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FRAILTY INDEX, HOSPITAL ADMISSION AND NUMBER OF DAYS SPENT IN HOSPITAL IN NURSING HOME RESIDENTS: RESULTS FROM THE INCUR STUDY

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Abstract: *Objectives:* To investigate the predictive capacity of an age-related deficit accumulation index (the so-called Frailty Index [FI] proposed by Rockwood) for hospital admission (HA) and number of days spent in hospital (DSH) among nursing home residents. *Design, setting and participants:* Data are from a longitudinal cohort study, the Incidence of pNeumonia and related ConseqUences in nursing home Residents (INCUR), of 768 elder people (75.4% women) living in 13 nursing homes in France. *Measurements:* The FI was computed taking into account 30 possible deficits at the baseline visit. Hospital admissions were defined as all urgent and involuntary admissions including unplanned readmissions. The length of stay was the total number of days spent by the resident in the hospital. Cox proportional hazard models in the presence of competing risks (death) were performed to study the relationship between the FI and HA over a 12-month follow-up. A Zero-inflated negative binomial regression was performed to study the association between the FI and DSH. *Results:* Mean age of participants was 86.7 (standard deviation [SD] 6.9) years, with a mean FI of 0.37 (SD 0.11). At the end of the follow-up, 238 (30.9%) HA events were recorded. Positive associations of the FI with DSH and HA were reported (per 0.01 FI increment: age- and gender-adjusted hazard ratio 1.15, 95% confidence interval 1.020-1.297, $p=0.02$ and OR 1.209 (1.075 - 1.359, $p<0.001$, respectively). *Conclusions and Implications:* The FI is a strong predictor of negative health-related outcomes as HA and DSH events, even with very old and complex nursing home residents.

Key words: Frailty index, nursing home, hospital admission, days spent in hospital, prospective study.

Introduction

The “frailty index” (FI) proposed by Rockwood and Mitnitski is one of the most promising instruments for the assessment of frailty across healthcare settings, including nursing homes (1, 2). It is widely used and based on the arithmetical computation of deficits occurring with aging. The FI is strongly associated with negative outcomes, including disability and mortality (3-6). The FI provides an opportunity to distinguish between “chronologically” versus “biologically” old individuals beyond nosological entities (1). In fact, it provides a comprehensive measure of the age-related fragilization of the individual’s biology by counting the relative accumulation of clinical manifestations. Conversely, hospitalizations expose nursing home (NH) residents to the risk of disruptions in care, iatrogenic events, and related morbidity, finally resulting in increased healthcare costs (7-9). Ouslander J et al (10), in a study aimed at examining the frequency and reasons of potentially avoidable hospitalizations of NH residents, showed that 67% of hospitalizations were rated as potentially avoidable after validation by a panel of expert (composed by geriatricians, general practitioners, and NH staff). NH residents are different from community-dwelling, suggesting the findings in community-dwelling are not generalizable to NH patients.

To our knowledge, the FI has not yet been tested for this outcome in NH residents, and yet, identifying NH residents at risk of hospitalization may allow the development of ad hoc interventions plans since the very beginning (eg, closer control, allocation of more resources, more staff...).

In the present article, it is hypothesized that the FI may discriminate the most vulnerable people at risk of hospital admission. The objective of this study was thus to determine the relationship between FI and hospital admissions in a sample of NH residents. Analyses will also be conducted to explore whether the FI is predictive of the length of hospital stay when the primary outcome occurs. To explore these hypotheses, our study took advantage of the “Incidence of pNeumonia and related ConseqUences in nursing home Residents” (INCUR) study database, a longitudinal cohort study conducted in multiple French nursing homes.

Methods

The data used in this study were collected as part of the INCUR study, a French multicenter observational cohort study. The INCUR study was primarily aimed at estimating the incidence of pneumonia events in older persons living in nursing homes in France over a period of 12 months. A detailed

FRAILTY INDEX IN NURSING HOME RESIDENTS

description of the INCUR methodology and study design was previously described (11). Briefly, a total of 800 nursing home residents aged 60 and older were recruited in 13 nursing homes randomly selected between 2012 and 2013. The participants were characterized by presenting a score ranging between 2 and 5 (both included) at the Groupes Iso-Ressources (GIR) scale, the French administrative tool used to rate the ability of the person to be independent in his or her daily life. It scores from 6 (fully independent) to 1 (fully dependent, bedridden). Each eligible participant was followed for 12 months with a total of 3 clinical assessments (baseline, 6-month, and 12-month visits). The INCUR visits were conducted by research staff specifically trained. The study personnel collected information from the nursing home medical charts and performed physical assessment. Collected data included sociodemographic and lifestyle characteristics, chronic diseases, and functional status. If data were missing, the staffs were authorized to use additional medical sources (eg, discharge letters from hospitalizations) and/or obtain them by administering specific tests.

The Ethical Committee approved the entire study protocol. Since the study was conducted as part of standard care activities, no formal written informed consent was administered (as per the Ethical Committee exemption). However, all participants and their proxies were informed by the study investigators about the ongoing research activity and left free to accept or refuse their participation.

Frailty index

In the present analyses, we created a FI based on available data, following the criteria set by Searle and colleagues (12). A FI was generated from the data collected at the baseline assessment (see Appendix) (13). Each deficit included in the FI was coded as 0 or 1 according with the absence or presence of the condition, respectively. Overall, 30 variables were considered for the computation of the FI, providing our model a sufficient amount of robustness (12). Items included the presence and/or severity of current diseases, ability in activities of daily living, and physical signs from the clinical examination. Each participant's FI was calculated as the ratio between the presented and evaluated deficits. In other words, a person presenting x number of deficits had an FI resulting from the division $x/30$. Thus, the FI ranged between 0 (no deficit was present) and 1 (all the deficits were present), with an increment of 0.033 (i.e., $1/30$) points, corresponding to the presence of each additional deficit.

Outcomes

The primary outcome of interest for the present analyses was the incidence of hospital admissions occurred during the 12-month follow-up period after the baseline assessment visit. Hospital admissions were defined as all urgent and involuntary admissions including unplanned readmissions and emergency department (ED) transfer. Days spent in the hospital (DSH),

secondary outcome of the study, was calculated as the number of days spent in the hospital by patient (including the resident who are transfer to the ED and come back to the NH after few hours spent in the ED corridor) during the follow-up. DSH was set as equal to 0 for those residents who did not experienced any hospital admission. Both measures were ascertained by research staff from medical charts, and confirmed by the administrative documentation available at the residents' nursing homes.

Other variables

Sociodemographic characteristics included age, gender, and education. The body mass index (BMI) was defined as weight (in kilograms) divided by the square of height (in meters). Physical function modifications were determined using the basic activities of daily living (ADL) (14), the modified instrumental ADL (IADL) (15), and the Groupe Iso-Ressource (GIR) scale. Additionally, cognitive status (using the Abbreviated Mental test (16)), flu vaccination, nutritional status and administrative status of the NHs were recorded at the baseline.

Statistical Analysis

Chi-squared tests and t-tests were used to describe the categorical and continuous characteristics of the study sample, respectively. Kaplan-Meier curves were used to show the association between the FI categories and time to first hospitalization; individuals not developing the event were censored at their follow-up time. Cox proportional hazard models and survival analysis in the presence of competing risks (death) were performed to study the relationship between the FI and incident hospital admission. Results are presented as Hazard ratios (HRs) and 95% confidence intervals (95% CIs). Within the subsample of participants who have been hospitalized, zero-inflated negative binomial regression was performed to study the association between the FI and DSH over the follow-up; results are presented as Incident rate ratios (IRRs) and 95% confidence intervals (95% CIs). In addition to unadjusted analyses, relationships were evaluated in models adjusted for age and gender. We are also tested the interactions between the FI and HA. Statistical significance was set at a P-value less than 0.05. All statistical analyses were performed using SAS version 9.4.

Results

The current analyses were performed in 768 participants, after exclusion of 32 individuals with missing data for the main variables of interest. Descriptive characteristics of the sample according to the study outcomes are presented in Table 1. A total of 238 (30.9%) participants were hospitalized during the follow-up. There were no significant differences for the main socio-demographic characteristics between residents who experienced an hospitalization event versus the others. The

average days spent in hospital for a single admission was 10 (standard deviation, SD 9) days. The mean age of the sample was 86.1 (SD 7.59); women were predominant (74.7%). The mean FI was 0.36 (SD 0.11).

Table 1

Baseline characteristics of nursing home residents (n =768)

Variable at baseline	
Age (years)	86.1±7.6
Gender (women)	74.7
ADL limitations, 0-6	87.7
IADL limitations, 0-3	49.9
Flu vaccination	78.6
Abbreviated Mental Test score (/10)	4.9±3.4
Mini Nutritional Assessment score (/14)	9.7±2.2
FI	0.36±0.11
Number of hospitalizations (range: 0-6)	1.5±0.8
Number of days spent in hospital (days)	10±9.0
Death events	16.8

Results are presented as means ± SDs, or percentages. FI: Frailty Index, ADL: Activities of Daily Living, IADL: Instrumental ADL.

Table 2 shows the relationship between FI and incident hospitalization events. The FI (as continuous variable) was significantly associated with increased risk of hospitalizations at the univariate Cox model and even after adjustment for age and gender (p=0.02). The risk of hospital admission was higher in participants in the highest tertile of the FI, even after adjustment for age and gender (HR: 1.36, 95%CI 1.01-1.87; p=0.05).

We also assessed the relationship between the FI and total number of days spent in the hospital during the first year (Table 3). The FI (as continuous variable) was significantly associated with a higher number of days spent in the hospital at the univariate model and after adjustments for age and gender (p<0.001). Based on the regression model on DSH (Table 3), an increase in FI by 0.01 generate 1.13 (SD 1) extra-days of hospital stay. No significant interaction of age and/or gender

was reported in the studied relationship between FI and HA (p values of the interaction terms >0.20).

Discussion

To our knowledge, this is the first prospective study investigating the association of the FI with incident hospital admissions and number of days spent in the hospital in nursing home residents. In this paper, we have shown that FI represents a significant predictor of hospital admission and number of days spent in the hospital in nursing home residents. These associations were independent of age and gender. The magnitude of the reported associations might be considered as relatively moderate. It is probably weak because the nursing home population is particularly frail and at extreme high risk of experiencing the studied outcomes, especially if compared to community-dwelling populations. In other words, a ceiling effect should be considered in the interpretation of the predictive capacity of the FI when applied to particularly frail individuals.

The proportion of hospital admission shown by the present study (30.2%) is comparable to that reported in other studies (17, 18) (varying between 20.8 and 40%). While the higher admission rate may represent the natural progression of NH residents conditions, it may also reflect inadequate coordination of care between hospital and nursing homes, and/or inadequate advanced care planning involving discussions with nursing home residents and their family members about the goals of care and the benefits and risks of specific medical treatments and repeated hospitalizations (19). We have expected more hospitalization in the very frail (because they have more diseases, risk of falls...), but we have less. One of explanations is because we are working on disabled very old people and palliative care in this population may be the good option instead of hospitalization.

Our results are important because they show that the adoption of the FI may constitute an additional tool for comprehensively measure the health status of the individual and predict negative outcomes. The clinical relevance is also given by the studied outcomes that are important for the individual as

Table 2

Relationship of Frailty Index and hospitalization over 1 year of follow-up in nursing home residents[analysis in the presence of competing risks (death)]

	Unadjusted HR (95% CI)	P	Adjusted* HR (95% CI)	P
Frailty Index (continuous), n/N=238/768	1.17 (1.03 - 1.30)	0.02	1.15 (1.02 - 1.30)	0.02
Frailty index tertiles				
Tertile 1 (FI: 0.00-0.30) n/N=70/258	1		1	
Tertile 2 (FI: 0.31-0.40) n/N=80/249	1.26 (0.91 - 1.74)	0.16	1.26 (0.92 - 1.75)	0.16
Tertile 3 (FI: 0.41-1.00) n/N=88/261	1.38 (1.01 - 1.89)	0.04	1.36 (1.01 - 1.87)	0.05

*Adjusted for age and gender, FI: Frailty Index, CI = confidence interval, p= p-values, HR= hazard ratio, n/N= number of frail persons /sample

FRAILITY INDEX IN NURSING HOME RESIDENTS

Table 3

Relationship of Frailty Index and number of days spent in hospital over 1 year of follow-up in nursing home residents (A Zero-inflated negative binomial regression was performed)

	Unadjusted IRR (95% CI)	P	Adjusted* IRR (95% CI)	P
Frailty Index (continuous), n/N=238/768	1.12 (1.11 - 1.13)	<0.001	1.21 (1.07 - 1.36)	<0.001
Frailty index tertiles				
Tertile 1 (FI: 0.03-0.30) n/N=70/258	1		1	
Tertile 2 (FI: 0.31-0.40) n/N=80/249	1.24 (1.21 - 1.27)	<0.001	1.24 (1.21 - 1.27)	<0.001
Tertile3 (FI: 0.41-0.63) n/N=88/261	1.40 (1.36 - 1.44)	<0.001	1.44 (1.40 - 2.47)	<0.001

*Adjusted for age and gender, FI: Frailty Index, CI = confidence interval, p= p-values, IRR: incident rate ratio, n/N= number of frail persons /sample

well as for public health reasons.

The FI was demonstrated to be feasible and confirms its capacity to predict HA and hospital stay, independently of potential confounders. The FI might be considered as a marker of biological aging (2). In fact, it is designed for overcoming traditional paradigms as chronological age or diseases for focusing on the age-related accumulation of abnormalities resulting from a comprehensive geriatric assessment. Therefore, the exercise of identifying frail older individuals with the FI could be useful for the development of targeted preventive interventions (20, 21), even in nursing homes residents who represent an extremely heterogeneous population. In this specific population the FI may be useful for the NH staff to anticipate and discuss the plan of care of those who must go to the hospital if needed, and the ones that may not benefit of the hospitalization.

The strengths of the present study are the large number of participants selected from multiple diverse nursing home residents, the quality of the follow-up of the cohort and the very low percentage (3.2%) of missing data. The advantage of the Frailty Index is that it does not require the same variables, nor even the same number of items, to estimate the proportions that represent the index values. Our data are collected as part of standard care, thus highly mirroring the current clinical practice.

Our study has several limitations that might have influenced the results: (1) third factors not considered in the present analyses may differently explain our findings; (2) the eligibility criteria of the INCUR study might potentially underestimate the predictive value of the FI for study outcomes; (3) the sample population was limited to nursing home residents, so the findings may not be transferable to community-dwelling individuals.

Conclusions and Implications: In conclusion, our study aimed to examine the association of HA and DSH in terms of age-related deficit accumulation, defined according to the FI. Our findings demonstrate the existence of an association between FI and HA and DSH in nursing home residents. The FI may be considered a useful tool for measuring the individual's frailty and determine the risk of negative endpoints (such as risk of hospital admission and hospital stay) also in nursing home

residents. For better understanding, this association should be investigated in more detail in future studies.

Summary

Frailty Index (FI) is associated with negative outcome. In the present study, we are reporting a positive association between FI and hospital admission, and number of days spent in hospital. The FI is a prognostic marker in nursing home residents.

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