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**SHORT REPORTS**

# The risk of adverse outcomes in hospitalized older patients in relation to a frailty index based on a comprehensive geriatric assessment

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## Abstract

**Background:** prognostication for frail older adults is complex, especially when they become seriously ill.
**Objectives:** to test the measurement properties, especially the predictive validity, of a frailty index based on a comprehensive geriatric assessment (FI-CGA) in an acute care setting in relation to the risk of death, length of stay and discharge destination.
**Design and setting:** prospective cohort study. Inpatient medical units in a teaching, acute care hospital.
**Subjects:** individuals on inpatient medical units in a hospital, $n = 752$, aged 75+ years, were evaluated on their first hospital day; to test reliability, a subsample ($n = 231$) was seen again on Day 3.
**Measurements:** all frailty data collected routinely as part of a CGA were used to create the FI-CGA. Mortality data were reviewed from hospital records, claims data, Social Security Death Index and interviews with Discharge Managers.
**Results:** thirty-day mortality was 93 (12.4%; 95% confidence interval (CI) = 10–15%) of whom 52 died in hospital. The risk of dying increased with each 0.01 increment in the FI-CGA: hazard ratio (HR) = 1.05, (95% CI = 1.04–1.07). People who were discharged home had the lowest admitting mean FI-CGA = 0.38 (±standard deviation 0.11) compared with those who died, FI-CGA = 0.51 (±0.12) or were discharged to nursing home, FI-CGA = 0.49 (±0.11). Likewise, increasing FI-CGA values on admission were significantly associated with a longer length of hospital stay.
**Conclusions:** frailty, measured by the FI-CGA, was independently associated with a higher risk of death and other adverse outcomes in older people admitted to an acute care hospital.

**Keywords:** *age, frailty index based on a comprehensive geriatric assessment, mortality, prognosis, acute care, older people*

## Introduction

When frail older adults become acutely ill, their risk of dying is higher than their fitter compatriots of the same age. How to quantify that risk in an acute care setting can be a challenge [1]. Broadly, risk stratification can take the form of various screening measures, such as Clinical Frailty Scale [2] or FRAIL questionnaire [3–5], or more detailed evaluations such as Fried frailty phenotype [6, 7, 8], Groningen Frailty Indicator [9, 10], Edmonton Frail Scale [11, 12] or frailty index based on a comprehensive geriatric assessment (FI-CGA) [13, 14]. Both screening and more detailed evaluations have been used to stratify outcomes from myocardial infarction [15, 16] or frailty assessments in various medical and surgical sessions [17, 18, 19, 20, 21, 22].

Many commentators propose either a two-part strategy, with a screening frailty measure followed by a geriatric assessment [23], or hospital-wide interventions [24, 25]. Others see the need for geriatric assessment very early in the hospital course (including in the Emergency Department—ED) when further risk stratification can inform care planning [26, 27, 28, 29]. Even so, tools with accurate predictive validity generally are seen as lacking [1, 3, 27, 30].

In general, more definitive frailty measures are the frailty phenotype [6] and the frailty index [31, 32]. Each has been criticized for being too cumbersome for the acute setting [23]. Even so, the FI-CGA can identify some people at very high risk in general populations [13, 33] or in the hospital course [14, 34]. Feasibility for the ED use of FI measures based on deficit accumulation has also been reported [14, 35]



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so that whether the FI-CGA might be useful remains an open question.

Mercy Hospital of Buffalo NY, a community hospital, routinely collects information on all older adults who present for care, but does not use prognostic tools in relation to frailty. Our objectives were: (i) to test the feasibility of using the FI-CGA shortly after admission from the ED to general medical wards; (ii) to test the properties of the FI-CGA used here (including its reliability) in comparison with its published properties in other studies, such as the relationship between age, sex differences and the presence of a sub-maximal limit; and (iii) to evaluate the predictive validity of the FI-CGA score in relation to near term (to 120 days) mortality, length of stay in hospital (LOS) and discharge destination.

## Methods

### Subjects and setting

Between 3 November 2010 and 31 May 2011, data were collected from 752 patients, aged 75 years or older, who were medical inpatients. Between Mondays–Fridays inclusive during each study week, within 48 h of admission (usually from the ED, but also from other hospitals, and specialists' offices) patients who appeared to meet study criteria were approached. Each study patient was evaluated on Day 1 and to test reliability, a convenience subsample (of those who had not been discharged by then) was also seen on Day 3. A Catholic Health System Quality Assurance nurse collected the data for the first 50 patients; the remaining 702 were assessed by a geriatric nurse practitioner. Patients who were not approached were either post 24 h from admission (and thus past our Day 1 time frame; these patients chiefly were people admitted on the weekend) or discharged (and hence unavailable) when the data collector were on site. The main sample was powered to detect at least a 10% difference, ±5% in the mortality rate between the most and least frail groups, assuming an overall mortality of 10%, with $\beta = 0.9$ and $a = 0.05$; the reliability sample size was calculated to achieve 90% power to detect a correlation of 0.60, with the null hypothesis being a notional correlation of 0.30.

### Measures

The standard CGA was completed from which the FI was later calculated. The CGA recorded information about patients' health on admission and at baseline (2 weeks previously) focusing on cognition, function, mobility, balance, appetite and weight. The data on baseline health status used the best information from the patient, the health record and a reliable informant, where available.

The FI-CGA was calculated from 55 binary or ordinal variables (deficits) recoded as described elsewhere [36] (see Supplementary data available in *Age and Ageing* online, Appendix, Table AS1).

### Data collection

Data collection began with a health record review, followed by patients and informant interviews, which focused on the baseline state. Mortality for all patients was determined from hospital records, claims data and the Social Security Death Index. To avoid an observation effect, FI-CGA scores were not disclosed to the hospital staff.

### Statistical analysis

Linear regression analyses (both linear and robust regression accounting for outliers) were performed to evaluate the relationships between the logarithm of the mean FI and age. Model goodness of fit was evaluated by the coefficient of determination ($R^2$). Survival was analysed by using Kaplan–Meier estimator and Cox proportional hazards regression adjusted for age and sex. The difference between the different survival curves were evaluated using the log-rank test. The proportionality of the hazards was verified with log-minus–log-plus plot. Spearman rank correlation and one-way-analysis of variance (ANOVA) were used to evaluate the FI-CGA in relation to the length of stay. Kruskal–Wallis ANOVA was used to study the relationships between the FI-CGA and discharge destination. The level of statistical significance was set to $P = 0.05$. Analyses were performed using the SPSS statistical software (IBM SPSS, ver. 19) and Matlab (MathWorks Inc., ver.7.12).

## Results

During assembly of the cohort, 1,755 medical patients 75 or older were admitted, of whom 1702 were eligible (non-ICU, medical). With just one data collector available, only 752 patients were approached. Complete data were available on 751 (mean age 84.0 (SD = 5.5); most (480; 60.7%) were women).

Completing the FI-CGA took 25 min on average (range 20–30). Most items were completed from the health records. Of the 231 people who had second readings within 72 h, the test–retest reliability (weighted $\kappa$) was 0.78.

On average, patients were moderately frail at baseline (both mean and median FI-CGA = 0.38). On average, patients with higher baseline FI-CGA scores more often had dementia, delirium, falls, multiple co-morbidities and more medications (Table 1). Their health typically had worsened in the two weeks prior to admission, as indicated by a significant increase in FI-CGA values (Supplementary data are available in *Age and Ageing* online, Appendix, Figure AS1A). Even so, the 99% limit to the FI-CGA was consistent (0.70 at baseline and 0.71 on admission).

The mean level of the FI-CGA was related to age ($R^2 = 0.87$, $P < .001$). The slope of the regression line relating the FI-CGA to age was 0.018 (95% confidence interval (CI) = 0.007–0.020) at baseline and 0.014 (95% CI = 0.010–0.027) at admission (Supplementary data are available in *Age and Ageing* online, Appendix, Figure AS1A).



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**Table 1.** Characteristics of the cohort at admission, in relation to frailty status at baseline (2 weeks prior to admission)

| | FI-CGA groups | | | |
|---|---|---|---|---|
| FI-CGA | <0.35 | 0.35–0.45 | 0.46–0.55 | >0.55 |
| *n* | 316 | 194 | 138 | 103 |
| Mean age (SD) | 82.4 (5.0) | 85.0 (5.1) | 85.2 (5.7) | 85.5 (6.0) |
| % of women | 62.7 | 72.2 | 60.9 | 60.2 |
| Mean years of education (SD) | 11.8 (2.8) | 11.3 (2.9) | 11.2 (2.9) | 11.6 (2.9) |
| % with dementia | 11.7 | 31.4 | 42.0 | 59.2 |
| % with delirium | 1.6 | 4.6 | 13.0 | 19.4 |
| % with falls | 16.8 | 22.2 | 24.6 | 31.8 |
| Mean number of medications (SD) | 6.4 (2.5) | 8.0 (2.6) | 8.8 (2.9) | 9.2 (2.9) |
| Mean number of co-morbidities (SD) | 6.3 (2.1) | 7.8 (2.3) | 8.0 (2.6) | 9.7 (2.6) |

### Outcomes

The mean length of stay in hospital was 5.2 (SD = 5.1) days. Most patients were discharged home (399; 53.7%) with 199 (26.8%) discharged to a nursing home, 76 (10.2%) to a rehabilitation facility and 23 (3%) to assisting living facilities. The 30-day mortality rate was 12.4% (93/751) which increased to 18.2% (137/751) by 90 days and to 19.8% (149/751) within 120 days. Of the 751 patients, 149 died within 120 days (death rate 19.8%; 95% CI = 16–26). Mortality was related to age and was highest amongst people aged 90+ years (28%; 95% CI = 18–36) (Figure 1A). It was also related to frailty (Table 2); note that the 32 people whose FI-CGA was >0.65 had a 60% 120 day mortality (95% CI = 42–78) (Figure 1B).

Age and sex were each significantly associated with the risk of death. In a Cox model which included these two variables, both were significantly associated with the risk of dying, for age hazard ratio (HR) = 1.053 (95% CI = 1.021–1.084) and for female sex HR = 0.523 (95% CI = 0.375–0.729). In a Cox model adjusted for age, sex and the FI-CGA, age was no longer significant compared with sex, HR = 0.55 (95% CI = 0.40–0.77); for the FI-CGA, HR = 1.05 (95% CI = 1.04–1.07). In other words, in the absence of the information about the FI-CGA, each year of age increases HR in relation to death by 5%; when the FI-CGA result is added in the multivariate model, age is no longer significant, and each 1% increase in the FI-CGA translates to a 5% increase in the risk of death.

The people who were discharged had the lowest mean FI 0.38 (±0.11) compared with those who died, who had the highest 0.52 (±0.12) or were discharged to nursing home, FI-CGA = 0.49 (±0.11). (Supplementary data are available in *Age and Ageing* online, Appendix, Figure AS2). The average length of stay also increased from 4.2 in the least frail group to 7.8 in the frailest group.

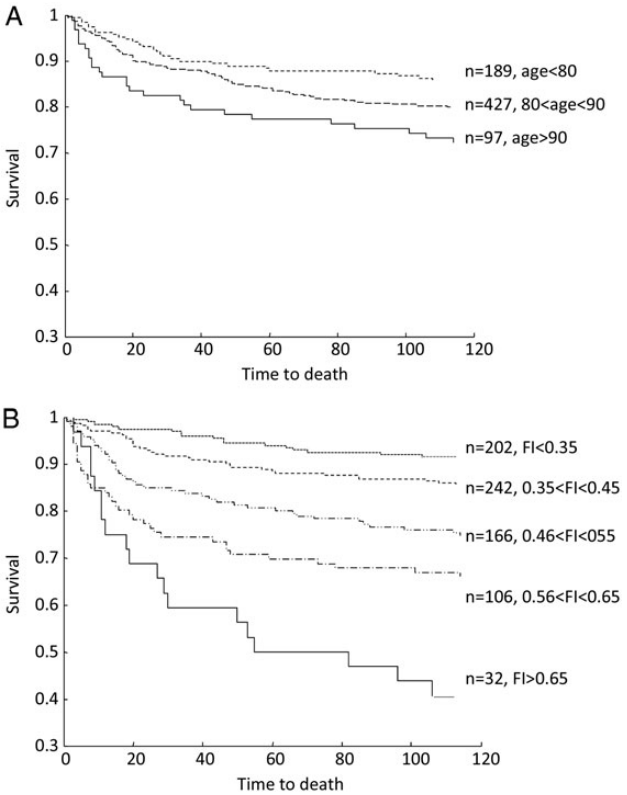


**Figure 1.** (A) Kaplan–Meier survival curves stratified by age. The number of people in each stratum are shown on the right of the curves. (B) Kaplan–Meier survival curves stratified by FI-CGA. The number of people in each stratum are shown on the right of the curves. FI, frailty index.

## Discussion

Here, we evaluated 752 older adults, aged ≥75 years, admitted to an acute care hospital between 3 November 2010 and 31 May 2011. For each, we completed a CGA, from which an FI was calculated. Increasing values of the FI-CGA were associated with higher risks of death and institutionalization and hospital lengths of stay. The association of frailty and death suggest that the degree of frailty, and not just its presence is important. The continuous score of the FI-CGA provides access to that nuance (e.g. mortality dose–response in relation to FI scores, illustrated in Figure 1B). Overall, age was significantly related to each of these adverse outcomes in sex-adjusted analyses, but was no longer significant when adjusted for the FI-CGA.

Our data must be interpreted with caution. They come from a single site, and for less than a full year, so may be



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Table 2. Death rate, risk ratios and average length of stay in hospital (ALOS) in relation to frailty status at admission

| FI-CGA groups | *n* | Death rate | Risk ratio (95% CI) | ALOS (SD) |
|---|---|---|---|---|
| <0.35 | 205 | 0.09 | 1[a] | 4.2 (5.0) |
| 0.35–0.45 | 242 | 0.17 | 2.0 (1.2–3.3) | 4.8 (5.1) |
| 0.46–0.55 | 166 | 0.27 | 3.1 (1.9–5.1) | 5.0 (3.2) |
| 0.56–0.65 | 106 | 0.35 | 4.0 (2.5–6.6) | 5.3 (4.3) |
| >0.65 | 32 | 0.59 | 6.8 (4.0–11.4) | 7.8 (8.9) |

[a]Death rate of the group with FI-CGA <0.35 is used as the basis for calculation of the risk ratios.

susceptible to secular trends. On average, most of the information needed to complete the FI-CGA (75%) had been recorded in the health record; the FI-CGA collates those in one place, and does not include additional performance testing, which is often seen as more objective than clinical data. On the other hand, performance data (including items as unobtrusive as clock drawing) [37] are commonly associated with incomplete records, especially in settings of routine clinical care [8, 38] Although the data in an electronic medical record could allow instantaneous calculation of an FI-CGA score, here FI-CGA values were calculated only after the study was completed. In consequence, we do not know the impact of this information on clinical care, which would require separate study. The sample of 751 people does not include everyone admitted during the study period. Because we collected as much data as we could, we do not have any data on the people for whom no data were collected. Even so, the sample is not small, and variability is evident, so selection bias for a uniform population does not appear to be operating.

A larger study would also allow for fuller exploration of sex-differences, differences in residence prior to admission, and differences in relation to other measures of illness severity [39]. The inter-rater reliability study was not blinded, although this is mitigated by much of the data coming from the health record, entered by people blind to the intent of test–retest reliability. Even so, a larger study with multiple raters is preferred. The generalizability of our findings to other acute care settings needs to be established. Mortality data were obtained through newspaper obituaries and monitoring of the Social Security Death Index. This may have led to missing deaths even though follow-up on the outcome continued for 12 months after completion of the study.

Many readers will not be familiar with the FI-CGA and the FI literature on which it was based [40], and therefore will be likely to ask two related questions: why not use a factor analysis or like data reduction technique to simplify the number of items to be included, and; why is that all items have the same weight: should some items not be weighted more than others? How might it be, for example, that cancer and a skin rash should carry the same weight? The issues of the specific explanatory value of individual items in a complex state rely on the items being able to be considered independently. In complex biological systems that are close to failure – which is one way to think about frail older adults, especially when they become acutely ill – items are rarely independent. Even if, in a given sample, independence of factors can be demonstrated statistically, this is by a convention that is not well grounded in biological reality. Likewise, by convention, statistical models in clinical medicine rarely take interactions into account, even though interactions obviously occur and are clinically important. What can be demonstrated is that although weighting can retrospectively improve fit in a given sample, they limit generalizability [41]. What is more, the accumulation of small effects can be very powerful; even when individually small items themselves are not significantly associated with an adverse outcome, they can combine to be powerful, an approach not well served by (indeed at odds with) just selecting out a few items [40, 41, 42]. As we get to grips with the complexity of frail older adults, it is important that we adopt analytical procedures which are well suited to their problems. Similarly, the purpose of the analysis is not mortality prediction: instead, looking at how the FI relates to the risk of death allows us to capture the larger point that people who are frail are at greater risk of adverse outcomes compared with others of the same age (Figure 1).

In community-based, institutional and clinical survivor cohorts (e.g. post-myocardial infarction, breast cancer chemotherapy), the 99% limit to the FI in most cases was 0.7 [33, 43, 44]. Here, the 99% limit was 0.70 at baseline and 0.71 on admission. Ninety-five percent and maximal values of FIs were 0.60 (baseline) and 0.63 (at admission). The presence of a sub-maximal limit is important. From a methodological standpoint, it demonstrates that there is no ceiling effect imposed by the instrument itself. Clinically, it corresponds to the common sense notion that there is a point at which an individual is as ill as they can be, even if they do not suffer from every known illness. The presence of a quantifiable limit to frailty, if established in clinical samples, could be of use in guiding difficult clinical decisions for frail older adults for whom prognostic tools that do not have ceiling effects are lacking.

Looking at which items were added from the patient interviews sheds light on how routine medical care proceeds. For the most part, the additional information needed to complete the CGA data so that a FI could be calculated was not the list of the co-morbidities or the medications, or whether the patient had ever smoked, been married, but instead, was how these deficits impact on life: how does the patient function now and how has that changed? Is cognitive impairment present and is it new? Does illness impact on social engagement? Can the patient walk, and if not, is that recent? Much of the frailty literature (and its more recent companion, the 'multi-morbidity' literature) [45] can be seen as a means of going beyond recounting the component parts to look at the whole person. This assessment is key, even if it is just the starting point to effective care planning, which is where the value added of a CGA arises.

As one of the first applications to acute setting, these data are of interest, but larger multi-centre studies are needed for the generalizability of this approach to be understood. That possibility is motivating further inquiries by our group.



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## Key points

- We tested the feasibility of using an FI-CGA shortly after admission from the ED to general medical wards.
- We evaluated the relationships between frailty and near term mortality, length of stay in hospital, and other adverse outcomes.
- We demonstrated that the FI-CGA is a strong predictor of the risk of death and other adverse outcomes.
- Our results suggest that 'how frail' a patient is has importance separate from 'whether a patient is frail'.
- The continuous score of the FI-CGA provides access to that nuance.

## Conflicts of interest

After completion of data collection and analysis, Dr. Evans has started a company, VIdex-US, LLC to commercialize frailty measurement.

## Funding

The Community Health Foundation of Western and Central NY, Grant number 650-10, timeframe 1 January –31 August 2011.

## Supplementary data

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

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The very long list of references supporting this paper has meant that only the most important are listed here and are represented by bold type throughout the text. A full list of references is provided in the Supplementary data available in *Age and Ageing* online, Appendix, All references.


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# Oral health in older patients with oropharyngeal dysphagia

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## Abstract

**Background**: oropharyngeal dysphagia (OD), aspiration and poor oral health status are potential risk factors in elderly patients with aspiration pneumonia (AP).
**Aim**: to assess the oral hygiene status and the prevalence of periodontal disease and dental caries in elderly patients with OD.
**Patients and methods**: fifty elderly patients (79.7 ± 6.64 years) with OD associated with ageing or neurological diseases and 15 elderly patients without OD (77.01 ± 4.51 years) were enrolled in this observational–transversal study. OD and aspiration were evaluated by videofluoroscopy (VFS). Oral health was assessed by: (i) the Simplified Oral Hygiene Index (OHI-S); (ii) a complete periodontal examination, assessing the periodontal pocket depth, clinical attachment loss and bleeding on probing to study periodontal diseases (periodontitis, gingivitis); and (iii) the presence of dental caries.
**Results**: 8/50 elderly patients with OD presented VFS signs of aspiration, half of them silent; 40/50, signs of penetration into laryngeal vestibule and 16/50, oropharyngeal residue. Prevalence of edentulism and caries was higher in patients with OD. Dentate older patients with OD (30/50) presented the following complications (i) poor oral hygiene in 18 patients (OHI-S 3.1–6), (ii) gingivitis in 2 and periodontitis in 28 and (iii) caries in 16.
**Conclusions**: older patients with OD presented polymorbidity and impaired health status, high prevalence of VFS signs of impaired safety of swallow and poor oral health status with high prevalence of periodontal diseases and caries. These patients are at great risk of developing AP. We recommend a policy of systematic oral health assessment in elderly patients with OD.

**Keywords:** *Swallowing disorders, elderly, oral hygiene, periodontal diseases, aspiration pneumonia, older people*