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Brief Report

How the Frailty Index May Support the Allocation of Health Care Resources: An Example From the INCUR Study

Matteo Cesari MD, PhD [a,b,*], Nadege Costa PhD [c], Emiel O. Hoogendijk PhD [d], Bruno Vellas MD, PhD [a,b], Marco Canevelli MD [e], Mario Ulises Pérez-Zepeda MD, PhD [f]

[a] *Gérontopôle, Centre Hospitalier Universitaire de Toulouse, Toulouse, France*
[b] *Université de Toulouse III Paul Sabatier, Toulouse, France*
[c] *Département d'Information Médicale, Centre Hospitalier Universitaire de Toulouse, Toulouse, France*
[d] *Department of Epidemiology and Biostatistics, EMGO+ Institute for Health and Care Research, VU University Medical Center, Amsterdam, The Netherlands*
[e] *Memory Clinic, Department of Neurology and Psychiatry, "Sapienza" University, Rome, Italy*
[f] *Instituto Nacional de Geriatria, Mexico City, Mexico*

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A B S T R A C T

Background: The Frailty Index (FI), proposed by Rockwood and Mitniski, measures the deficits accumulation occurring with aging, and can be generated from the results of a comprehensive clinical assessment. Its construct (based on pure arithmetical assumptions) may represent a unique feature for supporting unbiased comparisons among clinical facilities/services.
Objective: To propose an example depicting how the FI may support health economic evaluations and provide insights for public health.
Design: Observational study.
Setting: Nine nursing homes participating in the "Incidence of pNeumonia and related ConseqUences in nursing home Residents" (INCUR) study.
Subjects: A sample of 345 older persons living in nursing homes.
Methods: A 30-item FI was generated from clinical data retrieved from medical charts. Health care expenditures that occurred over 12 months of follow-up for each participant were obtained from the *Caisse Primaire d'Assurance Maladie*. Descriptive analyses describing the relationships between the FI of residents with the annual health care expenditures according to nursing home are presented.
Results: Mean age of the study sample was 86.0 (SD 7.9) years. The median annual cost per patient was 27,717.75 (interquartile range, IQR 25,917.60–32,118.02) Euros. The median FI was 0.33 (IQR 0.27–0.43). Results are graphically presented to highlight clinical and economic differences across nursing homes, so as to identify potential discrepancies between clinical burden and consumed resources.
Conclusions: In this article, an example on how the FI may support health economic analyses and promote an improved allocation of healthcare resources is presented.

Among the available operationalizations of frailty (some of them even specific for the nursing home setting[1–3]), the model proposed by Rockwood and colleagues[4] is one of the most used. The so-called Frailty Index (FI) measures the deficits accumulation occurring with aging,[5] and can be generated from the results of a comprehensive geriatric assessment. The FI is computed by calculating the ratio between the number of deficits the individual presents (ie, clinical signs, symptoms, conditions, and disabilities) and the total number of considered items.[6] The score, ranging from 0 (no deficit is present) to 1 (all deficits are present) has shown to be a strong predictor of negative health-related outcomes in different settings and populations,[7] and

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* Address correspondence to Matteo Cesari, MD, PhD, Gérontopôle, Université de Toulouse III – Paul Sabatier, 37 Allées Jules Guesde, Toulouse 31000, France.
E-mail address: macesari@gmail.com (M. Cesari).

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indicated as a marker of biological aging.[8] Interestingly, because it is purely based on arithmetical assumptions, it is not important which items are considered for its computation, as soon as sufficient quantity (at least 30, better if more than 50) and multidimensionality (focus on different domains of the individual's health status) of them are respected.[6] In this way, although every item will weight for 1/n (where n is the total number of considered deficits), the most clinically burdening conditions will still substantially affect the FI because likely coexisting with related corollary deficits.[9] Furthermore, one of the most relevant features of the FI consists of the possibility of retrospectively building it by taking advantage of databases created for completely different purposes than the study of frailty. In fact, the FI (1) does not rely on specific questions or tests to be administrated, (2) does not need special instruments or devices, and (3) is based only on the arithmetical computation of clinical deficits. All these characteristics also imply that its results are more consistent and reproducible compared with other models of frailty assessment (which, for example, might be biased by the way a question is asked/perceived, or a test is conducted).

Nevertheless, some applications of the FI are not yet sufficiently explored. For example, the increasing number of older persons is one of the major threats for the sustainability of modern health care systems.[10] In this context, the FI might be useful for supporting decisions in the allocation of health care resources. When the objective evaluation of frailty (again, replicable and comparable because free of qualitative assumptions and purely based on arithmetical foundations) can be combined with health economic data, it might be possible to draw the relationship between the clinical features of patients attending a specific service and the resources consumption of that facility. This approach may thus lead to more objective and patient-tailored comparisons of needs and resources, potentially supporting monitoring activities aimed at the identification of apparent discrepancies. Taking advantage of the "Incidence of pNeumonia and related ConseqUences in nursing home Residents" (INCUR) study database, we here propose an example depicting how the FI may provide this kind of interesting insight for public health.

Methods

The study protocol has been previously described elsewhere.[11] Briefly, INCUR is a prospective observational cohort study conducted in 13 nursing homes that were randomly selected in southwestern France. The INCUR study was primarily aimed at estimating the incidence of pneumonia events in older nursing home persons over a period of 12 months. The Ethical Committee of the Centre Hospitalier Universitaire de Toulouse approved the entire study protocol. Because the study was conducted as part of standard care activities, no formal written informed consent was administered (as per the Ethical Committee's 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.

Sociodemographic and clinical data were directly retrieved from the medical charts of the enrolled patients by trained personnel. Moreover, the health care costs sustained by the *Caisse Primaire d'Assurance Maladie* (CPAM; the major health care insurance in France) of the Midi-Pyrénées region during the entire 12-month period of follow-up were retrieved for all the INCUR participants referring to it. A 30-item FI was generated from data collected at the baseline assessment.[12] It included 5 clinical signs/symptoms, 18 diseases, and 7 disability conditions.

The total amount of expenditures (expressed in Euros) sustained by public health over the period of follow-up included the nursing home fees for hosting the patient as well as the costs of medications, outpatient visits (both medical and paramedical), emergency room admissions, hospitalizations, and transportation.

The present analyses were conducted in a sample of 345 INCUR participants (living in 9 different nursing homes), after exclusion of 455 individuals with missing data for health care costs because of referring to an insurance different from the CPAM-Région Midi-Pyrénées. Excluded participants did not substantially differ for main sociodemogaphic and clinical characteristics from those considered in the present analyses.

Descriptive analyses were performed to describe medians (with interquartile range [IQR]) of the health care costs and FI. Mann-Whiutney *U* tests were conducted to compare the continuous (non-normally distributed) variables of interest. Analyses were performed using SPSS for Mac (version 22.0; IBM Corporation, New York, NY).

Results

The studied sample (n = 345) had a mean age of 86.0 (SD 7.9) years, and presented a higher prevalence of women (77.4%). Figure 1 shows the median annual cost per patient (histograms and left *y*-axis) in relationship with the median FI of patients (bars and right *y*-axis) according to nursing home (*x*-axis). The median annual cost per patient in the studied group was 27,717.75 (IQR 25,917.60–32,118.02) Euros and is represented by the dashed horizontal line. The median FI in the studied sample was 0.33 (IQR 0.27–0.43) and is shown in Figure 1 as the dotted horizontal line. Looking at the graph, it seems as if nursing home 9 is more expensive than nursing home 2 (median annual cost/patient Euro 28,850.20, IQR 26,152.13–40,618.40 versus Euro 26,408.14, IQR 25,092.80–28,419.69, respectively; Mann-Whitney *U* test, $P = .02$) despite a similar clinical burden of patients (median FI = 0.41, IQR 0.33–0.49 versus FI = 0.38, IQR 0.30–0.473, respectively; Mann-Whitney *U* test, $P = .30$). The costs of nursing home 8 also exceed the median annual cost per patient of the entire group of analyzed facilities. Multiple factors might explain such discrepancies and these data should not automatically lead to negatively judging nursing home 9 (or positively judging nursing home 2). However, the findings might still lead to more detailed considerations by public health authorities in charge of allocating money to the 2 facilities.

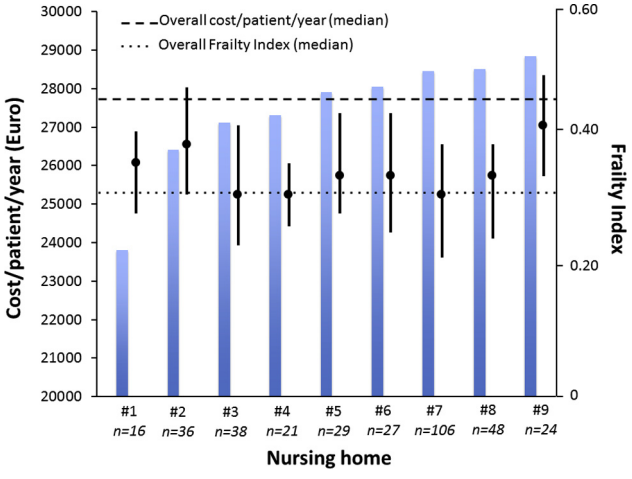

Fig. 1. Graphical description of the relationships between the FI of patients and the health care resources consumption according to nursing home. Histograms represent the median annual cost/patient (and IQR) sustained by the CPAM for each nursing home. Circles (and bars) represent the median FI of patients (and IQRs) in each nursing home. The dashed line is the median annual cost/patient sustained by the CPAM for the sample of studied participants. The dotted line is the median FI in the sample of studied participants.

Discussion

Health care systems are burdened by the costs of age-related conditions. Moreover, the paradigms currently adopted in medicine and health economics are difficult to apply to the older person, frequently presenting multiple and mutually interacting (chronic) conditions.[13] The need of new models is indeed necessary to adequately face the "gray tsunami." Thus, the frailty condition has been developed so as to leave the obsolete and inadequate criterion of "chronological age" in the definition of the "geriatric patient."[14] Among the multiple definitions of frailty, the FI is the one that more than others depicts the age-related accumulation of deficits, mirroring the needed "biological age" criterion. Such an objective parameter is particularly powerful because it is applicable to every living being (even animals[15,16]), independently of the age, setting, and specific clinical conditions. Interestingly, to date, the frailty concept has mainly been translated into a predictor of clinical outcomes[7] and health care costs.[17] To our knowledge, this is the first attempt to conduct such "higher-level" comparisons between clinical services. In this context, it is also noteworthy that Hubbard et al[18] recently demonstrated the possibility of easily generating the FI from data with administrative value routinely collected in the clinical setting (eg, the InterRAI instrument). In other words, the FI is an instrument suitable for both providing clinically meaningful information as well as supporting comparisons across populations and environments, thus potentially answering some issues that health economics experts are today facing.

By proposing our results, we do not want to diminish the value of other instruments designed and validated for measuring frailty. As we described in a previous article,[19] we believe that the FI has different and probably complementary purposes compared with the other available tools. For example, an instrument such as the FRAIL-NH, recently proposed for use in nursing homes,[2] might optimally serve for the first preliminary screening of residents so as to identify the subpopulation at higher risk of negative outcomes. The attribution of such task to the FRAIL-NH can be easily justified by its easiness and strong predictive capacity.[1,3] In parallel, the FI might then be generated from the results of the subsequent clinical assessment for (1) confirming the standardization, reproducibility, and comparability of the frailty profile across public health services, and (2) supporting the follow-up of residents by the means of a score more sensible to modifications.[19]

In this article, we have provided a simple example on how the FI may work in this field. Our analyses were far from exhaustive. Several weaknesses are nested in our analyses to claim them as definitive. For example, a higher number of items composing the FI might have provided more robust results. At the same time, our data from the *Caisse Primaire d'Assurance Maladie* do not take into account "out-of-pocket" expenses and/or indirect costs sustained by caregivers. However, our purpose was simply to highlight a possibility that is currently still unexplored, but of potential interest for improving the allocation of resources (and consequently promote high-quality standards) in our collapsing health care systems.

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