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The Feasibility of Measuring Frailty to Predict Disability and Mortality in Older Medical-ICU Survivors

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Abstract

Purpose—To determine whether frailty can be measured within 4 days prior to hospital discharge in older ICU survivors of respiratory failure, and whether it is associated with post-discharge disability and mortality.

Materials and Methods—We performed a single center prospective cohort study of 22 medical-ICU survivors age ≥ 65 years old who had received non-invasive or invasive mechanical ventilation for at least 24 hours. Frailty was defined as a score of ≥ 3 using Fried's 5-point scale.

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We measured disability with the Katz Activities of Daily Living. We estimated unadjusted associations between Fried's frailty score and incident disability at 1-month and 6-month mortality using Cox proportional hazard models.

Results—The mean (standard deviation) age was 77 (9) years, mean APACHE II score was 27 (9.7), mean frailty score was 3.4 (1.3), and 18 (82%) were frail. Nine subjects (41%) died within 6 months, and all were frail. Each 1-point increase in frailty score was associated with a 90% increased rate of incident disability at 1-month (rate ratio: 1.9, 95% CI 0.7-4.9) and a threefold increase in 6-month mortality (rate ratio: 3.0, 95% CI 1.4-6.3).

Conclusions:Frailty can be measured in older ICU survivors near hospital discharge and is associated with 6-month mortality in unadjusted analysis. Larger studies to determine if frailty independently predicts outcomes are warranted.

Keywords

Aged; Critically Ill; Frailty; Disability; Mortality

INTRODUCTION

Older adults (age ≥ 65 years) now comprise almost half of all intensive care unit (ICU) admissions in the United States, receive more intensive treatment than in the past, and survive what were previously fatal critical illnesses (1, 2). However, among the approximately 125,000 older adults who require mechanical ventilation and survive to hospital discharge annually in the United States, almost half are re-hospitalized and 30-65% die within 6 months (3, 4). These data demonstrate an urgent need to risk stratify and identify older ICU survivors for interventions aimed at improving their functional dependency, mortality, and/or quality-of-life after hospital discharge.

Existing risk-stratification models for ICU patients were designed to predict in-hospital mortality because the success of intensive care medicine has traditionally been gauged by the proportion of patients alive at hospital discharge (5-7). While post-hospitalization predictive models exist for older adults hospitalized without intensive care (8), there are no prospectively-derived models explicitly for older ICU survivors. In a prior study of older ICU survivors, we showed that surrogate measures of frailty and disability (older age, length of stay, and skilled-care facility need before or after hospitalization with intensive care) are associated independently with post-discharge mortality after controlling for critical illness severity and comorbidities, and account for 35% of a 6-month mortality model's predictive power. Moreover, we found that traditional physiologic variables measured during the first 24 hours of critical illness do not predict post-discharge mortality in older ICU survivors (9). However, this previous study lacked direct measures of frailty, thus limiting our ability to understand its role in risk stratification and identification of older ICU survivors for post-ICU care.

Physical frailty is a measurable clinical phenotype of increased vulnerability for developing adverse outcomes (e.g. disability and/or mortality) when exposed to a stressor. Fried and colleagues developed one of the most widely adopted measures of physical frailty based

upon 5 possible components (weight loss, weakness, slowness, reduced physical activity, and exhaustion) that mark an underlying physiological state of multisystem energy dysregulation. Subjects who have 1-2 or 3 components are considered intermediate-frail or frail, respectively (10). For community-dwelling elders, frailty predicts morbidity and mortality, independent of comorbidities and disability (10-12).

Recent studies of older ICU survivors of mechanical ventilation show that many of these patients develop new deficits or increase the magnitude of pre-existing deficits associated with the frailty syndrome while critically ill, and that these deficits often persist after the critical illness resolves (13, 14). These deficits may include malnutrition, weight loss, muscle wasting, and weakness (13, 15, 16). Since all these deficits are parts of Fried's vicious cycle of frailty (10), measuring Fried's frailty components in older ICU survivors may help risk-stratify and identify them for rehabilitative, therapeutic, or palliative interventions aimed at decreasing dependency, mortality, and/or improving quality-of-life after an ICU stay. However, the feasibility of measuring Fried's frailty in such a debilitated sample of older hospitalized adults has not been assessed. Therefore, we undertook a single-center prospective cohort pilot study to test the primary hypothesis that Fried's frailty components could be measured in older ICU survivors of respiratory failure just prior to hospital discharge. We also hypothesized that Fried's frailty index would be associated with both 1-month disability acquired since hospitalization involving intensive care and 6-month mortality in unadjusted analyses.

METHODS

Subjects

Subject inclusion criteria were (1) age $\geq$ 65 years and (2) invasive or non-invasive mechanical ventilation for respiratory failure for > 24 hours in a Columbia University medical-ICU (MICU). Subject exclusion criteria were (1) hospital discharge directly from a MICU, (2) discharge to hospice or home hospice, (3) respiratory failure due to a neurologic diagnosis (intracranial hemorrhage, stroke, or coma after cardiac arrest), (4) solid organ transplant recipient, (5) extracorporeal membrane oxygenation for severe Acute Respiratory Distress Syndrome (ARDS), (6) not English or Spanish speaking, (7) advanced dementia with inability to follow commands, and (8) no surrogate also consenting to participate. The rationale for the inclusion and exclusion criteria is described in the Supplement.

We screened consecutive MICU patients meeting inclusion criteria and determined their eligibility, since one of the aims of this pilot study was to estimate how many patients would be eligible for a larger study. Once screened patients survived the ICU and were transferred to the general wards, we worked with treating physicians to determine whether any met exclusion criteria, and to ascertain whether or not eligible patients lacked capacity to provide informed consent. The method for obtaining subject and/or surrogate informed consent is described in the Supplement.

Our goal was to recruit 24 subjects between February and July 2012. In light of our small sample size, we sought to minimize chance over- or under-enrollment of frail and/or disabled ICU survivors by employing a sampling method to ensure that 50-75% of subjects

were discharged to post-acute care facilities (institutional data from 2009 indicated that 55% of older ICU survivors were discharged to non-hospice post-acute care facilities). After every eighth subject was enrolled, we determined the proportion of subjects discharged to post-acute care facilities. If the proportion was below 50% or above 75%, we would preferentially recruit subjects being discharged post-acute care facilities or home, respectively, until the proportion fell between 50% and 75%. To examine whether selection bias resulted from our sampling method, we compared the characteristics of enrolled subjects and screened patients who were eligible but not approached for participation in the study. We defined post-acute care facilities as sub-acute rehabilitation centers, skilled-nursing facilities, long-term care facilities, or long-term acute care facilities.

Measurements

All questionnaire-based assessments were made within 4 days of hospital discharge. We ascertained demographic (age, gender, race, admission from or discharge to a post-acute care facility) and clinical variables (Acute Physiology and Chronic Health Evaluation (APACHE) II score (5), Berlin criteria for ARDS (17), duration of invasive and/or non-invasive mechanical ventilation, Charlson comorbidities, chronic critical illness status (tracheostomy with mechanical ventilation for 10 days (13)), Do-Not-Resuscitate preference at the time of hospital discharge, and whether or not they received a palliative care consultation during the hospitalization) from subjects, surrogates, treating physicians, and/or the electronic medical record as described in Table E1. The surrogate assisted with answering survey questions when the subject could not. This method of data collection has been used in previous cohort studies of debilitated ICU survivors (18, 19). We first assessed subjects for the presence of delirium using the Confusion Assessment Method (CAM) questionnaire (20), and tested subjects without delirium for cognitive dysfunction using the mini-COG questionnaire (21). We then assessed disability with the Katz Activities of Daily Living (ADLs) scale (22) and asked about pre-hospitalization ADLs (2-weeks prior to hospital admission). Surrogates estimated subjects' pre-hospitalization ADLs if subjects lacked decision-making capacity or if they could not recall their ability to perform ADLs. We anticipated that some subjects would not be able to stand. Therefore, we measured subjects' supine height and weighed them with a calibrated hospital bed scale with help from one of the nurse assistants on the general ward.

We assessed the 5 components of Fried's frailty index within 4 days of hospital discharge using the validated cutoffs to determine the presence or absence of each component (10). Shrinking was defined as an unintentional weight loss of > 10 pounds in the year prior to hospitalization involving intensive care. Based upon normative data from a community-dwelling population of adults 65 years (10), weakness was defined as grip strength in the lowest quintile, stratified by height and gender, slowness was defined as a 15-foot walk speed in the lowest quintile, stratified by height and gender, and low physical activity was defined as that in the lowest quintile of physical activity assessed with the short version of the Minnesota Leisure Time Activity questionnaire, stratified by gender. The specific cutoffs for these criteria are listed in Table E2. Exhaustion was defined as answers of 'moderate amount of time' or 'most of the time' to two statements from the modified 10-item Center for Epidemiologic Studies Depression Scale (23). "I felt everything I did was an effort" and

“I could not get going”. We asked subjects, “How often in the past two days did you feel this way?” Each component yielded a dichotomous score of 0 (absent) or 1 (present) that when added together would give a frailty score of 0 to 5.

We adhered to Fried’s protocol of frailty measurements (10) with some exceptions. If the subject was unable to provide an answer about weight loss, we asked the surrogate. We anticipated that some subjects would be bedbound; therefore we assessed dominant-hand dynamometry for all subjects seated as close to 90 degrees as possible in their hospital bed, as was done in a previous study with ICU subjects (24). Subjects were allowed to use canes or walkers when we assessed walk-speed, and those who required supplemental nasal cannula oxygen had their supply carried by one of the nurse assistants on the general ward. We used the fastest measured walk speed rather than the average of 3 trials since not all subjects were able to complete 3 trials. Ventilator-dependent subjects and subjects who could not stand were considered slow. If the subject was unable to provide estimates about leisure time activities, we asked the surrogate or home care-provider. Subjects who were bedbound and could not provide answers to the two statements from the modified 10-item Center for Epidemiologic Studies Depression Scale were considered exhausted. MRB screened all patients and made all measurements on enrolled subjects.

The primary outcome was 6-month mortality after the date of hospital discharge, and the secondary outcomes were any disability (dependency in any ADLs) and incident disability (new ADL dependency since prior to being hospitalized) at 1 month after hospital discharge. Follow-up was done either in person or by telephone. Surrogates and care-providers provided ADL dependence estimates if subjects lacked decision-making capacity or if subjects could not recall their ability to perform ADLs.

Statistical Analyses

Demographic and clinical variables were expressed as mean $\pm$ standard deviation (SD) or median and interquartile range (IQR) as appropriate. Using Fried’s criteria, we determined the prevalence of robust (score of 0), intermediate-frail (score 1-2), and frail (score ≥ 3) subjects (10). We estimated rate ratios for Fried’s frailty score as an ordinal variable from 0 to 5 for 6-month mortality, disability at 1 month, and incident disability at 1-month since hospitalization using only univariable (unadjusted) Cox proportional hazard models. We defined 1-month disability as any ADL dependence at 1 month after hospital discharge, and considered subjects to have incident disability at 1-month if the number of ADL dependencies at 1 month after hospitalization was greater than the number pre-hospitalization ADL dependencies. Follow-up for 6-month mortality was right-censored at 183 days, and follow-up for 1-month disability was right-censored at 30 days. One subject was missing pre-hospitalization and 1-month ADL data (died prior to 1-month follow-up), and 5 subjects were missing 1-month ADL data (3 subjects died prior to 1-month follow-up, 1 refused to actively participate at 1-month follow-up, and 1 missed the 1-month follow-up visit). These 6 subjects missing ADL data were excluded from the 1-month disability analyses.

Due to the small sample size we did not perform multivariable modeling with our outcomes. Instead, we regressed the frailty score on easily measured covariables that have been

associated with poor outcomes after hospitalization in prior studies: age, pre-existing disability, Charlson comorbidity index score, critical illness severity (APACHE II score), and chronic critical illness status. We calculated the fraction of frailty score variance unexplained ($1 - \text{the coefficient of determination (R}^2\text{)}$) by these covariables and used this value as an estimate of whether frailty may independently predict outcomes in a multivariable model derived from a larger sample of older ICU survivors. Analyses were performed with Stata 12.0 (Stata Corp LP, College Station, TX). The study was approved by the Columbia University Medical Center Institutional Review Board.

RESULTS

Subject Characteristics

We screened 110 older adult MICU survivors; 52 were excluded based upon pre-specified criteria, 3 were excluded because their cases were being reviewed by the hospital ethics committee, and 55 were found to be eligible. We approached 23 patients; 1 patient refused to participate and we enrolled 22 subjects who we followed until death or 6 months after hospital discharge. Since we nearly achieved our enrollment rate goal of 24 patients over 6 months, 32 eligible patients were not approached for participation in the study (Figure 1). There were no barriers to measurement that made ongoing recruitment challenging; rather, MRB's clinical service duties interrupted recruitment towards the end of the study. The mean (SD) age of the 22 subjects was 77 (9) years, and 68% were male. Subjects were of diverse races/ethnicities, had multiple comorbidities (mean (SD) Charlson comorbidity index score was 3.9 (2.0)), but only 2 (9%) had active malignancy. Nearly one third of subjects had brain dysfunction just prior to hospital discharge (3 (14%) had delirium by CAM criteria and 4 (18%) had cognitive dysfunction based upon the Mini-COG assessment). One half of subjects met the Berlin criteria for ARDS, 12 (55%) received only invasive mechanical ventilation, 3 (14%) received both invasive and noninvasive mechanical ventilation, and 7 (32%) received only non-invasive mechanical ventilation. The median (IQR) duration of invasive and non-invasive mechanical ventilation were 6 (3-11) and 4 (2-10) days, respectively.

The median (IQR) MICU and hospital length of stays were 4 (3-9) and 14 (10-20) days, respectively. The proportion of subjects requiring a skilled-facility care doubled from 32% prior to the hospitalization to 64% following intensive care. Disability also increased after the hospitalization involving intensive care (pre to post-hospitalization mean (SD) independent ADLs decreased from 4.5 (2.1) to 2.0 (2.6)). No subjects received a palliative care consultation during the hospitalization, but 7 (32%) had Do-Not-Resuscitate orders at the time of hospital discharge. Characteristics were similar between enrolled subjects and eligible patients we did not approach, with the exception of an imbalance in gender (see Table E3).

Frailty and Outcomes

Using our protocol, we were able to obtain measurements for all of Fried's frailty components for all subjects. The mean (SD) Fried frailty score was 3.4 (1.3); none were robust, 4 (18%) were intermediate-frail, and 18 (82%) were frail by Fried's categorization

(10) (Figure 2). Intermediate-frail and frail subjects had similar ages and initial severity of critical illnesses (APACHE II score), but frail subjects tended to have more comorbidities and disability, a longer duration of mechanical ventilation and length of stay, and a greater need for post-acute facility care (Table 1). The prevalence of frailty components among subjects within 4 days of hospital discharge was high. Broken down by frailty component, 19 (86%) subjects were slow, 18 (81%) were weak, 17 (77%) were exhausted, 13 (59%) had low pre-hospitalization physical activity, and 8 (36%) reported pre-hospitalization weight loss (Table E4).

The median (IQR) follow-up time was 167 (59-183) days, and the 6-month mortality was 41%. Among the 9 subjects who died within 6 months, all were frail prior to discharge, all had severe disability at hospital discharge (independent ADLs ≤ 2), 5 (45%) had ARDS, 8 (89%) were discharged to post-acute care facilities (versus home), and 3 (33%) had chronic critical illness (Table 2). None of the subjects enrolled in hospice during the study period.

Among frail subjects, 6-month mortality was 27% for those with a frailty score of 3, 67% for those with a frailty score of 4, and 83% for those with a frailty score of 5. Figure 3 shows the Kaplan-Meier survival curves by frailty score (p for trend < 0.001). Fried's frailty score was associated with both a higher 6-month mortality rate and a higher rate of 1-month disability, and showed a trend toward an association with a higher rate of incident disability at 1-month (Table 2). For each 1-point increase in frailty score the unadjusted 6-month mortality rate increased threefold (rate ratio 3.0, 95% CI, 1.4 – 6.3), the unadjusted 1-month disability rate ratio increased twofold (rate ratio: 2.2, 95% CI, 1.04 – 4.6), and the unadjusted 1-month incident disability rate ratio increased almost twofold (rate ratio: 1.9, 95% CI, 0.73-4.9).

Regressing Fried's frailty score on age, severity of critical illness (APACHE II score), comorbidities (Charlson index), pre-hospitalization disability, and chronic critical illness status yielded a fraction of unexplained variance of 0.56.

DISCUSSION

In a single-center prospective cohort pilot study, we have shown that Fried's frailty can be measured in older ICU survivors of respiratory failure just prior to hospital discharge, and that Fried's frailty score is associated in unadjusted analyses with 1-month disability and 6-month mortality after hospital discharge. Furthermore, given that easily measured demographic and clinical factors that have been associated with poor outcomes among ICU survivors explain less than half the variance in Fried's frailty score, frailty may represent a previously unmeasured phenotype of interest in this population.

Fried's frailty phenotype was initially derived and validated in community-dwelling older adults (10, 11), has been shown to improve prediction of elective surgical outcomes in older adults (25), and has been associated with both a longer hospital stay and in-hospital mortality when assessed on admission in general medical ward patients (26). Our study of older ICU survivors of respiratory failure adds to a growing body of work that suggests Fried's frailty can be measured in older adults receiving acute care in order to identify those

at risk for adverse outcomes during the early post-acute care period. We pre-specified that all measurements would be made within 4 days before hospital discharge, but found that for most subjects that we could complete all measurements within 2 days (we obtained consent and assessed demographic and clinical variables on the first day, and then performed frailty measurements the following day). Previous studies show that delirium is highly prevalent among hospitalized older adults (27), and despite the fact that advanced dementia was a pre-specified exclusion criteria, one third of our subjects had cognitive dysfunction. However, all subjects were still able to complete the frailty assessments of exhaustion, grip-strength, and walk speed (for those who could walk), perhaps because we performed our assessments near the time of hospital discharge when delirium or cognitive dysfunction was more mild. As expected, we did confer with surrogates among those with cognitive dysfunction to confirm or obtain estimates for weight loss and low physical activity prior to the subject's hospitalization with intensive care. We found that enrolling surrogates was also essential because they assisted with coordinating follow-up for debilitated subjects who were often difficult to contact directly.

Fried's frailty appears to have content and construct validity in older ICU survivors of respiratory failure since so many of Fried's frailty deficits, including weakness, muscle wasting, weight loss, and poor functional status that typically take years to accumulate in the outpatient geriatric population, rapidly worsen or develop in older ICU survivors of respiratory failure (13, 28). Our results, while inherently limited by the small sample size of our study, also suggest that Fried's frailty score has predictive validity among older ICU survivors of respiratory failure insofar as increasing frailty scores were associated with higher rates of disability and mortality after hospital discharge.

Older ICU survivors who required post-acute facility care often had disability and were almost always frail based upon the definition created for community-dwelling elders (score 3). Furthermore, 88% of older ICU survivors who died were discharged to post-acute care facilities. While disability and the need for post-acute facility care are two easily measured and strong predictors of post-hospitalization mortality (9, 29), measuring frailty and using the Fried index as an ordinal variable (score 0 to 5) is still important for older ICU survivors for at least two reasons. First, even if most older ICU survivors discharged to post-acute care facilities are frail (score 3), knowing whether they have more advanced frailty, i.e. higher scores, is important because our results suggest that the risk of disability and 6-month mortality increases substantially with each 1-point increase in Fried frailty score. Accordingly, a high frailty score of 5 may help inform a decision to pursue palliative goals-of-care either at the care transition from hospital to post-acute care facility, or after a trial of rehabilitative and therapeutic post-acute care that is unsuccessful. Second, measuring frailty is important because the components of Fried's frailty have potential to be in and of themselves targets for post-ICU rehabilitative and therapeutic interventions aimed at treating the often persistent debilitation that follows critical illness. For example, ICU survivors who are weak or slow may benefit from specific exercise interventions (e.g. bedside cycle ergometry (30), diaphragmatic strength training (31, 32)), pharmacologic therapies such as myostatin agonists to decrease and prevent muscle loss (33), or vitamin D supplementation to improve muscle function (34). Those who have weight loss and exhaustion may benefit from protein-calorie supplementation (35) and an evaluation for exogenous repletion of

anabolic hormone deficiencies that persist after the resolution of critical-illness (e.g. growth hormone releasing peptide-2 (36), ghrelin(37), and insulin-like growth factor-1 (38)). Those who have low activity may need treatment of their pain to improve mobility (39).

The prevalence of frailty in our cohort of older ICU survivors is much higher than that in Fried's derivation cohort of community-dwelling elders (81% versus 7%) (10). Therefore, the magnitude of the association between Fried's frailty score and post-discharge outcomes in older ICU survivors may be limited by the fact that the frailty measures derived for community-dwelling elders are too sensitive for older ICU survivors of respiratory failure. A previous study rescaled cutoffs for Fried's frailty components in order to achieve greater differentiation of healthy aging (40), another study of older adults undergoing elective surgery modified the original operational definition by Fried by defining intermittent frailty as 2 or 3 criteria, and frail as 4 or 5 criteria (25), and a third found that using only some of Fried's frailty components provided the best prediction of outcomes in community-dwelling elders (41). Accordingly, if frailty fails to independently predict outcomes in a larger study of older ICU survivors, rescaling cutoffs or only using some of the components may be necessary to achieve greater differentiation between degrees of post-ICU frailty and post-discharge disability and mortality.

Our study has several limitations. By chance, we enrolled proportionally more male patients, and screened and but did not approach proportionally more female patients. Our frailty assessments of pre-hospitalization weight loss and physical activity and pre-hospitalization disability are subject to recall and/or surrogate response bias. While studies have shown conflicting results about the degree of agreement between patient versus surrogate retrospective assessments of pre-hospitalization disability and health-related quality-of-life, most conclude that the magnitude of these differences are likely small, and that retrospective assessments from either subjects or surrogates have predictive validity (42-44). The fact that some of our results may be affected by surrogate response bias is an inherent limitation shared with previous investigations of outcomes in debilitated survivors of critical illness (18, 19). We did not have the resources to perform in-person follow-up for all subjects and therefore assessed ADLs by telephone interview with some subjects or surrogates who were caregivers. Studies have shown that ADLs can be reliably assessed in telephone interviews (45), and that ADL assessment by the nearest proxy is valid (46). The small sample size of our cohort precluded our ability to determine whether Fried's frailty score independently predicts outcomes. Despite sampling pre-specified proportions of older ICU survivors sent home and to post-acute care facilities based on our institution's data, our small sample size may not accurately reflect the true spectrum of frailty in older ICU survivors of respiratory failure at our institution, or at other institutions where case mix and patient care may differ. We chose to measure physical frailty with Fried's frailty score, but there are other validated measures of frailty that may be able to risk-stratify and identify older ICU survivors as well or better than Fried's (47-49). Recently, a study found that the Rockwood Clinical Frailty Scale assessed at ICU admission predicted in-hospital mortality and 1-year mortality in adults age $\geq$ 50 years, independent of other important demographic and clinical variables (50). Finally, many of our subjects had cognitive dysfunction which is increasingly recognized as a component of frailty (41), but we did not examine the relationships between

cognitive dysfunction, Fried's physical frailty measures, and post-discharge disability and mortality.

In conclusion, we have shown that Fried's frailty components can be measured in older ICU survivors of respiratory failure and that higher frailty scores at hospital discharge are associated in unadjusted analyses with higher risks of 1-month disability and 6-month mortality. In this context, Fried's frailty may represent a composite measure of an older ICU survivor's physiologic reserve that is affected by pre-hospitalization health and disability, and the severity and duration of critical illness that he or she just survived. Future studies might examine whether frailty measures add to chronic critical illness prognostication, whether frailty measurements can be used with other evolving criteria to identify different types of post-acute care needs, whether frailty moderates care trajectories, and whether frailty components identified at hospital discharge resolve after therapeutic measures taken during the post-acute care period. While our small sample size precluded multivariable analyses, the fact that more than half of the variance of Fried's frailty is unexplained by important covariates strongly suggests that frailty should be measured in older ICU survivors of respiratory failure, helping to identify them for post-acute rehabilitative, therapeutic, and palliative interventions aimed at improving their morbidity, mortality, and/or quality-of-life.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1.
Study subjects.

Figure 2.

Plots showing the distribution of Fried's frailty score as an ordinal variable from 0 to 5 among all subjects. The percentage of subjects are shown above the bars. Fried et al. categorized community-dwelling older adults as robust (score: 0), pre-frail (1-2), or frail (3-5) (10).

Figure 3.

Kaplan-Meier survival curves from the date of discharge following hospitalization involving intensive care by Fried's frailty score. No subjects had a frailty score of 0. All subjects with a frailty score of 1 or 2 at hospital discharge survived 6 months. P value represents the p for trend across Fried's frailty score.

Table 1

Older Medical-ICU survivor demographic and clinical characteristics

	All n = 22	Intermediate-Frail (Score 1-2) n = 4	Frail (Score 3-5) n = 18
Characteristic (n = 22)	No. (%)	No. (%)	No. (%)
Age, years (mean, SD, range)	77, 8.9, 65-95	78, 13, 65-95	76, 8.1, 65-94
Male	15 (68)	2 (50)	13 (72)
Race			
White	9 (41)	2 (50)	7 (39)
Black	5 (23)	0 (0)	5 (28)
Hispanic	8 (36)	2 (50)	6 (33)
Pre-Hospitalization Residence			
Home	15 (68)	4 (100)	11 (61)
Post-Acute/Skilled-Care Facility	7 (32)	0 (0)	7 (39)
Delirium by CAM	3 (14)	0 (0)	3 (17)
Cognitive Dysfunction by Mini-Cog	4 (18)	0 (0)	4 (22)
APACHE II (mean, SD, range)	27, 9.7, 8-47	24 (20-28)	28 (8-47)
Charlson Comorbidity Score (mean, SD, range)	3.9, 2.8, 1-9	1, 0, 1-1	4.6, 2.6, 1-9
Active Malignancy	2 (9)	0 (0)	2 (11)
Berlin ARDS Criteria	11 (50)	3 (75)	8 (44)
Mild	3 (27)	1 (25)	2 (11)
Moderate	6 (55)	1 (25)	5 (28)
Severe	2 (18)	1 (25)	1 (5.6)
Mechanical Ventilation (MV)	22 (100)	4 (100)	18 (100)
Only Invasive MV	12 (55)	0 (0)	12 (67)
Invasive and Non-invasive MV	3 (14)	2 (50)	1 (5.6)
Only Non-invasive MV	7 (32)	2 (50)	5 (28)
Duration of Mechanical Ventilation, days (median, IQR)	6, 3-11	4, 3-5	6, 3-11
Duration of Non-invasive MV, days (median, IQR)	4, 2-10	3, 1-8	6, 3-10
Chronically Critically Ill (tracheostomy & MV for 10 days)	4 (18)	0 (0)	4 (22)
Length of Stay			
MICU days (median, IQR)	5, 3-9	3, 2-4	5, 3-9
Hospital days (median, iQr)	14, 10-20	8, 7-11	15, 11-26
Discharge Locations			
Home	8 (36)	4 (100)	4 (22)
Post-Acute/Skilled-Care Facility	14 (64)	0 (0)	14 (78)
Disability			
Independent ADLs Pre-Hospitalization * (mean, SD, range)	4.5, 2.1, 0-6	6, 0, 6-6	4.2, 2.2, 0-6
Independent ADLs at Discharge (mean, SD, range)	2.0, 2.6, 0-6	6, 0, 6-6	1.2, 1.9, 0-6
Palliative Care and Resuscitation Preferences			
Received palliative care consultation prior to hospital discharge	0 (0)	0 (0)	0 (0)
Do-Not-Resuscitate at the time of hospital discharge	7 (32)	1 (25)	6 (33)

No subjects were robust (frailty score of 0).

CAM: Confusion Assessment Method; Mini-Cog: only subjects without delirium were assessed for cognitive dysfunction; APACHE: Acute Physiology and Chronic Health Evaluation score; ARDS: Acute Respiratory Distress Syndrome; MICU: Medical intensive care unit; ADLs: Katz Activities of Daily Living. Non-invasive Mechanical Ventilation: Continuous or bi-level non-invasive positive pressure ventilation. Post-Acute/Skilled-Care Facility: Sub-acute rehabilitation center, skilled-nursing facility, long-term care facility, or long-term acute care facility.

*
1 subject (who was frail) missing these data

Table 2

Associations between Fried's Frailty Score, Disability, and Mortality in older Medical-ICU survivors

Outcomes	No. (%)
Follow-up time, days (median, IQR)	167, 59-183
Overall 6-month Mortality	9 (41)
Intermediate-Frail (Frailty Score 1-2) (n = 4)	0 (0)
Frail (Frailty Score 3) (n = 18)	9 (50)
ARDS* (n = 11)	5 (45)
No ARDS (n = 11)	4 (36)
Mild or No Disability at Discharge (independent ADLs: 5 - 6) (n = 6)	0 (0)
Moderate Disability at Discharge (independent ADL: 3 - 4) (n = 2)	0 (0)
Severe Disability at Discharge (independent ADL: 0 - 2) (n = 14)	9 (64)
Discharged Home (n = 8)	1 (13)
Discharged to Post-Acute/Skilled-Care Facility (n = 14)	8 (57)
Admitted from and discharged to Post-Acute/Skilled-Care Facility (n = 7)	5 (71)
Chronically Critically Ill† (n = 4)	3 (75)
Independent ADLs at 1-Month (mean, SD, range) (n = 16)	3.8, 2.7, 0-6

Unadjusted Associations ¹	Hazard Ratio, 95% CI
6-month Mortality Rate Ratio (n = 22)	3.0, 95% CI: 1.4 - 6.3
1-Month Disability ² Rate Ratio (n = 16)	2.2, 95% CI: 1.04 - 4.6
1-Month Incident Disability ³ Rate Ratio (n = 16)	1.9, 95% CI: 0.73 - 4.9

* ARDS: Acute respiratory distress syndrome (at least mild by Berlin criteria (17))

† Chronically Critically Ill: tracheostomy and mechanical ventilation for ≥ 10 days (13). All chronically critically ill subjects were admitted from skilled-care facilities.

¹ Fried's frailty score modeled as an ordinal variable from 0 to 5.

² Any ADL dependence at 1 month after hospital discharge

³ Incident Disability: number of ADL dependencies at 1 month after hospitalization was greater than the number of ADL dependencies pre-hospitalization.