

Disability and Decline in Physical Function Associated with Hospital Use at End of Life

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BACKGROUND: Hospital use near the end of life is often undesirable to patients, represents considerable Medicare cost, and varies widely across regions.

OBJECTIVE: To concurrently examine regional and patient factors, including disability and functional decline, associated with end-of-life hospital use.

DESIGN/PARTICIPANTS: We sampled decedents aged 65 and older (n=2,493) from the Health and Retirement Study (2000–2006), and linked data from individual Medicare claims and the Dartmouth Atlas of Health Care. Two-part regression models estimated the relationship between total hospital days in the last 6 months and patient characteristics including physical function, while adjusting for regional resources and hospital care intensity (HCI).

KEY RESULTS: Median hospital days was 7 (range=0-183). 53% of respondents had functional decline. Compared with decedents without functional decline, those with severe disability or decline had more regression-adjusted hospital days (range 3.47-9.05, depending on category). Dementia was associated with fewer days (-3.02); while chronic kidney disease (2.37), diabetes (2.40), stroke or transient ischemic attack (2.11), and congestive heart failure (1.74) were associated with more days. African Americans and Hispanics had more days (5.91 and 4.61, respectively). Those with family nearby had 1.62 fewer days and hospice enrollees had 1.88 fewer days. Additional hospital days were associated with urban residence (1.74) and residence in a region with more specialists (1.97) and higher HCI (2.27).

CONCLUSIONS: Functional decline is significantly associated with end-of-life hospital use among older adults. To improve care and reduce costs, health care programs and policies should address specific needs of patients with functional decline and disability.

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INTRODUCTION

Hospital care represents the largest portion of Medicare spending¹ and varies by region, particularly near the end of life.^{2–5} Past research examining geographic variation in hospital use has relied on administrative data and has thus been unable to measure and adjust for key patient-level variables, such as physical function.² Decline in function and increasing dependence on assistance with activities of daily living have been strongly associated with hospital admission^{6–8} and mortality in older adults.^{9–12} The relationship between functional decline and hospital admission raises the possibility that function may contribute to geographic variation in hospital use, either through regional variation in functional debility or regional variation in available treatment resources or practice patterns related to functional decline and disability.

Studies of patients with serious illness suggest that hospitalization near end of life is often undesirable and can be associated with poorer outcomes, including uncontrolled pain and prolonged grief in caregivers. 13-17 Patients with functional impairment, specifically, have indicated home is the preferred site of treatment for acute illness. 18 Further exploring the relationship between functional characteristics and hospital use may, therefore, also have implications for health care policies and programs designed to improve care and reduce costs. For example, new healthcare delivery models aim to reduce unnecessary or unwanted hospitalizations by identifying individuals at high risk for hospitalization and implementing services to care for such individuals in the community. Greater understanding of all potential factors associated with hospital use among older adults near the end of life, i.e. those with the highest hospital-based costs, is needed to appropriately target these novel programs. This study examined the relationship between hospital use in the last 6 months of life and patient characteristics, including physical function, while controlling for other regional resources and regional variation in hospital utilization.

METHODS

Data Sources

Health and Retirement Study. We sampled decedents from the Health and Retirement Study (HRS), a longitudinal and nationally-representative cohort of adults over age 50. 19 Over 30,000 individuals have been enrolled since 1992. A complete description of HRS, is available at http://hrsonline. isr.umich.edu. Serial Core interviews are conducted every 2 years. Each interview cycle, HRS identifies participants who died since the last Core Interview and obtains dates of death from the National Death Index. Exit interviews are conducted with proxies knowledgeable about the deceased participant (response rate=88%). Together Core and Exit Interviews include the participant's demographic, economic, social and functional characteristics. Core interviews are completed a mean of 15.7 months (SD 12.6) before death and Exit interviews are completed a mean of 12.4 months (SD 3.9) post-death.

Medicare Data. Over 80% of HRS participants provided authorization to merge their HRS data with Medicare claims.

Regional Data. Using zip code, we linked each subject to a hospital referral region (HRR) as defined by The Dartmouth Atlas of Healthcare.² The Dartmouth Atlas database provides several measures of healthcare supply at the HRR level, including number of hospital beds, physicians, primary care physicians and specialist physicians. The Atlas has also calculated for each HRR a Hospital Care Intensity-Index (HCI), a standardized ratio that reflects each HRR's intensity of hospital use and physician services among Medicare beneficiaries in the region, compared to the national average.

Sample

We included HRS decedents aged 65 years or older, who died between July 1, 2000 and December 31, 2006, and had Medicare coverage at least 6 months prior to death (81% of these HRS subjects had authorized link to Medicare claims). This 6-year span included decedents from the 2002, 2004 and 2006 Exit interview waves (average response rate 88%). These data were merged with each

individual's final preceding Core interview in 2000, 2002, and 2004 (average response rate 88%), respectively, providing data from two interviews (one Core and the Exit) for each subject. To ensure complete claims data, we excluded those enrolled in Medicare managed care at any point during the last 6 months (n=445) or not continuously enrolled in Medicare Parts A and B (n=48). Those excluded were not significantly different from the final study sample (n=2394) in terms of age, sex, race, education or net worth.

Outcome Variable

The primary outcome was total hospital days in the last 6 months of life. Depending upon the individual's number of hospital admissions during that period, this measure may reflect the length of stay for a single hospital admission or the sum of days across multiple admissions.

Independent Variables

We chose independent variables based on our conceptual model: Determinants of Treatment Intensity for Patients with Serious Illness. This conceptual model postulates that treatment intensity is influenced by both *regional* and *patient/family* determinants. Regional determinants include supply of medical resources, local or institutional patterns of care, and physician practice patterns. Patient/family determinants include medical need, financial access to care, personal treatment preferences, and communication of preferences, all of which are in turn influenced by specific quantifiable patient characteristics (demographic, socioeconomic, medical, functional, and psychosocial characteristics).

We selected patient-level and regional variables that could serve as empirical measures of each construct in the conceptual model. Patient-level variables collected from the Core interview and proxy-reported variables from the Exit interview are in Table 1. Functional status, based upon the subject's need for assistance with six basic activities of daily living (ADL),²¹ was determined at the time of the Core interview and again after the subject's death by proxy report of the subject's functional status during the 3 months preceding death. Using both time points, we constructed six categorical measures of function over time: three for functional stability (independent, moderate debility, severe debility) and three for functional decline (independent to moderate debility, moderate to severe debility, independent to severe debility). Fifty-seven (2.4%) individuals experienced an improvement in function. Forty subjects transitioned from 1-3 ADL deficiencies (moderate debility) to no deficiencies and were combined with those who were independent at both time points; and 17 subjects transitioned from 4–6 ADL deficiencies (severe debility) to 1–3 ADL deficiencies and were combined with those with

Table 1. Participant Characteristics (n=2394) and Regional Characteristics

Characteristic	
Age*, mean (SD), years	83.4 (8.3)
Female*, $n (\%^{\dagger})$	1305 (55)
Race*	1505 (55)
Non-Hispanic White, n (%)	1890 (79)
African American, n (%)	303 (13)
Hispanic, n (%)	121 (5)
Other, n (%)	28 (1)
Education*	` /
Less than 12 years, n (%)	1112 (46)
12 years or more, n (%)	1260 (53)
Marital Status	
Married, n (%)	920 (38)
Never Married, n (%)	86 (4)
Widowed, n (%)	1155 (48)
Separated or Divorced, n (%)	208 (9)
Net Worth in US dollars, median	91,000
Residential Status [‡]	070 (41)
Nursing Home, n (%)	970 (41)
Live Alone, n (%)	958 (40)
Live with Others, n (%) Additional insurance coverage [‡]	444 (19)
Medicaid, n (%)	571 (24)
VA, n (%)	132 (6)
MediGap (private), n (%)	1439 (60)
Functional Status [§]	1437 (00)
Stable, Independent in ADLs, n (%)	512 (21)
Stable, Moderate debility (1–3 ADL	136 (6)
impairments), n (%)	(-)
Stable, Severe debility (4–6 ADL impairments), n (%)	425 (18)
Declined, Independent to Moderate, n (%)	216 (9)
Declined, Moderate to Severe, n (%)	331 (14)
Declined, Independent to Severe, n (%)	712 (30)
Chronic Medical Conditions	
Ischemic Heart Disease, n (%)	1049 (44)
Congestive Heart Failure, n (%)	917 (38)
Atrial Fibrillation, n (%)	558 (23)
Alzheimer's/Dementia, n (%)	620 (26)
Diabetes, n (%)	754 (32)
Chronic Kidney Disease, n (%)	437 (18)
Chronic Obstructive Pulmonary Disease, n (%)	759 (32)
Depression, n (%)	364 (15)
Cancer, n (%)	372 (15)
Arthritis (Osteoarthritis / Rheumatoid Arthritis), n (%)	647 (27)
Stroke or Transient Ischemic Attack, n (%)	458 (19)
4 or more Chronic Medical Conditions, n (%)	953(39.8) 1403 (63)
Self-rated Health*, fair/poor, n (%)	789 (33)
Relative Live Nearby*, n (%) Advance Directive completed [‡] , n (%)	1472 (61)
Discussion of end of life care preferences [‡] , n (%)	1301 (54)
Hospice Admission within 6 months	767 (32)
Urban Residence*	922 (38.5)
Regional Characteristics	()
Hospital Beds per 10,000 residents, mean (SD)	25 (5)
Specialists per 100,000 residents, mean (SD)	124 (23)
Hospital Care Intensity Index, mean (SD)	1.02 (0.29)

^{*}Collected from the last Core interview

||Regional data included for every subject, therefore weighted by the number of subjects in each region

moderate debility at both time points. We conducted the analyses with and without adjustment for number of months between Core interview and death, because this time period varied across subjects. We found no significant difference in the results. Chronic medical conditions were identified by the CMS Chronic Conditions ICD9 criteria, using Medicare

claims from 6 to 18 months preceding death to avoid potential reverse causality with the outcome. Hospice admission in the last 6 months was determined from Medicare Hospice claims. Regional variables drawn from the Dartmouth Atlas included: HCI, number of hospital beds per 10,000 residents, and number of primary care physicians per 100,000 residents and specialist physicians per 100,000 residents. The latter two variables were highly collinear (0.80, p<0.01) and could not be included simultaneously in regression models. Therefore, only number of specialist physicians per 100,000 residents was included. We used multiple imputations (cycles=5) to account for missing data.²² Missing data accounted for 3.5% of data values and were most frequent among race (2%), education (7%), and net worth (14%). For all continuous variables we checked for nonlinear effects by including a squared term and found none.

Statistical Analysis

We evaluated summary statistics and frequency distributions for all variables. We did not use HRS sampling weights because we were not trying to make national-level estimates of utilization. We used a two-part regression model for hospital days because many participants had zero days in the last 6 months and the distribution among those who did have days was skewed. Logistic regression was used to estimate the probability of any hospital days and a zero-truncated negative binomial model (ZTNB) was used to estimate the total number of days conditional on any, i.e., among the subset of patients who had at least one hospitalization. We used Wald tests of joint significance for the functional status measures.

We used the logit estimates to calculate the relative risk of any hospital days associated with each independent variable, i.e., the mean of the predicted probability that the subject would be admitted to the hospital if they had X characteristic divided by the predicted probability if they did not have that characteristic. We then used the ZTNB estimates to predict the conditional differences, i.e., each covariate's effect on the expected number of hospital days, conditional on any days. Finally, we used both sets of estimates to predict the unconditional differences among the entire sample. For continuous independent variables (net worth and the regional variables), we calculated change in expected number of hospital days when the value of the variable changed from the mean value minus one standard deviation (SD) to the mean plus one SD. Bias-corrected empirical 95% confidence intervals (CI) were bootstrapped using 1000 repetitions. 25–27 We used STATA 10 for all statistical analyses.²⁸ See Online appendix for annotated code. The study was approved by the Mount Sinai School

 $^{^\}dagger$ Percentage may not add to 100 due to rounding error

[‡]Proxv-reported variables from the Exit interview

[§]Functional stability or decline over time measured by comparing functional status at last Core interview to proxy report after death of functional status during the 3 months prior to death

of Medicine IRB, the HRS Data Confidentiality Committee, and the CMS Privacy Board.

RESULTS

Table 1 presents patient characteristics. Over time, 21% of subjects remained independent in ADLs; 24% has a stable functional debility; and 53% experienced a functional decline. Median total number of hospital days in the last 6 months of life was 7 days (range=0–183); 25% of subjects had 0 hospital days (Fig. 1). Table 2 summarizes associations of each factor with hospital use in the last 6 months of life. Each variable's association with the overall expected number of hospital days, the unconditional difference, appears in column 2.

Compared to those independent in ADLs, we found higher hospital use among all subjects with functional decline, as well as those with stable severe functional disability. Holding all other factors equal, the increase in hospital days was estimated to be 3.47 for those those with stable severe functional disability, 4.70 among those with a functional decline from indendent to moderate disability, 7.60 for those declining from moderate to severe disability, and 9.05 for those declining from independent to severe disability. The joint significance test found that functional measures contributed significantly to the predictive value of the model, p < 0.001.

Holding other factors constant and compared to those under 75, those aged 85 and older had 2.91 fewer hospital days in the last 6 months of life. Female subjects had 1.74 fewer hospital days than males. Relative to non-Hispanic whites, African-Americans had 5.91 more hospital days,

while Hispanics had 4.61 more days. A person with private Medigap insurance, relative to one with no Medigap insurance, had 1.99 more hospital days at the end of life.

Several medical conditions are associated with additional hospital days in the last 6 months of life, all other factors held equal: chronic kidney disease 2.37 days, diabetes 2.40 days, stroke or transient ischemic attack 2.11 days, and congestive heart failure 1.74 days. In contrast, those with Alzheimer's disease or dementia had 3.02 fewer hospital days.

Similarly, those with a relative living nearby had 1.62 fewer hospital days. Participants who had enrolled in hospice at any point in the last 6 months of life had 1.88 fewer days. Advance directive completion or discussion of end-of-life care preferences was not significantly associated with hospital use.

All else equal, those living in urban areas had 1.74 more hospital days in the last 6 months of life than those in non-urban areas. Living in a region with more hospital beds and specialists (mean+1SD vs. mean-1SD) was associated with 1.38 and 1.97 additional days, respectively. Similarly, living in a region with a higher HCI (mean+1SD vs. mean-1SD) was associated with 2.27 additional days.

Overall hospital use is influenced by both the relative risk of being admitted to the hospital and the total number of hospital days among those admitted (the conditional difference). Estimates from these separate parts of the two-part model are available online (eTables 1 and 2).

DISCUSSION

Functional decline, as well as stable severe disability, has a consistent and powerful association with hospital use in the

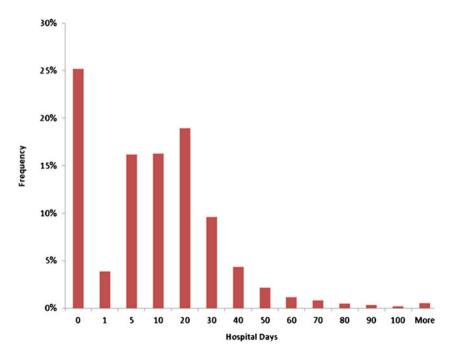


Figure 1. Distribution of total hospital days in last 6 months of life.

Table 2. Adjusted Associations of Patient Characteristics with Number of Hospital Days in Last 6 Months of Life

Patient Characteristics	Hospital Days unconditional on admission, (95% CI)*
Functional Status, reference group Independent Stable, Moderate debility (1–3 ADL	0.36 (-2.21,3.63)
impairments) Stable, Severe debility (4–6 ADL impairments)	3.47 (0.49,7.15)
Declined, Independent to Moderate Declined, Moderate to Severe Declined, Independent to Severe Female	4.70 (2.27,7.60) 7.60 (4.63,11.61) 9.05 (6.72,11.47) -1.74 (-3.21, -0.33)
Age, reference group 65–75 years Age 75–84 years Age 85 years or more Race, reference group non-Hispanic	-0.22 (-1.73,1.46) - 2.91 (-4.50,-1.14)
white African American Hispanic Medicaid MediGap (private)	5.91 (3.36,8.56) 4.61 (1.32,8.94) -1.23 (-2.83,0.55) 1.99 (0.47,3.41)
Medical Conditions Alzheimer's/Dementia Chronic Kidney Disease Congestive Heart Failure Diabetes Arthritis Stroke or TIA Relative Live Nearby	-3.02 (-4.34,-1.57) 2.37 (0.77,4.09) 1.74 (0.29,3.32) 2.40 (0.97,3.86) 2.48 (0.93,3.86) 2.11 (0.36,4.12) -1.62 (-2.90,-0.44)
Advance Directive completed Discussion of end of life care preferences Hospice Admission within 6 months Urban Residence Hospital Beds per 10,000 residents in HRR (mean+1std vs. mean-1std) Specialists per 100,000 residents in HRR	0.14 (-1.33,1.60) -0.78 (-2.21,0.53) -1.88 (-3.17,-0.73) 1.74 (0.25,3.34) 1.38 (-0.08,2.70) 1.97 (0.69,3.23)
(mean+1std vs. mean-1std) Hospital Care Intensity Index (mean+1std vs. mean-1std)	2.27 (0.75,3.71)

^{*}Unconditional Difference reaches statistical significance (p< 0.05) if 95%CI does not include 0; statistically significant results are indicated by bold font

last 6 months of life, even after controlling for medical diagnoses and all other patient or regional factors in this study. This finding has important implications for patient care and health policy. First, to improve quality and decrease excess and unwanted hospital services, new clinical care models must develop and prioritize care coordination and supportive care services for the most vulnerable and at-risk patients. At present, functional characteristics are not collected routinely in electronic medical records and administrative datasets, with the exception of the minimum data set for nursing home residents.²⁹ As such, health care providers and organizations are unable to prospectively identify patients at highest risk for hospital-based care, and therefore miss the opportunity to modify that risk and improve care for this

vulnerable population. By routinely assessing functional status, the health care system could more easily identify patients most likely to benefit from specialized care programs and services and clarify those patients' treatment preferences in order to improve the delivery of goal-driven care.

Second, data from this study and our prior work indicate that for patients who are approaching death, functional decline has a powerful and more consistent association with overall hospital use than medical diagnoses, age, sex, and co-morbidities and suggest that patients with functional decline may generally be more complex patients. 30,31 Measurement of functional status and screening for decline every one to two years, as done in this study, is reproducible in the clinical setting and could be readily integrated into hospital and ambulatory electronic health records. Yet, with the exception of rehabilitation services, functional status measurements are not incorporated in standard risk-adjustment methods in the U.S. nor utilized to determine hospital payments.³² Patients at high risk of death have care needs that, at times, may be best served in the hospital. Further work is needed to determine if including functional characteristics in risk-adjusted payment models would help to recognize the complexity of this care and better match reimbursement to needed hospital services. Improving the accuracy of illness severity assessments and case-mix adjustments is critically important to the success of new healthcare delivery structures, including accountable care organizations, patient-centered medical homes, and bundled payment models.

The negative association between dementia and hospital use, after adjusting for functional impairment and nursing home residence, is notable. Specifically, within all functional categories, those with dementia were less likely to be admitted to the hospital and had fewer hospital days if admitted. We hypothesize that due to the progressive and irreversible nature of dementia, these patients are more likely to have palliative-focused goals of care established earlier in the course of their illness. Indeed, a recent study found the assessment of goals of care for patients with advanced dementia to be one of the most frequently completed end-of-life care quality indicators.³³ Having a nearby relative was also negatively associated with hospital days. This effect was primarily due to the conditional difference among those admitted to the hospital. We hypothesize that having a relative nearby, in some cases a caregiver or advocate, may simplify hospital discharge planning and possibly prevent unwanted or unnecessary hospital admissions.

Similar to other studies of treatment intensity at the end of life, we found a significant association of higher hospital use with African American race and Hispanic ethnicity. 30,31,34,35 Exploring whether this finding is related to patient preferences, limited availability of outpatient or

^{*}Estimates are from the 2-part regression model of hospital days and are also adjusted for the following non-significant variables: Marital status, Education, Net Worth, VA insurance coverage, Nursing Home Residence, Living Alone, Self Rated Health, Ischemic Heart Disease, Atrial Fibrillation, Cancer, Depression and Chronic Obstructive Pulmonary Disease

home-based medical services, disparities in preventative care and provider continuity, or other unknown factors is a critical area for future research—particularly given the magnitude of the effect size. 36–40 We also found that those with Medigap private insurance coverage had more hospital days overall. This finding is consistent with prior research that has demonstrated that patients contributing a lower share of medical costs (e.g., through lower deductibles or Medigap coverage) access health care services more frequently. 23

This study has limitations. First, we are unable to determine from these data whether or not hospital days were consistent with the subjects' personal goals of care. For example, a person with a sudden illness may desire intensive hospital treatment either to return to a previously high level of function, return to a lower but acceptable level of function, or simply to do anything to fend off the inevitable death. Alternatively, a person who desires to avoid hospitalization, yet was never counseled about alternative plans of care, may experience an unwanted hospital admission. The study is retrospective and sampled decedents only, which may introduce selection bias.⁴¹ Function was measured at only two time periods. Therefore, the study does not assess the timing of functional decline in relation to hospitalization, nor would it capture intervening periods of functional recovery. 42 Also, the timespan between the first measurement and death varied across subjects; however, adjusting the regression for this timespan did not change the results. Limited information regarding patient preferences were available in these data and the results may be biased by unmeasured confounders. We recognize the potential endogeneity of the Medigap insurance status and hospice enrollment variables; however, sensitivity analyses with and without the hospice enrollment variable did not change other results. By making multiple comparisons, a statistically significant result may occur by chance. Therefore, we interpreted our results in the context of broader patterns, e.g. across all categories of functional impairment and decline, and in relation to existing evidence in the literature. An insufficient number of participants in each geographic region prohibited our ability to evaluate regional variation.

In conclusion, functional decline and severe functional disability are powerfully associated with hospital use among older adults in the last 6 months of life, adjusting for demographic, socioeconomic, medical and regional characteristics. A simple annual functional assessment may offer the potential opportunity to prospectively identify patients at high risk for hospital use that may be unnecessary or unwanted and to adjust treatment plans to reflect patient preferences and goals. The majority of clinical practice settings could collect this important patient characteristic and include it in administrative or electronic medical record data. By doing so, new health care programs

may begin to identify and address the specific needs of patients with functional decline and disability and, thereby, increase their ability to effectively improve care and reduce costs.

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Conflict of Interest: The authors declare that they do not have a conflict of interest.

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