Hospitalization-Associated Disability in Adults Admitted to a Safety-Net Hospital

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BACKGROUND: Little is known about hospitalization-associated disability (HAD) in older adults who receive care in safety-net hospitals.

OBJECTIVES: To describe HAD and to examine its association with age in adults aged 55 and older hospitalized in a safety-net hospital.

DESIGN: Secondary post hoc analysis of a prospective cohort from a discharge intervention trial, the Support from Hospital to Home for Elders.

SETTING: Medicine, cardiology, and neurology inpatient services of San Francisco General Hospital, a safety-net hospital.

PARTICIPANTS: A total of 583 participants 55 and older who spoke English, Spanish, or Chinese. We determined the incidence of HAD 30 days post-hospitalization and ORs for HAD by age group.

MEASUREMENTS: The outcome measure was death or HAD at 30 days after hospital discharge. HAD is defined as a new or additional disability in one or more activities of daily living (ADL) that is present at hospital discharge compared to baseline. Participants' functional status at baseline (2 weeks prior to admission) and 30 days post-discharge was ascertained by self-report of ADL function.

RESULTS: Many participants (75.3 %) were functionally independent at baseline. By age group, HAD occurred as follows: 27.4 % in ages 55–59, 22.2 % in ages 60–64, 17.4 % in ages 65–69, 30.3 % in ages 70–79, and 61.7 % in ages 80 or older. Compared to the youngest group, only the adjusted OR for HAD in adults over 80 was significant, at 2.45 (95 % CI 1.17, 5.15).

CONCLUSIONS: In adults at a safety-net hospital, HAD occurred in similar proportions among adults aged 55–59 and those aged 70–79, and was highest in the oldest adults, aged $\geq$ 80. In safety-net hospitals, interventions to reduce HAD among patients 70 years and older should consider expanding age criteria to adults as young as 55.

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INTRODUCTION

Hospitalization-associated disability (HAD) refers to new or additional disability in activities of daily living (ADL) at hospital discharge compared to pre-admission baseline, and occurs in one-third of hospitalized adults over the age of 70.[1–3] Among older adults, ADL disability threatens independence and quality of life and is predictive of higher resource utilization and death.[4–8] Since half of all new-onset ADL disability is attributable to hospitalization, HAD has important implications for patients, caregivers, and policymakers.[6]

However, the prevalence of HAD in adults seen in safety-net settings (hospitals or health care systems that provide a significant level of care to low-income, uninsured, and vulnerable populations) is unknown.[9] Furthermore, even at ages younger than 70, adults in safety-net care settings have a concentration of risk factors for HAD, including minority race status, baseline functional impairment, low socioeconomic status, substance use, and homelessness.[10–16] Understanding the prevalence of and the risk factors for HAD in persons as young as 55 is important, as hospitals could target areas of high prevalence for interventions to reduce functional decline in older adults, thus benefitting a greater number of people at risk.[1,17–19]

In order to understand the prevalence of HAD in a safety-net setting, we describe HAD in a cohort of racially and ethnically diverse adults aged 55 and older who were hospitalized at an urban safety-net facility. We describe disability at baseline, admission, and 30 days post-discharge. Because disability is strongly associated with age, we further examine the relationship between age and HAD. We hypothesize that HAD is highly prevalent in adults aged 55–59 in this cohort.

METHODS

Design Overview

This study is a post hoc analysis of a larger study, the Support from Hospital to Home for Elders, a randomized controlled trial comparing usual hospital discharge care to a nurse-led discharge intervention.[20] The study took place at San Francisco General Hospital and Trauma Center, an urban safety-net hospital with 590 beds and over 100,000 patient visits per year.[21]

Study Design and Sample. Between July 2010 and August 2012, we recruited patients aged 60 and older who spoke English, Spanish, Cantonese, or Mandarin, and who were admitted to the medicine, cardiology, or neurology services of San Francisco General Hospital. Because the number of eligible patients was lower than projected, we expanded age eligibility to include patients aged 55 and older in March 2011, when 239 participants had been enrolled. Potential participants were ineligible if they lacked access to a telephone; were transferred from an outside hospital or skilled nursing facility; were admitted for a planned hospitalization; were expected by the admitting physician to be discharged to a hospice, nursing home, or rehabilitation center; could not independently provide written informed consent for any reason (e.g., severe cognitive impairment or hearing impairment); had metastatic cancer; or were aphasic. Study staff received a daily list of hospitalized patients meeting the age and admitting service criteria, and then approached the patient's attending physician to ask permission to recruit the patient and screen for all eligibility criteria. We excluded patients who could not confirm understanding of the consent process.[22] For this study, we excluded those who died before discharge, were completely dependent in all ADLs at baseline, did not have information on at least four ADLs at each interview, or did not have 30-day follow-up. Participants who completed the baseline interview received a $10 pharmacy or grocery store gift certificate. The study was approved by the institutional review board of the University of California, San Francisco.

Measures

At study enrollment, study staff conducted in-person interviews with participants in English, Spanish, Cantonese or Mandarin. Study staff completed follow-up interviews at 30 days by telephone.

Outcome. We defined the outcome of hospitalization-associated disability (HAD) at 30 days post-discharge as 1) death or 2) new ADL disability (needing help performing any of the five ADLs for which the participant did not need help at baseline 2 weeks before admission). We included death in functional decline because it often is preceded by a functional decline that might not otherwise be captured.[23] We verified deaths using medical records and by submitting queries to the California Department of Public Health Vital Records.

Other Measures. Functional Status. To assess function, we asked participants to report their functional status 2 weeks before admission, at admission, and at the 30-day follow-up interview. Self-reporting has been used for pre-admission functional status in most studies measuring function and HAD, as baseline function is not usually recorded, and this measure has face and predictive validity.[24] Participants reported their ability to perform ADLs without help (bathing, dressing, eating, transferring, toileting),[25] and similarly reported their ability to perform instrumental activities of daily living (IADLs) (using the telephone, transportation, shopping, meal preparation, light housework, medication management, money management) without the need for help.[26] We defined ADL or IADL disability as needing help to perform the task. We present ADL disability both categorically (any versus none) and by number impaired. We present IADL disability in three categories: none, 1–2, and 3 or more.

Demographic and Socioeconomic Variables. We assessed participant characteristics through interviews, except where otherwise noted. Demographic characteristics included age, sex, and race/ethnicity. We categorized age as 55–59, 60–64, 65–69, 70–79, and $\geq$ 80. We grouped more ages in the higher age categories because of smaller numbers. Measures of socioeconomic status included years of education (< 12 vs. $\geq$ 12 years) and total household income (< $20,000 vs. $\geq$ $20,000).

We measured acculturation through self-reported ability to speak English ("not at all"/"not well" vs. "well"/"very well"). We assessed health literacy using a validated instrument comprising three questions, each scored on a five-point Likert scale: "How confident are you filling out medical forms?"; "How often do you have problems learning about your medical condition because of difficulty understanding written information?"; and "How often do you have someone help you read hospital materials?" (range, 3–15; inadequate health literacy defined as a score $\geq$ 9).[27]

We defined housing instability in the past year as experiencing homelessness (sleeping in the street, a homeless shelter, or a place not ordinarily used as a sleeping accommodation), doubling-up with friends or family, staying in a single-room occupancy hotel, or living in more than four places during the prior year.[28]

Health-Related Behaviors. We used the World Health Organization Alcohol, Smoking and Substance Involvement instrument to assess alcohol and substance use (range, 0–39; scores of 0–10, 11–26, and $\geq$ 27 correspond to low-, moderate-, and high-risk alcohol use, respectively).[29] Participants provided self-reporting of tobacco use and illicit drug use of cocaine, amphetamines, or opioids in the prior 3 months.

Health Status. We used the 12-Item Short Form Health Survey (SF-12) to measure physical and mental health (range 0–100 for each subscale; higher scores indicate better health).[30] To assess comorbidity burden, we calculated the Charlson Comorbidity Index using International Classification of Diseases, Ninth Revision (ICD-9) codes extracted from administrative data recorded during hospital admission (scores 0, 1–2, 3–4, and ≥ 5; higher scores indicate higher mortality risk).[31,32] We defined depression as a score of ≥ 10 on the 9-item Patient Health Questionnaire (range, 0–27).[33] We assessed cognition at admission using the modified Telephone Interview for Cognitive Status (M-TICS), and defined cognitive impairment as an M-TICS score of < 20.[34] We obtained laboratory data from the date closest to admission for values of creatinine (mg/dL) and albumin (g/dL), and for analyses we dichotomized them at levels consistent with prior studies.[8]

Health Care Access. Participants reported whether they had a usual source of medical care other than the emergency department and any overnight hospitalizations during the 6 months prior to the index hospitalization.

Statistical Analyses

We described participant characteristics, health status and functional status (ADLs and IADLs) using means and standard deviations for continuous variables, and frequencies and proportions for categorical variables. To compare characteristics between participants with and without HAD, we used t tests for continuous variables and chi-square tests for categorical variables.

To examine the association between the various age groups and HAD, we used chi-square tests for age group comparisons and for linear trend to test the relationship. We used a logistic regression model to estimate the unadjusted and adjusted associations between age groups and HAD. We adjusted for variables that were chosen a priori based on previous literature as showing an association with HAD: sex, any ADL or IADL pre-admission disability, comorbidity burden, cognitive impairment, and renal disease (creatinine ≥ 1.5 mg/dL).[8,35,36] To assess whether cognitive impairment was associated with HAD in younger as well as older adults, we stratified the sample by age group and performed adjusted multivariate models for the association of cognitive impairment with HAD for each group. The strength of associations are reported using odds ratios (ORs) and 95 % confidence intervals (CIs). We used Stata version 12 statistical software for analyses (StataCorp LP, College Station, TX, USA).

RESULTS

Of the 700 participants who consented, one individual was not eligible for the study and was excluded before the baseline interview, and five persons died before discharge. For the study, we excluded 27 (3.9 %) persons who were completely dependent at baseline, 33 (4.8 %) who were alive but did not have 30-day follow-up, and 51 (7.3 %) who did not answer at least four ADL questions at 30 days. Participants omitted from analyses for having no ADL data at 30 days (n=84) did not differ from the rest of the cohort in age or baseline functional status. They were more likely to be black, speak English "well" or "very well", have ≥ 12 years of education, have congestive heart failure or liver disease, and to report housing instability, high-risk alcohol use, and depression on admission. They were less likely to be Asian and had lower mean mental component scores on the SF-12. In total, we included 583 participants in our analyses, and for participants with one missing ADL at baseline (n=2) or 30 days (n=6), we determined HAD based on the four ADLs for which information was known.

Participant characteristics are described in Table 1. Over half (58.0 %) were younger than 65. Less than half (43.1 %) were female, and 11.1 % reported an annual income of more than $20,000. Participants were diverse: 34.0 % Asian, 22.5 % African-American, 18.9 % white and non-Latino, and 20.1 % Latino or Hispanic. Most (56.6 %) reported 12 or more years of education, 38.8 % reported speaking English "not at all" or "not well", and 35.3 % had inadequate health literacy. Approximately one-fourth, 25.7 %, reported living alone, and housing instability was noted in 14.4 %. High- or moderate-risk alcohol use was present in 9.6 %, and 17.7 % reported some illicit drug use in the prior 3 months.

At baseline, 24.7 % of participants had at least one ADL disability (see Table 1). For the youngest adults, those aged 55–59, 25.9 % had at least one ADL disability at baseline, and for the oldest adults, aged 80 and above, 45.0 % had at least one ADL disability at baseline (data not shown). Of those with complete information about IADL disabilities at baseline (n=506), 26.6 % had one or more IADL disabilities. At admission, almost one-third (30.7 %) of patients were experiencing depression, and over half (52.2 %) had cognitive impairment. Common medical diagnoses were diabetes (38.9 %), chronic pulmonary disease (28.1 %), and congestive heart failure (22.6 %). The majority of participants, 84.5 %, reported access to a regular place of care, and 17.6 % reported a hospitalization within the prior 6 months.

Hospitalization-Associated Disability

Figure 1 shows the development of HAD in the cohort. Compared to baseline function, 164 (28.1 %) developed HAD at 30 days, including five (0.9 %) participants who died between discharge and 30 days. Of these, 83 (14.2 %) developed a disability in the period between 2 weeks prior to admission and admission, and 81 (13.9 %) developed an impairment between admission and 30 days.

Table 1 shows the characteristics of participants who developed HAD (also see Fig. 1) compared to those who did not. Participants with HAD were more likely to be female (51.8 % vs. 39.6 %, p=0.007), have very low income (7.0 % vs.

Table 1 Characteristics of Participants by Hospitalization-Associated Disability, n=583

Characteristic	Entire cohort N (Column Percent) Total N=583	No hospitalization-associated disability[a] N (%) Total N=419 (71.9 %)	Hospitalization-associated disability[a] N (%) Total N=164 (28.1 %)	p value[*]
Sociodemographics				
Age, mean (±SD)	66.1 (8.8)	65.0 (7.6)	68.9 (10.7)	<0.001
55–59	135 (23.2)	98 (23.4)	37 (22.6)	<0.001
60–64	203 (34.8)	158 (37.7)	45 (27.4)	
65–69	86 (14.8)	71 (17.0)	15 (9.2)	
70–79	99 (17.0)	69 (16.5)	30 (18.3)	
80+	60 (10.3)	23 (5.5)	37 (22.6)	
Female sex	251 (43.1)	166 (39.6)	85 (51.8)	0.007
Ethnicity				
Black/African-American, Non-Latino	131 (22.5)	89 (21.2)	42 (25.6)	0.273
White, Non-Latino	110 (18.9)	84 (20.0)	26 (15.9)	
Latino/Hispanic	117 (20.1)	91 (21.7)	26 (15.8)	
Asian	198 (34.0)	136 (32.5)	62 (37.8)	
Other, Don't know	27 (4.6)	19 (4.5)	8 (4.9)	
Education ≥12 yrs	330 (56.6)	246 (58.7)	84 (51.2)	0.101
Speaks English				
Not at all/ Not well	226 (38.8)	165 (39.4)	61 (37.2)	0.626
Inadequate health literacy[b]	201 (35.3)	143 (35.0)	58 (36.3)	0.773
Income>$20,000	63 (11.1)	52 (12.7)	11 (7.0)	0.053
Living alone[c]	149 (25.7)	119 (28.5)	30 (18.5)	0.013
Housing instability in past 30 days (includes homelessness)	84 (14.4)	63 (15.0)	21 (12.8)	0.490
Functional status pre-admission				
Number of ADL disabilities pre-admission [d]				
No disability	439 (75.3)	334 (79.7)	105 (64.0)	< 0.001
1 ADL disability	40 (6.9)	18 (4.3)	22 (13.4)	
2 ADL disabilities	40 (6.9)	28 (6.7)	12 (7.3)	
3 ADL disabilities	35 (6.0)	18 (4.3)	17 (10.4)	
4 ADL disabilities	29 (5.0)	21 (5.0)	8 (4.9	
Any ADL disability (1–4)	144 (24.7)	85 (20.3)	59 (36.0)	<0.001
Number of IADL disabilities pre-admission [e]				
No disability	351 (69.4)	278 (76.6)	75 (51.1)	<0.001
1–2 IADL disabilities	85 (16.8)	56 (15.4)	29 (20.3)	
3+ IADL disabilities	70 (13.8)	29 (8.0)	41 (28.7)	
Any IADL disability (1–7)	155 (10.6)	85 (23.4)	70 (49.0)	<0.001
Health-related Behaviors				
Current tobacco use	130 (22.3)	93 (22.3)	37 (22.6)	0.872
High- or moderate-risk alcohol use [f]	56 (9.6)	42 (10.0)	14 (8.5)	0.584
Any illicit drug use in last 3 months [g]	103 (17.7)	72 (17.2)	31 (18.9)	0.625
Health status				
SF-12 [h]				
Mental score, mean (range)	46.0 (16.2–69.8)	46.3 (16.2–69.8)	45.2 (17.9–65.7)	0.330
Physical score, mean (range)	36.1 (14.3–62.8)	37.6 (14.3–62.8)	32.1 (15.4–57.3)	<0.001
Depression [i]	178 (30.7)	125 (30.0)	53 (32.7)	0.521
M-TICS score < 20 [j]	302 (52.2)	192 (46.0)	110 (67.9)	<0.001
Major diagnoses				
Congestive heart failure	132 (22.6)	87 (20.8)	45 (27.4)	0.083
Chronic pulmonary disease	164 (28.1)	109 (26.0)	55 (33.6)	0.069
Diabetes	227 (38.9)	153 (36.5)	74 (45.1)	0.055
Liver disease	122 (21.0)	83 (19.8)	39 (23.8)	0.289
Renal disease	116 (19.9)	70 (16.7)	46 (28.1)	0.002
Charlson score, mean (SD) [k]	2.3 (2.0)	2.1 (1.9)	2.8 (2.1)	<0.001
0	80 (13.7)	61 (14.6)	19 (11.6)	0.002
1–2	299 (51.3)	227 (54.2)	72 (43.9)	
3–4	132 (22.6)	92 (22.0)	40 (24.4)	
≥ 5	72 (12.4)	39 (9.3)	33 (20.1)	
Creatinine ≥ 1.5 mg/dL	137 (23.5)	83 (19.8)	54 (33.1)	0.001
Albumin < 3.5 g/dL	106 (19.0)	68 (17.1)	38 (23.8)	0.072
Health care access				
Has a regular place of care	492 (84.5)	348 (83.1)	144 (88.3)	0.113
Hospitalized in past 6 months	102 (17.6)	67 (16.0)	35 (21.7)	0.106

Abbreviations: ADL activities of daily living, IADL instrumental activities of daily living, SF-12 12-Item Short Form Health Survey, M-TICS modified Telephone Interview for Cognitive Status

[*]*P value for appropriate test of comparison to group without functional decline or death at 30 days*

[a]*Hospitalization-associated disability was defined as any reported new impairment in ADL function compared to pre-admission baseline (2 weeks prior) or death before 30 days.*

[b]*Inadequate health literacy was defined with a positive screen using a 3-item screening tool (see text).*

[c]*Housing instability in the past year was defined as experiencing homelessness, doubling-up with friends or family, staying in a single-room occupancy hotel, or living in more than 4 different places during the prior year.*

[d]*Self-reported ability to perform activities of daily living (ADLs) without help 2 weeks prior to admission*

[e]*Self-reported ability to perform instrumental activities of daily living (IADLs) without help 2 weeks prior to admission (N=509)*

[f]*High- or moderate-risk alcohol use was defined as a score of ≥ 11 on the World Health Organization Alcohol, Smoking and Substance Involvement instrument.*

[g]*Illicit drug use was defined as self-reported use of cocaine, amphetamines, or opioids during the prior 3 months.*

[h]*The SF-12 was used to measure physical and mental health (range 0–100 for physical and mental health subscales; higher scores indicate better health).*

[i]*Depression was defined as a score of ≥ 10 on the Patient Health Questionnaire-9 measured at admission.*

[j]*The M-TICS was used to detect cognitive impairment, defined as a score of < 20 measured at admission.*

[k]*The Charlson Comorbidity Index was extracted from administrative data recorded during hospital admission.*

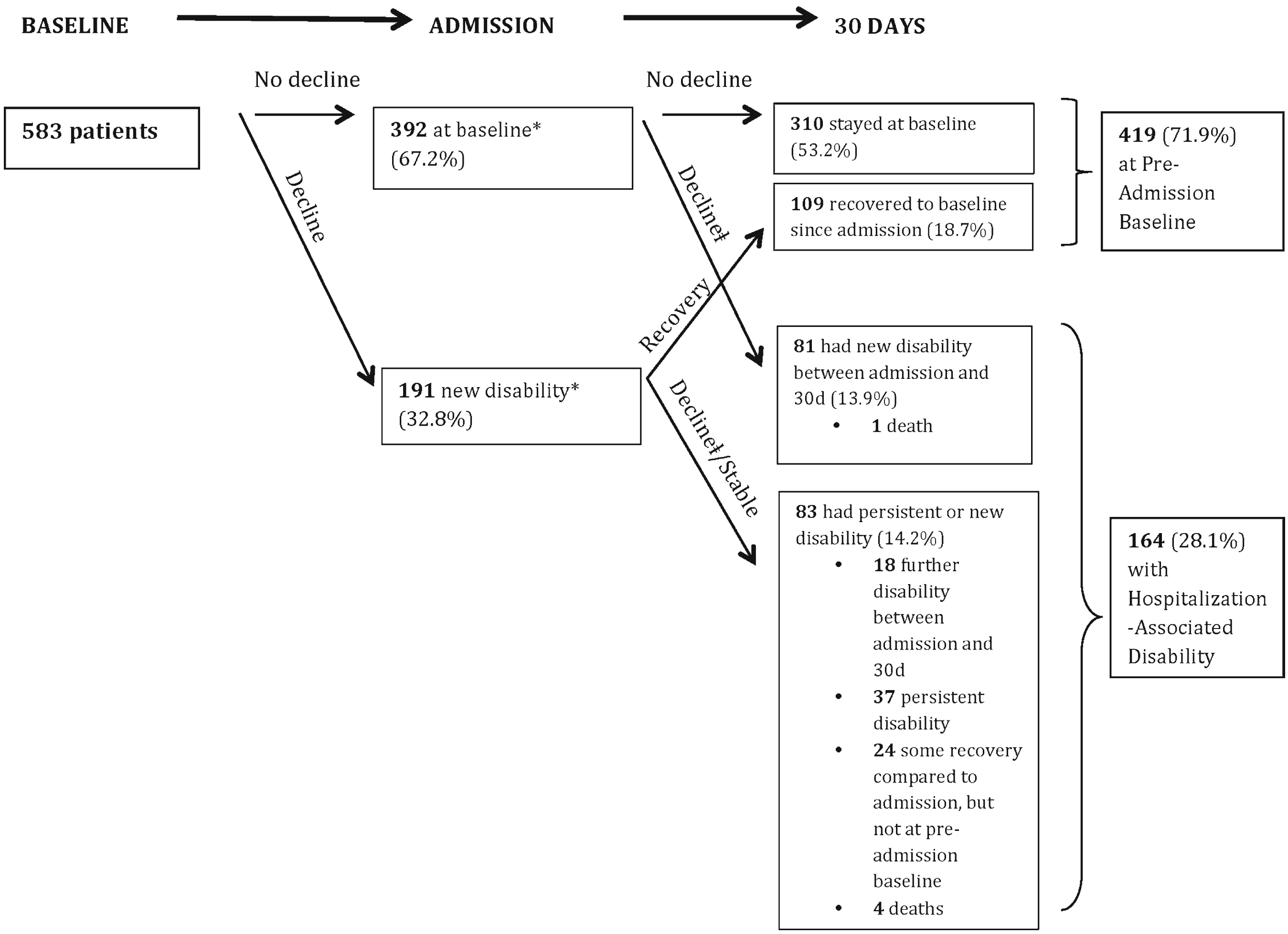

Figure 1. Changes in activities of daily living from baseline to hospital admission and 30 days after discharge, N=583 *23 (3.9 %) participants were missing information on all five activities of daily living at admission. Decline is defined as loss of independence.

12.7 %, p=0.053 reported an annual income of over $20,000), and less likely to be living alone (18.5 % vs. 28.5 %, p=0.013). Other sociodemographic characteristics (ethnicity, education, health literacy, English-speaking ability, and housing instability) and health-related behaviors were not associated with developing HAD.

Participants who were dependent in any baseline ADL or IADL function were more likely to develop HAD than those who were independent in all ADLs or IADLs (ADLs 36.0 % vs. 23.0 %, p<0.001; and IADLs 49.0 % vs. 23.4 %, p<0.001) (see Table 1). Patients with cognitive impairment had higher incidence of HAD (67.9 % vs. 46.0 %, p<0.001) compared to those without it. A higher Charlson comorbidity score and renal disease were also associated with higher likelihood of HAD. Incidence of HAD did not differ based on intervention group assignment (data not shown).

Age and Hospitalization-Associated Disability at 30 days

Age was associated with incidence of HAD (p<0.001 for trend), as reflected in a U-shaped trend (Fig. 2). Patients 80 and older had the highest incidence of HAD (62.3 %), followed by patients 70–79 (30.3 %) and those 55–59 (27.4 %); there was no difference among the 55–59, 60–64, and 65–69 age groups. The incidence of HAD in patients aged 70–79 was significantly different from that for patients aged 65–69 (30.3 % vs. 17.4 %, respectively, p=0.042).

We conducted a sensitivity analysis to evaluate the potential for a ceiling effect among participants with high baseline disability and thus less opportunity for further disability. When restricting our analysis to only those adults with 0–1 ADL disability at baseline (n=479), there was the same U-shaped appearance (p<0.001 for trend; data not shown). The oldest age group had a statistically significant higher incidence of HAD than the other age groups (all p≤0.001).

In Table 2 we show multivariate analyses, controlling for variables known to be associated with HAD. The adjusted OR for HAD for adults aged 80 and older was 2.45 (95 % CI 1.17, 5.15) compared to the youngest group aged 55–59. There was no statistical difference in risk of HAD among any of the other age groups. In multivariate models stratified by age group, cognitive impairment was associated with HAD in all age

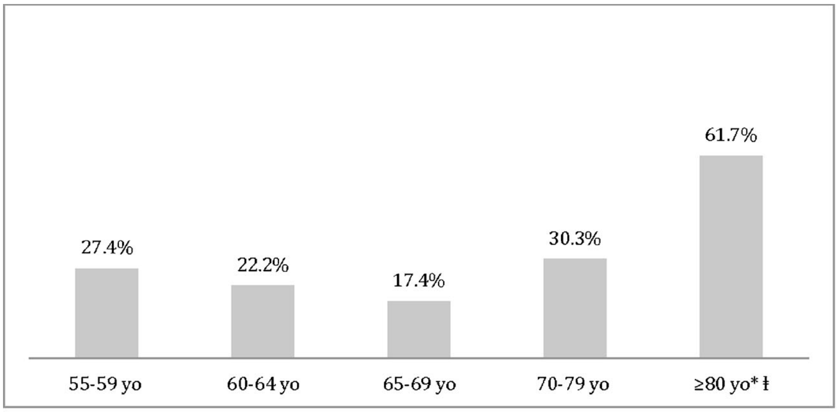

Figure 2. Hospitalization-Associated Disability by Age Group, N=583 Hospitalization-associated disability is defined as any reported new impairment in ADL function at 30 days compared to pre-admission baseline (2 weeks prior) or death before 30 days. Abbreviations: ADL activities of daily living, yo years old P value for chi-square test for comparison among all age groups: p<0.001 *There was a significant difference between the oldest age group, adults ≥ 80, and all other age groups (chi-square test p value < 0.001). The age group 70–79 was significantly different from the middle group, aged 65–69 (p=0.042).

groups (55–59: OR=2.46 [1.0, 6.09]; 60–64: OR: 2.36 [1.03, 5.42]; 65–69: OR=1.81 [0.47, 6.88]; 70–79: OR = 1.59 [0.44, 5.77]; 80+: OR=1.51 [0.31, 7.40]).

DISCUSSION

In a cohort of adults aged 55 and older who were hospitalized at a safety-net hospital, 28.1 % developed HAD, and the incidence of HAD in the youngest age group (27.4 %) was similar to that in adults 70–79 years of age (30.3 %). To our knowledge, this is the first study to examine the incidence of HAD in a safety-net population.

Our study population was racially and ethnically diverse, low-income, with low health literacy and a high prevalence of medical comorbidities and substance use. Our finding that HAD is highly prevalent in adults as young as 55 suggests that it may be just as important a consideration in middle-aged adults from highly disadvantaged populations as in adults over 70, who have been more widely studied.

One reason for this high prevalence may be a concentration of risk factors for prevalent functional disability, which is a risk factor for HAD.[5,8,12–14,37–40] Socioeconomic factors (e.g., poverty and education) have been shown to be associated with prevalent functional disability but not HAD.[11,12] The distribution of HAD suggests that there may also be different factors contributing to susceptibility for or poor recovery from HAD within each age group. Long-term substance abuse and low socioeconomic status is associated with a higher incidence of disability, and these factors have been shown to have damaging effects on health by middle age.[12,14,38,41,42] In older adults, who had the highest incidence of HAD in this cohort, age-related factors may have played a greater role, such as more detrimental effects on function from acute illness and deconditioning associated with hospitalization.[36,43–45]

Consistent with other studies, cognitive impairment, which was highly prevalent in this population, was associated with the incidence of HAD,[35,46] and it was significantly associated with HAD in the youngest age group. As this was measured at admission, the high prevalence may be due in part to reversible causes such as delirium and reversible cognitive impairment, and may affect recovery.[47,48]

The identification of a middle-aged population at high risk for HAD is a first step. In community-living older adults, 50 % of new disability is attributable to hospitalization.[1,6] Models of care for older adults that are designed to improve function, such as the Hospital at Home model and Acute Care for Elders (ACE) units, may be effective in middle-aged adults at risk for HAD.[49–5152] Further work is necessary to elucidate the modifiable patient-level and hospital-level factors that can affect the incidence of HAD in adults over 55 hospitalized in a safety-net setting.[1,19]

The strengths of this study include its large sample size, the diverse population, high ascertainment of outcomes, and the understudied population. There are also several limitations. This study cohort is a unique population with homogeneity of some social factors, e.g., income, which may have limited our ability to detect the impact of these factors on our outcome. As this is an urban safety-net population, it may also limit the study's generalizability to other populations such as those in rural safety-net settings. For baseline ADL disability 2 weeks

Table 2 Odds Ratios for Hospitalization-Associated Disability (HAD) by Age Group

Age group in years (N) Total N=583	Unadjusted odds ratio for HAD OR (95 % CI)	Adjusted* odds ratio for HAD OR (95 % CI)
55–59 (N=135)	reference	reference
60–64 (N=203)	0.75 (0.46, 1.25)	0.67 (0.37, 1.20)
65–69 (N=86)	0.56 (0.29, 1.10)	0.54 (0.25, 1.14)
70–79 (N=99)	1.15 (0.65, 2.04)	0.76 (0.39, 1.49)
80+ (N=60)	4.26 (2.24, 8.11)	2.45 (1.17, 5.15)

Abbreviations: HAD hospitalization-associated disability, ADL activities of daily living, IADL instrumental activities of daily living
**Adjusted for sex, any ADL or IADL disability at pre-admission baseline, cognitive impairment, Charlson score, creatinine ≥ 1.5*

prior to admission, we used participant self-reporting, which is the most commonly used measure in studies on HAD.[24] However, concurrent validation of this measure with actual function is lacking. We did not assess discharge disability, which has been reported in other studies, but only 30-day post-hospitalization, thus limiting our ability to explore the role of immediate post-discharge interventions. However, 30-day disability is a clinically relevant outcome and correlates with further disability and outcomes.[8] We did not measure cognitive impairment or depression pre-admission, but this is common, as cognitive impairment is poorly detected and documented. Finally, we could have missed some deaths if they occurred out of state.

CONCLUSIONS

In summary, our findings that HAD is as common among adults of late middle age as it is in adults aged 70–79 years suggests that this population has higher susceptibility to HAD than previously appreciated. For safety-net hospitals and care systems, middle-aged adults as young as 55 may be an additional important target for interventions to prevent functional decline during hospitalization. Further research is needed in middle-aged adults on factors associated with HAD and the impact of interventions, such as ACE units, to reduce functional decline during and after hospitalization.

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