18.0)	1,822 (18.9)	1,035 (23.1)	<0.001
1-year	2,471 (30.2)	3,222 (33.4)	1,856 (41.4)	<0.001
Readmissions (*N*)[b]	7,593	8,941	4,039	
Rate	280 (3.7)	336 (3.8)	170 (4.2)	0.347
Costs (*N*)[c]				
Total (CHF)	11,161 [7,350; 17,946]	13,396 [8,918; 21,972]	15,303 [10,359; 26,924]	<0.001‡
Reimbursed (CHF)	9,553 [7,604; 14,366]	10,516 [8,591; 16,518]	11,630 [9,419; 18,543]	<0.001‡
Difference (CHF)	−846 [−4,491; 2,231]	−2,176 [−6,532; 1,439]	−3,216 [−8,548; 1,068]	<0.001‡
Costs ≥70,000 CHF (%)	119 (1.5)	340 (3.5)	304 (6.8)	<0.001
Full coverage (%)	2,204 (42.8)	2,143 (34.8)	923 (30.4)	<0.001
DRG category (%)				<0.001
Lowlier	157 (3.1)	104 (1.7)	32 (1.1)	
Inlier	4,036 (78.4)	4,612 (74.9)	2,094 (68.9)	
Highlier	956 (18.6)	1,442 (23.4)	913 (30.0)	

Results are expressed as number of patients (column percentage) for categorical variables and as average ± standard deviation or median and [interquartile range] for continuous variables. Between-group comparisons performed using chi-square for categorical variables and analysis of variance or Kruskal–Wallis test (‡) for continuous variables. [a]Among patients admitted to ICU. [b]Considering the 1st hospitalisation. [c]Data for period 2012–17.

was 43.1 and 22.0%, respectively. On bivariate analysis, patients at intermediate or high risk of frailty were more frequently admitted to the ICU, spent more time in the ICU, were more frequently institutionalised after discharge than patients at low risk, and had higher 30-day, 90-day and 1-year mortality than patients at low risk. Patients at intermediate or high risk had a higher total and reimbursed costs, their stay was less frequently

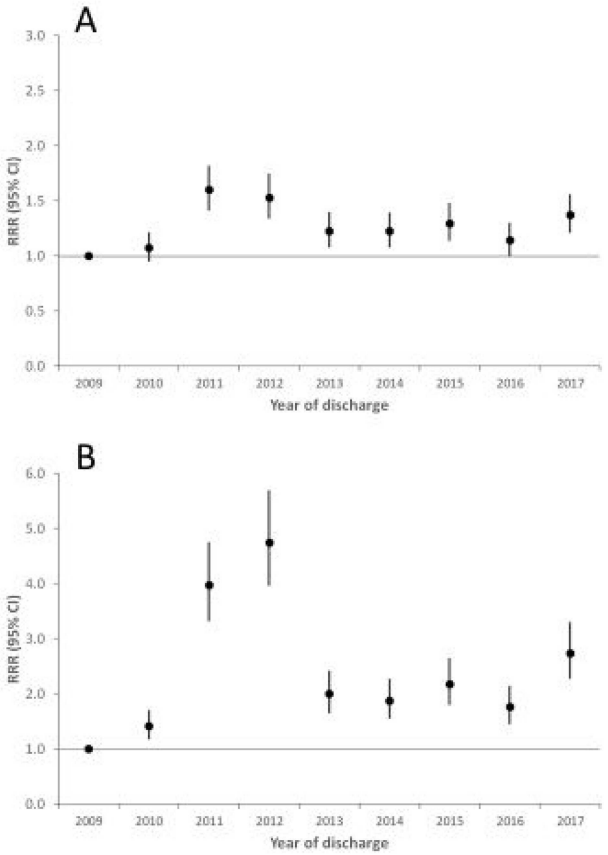

Figure 2. Trends in the prevalence of intermediate (A) and high (B) risk of frailty in the Department of Internal Medicine of the Lausanne University Hospital, 2009–17. Results are expressed as relative risk ratio and 95% confidence interval. Analysis conducted using multinomial logistic regression adjusting for gender (man, woman), age group (65–74, 75–84, 85+), Charlson index categories (0, 1–2, 3–4, 5+), intensive care unit stay (yes, no), number of previous hospitalisations (continuous) and length of stay (quartiles).

Table 3. Survival analysis for the different frailty risk categories, Lausanne University Hospital, for the 2009–17 period

	Low	Intermediate	High	*P*-value for trend
30-day	1 (ref.)	1.04 (0.95–1.14)	1.31 (1.16–1.47)	<0.001
90-day	1 (ref.)	1.04 (0.97–1.12)	1.22 (1.12–1.34)	<0.001
1-year	1 (ref.)	1.05 (1.00–1.11)	1.21 (1.13–1.30)	<0.001

Results are expressed as multivariable-adjusted relative risk (95% confidence interval). Between-group comparisons performed using Cox survival analysis adjusted on year of discharge (categorical), gender (man, woman), age group (65–74, 75–84, 85+), Charlson index categories (0, 1–2, 3–4, 5+), ICU stay (yes, no), number of previous hospitalisations (continuous) and length of stay (quartiles).

fully covered and they were more frequently highliers than patients at low risk, whereas no differences were found regarding rehospitalisation (Supplementary Table S7). These associations were confirmed after multivariable analysis (Supplementary Table S8). Further adjusting on ICU stay and LOS led to similar findings, except that the differences between total and reimbursed costs and cost coverage were no longer significant (Supplementary Tables S9 and S10).

Discussion

Our results indicate that frailty is a prevalent condition among hospitalised patients and associated with increased hospital costs. Frailty levels appear to be dependent on the coding system of diseases, and the association between frailty and mortality should be further explored.

Prevalence and characteristics of frail patients

Prevalence of intermediate and high risk of frailty was 63%, a value within the range published in a scoping review by Theou *et al*. [21], where frailty was measured with various scores. However, this prevalence is higher than reported in other studies, ranging from 32 to 40% [17,22]. A possible explanation would be the hospital setting (university hospital), where patients with multiple comorbidities and possibly more frail could be transferred from other structures.

Evolution of frailty between 2009 and 2017

Prevalence of high risk of frailty increased from 2009 to 2012, to decrease afterwards. To our knowledge, there is no other study assessing trends in frailty among hospitalised subjects. Interestingly, the decrease in prevalence occurred during the year of DRG implementation in Switzerland. The introduction of the DRG system in Switzerland decreased in-hospital mortality and increased readmission rates, but it did not impact LOS [23] or ICU mortality [24]. Although no study assessed the impact of DRG implementation on disease coding, it is likely that some changes occurred as some ICD codes were no longer valid to calculate DRG and subsequently healthcare reimbursement [25]. Overall, our results suggest that the prevalence of frailty is heavily dependent on the ICD-10 codes used, and that changes in disease coding can lead to considerable changes in the prevalence of frailty.

Association between frailty and LOS, ICU stay, mortality and costs

Frail patients had a higher likelihood of being admitted in the ICU. These findings are in agreement with a recent study showing an association between frailty (as measured by the HFRS) and unplanned admission to the ICU [26]. A 2nd study also showed an association between frailty (as measured by Clinical Frailty Scale) and short-term mortality in older patients admitted to the ICU [27]. Conversely, another study found no significant association between frailty and adverse outcome after adjusting for disease severity [28]. However, patients in this last study had a very low mean HFRS (31), probably reflecting a severe selection of patients at ICU

admission. Overall, our results strengthen the evidence of frailty as a risk factor for ICU admission.

Risk of frailty was positively associated with hospital costs, a finding in agreement with a study conducted in a community setting [11]. Risk of frailty was also associated with higher reimbursements, but the increase in reimbursements did not fully compensate the increase in hospital costs. Hence, patients at high risk of frailty led to higher financial losses to the hospital. Given the expected increase in the number of frail, older patients being admitted to the hospital, this finding is of great concern for hospital administrations who face a burden of additional costs. Hence, adequate screening and management of frail patients should be implemented to contain the rising associated costs.

Risk of frailty was not associated with hospital readmission, a finding consistent with a previous study [17], but not with another [22]. Still, in the last study, the association between frailty and readmission only held because early readmissions were included in a composite outcome [22]. Hence, our results do not support the hypothesis that risk of frailty is associated with increased risk of hospital readmission.

We found a significant association of frailty with 1-year mortality, whereas the association with 30-day and 90-day mortality was inconsistent. A positive association between frailty and 30-day mortality has been reported [17]. Several explanations can be put forward to explain this inconsistency. First, it could be explained by a much higher 30-day mortality (25 versus 12%) in the high-risk group in the study of Eckart *et al*. [17] than in the present study. Second, caring of high-risk patients could differ largely between hospitals or even between countries. Overall, our results suggest that frailty is related with 1-year mortality after discharge from hospital, whereas the association with short-term (30- and 90-day) mortality should be further checked.

Strengths and limitations

The main strengths of our study are the long survey period, which allowed to present trends and evaluation of status at discharge including institutionalisation.

This study also has some limitations. First, it is a monocentric, retrospective, observational study conducted in a Swiss tertiary hospital. Hence, the characteristics of the patients admitted (mostly multimorbid older patients) might not correspond to other settings. Still, the ageing of the population is occurring worldwide, and we believe that our results can be generalisable to most internal unit wards in developed countries. Second, as healthcare and reimbursement systems vary between countries, it is possible that the associations between HFRS and LOS or health costs might also change. Hence, it would be of interest that our findings be replicated in countries with different healthcare or reimbursement systems. Third, our definition of frailty may not reflect true frailty because of being based on comorbidities rather than on measurements such as grip strength. Still, they allow comparing our results with those of studies that used the same methodology [16,17]. Finally, the HFRS calculation is based on the ICD-10 codes from the discharge letter and not on the ICD-10 codes at the admission; furthermore, the coding of the conditions might vary between countries [29]. This can lead to an over- or under-estimation of the frailty risk and complicate between-country comparisons.

Conclusion

Frailty is frequent among hospitalised patients and is associated with higher hospital costs. The association between frailty and mortality awaits further investigation. This study demonstrates the feasibility of systematic screening for frailty in acute medicine. This could make it possible to improve the care of this population. Future studies investigating the correlation of HFRS with other validated scales in an acute care medicine setting such as CFS should be conducted.

Supplementary Data: Supplementary data mentioned in the text are available to subscribers in *Age and Ageing* online.

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