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Frailty prior to Critical Illness and Mortality for Elderly Medicare Beneficiaries

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Abstract

Background—Health categories of elderly patients prior to critical illness may explain differences in mortality during and after admission to intensive care units (ICUs).

Objectives—To estimate the effect of pre-ICU health categories on mortality during and after critical illness, focusing specifically on the effect of pre-ICU frailty on short- and long-term mortality.

Design—Retrospective cohort study using linked Medicare claims data from 2004–2008.

Participants—A nationally representative sample of elderly Medicare beneficiaries who were admitted to an ICU in 2005.

Measurements—Patients were classified into four pre-ICU health categories (Robust; Cancer; Chronic Organ Failure; Frailty) using claims data from the year prior to admission, allowing for assignment to multiple categories. We assessed the association between pre-ICU health categories and hospital and 3-year mortality using multivariable logistic regression and Cox proportional Hazards models.

Results—Among 47,427 elderly ICU patients, 18.8% were Robust; 28.6% had pre-ICU Cancer; 68.1% Chronic Organ Failure and 34.0% Frailty; 41.3% qualified for multiple categories. Overall

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hospital mortality was 12.6%, with the lowest mortality for Robust patients (9.7%). Patients with pre-ICU Frailty had a higher hospital mortality compared to patients with the same pre-ICU health categories without frailty (adjusted Odds Ratios ranged from 1.27 (95% confidence interval (CI) 1.10–1.47) to 1.52 (95% CI 1.35–1.63)). Robust hospital survivors had the lowest 3-year mortality (24.6%). Pre-ICU Frailty conferred a higher 3-year mortality compared to pre-ICU categories without frailty (adjusted Hazard Ratios ranged from 1.54 (95% CI 1.45–1.64) to 1.84 (95% CI 1.70–1.99).

Conclusion—Critically ill elderly patients can be categorized by Pre-ICU health categories. These categories, particularly pre-ICU Frailty, may be important for understanding risk of death during and after critical illness.

Keywords

Frailty; aged; prognosis; critical illness; Medicare

INTRODUCTION

Elderly people make up a large proportion of the patients cared for in intensive care units (ICUs) worldwide (1). While we have substantial understanding of the impact of acute illness on both short and long-term outcomes for elderly critically ill patients, there is increasing awareness that information on a patient's status prior to the critical illness may be essential to understanding prognosis (2–4). Four health categories that occur prior to death were previously defined in an elderly Medicare population: sudden death, chronic organ failure, cancer, and frailty (5), each with a distinctive pattern of functional decline in the year before death (5, 6). Such patterns may also be relevant prior to an event such as an episode of critical illness.

Frailty, in particular, may represent a key syndrome that could impact a patient's resilience from an episode of critical illness. It is a geriatric multi-dimensional syndrome that has been associated with an increased risk of disability, hospitalizations and death in community living elderly patients (7, 8). The presence of frailty may result in decreased physiologic reserve and increase the risk of poor outcomes after illness or surgery (9–11). Prospectively studying the association between pre-ICU frailty and ICU outcomes in elderly patients is particularly difficult due to the low incidence of critical illness in the large cohorts of community dwelling elderly patients where functional status and frailty measures have been captured (12, 13).

Therefore, using a nationally representative sample of elderly Medicare beneficiaries, we sought to use a claims based approach to describe categories of pre-ICU health of elderly patients. We hypothesized that Medicare claims from the year prior to ICU admission could be used to describe distinct groups of elderly patients with clinically significant differences in short- and long-term mortality after critical illness. We, *a priori*, hypothesized that a pre-ICU frailty would be associated with a substantially increased short and long-term mortality relative to patients in other health categories.

METHODS

Data Source

This was a retrospective cohort study using the Medicare Standard Analytic Files (SAF) from the Center for Medicare and Medicaid Services (CMS). The data set contains all fee-for-service claims, including hospital inpatient, hospital outpatient, skilled nursing facility, "carrier" claims (physician supplier part B files which includes all office visits), home health agency, and durable medical equipment for a random, longitudinal 5% sample of beneficiaries. This was a limited data set with all healthcare encounters identified by the quarter (3-month interval) of the year. We linked data from the years 2004 through 2008 and derived the inception cohort from the 2005 sample. Our cohort consisted of a random 5% sample of Medicare beneficiaries ≥ 66 years old who received intensive care during the year 2005. We excluded patients who were treated only in Intermediate ICU, Coronary Care Units or Psychiatric ICUs.

Defining Health Categories prior to Admission to an ICU

We used all Medicare claims from the 4 quarters prior to the index hospitalization to provide information on previously existing conditions using the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) diagnosis codes. We modified a descriptive classification scheme developed for Medicare decedents and grouped patients into four pre-ICU health categories using ICD-9 diagnoses and specific facility claims (see table S1 on the Appendix) (5, 6, 14). Patients with ≥ 1 claim with a diagnosis of cancer (excluding benign neoplasm, carcinoma in-situ or malignancies labeled as "unspecified nature") were classified into the Cancer group. Patients who had a diagnosis of congestive heart failure, ischemic heart disease, chronic liver disease, chronic obstructive pulmonary disease (excluding patients with a diagnosis of acute bronchitis) were classified in the Chronic Organ Failure group.

We identified patients as being in the Frailty group if they had claims from a nursing facility in the year prior to the index hospitalization or if they had at least one claim in the year prior to ICU hospitalization associated with any of the following diagnoses previously associated with frailty: dementias or dementia from Alzheimer's disease or senility; sub-acute delirium; Parkinson's disease pathologic fracture; functional urinary and fecal incontinence; dehydration; debility; pressure ulcer; other unspecified protein-calorie malnutrition, kwashiorkor, nutritional marasmus, severe protein calorie malnutrition or abnormal loss of weight or adult failure to thrive; accidental falls or abnormality of gait or lack of coordination (see table S1) (5, 15, 16). Patients who did not fall into the Cancer, Chronic Organ Failure, or Frailty were classified as Robust. For the patients with pre-ICU Cancer, Chronic Organ Failure and Frailty, we counted the number of ICD-9-CM claims in the year before the index hospitalization that fit the health category criteria to determine whether patients were being categorized primarily based on a single claim, or whether there was substantial redundancy in categorization of patients (see table S3 in the Appendix).

We anticipated substantial overlap among the Cancer, Chronic Organ Failure and Frailty groups (i.e. patients could be classified as fitting into more than one category). Using the

four proposed pre-ICU health categories, we also created distinct groups (eight in total) that would classify each individual into mutually exclusive categories: Cancer only; Chronic Organ Failure only; Frailty only; Cancer & Chronic Organ Failure; Cancer & Frailty; Chronic Organ Failure & Frailty; Cancer, Chronic Organ Failure & Frailty.

Data Analyses

We calculated descriptive statistics for demographics, clinical characteristics and outcomes using percentages, means (± standard deviations, SD), and medians (with inter-quartile ranges, IQR) as appropriate for our study cohort. We grouped age into four categories (<70, 70–79, 80–89, >90 years old) and grouped race/ethnicity as: White, non-Hispanic; Black, non-Hispanic; and Other. We categorized each patient as medical or surgical using diagnosis related groups (DRG) for the index hospitalization. We examined specific aspects of the index hospitalization: the frequency of mechanical ventilation (ICD-9-CM codes 96.7x or tracheostomy 31.1 or DRG 483) (17), acute renal failure (ICD-9-CM 584.x) and community-acquired pneumonia (18); we also assessed acute organ dysfunctions (cardiac, respiratory, renal, neurologic, and hepatic) and diagnoses of infection and severe sepsis with ICD-9-CM codes, using standard definitions (19).

We next examined mortality based on pre-ICU health categories. When groups had overlapping patient populations, we did not test for statistical differences between groups. We compared differences in hospital mortality for the eight non-overlapping subgroups using the chi-squared test and logistic regression, with Robust patients as the comparison group. For patients who survived to acute hospital discharge, we assessed 3-year mortality using Kaplan-Meier curves; we used the log-rank test to test for statistical differences in survival curves between non-overlapping pre-ICU health groups and calculated hazard ratios (HRs) using a Cox proportional hazard model after assessing graphically that the proportionality assumption was not violated. Multivariable Cox and logistic regression models were adjusted for age, sex, race/ethnicity and markers of illness severity in the ICU (acute renal failure, severe sepsis, and mechanical ventilation).

We focused on the additive effect of frailty on hospital mortality and on 3-year mortality in hospital survivors by comparing mortality for groups of patients with and without frailty: Frailty only versus Robust; Cancer & Frailty versus Cancer only; Chronic Organ Failure & Frailty versus Chronic Organ Failure only; Cancer, Chronic Organ Failure & Frailty versus Cancer & Chronic Organ Failure. For further assessment of the relationship between pre-ICU frailty and outcomes, we also stratified patients by the individual markers of frailty (dementia diagnoses, other diagnoses, and skilled nursing facility use) and examined hospital mortality and 3- year mortality for these sub-groups.

We used a two-sided p-value of < 0.05 as our threshold for statistical significance. Due to the large size of the dataset, we also determined *a priori* that a clinically significant change in mortality would be an absolute difference in mortality of 2% or a change in HR of 0.05 (20). All analyses were done using Stata SE 11.0 (StataCorp, College Station, Texas) and Microsoft Excel 2010 (Microsoft, Redmond, Washington). Because the study involved retrospective analysis of deidentified data, it was reviewed by the Columbia University's and Montefiore Medical Center's Institutional Review and was deemed exempt.

RESULTS

Pre-ICU Health Categories

After exclusions (see Figure S1 of the appendix), the study population consisted of 47,427 Medicare recipients admitted to an ICU in 2005. In the cohort, 18.8% (n=8,901) were Robust, 68.1% (n=32,287) had Chronic Organ Failure; 28.6% (n=13,571) had Cancer; and 34.0% (n=16,147) met criteria for Frailty. 41.3% patients were classified into more than one health category (Figure S2 of the appendix). Notably, 95% of patients with pre-ICU Frailty also were classified as either having Chronic Organ Failure and/or Cancer.

The mean age of the cohort was 77.5 ±7.2, with 45.9% between the ages of 70 and 79 years. The median length of stay in the ICU was 3 days (IQR 1–5) with a median hospital length of stay of 6 days (3–11) (see Table 1). The patients with pre-ICU Frailty were oldest (mean age 79.4 ±7.3 vs. 76.4 ±7.2 for Robust patients). A higher proportion of the patients with pre-ICU Frailty were women (57.4%) compared with other categories of patients. Robust patients and those with pre-ICU Cancer were more likely to have surgery during the hospitalization (51.3% and 50.5% respectively) than the patients with pre-ICU Chronic Organ Failure (43.7%) or Frailty (36.5%). (Table 1; see Table S2 in the Appendix for characteristics of the eight non-overlapping subgroups).

Hospital and 3-year mortality by four overlapping pre-ICU Health Categories

Of the whole study population, 12.6% (n=5,991) died during the index hospitalization. The Robust patients had the lowest hospital mortality (9.7%) and the patients with pre-ICU Frailty had the highest (17.3%). Pre-ICU Cancer patients had a 13.6% hospital mortality and those with pre-ICU Chronic Organ Failure a 13.4% hospital mortality. A similar pattern was observed for 3-year mortality in hospital survivors: Robust patients had the lowest mortality (24.6%) while patients with pre-ICU frailty had the highest (58.8%); 3-year mortality for patients with pre-ICU Cancer (47.6%) was similar to the 3-year mortality for the patients with pre-ICU Chronic Organ Failure (46.4%).

Hospital and 3-year mortality for non-overlapping pre-ICU health categories

Hospital mortality was similar for patients with pre-ICU Cancer only (9.4%) and with pre-ICU Chronic Organ Failure only (10.3%) compared with Robust patients (9.7%) (adjusted odds ratio (aOR) 0.99; 95% CI 0.84–1.16 for Cancer only vs. Robust; aOR 0.99; 95% CI 0.87–1.06 for Chronic Organ Failure vs. Robust) (see Table 2). Hospital mortality was the highest for patients who had pre-ICU Frailty (15.9% for Frailty only up to 19.6% for those with Cancer, Chronic Organ Failure & Frailty: aOR for Frailty only vs. Robust 1.75; 95% CI 1.54–1.99; aOR for Cancer, Chronic Organ Failure & Frailty vs Robust 1.61; 95% CI 1.43–1.81) (Table 2).

Among hospital survivors, all other pre-ICU health categories were associated with significantly higher 3-year mortality than the Robust patients (Table 2). Differences in comparison with Robust patients remained significant after multivariable adjustment (Table 2), with the largest difference in mortality for patients with Cancer, Chronic Organ Failure

& Frailty compared with the Robust population (adjusted Hazard Ratio (aHR) 2.83; 95% CI 2.65–3.02).

Additional impact of Frailty on hospital and 3-year mortality

The prevalence of pre-ICU Frailty among elderly patients admitted to ICU increased with age (22.8% of those age 66 to 69 years; 42.0% of those between 80 and 89 years; 52.7% for those over age 90). Comparing patients with each pre-ICU health category with and without frailty, there was a consistent increased hospital mortality with frailty (aOR 1.27; 95% CI 1.10–1.47 for Frailty only vs. Robust up to an aOR of 1.52; 95% CI 1.35–1.63 for Cancer, Chronic Organ Failure & Frailty vs. Cancer & Chronic Organ Failure). Adjusted hazard ratios (aHRs) for 3-year mortality showed an even larger effect, with the highest additional mortality for those who were Frail only vs. Robust (aHR 1.84; 95% CI 1.70–1.99). Pre-ICU Frailty was also consistently associated with an increased risk of hospital mortality and 3-year mortality across all age-groups (Figures 1&2).

For patients categorized as having pre-ICU Frailty, we examined the hospital- and 3-year mortality based on the reason they qualified as having pre-ICU Frailty (e.g. diagnoses of dementia, other frailty diagnoses or skilled nursing facility use in the year prior to ICU admission) (Table S4 in the appendix). Hospital- and 3-year mortality were similarly high for patients who qualified for pre-ICU Frailty by either a diagnosis of dementia, other frailty diagnoses or the use of a skilled nursing home in the year prior to the ICU; the presence of multiple frailty markers in the year prior was associated with a higher mortality (table S4).

DISCUSSION

Using Medicare claims data from the year prior to critical illness we were able to categorize pre-ICU health of elderly patients using previously described categories used for decedents (5, 6). Notably, among elderly ICU patients, 70% had Chronic Organ Failure prior to admission, 35% were Frail, and only 19% were Robust. Patients with pre-ICU Frailty had a substantially higher hospital- and 3-year mortality than other groups of patients. When pre-ICU Frailty overlapped with other pre-ICU categories, it was associated with an increase in mortality above and beyond other pre-ICU health categories and across all age-groups. These results will help policy makers, caregivers and clinicians to better understand the impact of pre-ICU health on mortality outcomes after critical illness for elderly patients.

In this study we modified a claims-based approach to classifying health of Medicare decedents and applied it to the “black box” of the year prior to a critical illness. Diagnoses were informed by previous work on the classification of Medicare decedents (5, 6, 14) and the definition of frailty was supplemented by an extensive review of the geriatric literature to include such multifactorial geriatric conditions like debility, accidental falls, pathologic fractures, malnutrition and weight loss, and pressure ulcers, that have all been associated with disability and decreased quality of life in the elderly (21, 22). The face validity of this approach is reflected in the fact that our patients with pre-ICU Frailty were older, were more likely to be female and less likely to be admitted to ICU for surgical treatment, consistent with much of the literature (8, 11, 21). Most patients qualified for pre-ICU Frailty by more

than one ICD-9 claim making spurious or erroneous classification less likely (see table S3 in the Appendix).

Our study is novel for its focus on elderly patients *with critical illness*, and we departed from previous work in this area by acknowledging that the pre-ICU Frailty may occur with, rather than independent from, other health categories such as chronic organ dysfunction. The idea of concomitant frailty is important as elderly patients commonly have multiple medical problems supported by our finding that 19,597 (41.3%) of patients were classified into more than one health category.

In this retrospective cohort of elderly patients with three years of follow-up, pre-ICU Frailty was associated with a 50% or greater increase in the risk of death over 3 years of follow-up when compared to patients without pre-ICU Frailty. These results are consistent with those from the first prospective evaluation of the prevalence and associated outcomes of frailty among critically ill patients which found that frailty, as diagnosed by a subjective bedside assessment tool, was associated with higher hospital and 1-year mortality (23).

This association between pre-hospital frailty and risk of death is consistent with the growing literature to suggest that the baseline functional status and pre-existing comorbid illness have prognostic value in critically ill patients (2–4). The concept of pre-ICU Frailty may more easily capture the decreased physiologic reserve that is associated with poorer outcomes after acute illness. Many of the operational definitions of frailty described in the geriatric literature currently include performance and questionnaire measures that are impractical for use in the acutely ill patient (24,25). As such, the strong association seen in this study between the pre-ICU Frailty (easily defined by medical history) and mortality is a step towards developing more practical approaches to assessing pre-ICU frailty of patients who are often unable to provide detailed medical history.

The association between pre-ICU health categories and outcomes has important methodological implications for studies focused on the long-term effects of critical illness in elderly patients. Many studies of long-term outcomes have found that older survivors of critical illness have limitations and deficits – muscle weakness, cognitive impairment, muscle wasting -- that mirror the frailty syndrome (26–30). Recent work using the Health and Retirement Study demonstrated that it was important to adjust accurately for the pre-diagnosis health trajectory in order to avoid spurious inferences about the effect of critical illness on long-term outcomes (13). A “progeric hypothesis” has been proposed whereby critical illness facilitates a more rapid development of accumulated deficits which would have taken years to develop in the outpatient geriatric population without critical illness (13, 31). The relationship we found between pre-ICU health categories and outcomes after critical illness in a representative population of elderly patients, most of whom had multiple chronic co-morbidities, is further evidence to suggest that understanding long-term outcomes of critical illness will require a longitudinal perspective that carefully assesses pre-ICU status (32).

This study has important limitations. First, we used billing claims to describe pre-ICU health categories, which cannot fully reflect the true clinical picture. Our approach has been

validated in previous studies with Medicare decedents but never used to describe a population of ICU patients. Nevertheless, the use of administrative data is an important option to consider given the difficulty of obtaining full pre-ICU history (and in particular, information on frailty) for many patients. Second, although we adjusted for identifiable markers of the critical illness, we could not fully assess the severity of illness of patients on admission to hospital or ICU using data available from Medicare. However, the substantial associations we found between pre-ICU health categories and mortality suggest that important effects would remain even with further adjustment for other potential confounders.

In conclusion, we were able to classify elderly critically ill patients into four pre-ICU health categories and some of these categories are associated with an increase in both short and long-term mortality after intensive care. Pre-ICU Frailty was associated with the greatest increase in mortality. Future research may focus on both assessment strategies for pre-ICU Frailty in the critically ill elderly population and on specific approaches to modifying ICU treatment to improve post-ICU outcomes in this high-risk patient population.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Elements of Financial/Personal Conflicts	Aluko Hope		Michelle Gong		Carmen Guerra		Hannah Wunsch	
	Yes	No	Yes	No	Yes	No	Yes	No
Employment or Affiliation		x		x		x		x
Grants/Funds		x		x		x		x
Honoraria		x		x		x		x
Speaker Forum		x		x		x		x
Consultant		x		x		x		x
Stocks		x		x		x		x
Royalties		x		x		x		x
Expert Testimony		x		x		x		x
Board Member		x		x		x		x
Patents		x		x		x		x
Personal Relationship		x		x		x		x

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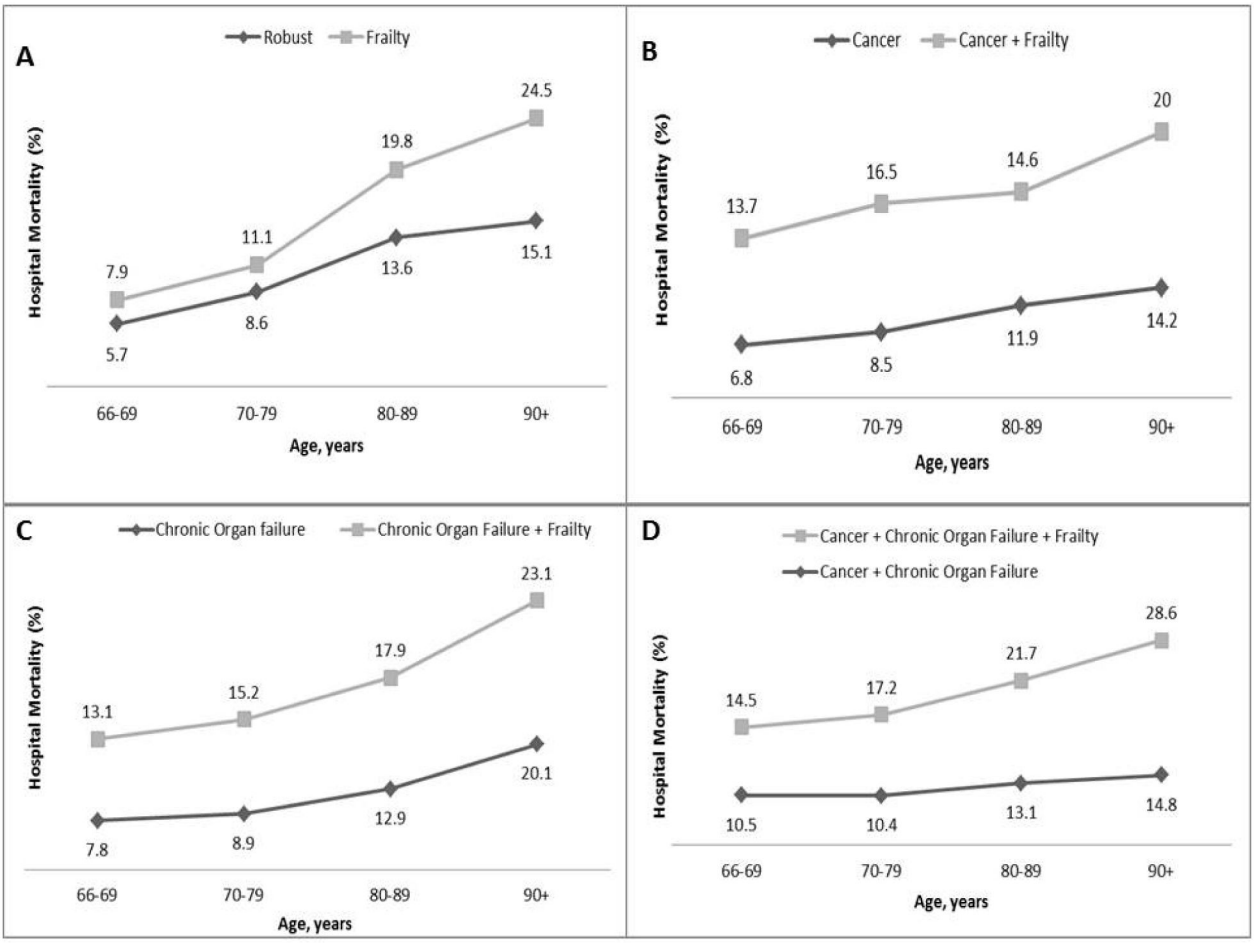

Figure 1.

Additive effect of pre-ICU frailty on hospital mortality for elderly Medicare beneficiaries stratified by age for **A)** Frailty only versus Robust, **B)** pre-ICU Cancer & Frailty versus pre-ICU Cancer only, **C)** pre-ICU Chronic Organ Failure & Frailty versus pre-ICU Chronic Organ Failure only **D)** pre-ICU Cancer, Chronic Organ Failure & Frailty versus pre-ICU Cancer & Chronic Organ Failure

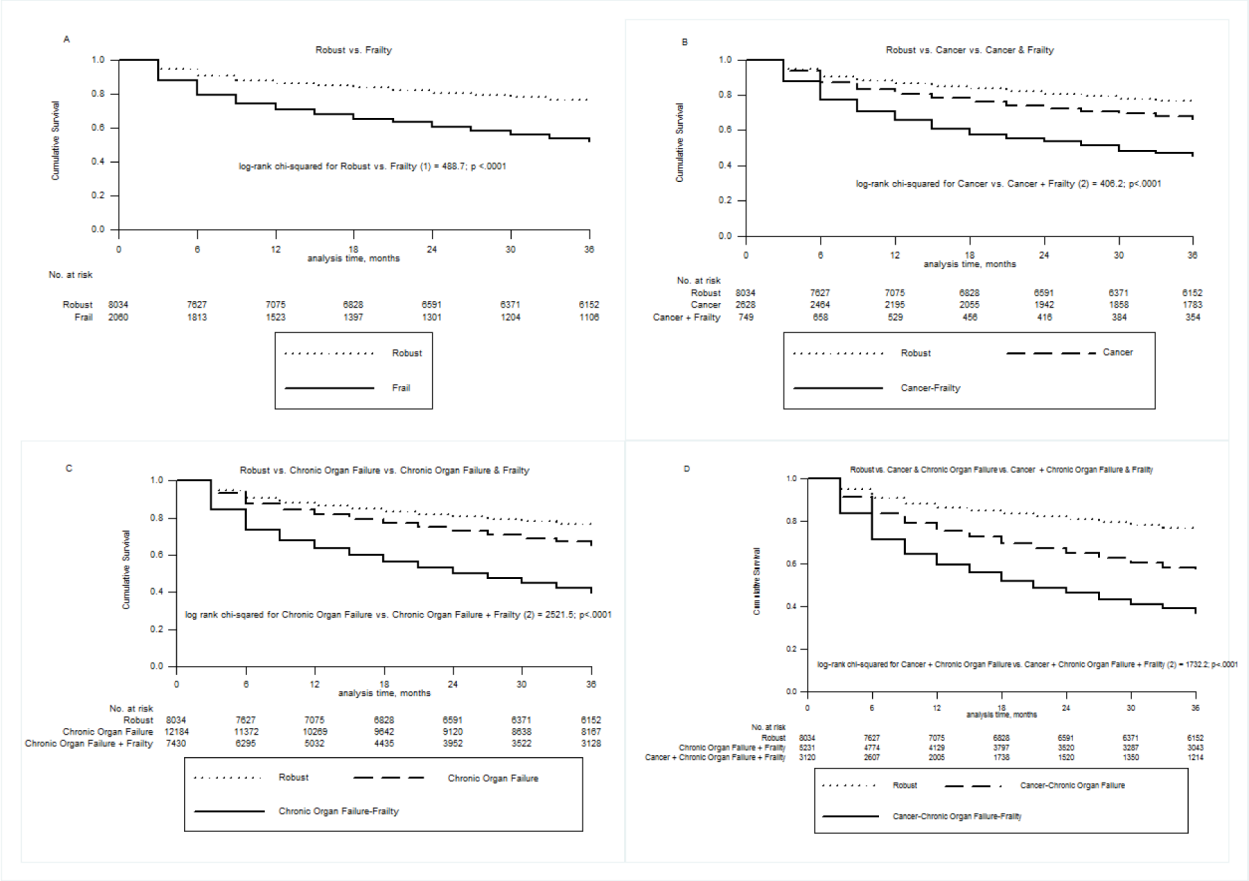

Figure 2.

Kaplan-Meier curves of 3-year mortality for elderly Medicare beneficiaries who survived the index hospitalization with critical illness, comparing patients with and without pre-ICU Frailty: **A)** Robust versus Frailty only **B)** Robust versus pre-ICU Cancer & Frailty versus pre-ICU Cancer only, **C)** Robust versus pre-ICU Chronic Organ Failure and Frailty versus pre-ICU Chronic Organ Failure only, **D)** Robust versus pre-ICU Cancer, Chronic Organ Failure & Frailty versus pre-ICU Cancer & Chronic Organ Failure

Table 1

Characteristics of the Study Population by pre-ICU health categories[a]

Characteristics	All (N=47,427)	Robust (N=8,901)	Cancer (N=13,571)	Chronic Organ Failure (N=32,287)	Frailty (N=16,147)
Male, n (%)	22,734 (47.9)	3,950 (44.4)	7,866 (58.0)	15,982 (49.5)	6,883 (42.6)
Age, mean (yrs) ± SD	77.5 ± 7.2	76.4 ± 7.2	77.6 ± 6.9	77.6 ± 7.10	79.4 ± 7.3
Race/Ethnicity, n (%)					
White, non-Hispanic	41,311 (87.1)	7,702 (86.5)	12,215 (90.0)	28,186 (87.3)	13,676 (84.7)
Black, non-Hispanic	4,126 (8.7)	822 (9.2)	947 (7.0)	2,740 (8.5)	1,763 (10.9)
Other	1,990 (4.2)	377 (4.2)	405 (3.0)	1,361 (4.2)	708 (4.4)
Hospitalized in year prior, n (%)	17,780 (37.5)	632 (7.1)	5,865 (43.2)	15,406 (47.9)	10,148 (62.9)
SNF in year prior, n (%)	5,016 (10.6)	n/a	1,459 (10.7)	4,436 (13.7)	5,016 (31.1)
ICU length of stay, median days (IQR)	3 (1–5)	2 (1–5)	3 (1–5)	3 (1–6)	3 (1–6)
Hospital length of stay, median days (IQR)	6 (3–11)	5 (3–9)	7 (4–12)	6 (3–11)	7 (4–12)
Surgical patients, n (%)[b]	21,746 (45.9)	4,568 (51.3)	6,846 (50.5)	14,121 (43.7)	5,898 (36.5)
Clinical Diagnoses during Index Hospitalization, n (%)					
Pneumonia	2,479 (5.2)	242 (2.7)	678 (5.0)	2,044 (6.3)	1,098 (6.8)
Infection	15,956 (33.6)	2,364 (26.6)	4,549 (33.5)	11,404 (35.3)	7234 (44.8)
Acute Renal Failure	5,990 (12.6)	84.1 (9.5)	1,732 (12.8)	4,404 (13.6)	2,585 (16.0)
Severe Sepsis[c]	7,579 (16.0)	978 (11.0)	2,199 (16.2)	5,670 (17.6)	3,604 (22.3)
Mechanical Ventilation	5,151 (10.9)	808 (9.1)	1,505 (11.1)	3,729 (11.6)	2,085 (12.9)
Discharge Destination, n (%)					
Died in hospital	5,991 (12.6)	867 (9.7)	1,843 (13.6)	4,322 (13.4)	2,786 (17.3)
Home with self care	18,315 (38.6)	4,177 (46.9)	5,186 (38.2)	11,950 (37.0)	3,715 (23.0)
Home with health services	6,407 (13.5)	1,137 (12.8)	2,041 (15.0)	4,444 (13.8)	1,921 (11.9)
Skilled Care Facility/Rehab	13,058 (27.5)	2,007 (22.6)	3,490 (25.7)	9,127 (28.3)	6,430 (39.8)
Other[d]	9,647 (20.3)	1,580 (17.8)	2,853(21.0)	6,766 (21.0)	4,081(25.3)

Notes

Abbreviations: ICU – Intensive Care Unit; SD – Standard Deviation; IQR – interquartile range; SNF – Skilled Nursing Facility; NA – not applicable

[a]Elderly Medicare recipients are grouped based on pre-ICU Medicare claims in the year prior to the index hospitalization during which they received intensive care; patients could be classified into more than one category, thus the groups together add to more than the total cohort.

[b] Diagnosis-related groups were used to classify the index hospitalization as primarily medical or surgical

[c] Severe Sepsis included those patients with infection and acute organ dysfunction (see text for details)

[d] Includes those who left against medical advice or were discharged to other inpatient facility, federal health care facility, hospice or psychiatric hospital

Table 2

Models of the association between pre-ICU health categories and hospital- and 3-year mortality. All statistical testing is comparing each group with the Robust category

Pre-ICU health categories	Number Hospital Deaths/Total at Risk (%)	Hospital mortality[a] AOR (95% CI)[b]	Died within 3- years/Survived to Hospital Discharge (%)	3-year mortality[a] AHR (95% CI)[b]
Robust	867/8,901 (9.7)	____	1,973/8,034 (24.6)	____
Cancer only	274/2,902 (9.4)	0.99 (0.84, 1.16)	884/2,628 (33.6)	1.43 (1.32, 1.55)
Chronic Organ Failure only	1,396/13,578 (10.3)	0.99 (0.87, 1.06)	4,240/12,182 (34.8)	1.47 (1.39, 1.54)
Cancer & Chronic Organ Failure	668/5,899 (11.3)	1.11 (0.99, 1.25)	2,281/5,231 (43.6)	1.93 (1.82, 2.06)
Frailty only	389/2,499 (15.9)	1.27 (1.10, 1.47)	987/2,060 (47.9)	1.84 (1.70, 1.99)
Cancer & Frailty	139/888 (15.7)	1.48 (1.19, 1.85)	409/749 (54.6)	2.27 (2.04, 2.53)
Chronic Organ Failure & Frailty	1,496/8,928 (16.8)	1.37 (1.24, 1.51)	4,488/7,432 (60.4)	2.66 (2.52, 2.81)
Cancer, Chronic Organ Failure & Frailty	762/3,882 (19.6)	1.61 (1.43, 1.81)	1,974/3,120 (63.3)	2.83 (2.65, 3.02)

Notes

Abbreviations: ICU – Intensive Care Unit; AOR – Adjusted Odds Ratio; AHR – Adjusted Hazard Ratio

[a] For the outcome of hospital mortality we used logistic regression models and for 3-year mortality Cox proportional hazard models

[b] Multivariable models were adjusted for age, sex, race/ethnicity, acute renal failure, severe sepsis and mechanical ventilation (see text for details)

Table 3

Comparison of hospital- and 3-year mortality for patients categorized into pre-ICU health categories with or without frailty

Pre-ICU Health Categories		**Hospital Mortality**[a]	**3-year mortality**[a]
Comparison group	**Reference group**	**AOR (95% CI)**[b]	**AHR (95% CI)**[b]
Frailty only	Robust	1.27 (1.10, 1.47)	1.84 (1.70, 1.99)
Cancer & Frailty	Cancer only	1.52 (1.19, 1.95)	1.69 (1.50, 1.91)
Chronic Organ Failure & Frailty	Chronic Organ Failure	1.42 (1.30, 1.54)	1.82 (1.74, 1.90)
Cancer, Chronic Organ Failure & Frailty	Cancer & Chronic Organ Failure	1.52 (1.35, 1.72)	1.54 (1.45, 1.64)

Notes

Abbreviations: ICU – Intensive Care Unit; AOR – Adjusted Odds Ratio; AHR – Adjusted Hazard Ratio

[a]For the outcome of hospital mortality we used logistic regression models and for 3-year mortality Cox proportional hazard models

[b]Multivariable models were adjusted for age, sex, race/ethnicity, acute renal failure, severe sepsis and mechanical ventilation (see text for details)