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Trends in Geriatric Conditions Among Older Adults Admitted to US ICUs Between 1998 and 2015

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BACKGROUND: Older adults are increasingly admitted to the ICU, and those with disabilities, dementia, frailty, and multimorbidity are vulnerable to adverse outcomes. Little is known about how pre-existing geriatric conditions have changed over time.

RESEARCH QUESTION: How have changes in disability, dementia, frailty, and multimorbidity in older adults admitted to the ICU changed from 1998 through 2015?

STUDY DESIGN AND METHODS: Medicare-linked Health and Retirement Survey (HRS) data identifying patients 65 years of age and older admitted to an ICU between 1998 and 2015. ICU admission was the unit of analysis. Year of ICU admission was the exposure. Disability, dementia, frailty, and multimorbidity were identified based on responses to HRS surveys before ICU admission. Disability represented the need for assistance with ≥ 1 activity of daily living. Dementia used cognitive and functional measures. Frailty included deficits in ≥ 2 domains (physical, nutritive, cognitive, or sensory function). Multimorbidity represented ≥ 3 self-reported chronic diseases. Time trends in geriatric conditions were modeled as a function of year of ICU admission and were adjusted for age, sex, race or ethnicity, and proxy interview status.

RESULTS: Across 6,084 ICU patients, age at admission increased from 77.6 years (95% CI, 76.7-78.4 years) in 1998 to 78.7 years (95% CI, 77.5-79.8 years) in 2015 ($P < .001$ for trend). The adjusted proportion of ICU admissions with pre-existing disability rose from 15.5% (95% CI, 12.1%-18.8%) in 1998 to 24.0% (95% CI, 18.5%-29.6%) in 2015 ($P = .001$). Rates of dementia did not change significantly ($P = .21$). Frailty increased from 36.6% (95% CI, 30.9%-42.3%) in 1998 to 45.0% (95% CI, 39.7%-50.2%) in 2015 ($P = .04$); multimorbidity rose from 54.4% (95% CI, 49.2%-59.7%) in 1998 to 71.8% (95% CI, 66.3%-77.2%) in 2015 ($P < .001$).

INTERPRETATION: Rates of pre-existing disability, frailty, and multimorbidity in older adults admitted to ICUs increased over time. Geriatric principles need to be deeply integrated into the ICU setting.

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KEY WORDS: dementia; disability; epidemiology; frailty; geriatrics

FOR EDITORIAL COMMENT, SEE PAGE 1436

ABBREVIATIONS: ADL = activity of daily living; HRS = Health and Retirement Study

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Take-home Points

Study Question: How have rates of geriatric conditions in older adults admitted to the ICU changed over time?

Results: From 1998 through 2015, rates of pre-existing disability, frailty, and multimorbidity increased in older patients admitted to the ICU.

Interpretation: Growing prevalence in pre-existing functional impairment and geriatric conditions in critically ill older adults supports the need for incorporating geriatric-focused interventions and principles in the ICU.

For older patients admitted to the ICU, the presence of disability, cognitive decline, and frailty is associated with higher mortality, worse long-term quality of life, and accelerated cognitive decline after discharge.[1-3] Although the mean age of older adults admitted to the ICU in the United States has increased slightly over time, the proportion of patients older than 85 years has increased substantially here and internationally.[4,5] When the known morbidity associated with critical illness in vulnerable older adults[6,7] is coupled with the functional impairments after ICU discharge that are well described in older people, ICU providers must consider the individual geriatric needs of their patients and adopt geriatric principles into their practice.[8]

Less well understood, and critically needed for planning purposes, is how the prevalence of common, clinically relevant geriatric conditions that are present on ICU admission has evolved over time. At the ICU level, understanding time trends in the prevalence of pre-existing geriatric conditions is critical to assessing the urgency with which we need to "geriatricize" ICUs (ie, modify ICU environments and integrate geriatrics principles into critical care medicine) for two reasons: first, to accommodate the cognitive and functional needs of people admitted to ICUs with pre-existing geriatric conditions[8] and second, to prevent progression of disability and the development of geriatric syndromes associated with ICU stays, such as delirium, for which those with geriatric conditions are at higher risk.[9] Finding, for example, rising rates of pre-existing disability suggests the need for interventions to promote early mobilization to minimize progression of disability.[10] If rates of pre-existing cognitive impairment are increasing, an important risk factor for delirium, then altering how patients receive direct sunlight could impact sleep-wake cycles positively.[11] Additionally, the incorporation of digital technology for early delirium recognition should be prioritized.[12]

The purpose of this study was to determine whether disability, dementia, frailty, and multimorbidity among older adults admitted to the ICU changed from 1998 through 2015 in a nationally representative survey of older adults. We hypothesized that geriatric conditions have increased between 1998 and 2015.

Study Design and Methods

Data Source and Participants

The Health and Retirement Study (HRS) is an ongoing nationally representative sample of US community-based adults 50 years of age or older that has assessed physical, psychological, and economic measures through detailed biennial longitudinal surveys since 1992.[13] The HRS is based on a multistage area probability sample design including clustering and oversampling of certain racial, ethnic, and geographic groups. Interviews are conducted every 2 years. Response rates in the sample used for our study were 89% to 91%.[14] The HRS cohort was linked to Medicare claims files to identify participants 65 years of age and older who had an ICU admission between 1998 and 2015. HRS data collection is approved by the Health Sciences and Behavioral Sciences institutional review board at the University of Michigan. This specific study was approved by the institutional review board at the University of California, San Francisco.

ICU admission was the unit of analysis. We included ICU admissions identified by revenue center codes from inpatient Medicare files (claim revenue center codes 200-202, 207-211, 213, and 219) to define patients who had an ICU stay and excluding PICUs, psychiatric units, general post-ICU units, and coronary post-ICU units (codes 203, 204, 206 and 214, respectively) because they were considered step-down units, were not explicitly for adults with critical illness, or both. The Medicare claim code 200 is described as "general" and likely represents a mixed ICU, particularly for smaller facilities without dedicated ICU types. Of 21,843 HRS participants 65 years of age or older in the HRS, 19,926 had linked Medicare claims. We identified 6,856 individuals who had at least one ICU admission during the study period across 10,668 unique ICU admissions. Because pre-existing geriatric conditions are drawn from HRS interviews before each ICU admission, our final cohort included 6,084 participants interviewed within 2.5 years of an ICU admission.

Measures

The geriatric outcomes of interest were disability, dementia, frailty, and multimorbidity. We selected pre-existing geriatric conditions and not acute ICU conditions (eg, delirium) because we sought to capture the prevalence of conditions that predated the ICU admission, and therefore likely were present on admission, rather than conditions resulting from the disease, hospitalization, or ICU stay. We examined disability (defined as the need for assistance with any activity of daily living [ADL], specifically: dressing, bathing, walking across a room, eating, toileting, or transferring) and we used a

validated algorithmic classification of dementia[15] (Wu-Glymour method, which uses cognitive and functional measures). Frailty was measured using HRS-adapted criteria[17] based on deficiencies in physical, nutritive, cognitive, and sensory functioning (Functional Domains Model).[18] Frailty was considered present if any two or more of the following four criteria were fulfilled: (1) two or more falls in the previous 2 years or difficulty lifting 10 pounds, (2) 10% or more weight loss over the previous two HRS surveys, (3) mild to severe cognitive impairment, and (4) fair, poor, or blind eyesight despite corrective lenses or fair or poor hearing despite hearing aids. Although no consensus definition exists, we defined multimorbidity according to previous literature as the presence of three or more HRS self-reported chronic diseases: hypertension, diabetes mellitus, cancer, chronic lung disease, coronary heart disease, congestive heart failure, stroke, arthritis, and psychiatric conditions.[16]

Measures used to characterize the analytic sample were based on self-reported HRS measures and International Classification of Diseases claims. We used self-reported sociodemographic factors from the HRS, including: age at ICU admission, sex, race or ethnicity, smoking status, marital status, if interviews were through a proxy (vs from the individual patient), and self-rated health status (ranging from poor to excellent). Race and ethnicity were self-reported by the HRS study participants, and race categories were defined by HRS investigators and categorized as Hispanic or non-Hispanic, Black, or White. Patients who did not self-report their race or ethnicity under these categories were < 2% of initial ICU admissions and were not included in the table reporting. Primary diagnoses for the hospitalization were measured using the International Classification of Diseases, Ninth and Tenth Revisions, codes from HRS Medicare-linked data. Each hospital claim has one admission diagnosis and one primary diagnosis, in addition to different numbers of secondary diagnoses depending on the year of admission.[19] Primary diagnosis is defined at the time of discharge and may differ from the diagnosis that originally led to the hospitalization (ie, hospital admission diagnosis). Only primary diagnoses are presented, and we categorized primary diagnosis by organ, specialty, and disease category, given the large number of heterogeneous diagnoses across the cohort. Self-reported chronic diseases contributing to multimorbidity outcome were tabulated, and frequencies and cumulative frequencies of individual chronic diseases were calculated across the cohort. We used the Lee index to describe pre-existing risk of mortality. The Lee index is an HRS-validated[20] measure of all cause 4-year mortality. A score of ≥ 13 correlates to > 50% mortality risk. HRS survey questions related to outcomes of interest for this study are shown in e-Table 1.

Statistical Analysis

We examined trends in the prevalence of pre-existing geriatric conditions. Descriptive statistics were presented at the patient-level and ICU-level using means with SDs and medians with interquartile ranges, when appropriate. Second, we used multiple logistic regression to determine the prevalence of pre-existing geriatric conditions adjusted for age at time of ICU admission, sex, race or ethnicity, and proxy status to understand if changes in these covariates may be driving observed trends. We adjusted for proxy status given changes in self-survey and proxy survey rates in the HRS over time.[21] We included each calendar year as a factor variable in regressions and obtained the predicted prevalence of pre-existing geriatric conditions for each year. The predicted prevalence was obtained by implementing predictive margins that average marginal effects by year. We then tested whether a significant linear relationship existed between prevalence of geriatric conditions and year. We further fitted a restricted cubic spline to examine whether a nonlinear relationship existed between prevalence and years.

In secondary analyses, we examined particular subcomponents of disability and frailty. For frailty subcomponents, we examined two or more falls; difficulty lifting 10 pounds; 10% or more weight loss; fair, poor, or blind eyesight; and fair or poor hearing. These subcomponents and those for ADLs were chosen because they could serve as targets for clinical interventions and targets for modification of ICU practice to accommodate the needs of older adults. To test the robustness of our findings for dementia, we used an alternative Langa-Weir method[22] that divides people into dementia, no cognitive impairment, and cognitive impairment without dementia, a research definition analogous to mild cognitive impairment.

All analyses were weighted to account for HRS complex survey design and differential probability of subject selection. The *P* values presented represent whether the slope of the linear trend line is significantly different from zero. We computed 95% CIs using SE of the average determined by the Delta method.[23] Statistical analyses were performed in SAS version 9.4 software (SAS Institute) and Stata version 16.1 software (StataCorp).

Results

Sociodemographic and clinical characteristics are reported at the patient and ICU admission levels in Table 1, and characteristics of ICU admissions are shown in Table 2. Although 10,668 ICU admissions were counted in the cohort across 6,084 distinct individuals, the median number of ICU admissions per person was 1 (interquartile range, 1-2 admissions; range, 1-17 admissions). Cardiac diseases were the most common reason for hospitalization and remained the most common primary diagnosis listed for a given hospitalization (Table 1). Age at first ICU admission increased from 77.6 years (95% CI, 76.7-78.4 years) in 1998 to 78.7 years (95% CI, 77.5-79.8 years) in 2015 ($P < .001$ for trend) (e-Fig 1). Most patients in the cohort were self-reported non-Hispanic and White (76.7%), and the cohort comprised 14.0% non-Hispanic Black patients and 7.6% Hispanic patients. On average across all years, 61.4% of patients had multiple morbidities and 84.2% had at least two chronic diseases. The frequency and cumulative frequency of multimorbidity broken down by number of chronic diseases (0-8) from the HRS is shown in e-Table 2. Overall, 18.5% showed a more than 50% risk of mortality at 4 years as measured by the Lee index at the HRS interview before admission.

Adjusted time trends in geriatric conditions are shown in Figure 1. For disability, the rate increased from 15.5% (95% CI, 12.1%-18.8%) in 1998 to 24.0% (95% CI, 18.5%-29.6%) in 2015 ($P = .001$). Adjusted rates of dementia remained stable (10.4% in 1998 [95% CI,

TABLE 1] Patient and ICU Characteristics

Characteristic	Patients[a] (N = 6,084)	ICU Admissions (n = 10,668)
Age at ICU admission,[a] y		
65-74	2,521 (41.4)	4,102 (38.5)
75-84	2,441 (40.1)	4,477 (42.0)
85+	1,122 (18.5)	2,089 (19.6)
Mean age at first ICU admission, y	77.6 ± 7.7	78.1 ± 7.5
Female sex	3,137 (51.6)	5,420 (50.8)
Race or ethnicity		
Non-Hispanic White	4,669 (76.7)	8,066 (75.6)
Non-Hispanic Black	851 (14.0)	1,542 (14.5)
Hispanic	459 (7.6)	860 (8.1)
Other[b]	105 (1.7)	200 (1.9)
Education		
Less than high school/GED	2,324 (38.2)	4,269 (40.0)
High school graduate	1,830 (30.1)	3,169 (29.7)
Some college	1,052 (17.3)	1,777 (16.7)
College+	878 (14.4	1,453 (13.6)
Ever smoker	3,869 (63.6)	6,936 (65.0)
Marital status[c]		
Married/partnered	3,370 (55.4)	5,862 (55.0)
Single/widowed	2,710 (44.5)	4,800 (45.0)
Proxy	557 (9.2)	1,028 (9.6)
Self-rated health[c]		
Excellent	279 (4.6)	395 (3.7)
Very good	1,105 (18.2)	1,594 (14.9)
Good	1,907 (31.3)	3,083 (28.9)
Fair	1,714 (28.2)	3,271 (30.7)
Poor	1,072 (17.6)	2,313 (21.7)
Lee index ≥ 13[d]	1,124 (18.5)	2,680 (25.1)
Individual self-reported chronic conditions		
Hypertension	4,070 (66.9)	7,513 (70.4)
Diabetes	1,705 (28.0)	3,449 (32.3)
Cancer	1,171 (19.3)	2,245 (21.0)
Lung disease	968 (15.9)	2,065 (19.4)
Heart disease	2,583 (42.5)	5,566 (52.2)
Stroke	931 (15.4)	1,971 (18.5)
Arthritis	4,165 (68.5)	7,555 (70.8)
Psychiatric problems	975 (16.0)	1,955 (18.3)

Data are presented as No. (%) or mean ± SD. GED = General Education Development.
[a]Patient data represent characteristics of patients at the first ICU admission, whereas ICU ages represent age at time of each ICU admission.
[b]Other races or ethnicities include American Indian, Asian, "something else," don't know, or declined to answer. These were collapsed to Other in the Health and Retirement Study to protect respondent confidentiality, given the small sample sizes.
[c]Missing data not included and represents < 1% of cohort.
[d]Health and Retirement Study-validated measure of all-cause 4-year and 10-year mortality.[20] A score of ≥ 13 correlates to a > 50% mortality risk at 4 years.

8.1%-12.7%] to 12.8% in 2015 [95% CI, 9.7%-15.8%]; $P = .21$). Frailty increased from 36.6% (95% CI, 30.9%-42.3%) in 1998 to 45.0% (95% CI, 39.7%-50.2%) in 2015 ($P = .04$). Multimorbidity increased from 54.4% (95% CI, 49.2%-59.7%) in 1998 to 71.8% (95% CI, 66.3%-77.2%) in 2015 ($P < .001$). Unadjusted rates of

TABLE 2] Clinical ICU Admission Characteristics (n = 10,668 Admissions)

Characteristic	No. (%)
ICU type	
General	6,139 (57.6)
Coronary care-general	2,130 (20.0)
Medical	749 (7.0)
Surgical	736 (6.9)
Other intensive care[a]	914 (8.5)
Primary diagnoses by category (ICD-9/10-CM)	
Cardiac	3,900 (36.6)
Pulmonary/ENT	1,063 (10.0)
Infectious diseases	1,125 (10.5)
Neurologic/psychiatric	1,120 (10.5)
GI	1,022 (9.6)
Oncologic	611 (5.7)
Orthopedic	545 (5.1)
Vascular	460 (4.3)
Genitourinary/renal	397 (3.7)
Endocrine	200 (1.9)
Other[b]	118 (1.1)
Hematologic	107 (1.0)
Hospital discharge	
Home with self-care	4,533 (42.5)
Home with health services	1,487 (13.9)
SNF	1,761 (16.5)
Hospice	153 (1.5)
Deceased	1,184 (11.1)
Others[c]	1,550 (14.5)
Length of stay, hospital	
Median (IQR)	6 (3-10)

ENT = ear, nose, and throat; ICD-9/10-CM = International Classification of Diseases, Ninth or Tenth Revisions, Clinical Modification; IQR = interquartile range; SNF = skilled nursing facility.

[a]Represents the combination of multiple specialty coronary care units (n = 240), burn units (n = 14), trauma (n = 78), defined as "other" per Medicare (n = 582).

[b]Other primary diagnoses include: dermatologic, rheumatologic, transplant complications, ophthalmologic, and other diagnoses not easily classifiable (eg, postoperative wound complications, cachexia). Of note, admission diagnoses (ICD codes listed as the reason for initial hospitalization) are not presented, but largely are similar in number to the primary diagnoses presented in the table.

[c]Other discharge locations include: other short-term general hospital for inpatient care, designated cancer center, federal hospital, inpatient rehabilitation facility, long-term acute care hospital, psychiatric hospital, critical access hospital, another institution for outpatient services, left against medical advice, swing bed, admitted as an inpatient to the same hospital, and another health-care institution not defined.

geriatric outcomes did not change substantially from unadjusted rates except for frailty, which was not statistically significant ($P = .08$) (e-Fig 2).

In addition to increasing overall disability in any ADL, secondary analyses showed disability in each individual ADL grew over the study period (Fig 2). Unadjusted rates of individual ADLs and individual frailty subcomponents are shown in e-Figures 3 and 4. For adjusted trends, needing assistance with walking increased from 4.8% (95% CI, 3.1%-6.5%) to 12.9% (95% CI, 9.4%-16.4%; $P < .001$), and needing assistance with bathing increased from 9.7% (95% CI, 6.8%-12.6%) to 15.1% (95% CI, 9.2%-21.0%), although this change was not significant ($P = .06$). Disability in eating increased from 4.1% (95% CI, 2.0%-6.2%) to 7.6% (95% CI, 3.3%-12.0%; $P = .01$), disability in toileting increased from 3.9% (95% CI, 1.8%-5.9%) to 7.3% (95% CI, 2.5%-12.0%; $P = .03$), and disability in transferring from bed grew from 3.4% (95% CI, 1.8%-5.0%) to 8.5% (95% CI, 4.1%-12.9%; $P = .007$). Rates of inability to dress independently increased from 10.1% (95% CI, 7.1%-13.2%) to 13.8% (95% CI, 8.7%-18.8%; $P = .004$). Hearing loss (from 32.6% [95% CI, 27.5%-37.6%] to 39.4% [95% CI, 32.1%-46.7%]) (P = .71), vision loss (from 34.2% [95% CI, 29.4%-39.0%] to 35.8% [95% CI, 30.9%-40.7%]; $P = .75$), and inability to lift 10 pounds (from 43.4% [95% CI, 38.4%-48.4%] to 45.1% [95% CI, 37.7%-52.6%; $P = .06$) all showed increasing trends (Fig 3), but were not significant. Adjusted rates of older adults who reported a fall rose notably from 31.8% (95% CI, 26.6%-37.0%) in 1998 to 44.9% (95% CI, 40.1%-49.7%; $P < .001$) in 2015.

A sensitivity analysis for unadjusted and adjusted cognitive impairment without dementia and dementia using the Langa-Weir criteria[22] demonstrated similar stable trends (e-Figs 5, 6). Although adjusted rates of cognitive impairment without dementia decreased significantly from 28.6% (95% CI, 24.7%-32.5%) in 1998 to 22.6% (95% CI, 15.8%-29.3%) in 2015 ($P = .01$), adjusted rates of dementia using the Langa-Weir criteria did not change significantly: 13.7% (95% CI, 10.3%-17.2%) in 1998 and 12.4% (95% CI, 9.4%-15.5%) in 2015 ($P = .24$). Analysis of nonlinear cubic splines were similar to the linear approximation (e-Fig 7).

Discussion

In this nationally representative survey of older adults linked to Medicare data, the prevalence of pre-existing disability, frailty, and multimorbidity among older ICU patients was high and grew over time. Over the 17-year study period, the prevalence of disability and frailty each rose 8 percentage points, and the prevalence of multimorbidity grew 17 percentage points. By 2015,

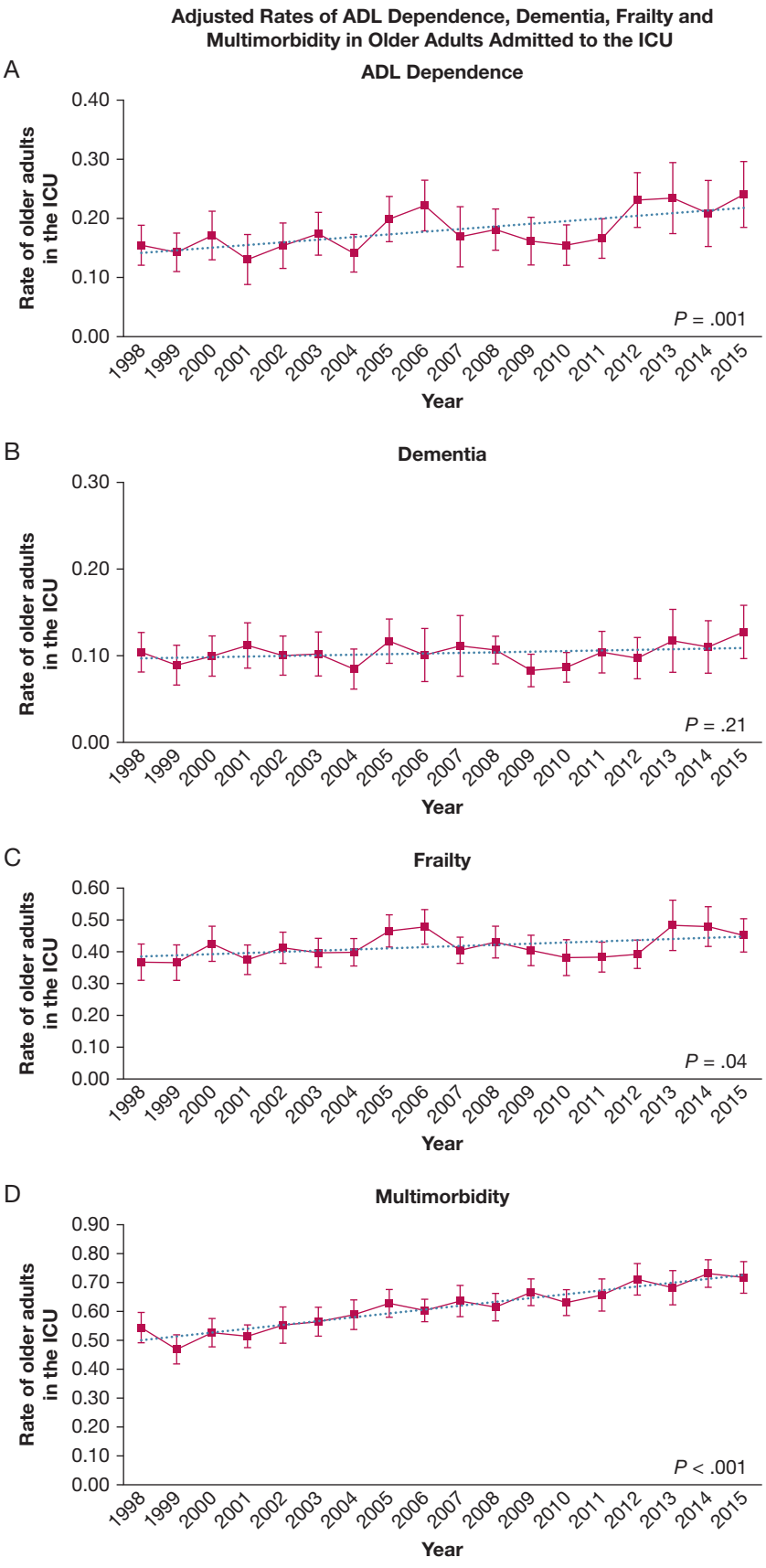

Figure 1 – *A-D, Line graphs showing adjusted rates of ADL dependence (A), dementia (Wu-Glymour) (B), frailty (C), and multimorbidity (D) in older adults admitted to the ICU. Trends in ADL dependence, frailty and multimorbidity are statistically significant, with* P *values shown above. Dementia trend showed a* P *value of* > *.05 and was deemed not statistically significant. All trends were adjusted for age, sex, race, ethnicity, and proxy interview status and were weighted to account for the complex survey design of the Health and Retirement Study. Dementia was defined using the Wu-Glymour criteria for dementia.*[15] *Multimorbidity was defined as having three or more self-reported chronic diseases. Horizontal lines represent 0.10 or 10% increments. ADL = activity of daily living.*

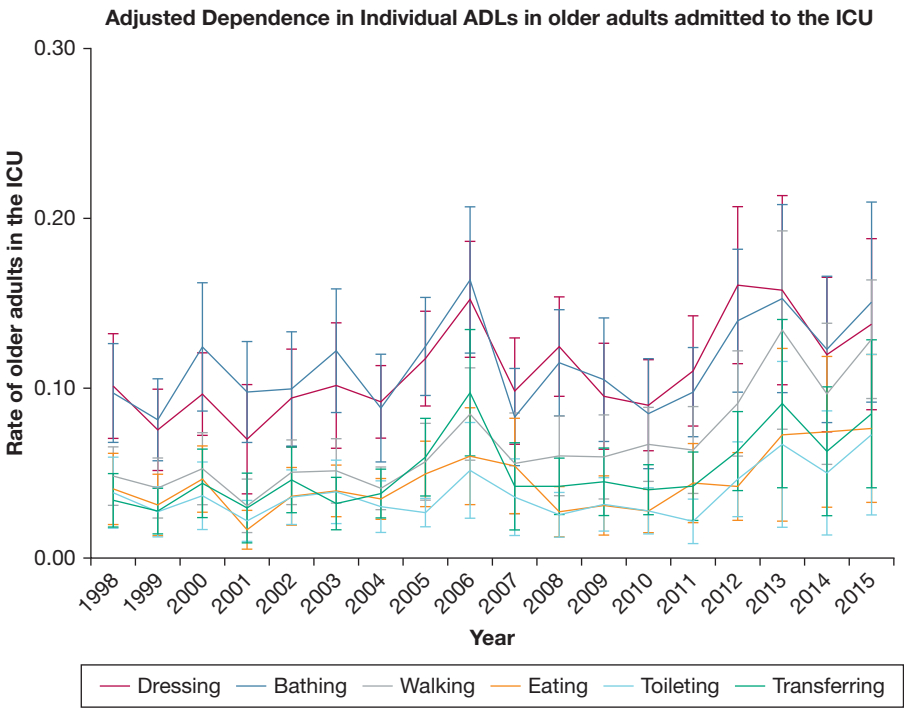

Figure 2 – *Line graph showing adjusted dependence in individual ADLs in older adults admitted to the ICU. Trends for dressing (P = .004), walking (P < .001), eating (P = .01), toileting (P = .03), and transferring (P = .007) all were deemed statistically significant. Trend for bathing (P = .06) was deemed statistically nonsignificant. Trends were adjusted and weighted to account for the complex survey design of the Health and Retirement Study. Horizontal lines represent 0.10 or 10% increments. ADL = activity of daily living.*

nearly one-quarter of older adults admitted to the ICU had a disability, half had frailty, and three-quarters had multimorbidity. As the population continues to age, the prevalence of geriatric conditions likely will increase further, with the possible exception of dementia, escalating the need to incorporate geriatric principles into ICU care.

We build on previous work demonstrating increasing age and rates of comorbidities and worsening outcomes in ICU admissions among elderly patients.[4,24,25] A number of studies note that disability, cognitive impairment, and frailty before ICU admission[26,27] play important roles in recovery after ICU discharge or hospital recovery and eventual frailty progression.[1,3,28,29] Previous studies using the HRS found that cognitive dysfunction, functional impairments, and disability before sepsis were relatively common and worsened in survivors, but that only approximately 50% of these patients were critically ill.[7] Our study demonstrated longitudinal increases of pre-existing geriatric conditions among patients admitted to the ICU. Trends remained present even after controlling for age and other factors that may contribute to the growing prevalence of these conditions. These results suggest that if trends in pre-existing disability, frailty, and multimorbidity continue, then the functional burden in ICU survivors similarly is likely to rise over time. Although observed time trends were modest, given the high frequency of ICU admission among older adults and extrapolated over decades, these trends portend a substantial impact on a population level. The adoption of post-intensive care syndrome clinics or dedicated cognitive and physical rehabilitation interventions in patients after an ICU stay[30] will need to grow to accommodate growing numbers of older adults survivors of critical illness.[31] Overall, low staffing of ICUs with physical therapists remains a significant barrier to high-intensity mobilization of patients with critical illness.[32] Formal early mobilization protocols are present only in 30% of US ICUs as measured by one study.[33] Barriers for early mobilization in ICU patients have been well described,[34] but undoubtedly will become magnified should the proportion of patients with pre-existing disability and frailty admitted to the ICU increase over time.

The recognition of disability, frailty, and other geriatric conditions before critical illness should guide focused management of and ICU environmental modifications for older adults. Geriatric treatment principles should be incorporated from the moment of ICU admission.[8] Early mobilization,[35] delirium prevention,[36] and multicomponent environmental modifications and interventions[9] all improve various functional and morbidity outcomes in older patients when used before and during ICU stays.[37] It remains largely unknown how or even if early mobilization or multicomponent

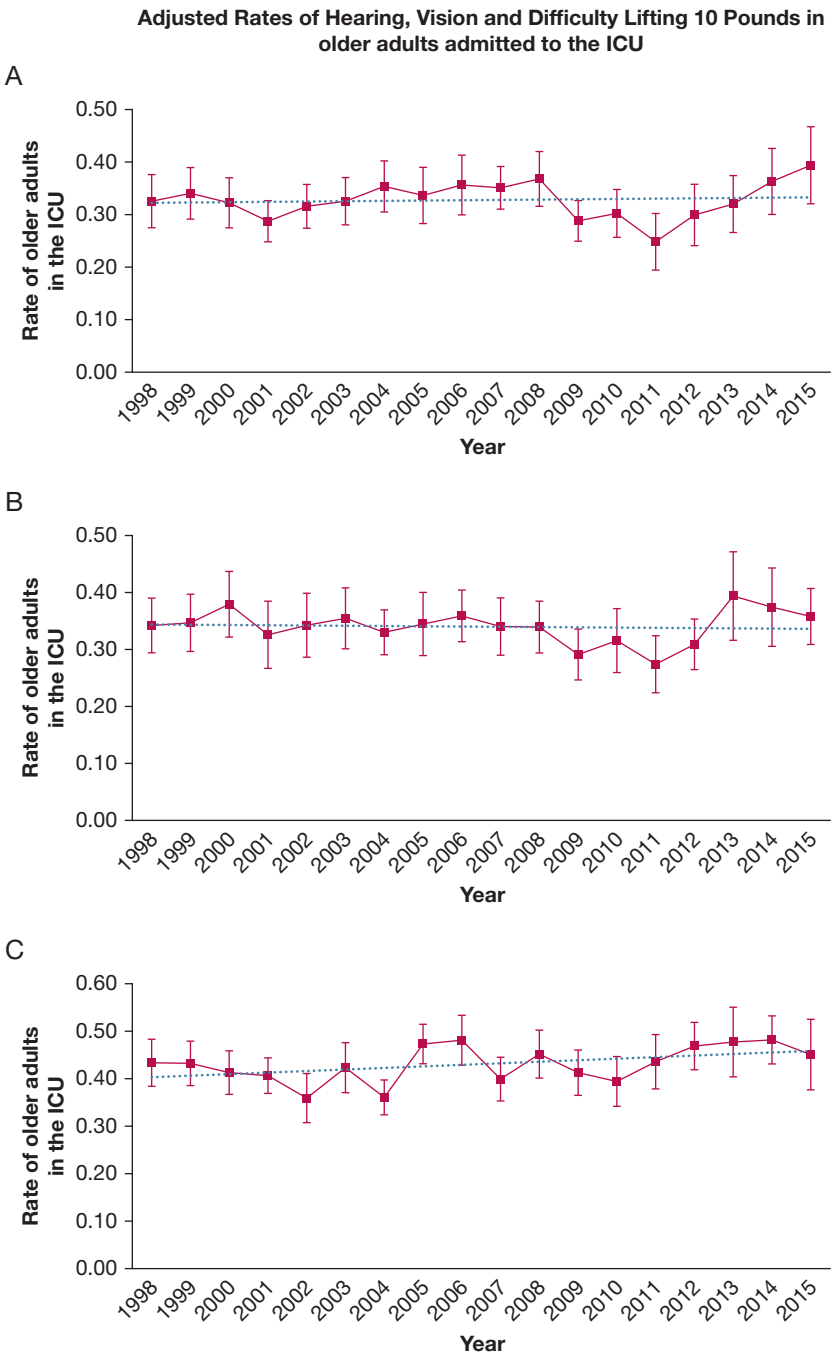

Figure 3 – *A-C, Line graphs showing adjusted rates of fair or poor hearing (A); fair, poor, or blind vision (B), and difficulty lifting 10 pounds (C) in older adults admitted to the ICU. Trend for fair or poor hearing had a* P *value of .71 and fair, poor, or blind vision had a* P *value of .75 and were deemed not statistically significant. Trend for difficulty lifting 10 pounds had a* P *value of .06 and was deemed not statistically significant. All trends were adjusted for age, sex, race, ethnicity, and proxy interview status and were weighted to account for the complex survey design of the Health and Retirement Study. Horizontal lines represent 0.10 or 10% increments.*

environmental modifications can affect patient outcomes or can alter functional trajectories after ICU discharge specifically in patients with pre-existing functional impairments. Nonetheless, multiple groups advocate for the adoption of geriatric care models and additional provider training to improve care for older adults.[6,8] These include increased intensivist training in geriatric conditions and the adoption of systems practices aimed at improving care for older adults such as the Age-Friendly Health System using the "4Ms" framework (emphasizing what matters, medications, mentation, and mobility).[38] Environmental modifications that redesign the physical ICU structure to promote the needs of older adults also may improve care experiences and outcomes, such as using single-occupancy rooms, natural light, and noise-dampening furnishings and materials.[39] We believe these trends change how we should approach the global care of patients with critical illness, many of whom are older, have multiple morbidities, and are frail. A shift from a

focus on curative goals to one by which we consider patient-oriented outcomes related to function side-by-side with illness cure could align treatment with goals and could augment patient and family satisfaction.

The potential for development of critical illness in an elderly patient should be viewed as an opportunity to engage patients and family surrogates in conversations to understand patient values, preferences, and goals before ICU admission. Of note, we did not observe a significant change in ICU admissions for people with dementia. Lack of an increase in the prevalence of dementia, despite an increase in mean age, may reflect efforts to bolster early advanced care planning and goals-of-care discussions among individuals with early-stage dementia and their caregivers.[40]

To be sure, certain older patients may benefit from increased ICU access. When clinically indicated, very old (> 80 years) patients admitted to the ICU had lower mortality rates compared with similar patients who were not admitted to the ICU in one French study.[41] In older patients with pneumonia, in whom the decision for ICU admission was discretionary, ICU admission was associated with lower mortality.[42] It is possible that over the study period, morbidity and mortality improved across patients of all ages, as has been shown with sepsis.[43] In contrast, a randomized clinical trial in France found that systematic ICU admission of certain older adults did not improve mortality, disability, or quality of life in those discharged from the ICU.[44] Hence, our results do not necessarily argue against ICU admission of older adults with geriatric conditions, but rather, emphasize the need to integrate geriatric principles in the ICU, particularly when a given older patient is particularly vulnerable to potential risks of ICU care.

Our study has notable strengths. We leveraged HRS data to assess function and disability before an incident ICU admission, as opposed to extrapolating these measures from cohorts isolated after an ICU admission. Our sample size was large and nationally representative, and our prevalence calculations of frailty and dementia were consistent with other studies using different datasets, algorithms, or both in ICU patients.[1,45,46]

This study has limitations. Residual confounding may explain observed trends. However, regardless of possible confounders, unadjusted rates demonstrate trends at the ICU admission level at the level of an intensivist practicing over a 17-year period. We used a functional domains model of frailty, but other models (eg, deficit accumulation model[47]) may provide different results, as has been shown elsewhere.[48] We chose self-identified chronic conditions for multimorbidity as others have,[49] but the concept of multimorbidity lacks a consensus definition. Given that HRS core surveys occur every 2 years, surveys may not represent conditions present at time of the ICU admission. We assume that the prevalence of geriatric conditions is similar if not higher at the time of ICU admission because of the passage of time, the fact that diseases leading to hospitalization among older adults often are associated with disability, and hospital-acquired geriatric conditions such as disability.[50]

Interpretation

Our findings suggest a growing prevalence of geriatric conditions among older adults admitted to the ICU, suggesting a pressing need to integrate geriatrics principles into critical care medicine. Further research could examine if early interventions emphasizing physical, cognitive, mental health, delirium-prevention, advance care planning and rehabilitation individualized to elderly patients with critical illness and with pre-existing geriatric conditions could improve ICU outcomes and recovery after ICU discharge.

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