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Feature Article

The association of patient-reported improvement and rehabilitation characteristics with mortality

Adam Simning, MD, PhD^{a,*}, Thomas V. Caprio, MD^b, Sarah L. Szanton, PhD, ANP^c, Helena Temkin-Greener, PhD^d, Yeates Conwell, MD^{a,e}^a Department of Psychiatry, University of Rochester Medical Center (URMC), 300 Crittenden Blvd, Rochester, NY 14642, USA^b Division of Geriatrics, Department of Medicine, URMC, 435 East Henrietta Road, Rochester, NY 14620, USA^c School of Nursing, Johns Hopkins University, 525 North Wolfe Street #424, Baltimore, MD 21205, USA^d Department of Public Health Sciences, URMC, 265 Crittenden Blvd, Rochester, NY 14642, USA^e Office for Aging Research and Health Services, URMC, 300 Crittenden Blvd, Rochester, NY 14642, USA

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ABSTRACT

This study aims to investigate the association of patient-reported improvement and rehabilitation characteristics with mortality among older adults who received rehabilitation. To do so, a national sample of Medicare beneficiaries from the National Health and Aging Trends Study was examined. Among those who reported receiving rehabilitation services in the 2015 interview ($N = 1,188$), 4.2% were deceased at the 2016 follow-up interview. Mortality was more common among those who had received rehabilitation in nursing home or inpatient and in-home settings compared to outpatient rehabilitation settings. In multivariable analyses accounting for demographics and health status, patient-reported worsening of functioning during rehabilitation (OR=15.69; 95% CI: 1.84–133.45) and cardiovascular disease (OR=4.15; 95% CI: 1.41–12.17) were associated with mortality. Among older adults who received rehabilitation, 1 in 25 were deceased at follow-up. That patient-reported functioning is associated with mortality suggests that more systematically including patient-reported outcomes in rehabilitation care may be clinically pertinent.

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Introduction

Acute illnesses and hospitalizations may be associated with functional loss, worsening disability, and increased mortality.^{1–4} Rehabilitation services perform a critical role in helping older adults regain or maintain function after these events, and can be delivered at a hospital, nursing home, rehabilitation facility, outpatient clinic, or home.^{5–7} Clinicians and researchers are increasingly focused on patient-centered outcomes and treatment goals to enhance patient care.^{8–11} To improve quality of care, innovations such as the Chronic Care Model are being developed and disseminated, which emphasize patients'

central role in managing their own health.^{12–14} Patient-reported outcomes can be used to more fully engage patients in their care as well as to assess the severity of symptoms, track outcomes, monitor wellbeing, and prioritize treatment discussions and treatment decisions.⁸ Although millions of Medicare beneficiaries engage with rehabilitation services yearly, relatively little is known about the association of rehabilitation-specific patient-reported outcomes and other rehabilitation characteristics with mortality in this population.

Epidemiologic studies of mortality among individuals receiving rehabilitation services typically have been limited to those with specific diseases such as stroke,^{15,16} hip fracture,¹⁶ or heart failure.¹⁷ An increased risk for mortality among older adults has been associated with increasing age, male sex, Black race, single marital status, living alone, fewer years of formal education, increased disability, and medical conditions (e.g., stroke, dementia, cancer, depression, lung disease, cardiovascular health).^{15,18–22} To our knowledge, no studies have examined the association of rehabilitation-specific patient-reported improvement and rehabilitation characteristics with mortality in a national sample of older adult Medicare beneficiaries. Examination of this association may provide clinically relevant information regarding Medicare rehabilitation patients' mortality risk and whether rehabilitation-specific information can assist with stratifying this risk.

Declarations of Conflict of Interest: The authors declare that there are no conflicts of interest.

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* Corresponding author.

E-mail address: adam_simning@urmc.rochester.edu (A. Simning).

Although, it may be anticipated that mortality rates will be associated with patient-reported lack of improvement and may differ by rehabilitation characteristics (e.g., higher mortality in inpatient versus outpatient rehabilitation settings), these associations may be moderated by other factors such as older age and medical comorbidity. For example, adults with poor self-rated physical health typically have increased medical comorbidities,²³ and functional status and medical comorbidity can vary across rehabilitation settings.²⁴ If patient-reported improvement status and other rehabilitation characteristics are associated with mortality after accounting for demographics, socioeconomic status, and health status, then this information may help identify rehabilitation subgroups with an increased mortality risk and lend support to focusing more attention on patient-reported outcomes in this population. Furthermore, while functional outcomes during rehabilitation are typically tracked by physical, occupational, and speech therapist assessments, if this study finds that patient-reported change in functional status is associated with meaningful clinical outcomes such as mortality, then more systematically incorporating patient-reported measures in the rehabilitation process should be considered and investigated.

This study aims to answer this research question: Among community-dwelling Medicare beneficiaries aged 65 years and older who received rehabilitation services in the past year, how are 1) patient-reported improvement status, 2) rehabilitation site, and 3) rehabilitation characteristics associated with mortality at the one-year follow-up interview? The study hypothesis is that patient-reported lack of improvement while receiving rehabilitation will be associated with an increased odds for mortality after accounting for demographics, socioeconomic status, and health status (e.g., medical comorbidities, functional impairment). This study also aims to provide mortality estimates across rehabilitation sites among a national sample of older adults who received rehabilitation for a wide variety of conditions.

Methods

Participants and study design

The National Health and Aging Trends Study (NHATS) is a longitudinal cohort study that commenced in 2011 and examines a nationally representative sample of Medicare beneficiaries aged 65 years and older with annual interviews.²⁵ NHATS is administered in English and Spanish, oversamples Black older adults and older age groups, and is publicly available at www.nhats.org. This study relied solely on the publicly available NHATS survey data and did not use other sources of information such as Medicare claims data. When Medicare beneficiaries were unable to participate in the interview (e.g., because of cognitive or physical problems), proxy respondents were used. In the 2015 interview, NHATS added questions on rehabilitation services.²⁵ The 2015 interview had an unweighted response rate of 76.8% and, conditional on participating in the 2015 interview, 90.6% participated in the 2016 NHATS interview.²⁵ NHATS was approved by the Johns Hopkins Bloomberg School of Public Health Institutional Review Board.

There were 6346 NHATS participants who were living in the community at the 2015 interview and had information about mortality status at the 2016 interview. Of these 6346 participants, 1188 (18.8%) reported receiving any rehabilitation services and had information on patient-reported improvement. This study examined the 1188 community-dwelling older adults who reported receiving rehabilitation services in 2015 and had information on patient-reported improvement status in 2015 and mortality in 2016, which represents a weighted sample of 6411,089 older adult Medicare beneficiaries.

Dependent variable

The outcome measure was whether community-dwelling adults aged 65 years and older at the 2015 interview who received rehabilitation services were deceased at the 2016 interview (binary outcome, coded yes/no).

Independent variables

The covariates were in the rehabilitation, demographics, socioeconomic status, and health status domains, many of which are associated with mortality in older adults.^{18,20} All of the covariate data were collected in the 2015 interview, were cross-sectional, and were based on self- or proxy-report ($n = 1105$ and $n = 83$, respectively). With the exception of number of medical conditions, covariates were treated as unordered dummy variables with a reference category.

For the primary independent variable, NHATS participants were asked: "While you were receiving rehab services in the last year, did your functioning and ability to do activities improve, get worse, or stay about the same?"²⁶ This variable recorded whether participants reported that their functioning and ability to do activities got worse, stayed about the same, or improved.²⁶

With regard to rehabilitation site, NHATS participants were asked whether they had received rehabilitation in nursing home or inpatient, outpatient, or home settings. Based on their response, NHATS participants were grouped into: (1) nursing home or inpatient (including hospitals or rehab facilities) rehabilitation only, (2) outpatient rehabilitation only, (3) in-home rehabilitation only, and (4) multiple rehabilitation sites.

The rehabilitation characteristics domain consisted of the reason participants received rehabilitation services in the last year (surgical versus nonsurgical), the main condition for which participants received surgery or rehabilitation services, and the number of months participants received rehabilitation services.²⁶

The demographic domain consisted of respondent age (65–74, 75–84, 85+ years old), a binary indicator for sex (female or male), race and ethnicity (white non-Hispanic, black non-Hispanic, Hispanic or other), and living arrangement (alone, with spouse/partner and maybe others, with others only). The socioeconomic status domain included education (high school or less, some college or vocational training, college degree) and Medicaid status (yes, no).

The health status domain examined hospitalization and self-reported measures of physical and mental health. Self-report determined the presence of hospitalization (yes, no) in the prior 12 months to the 2015 interview. Medical conditions were coded as being present if older adults reported that – at the 2015 or an earlier interview – a doctor had ever told them they have one of these conditions.²⁶ The number of medical conditions included heart attack, heart disease, high blood pressure, arthritis, osteoporosis, diabetes, lung disease, stroke, or cancer with totals ranging from 0 to 9. Dementia was examined separately. ADL impairments²⁷ were present if participants either had difficulty with performing or "can't do/don't do" the following activities without assistance: eating, transferring out of bed, transferring out of chairs, walking inside, going outside, dressing, bathing, or toileting. IADL impairments²⁸ were present if the participants were unable to perform the following activities: prepare meals, do laundry, do light housework, shop for groceries, manage money, take medicine, or make phone calls. ADL and IADL were dichotomized into the presence or absence of any ADL or any IADL impairment, respectively. The Patient Health Questionnaire (PHQ-2), a validated two-item depression screening instrument,²⁹ examined depressive symptoms, and the Generalized Anxiety Disorder (GAD-2) scale, a validated two-item anxiety screening instrument,³⁰ examined anxiety symptoms. NHATS

modified the PHQ-2 and GAD-2 to examine the prior one month period (rather than a two week period) and scored both from 2 to 8,²⁵ with scores of 5 or higher indicating the presence of clinically significant depressive or anxiety symptoms.

Statistical analyses

Bivariate and multivariable analyses characterized the associations of patient-reported improvement, rehabilitation site, rehabilitation characteristics, demographics, socioeconomic status, and health status variables with mortality status among community-dwelling Medicare beneficiaries who received rehabilitation services in the prior year. The Rao-Scott F adjusted chi-square statistic for categorical variables and F statistic for continuous covariates examined differences by whether participants were alive or deceased at the one-year follow-up interview. A series of logistic regression analyses were then conducted to test the hypothesis with mortality status at the one-year follow-up interview serving as the outcome (deceased=1, living=0). The base logistic regression analysis model included patient-reported improvement status, rehabilitation site, rehabilitation characteristics, demographics (and proxy interview status), and health status characteristics were sequentially added to the base model to determine the independent effect of patient-reported lack of improvement with mortality. All of the covariates in the logistic regression model were collected at the 2015 NHATS interview and were time-invariant. Due to the relatively small sample size, only rehabilitation, socioeconomic status, and health status characteristics that were associated with mortality status at a p-value of 0.10 or less were included in the multivariable analyses. SAS survey procedures were utilized to calculate population-weighted adjusted estimates (version 9.4, SAS Institute, Inc., Cary, NC). To adjust for complex sampling design and nonresponse, Round 5 analytic weights as well as the stratification and cluster variables were applied.²⁵ As most NHATS participants in the sample had complete covariate data, no imputation methods were used. Instead list-wise deletion was applied to manage participants with missing covariate data in the multivariable analyses. To account for participants with missing data in the variance computation, the “nomcar” option available in SAS’s survey procedures was used, which treated these participants as being “not missing completely at random” and computed variance estimates by analyzing the non-missing values as a domain or sub-population. All percentages refer to weighted values.

Results

Sample characteristics

Among the 6346 Medicare beneficiaries in the NHATS 2015 interview who were living in the community and had information about mortality status at the 2016 interview, 18.8% ($N = 1188$) reported utilizing rehabilitation services in the prior year and had information on patient-reported improvement. Of these, 31.7% ($N = 379$), 69.5% ($N = 750$), and 34.0% ($N = 476$) received rehabilitation services in a nursing home or inpatient facility, outpatient, and/or home setting respectively, 25.7% ($N = 302$) of whom received care in two of these settings and 5.9% ($N = 71$) reported receiving care in all three settings.

Among these Medicare beneficiaries, 1.4% ($N = 19$) reported worsening in functioning and 25.6% ($N = 343$) reported that functioning stayed the same while receiving rehabilitation services, and 4.2% ($N = 72$) were deceased by the time of the one-year follow-up interview. Examination of the different rehabilitation settings for community-dwelling older adults showed that the mortality rate varied by rehabilitation setting: (1) of the 85 older adults who only received nursing home or inpatient rehabilitation, 12.0% were deceased at follow-up; (2) of the 517 older adults who received rehabilitation only

in outpatient settings, 1.3% were deceased at follow-up; (3) of the 186 older adults who received only in-home rehabilitation services, 8.9% were deceased at follow-up; and (4) of the 373 who received rehabilitation in multiple settings, 5.4% were deceased at follow-up (Rao-Scott F adjusted chi-square statistic=11.06, degrees of freedom=3, 168, $p < 0.001$).

There were differences in patient-reported improvement and rehabilitation factors as well as demographic and health status characteristics by mortality status that are shown in Table 1. Additionally, compared to outpatient settings, participants who received rehabilitation in inpatient or nursing home facilities or in their homes had higher mortality, less reported improvement, less formal education, and more medical conditions; were less likely to receive rehabilitation for a musculoskeletal condition or to live with a spouse or partner; and were more likely to have Medicaid, have been hospitalized in the past year, have ADL and IADL impairments, and have anxiety symptoms (Table 2).

Of the 83 NHATS participants in the sample with a proxy informant, 48 participants were not interviewed due to dementia and 47 participants were not interviewed due to medical illness (these categories are not mutually exclusive). The most common informants were daughters ($N = 29$) and spouses/partners ($N = 28$).

Multivariable analyses

A series of logistic regression analyses examined the association of patient-reported lack of improvement with mortality status (Model 1) and sequentially added rehabilitation site (Model 2), rehabilitation characteristics (Model 3), demographic covariates (Model 4), and health status characteristics (Model 5). In Model 1, compared to patient-reported improvement in functioning, patient-reported worsening of function (odds ratio, OR=7.19, 95% confidence interval, CI: 1.42–36.45) or that functioning stayed the same (OR=2.41, 95% CI: 1.25–4.66) were associated with an increased odds for mortality. This association persisted across Models 2 through 5, except that functioning that stayed the same was no longer associated with mortality in Model 5. Although rehabilitation site was associated with increased odds for mortality in Model 2, this association became attenuated as rehabilitation characteristics, demographics, and health status covariates were sequentially added to the regression analyses. In Model 5, rehabilitation site was not associated with mortality. In Model 5, in addition to patient-reported worsening of function (OR=15.69, 95% CI: 1.84–133.45), the following characteristics were associated with an increased odds for being deceased at follow-up: when the main reason for rehabilitation was a cardiovascular condition (OR=4.15; 95% CI: 1.41–12.17) or other reason (OR=3.40, 95% CI: 1.16–10.00), male sex (OR=2.79, 95% CI: 1.08–7.23), living alone (OR=2.68; 95% CI: 1.07–6.70), and ADL impairment (OR=2.81; 95% CI: 1.51–5.22) (Table 3).

A sensitivity analysis consisting of the fully adjusted logistic regression model that excluded participants in the sample who had proxy respondents was conducted (Table 4). Similar to the logistic regression model including proxy informants, patient-reported worsening of function (OR=31.93, 95% CI: 3.48–293.12), when the main reason for rehabilitation was a cardiovascular condition (OR=3.97, 95% CI: 1.11–14.25) or other reason (OR=4.31, 95% CI: 1.20–15.50), male sex (OR=4.85, 95% CI: 1.66–14.20), living alone (OR=3.54, 95% CI: 1.32–9.52), and ADL impairment (OR=2.68, 95% CI: 1.43–5.05) were associated with mortality. There were some differences between these regression analyses, however, with patient-reported function staying the same (OR=2.29, 95% CI: 1.001–5.24), 85+ years old (OR=2.30, 95% CI: 1.06–5.01), and number of medical conditions (OR=1.33, 95% CI: 1.03–1.72) also being associated with mortality in the sensitivity analysis.

Table 1

Rehabilitation characteristics, demographics, socioeconomic status, and health status among community-dwelling Medicare beneficiaries aged 65 years and older who received rehabilitation services in the past year, stratified by mortality status at one-year follow-up (N = 1188).

	Deceased N = 72			Living N = 1116			P value ^a
	N	% or mean	SE	N	% or mean	SE	
<i>Patient-reported improvement</i>							0.003
Improved	37	51.8	7.9	789	73.9	1.8	
Got worse	4	6.2	4.3	15	1.2	0.4	
Stayed the same	31	42.0	7.2	312	24.9	1.6	
<i>Rehabilitation site</i>							<0.001
Inpatient rehab services in past year	11	20.1	5.4	74	6.6	0.8	
Outpatient rehab services in past year	11	15.3	5.6	506	50.8	1.7	
Home rehab services in past year	20	23.6	5.3	166	10.8	0.9	
Multiple rehab sites in past year	30	41.0	6.6	343	31.8	1.6	
<i>Rehabilitation characteristics</i>							0.854
<i>Reason for rehabilitation</i>							
Surgical	23	36.9	6.1	380	35.7	1.6	
Non-surgical	48	63.1	6.1	734	64.3	1.6	
<i>Main condition for rehabilitation</i>							<0.001
Fracture, sprain, or other injury or hip, knee, or other joint replacement	15	18.0	5.0	361	34.9	1.6	
Other musculoskeletal condition	10	13.3	5.1	384	36.0	1.8	
Stroke or transient ischemic attack	8	11.5	5.4	48	3.1	0.6	
Heart attack, heart condition, or vascular disease	13	18.0	4.5	82	5.8	0.7	
Other	24	39.2	7.3	235	20.2	1.2	
<i>Total months of rehab services in past year</i>							0.073
Less than 1 month	21	34.7	5.6	252	23.9	1.4	
1–3 months	36	44.7	6.4	677	60.3	1.6	
4+ months	13	20.6	6.3	182	15.8	1.5	
<i>Interview type</i>							<0.001
<i>Proxy interview</i>							
Yes	16	17.0	4.8	67	4.5	0.8	
No	56	83.0	4.8	1049	95.5	0.8	
<i>Demographics</i>							0.010
<i>Age in years</i>							
65–74	13	37.1	7.4	407	55.4	1.3	
75–84	31	37.5	7.6	455	32.2	1.1	
85+	28	25.4	5.0	254	12.4	0.8	
<i>Sex</i>							0.340
Female	36	52.7	7.5	704	60.2	1.8	
Male	36	47.3	7.5	412	39.8	1.8	
<i>Race and ethnicity</i>							0.792
White, non-Hispanic	50	81.8	5.9	822	84.9	1.1	
Black, non-Hispanic	17	8.5	2.0	187	6.5	0.7	
Hispanic or Other	5	9.7	5.2	80	8.6	1.0	
<i>Living arrangement</i>							0.013
Alone	22	36.6	6.9	355	30.0	1.6	
With spouse/partner and maybe others	27	37.0	7.2	560	56.0	1.6	
With others only	23	26.4	6.1	201	14.0	1.2	
<i>Socioeconomic status</i>							0.171
<i>Education</i>							
High school degree or equivalent or less	37	51.8	7.6	473	38.7	1.9	
Some college or vocational training	14	20.8	6.4	226	20.5	1.3	
College degree	20	27.3	6.5	391	40.8	2.0	
<i>Medicaid</i>							0.106
Yes	10	21.2	7.1	149	12.0	1.2	
No	57	78.8	7.1	916	88.0	1.2	
<i>Health status</i>							<0.001
<i>Hospitalization in prior year</i>							
Yes	52	76.5	5.5	533	45.1	1.6	
No	20	23.5	5.5	583	54.9	1.6	
<i>Total number of self-reported conditions (0 to 9)</i>	70	4.1	0.3	1097	2.9	0.1	0.001
<i>Dementia or Alzheimer's</i>							0.002
Yes	15	12.7	3.6	74	4.4	0.6	
No	57	87.3	3.6	1040	95.6	0.6	
<i>Activities of daily living</i>							<0.001
Impairments present	47	66.6	6.6	302	22.2	1.4	
Impairments absent	24	33.4	6.6	773	77.8	1.4	
<i>Instrumental activities of daily living</i>							<0.001
Impairments present	53	75.0	7.2	355	25.8	1.6	
Impairments absent	17	25.0	7.2	715	74.2	1.6	
<i>Depression</i>							0.072
Present	18	24.4	6.1	179	14.8	1.3	
Absent	51	75.6	6.1	932	85.2	1.3	
<i>Anxiety</i>							0.777
Present	9	11.4	4.4	148	12.7	1.1	
Absent	60	88.6	4.4	956	87.3	1.1	

SE, standard error.

^a P values determined by Rao–Scott F adjusted chi-square statistic for categorical variables or F test statistic for continuous variables.

Table 2
Rehabilitation characteristics, demographics, socioeconomic status, and health status among community-dwelling Medicare beneficiaries aged 65 years and older who received rehabilitation services in the past year, stratified by rehabilitation site ($N = 1161$).

	Inpatient or Nursing Home Rehab, $N = 85$			Outpatient Rehab, $N = 517$			Home Rehab, $N = 186$			Multiple Rehab Sites, $N = 373$			P value ^a
	N	% or mean	SE	N	% or mean	SE	N	% or mean	SE	N	% or mean	SE	
Mortality status in 2016													<0.001
Alive	74	88.0	3.3	506	98.7	0.5	166	91.1	2.4	343	94.6	1.2	
Deceased	11	12.0	3.3	11	1.3	0.5	20	8.9	2.4	30	5.4	1.2	
Patient-reported improvement													<0.001
Improved	50	62.6	6.6	372	75.3	2.2	104	59.0	5.5	287	78.0	2.7	
Got worse	1	0.3	0.3	8	1.3	0.5	2	0.7	0.5	7	2.1	1.0	
Stayed the same	34	37.2	6.5	137	23.4	2.0	80	40.3	5.3	79	19.9	2.5	
Rehabilitation characteristics													<0.001
Reason for rehabilitation													
Surgical	37	44.0	6.3	107	20.7	2.4	32	20.6	4.0	220	62.7	3.3	
Non-surgical	48	56.0	6.3	409	79.3	2.4	152	79.4	4.0	153	37.3	3.3	
Main condition for rehabilitation													<0.001
Fracture, sprain, or other injury or hip, knee, or other joint replacement	16	16.8	4.4	143	30.2	2.6	37	20.7	3.3	179	51.2	2.9	
Other musculoskeletal condition	15	16.3	4.6	263	52.0	2.9	48	22.3	3.2	54	15.7	2.1	
Stroke or transient ischemic attack	5	8.4	4.1	7	0.9	0.4	14	6.0	2.2	29	5.6	1.3	
Heart attack, heart condition, or vascular disease	16	20.3	4.3	19	2.5	0.8	18	7.0	1.7	38	8.0	1.5	
Other	30	38.3	6.2	83	14.3	1.6	69	44.0	3.9	70	19.6	2.2	
Total months of rehab services in past year													<0.001
Less than 1 month	41	53.1	6.3	108	22.2	2.0	41	24.4	3.6	73	20.4	2.2	
1–3 months	34	37.8	6.1	333	63.0	2.6	114	63.1	3.7	218	58.9	2.4	
4+ months	9	9.1	3.5	75	14.8	2.2	29	12.5	2.5	79	20.7	2.2	
Interview type													<0.001
Proxy interview													
Yes	5	3.1	1.9	6	0.9	0.4	39	19.0	3.3	33	7.2	1.7	
No	80	96.9	1.9	511	99.1	0.4	147	81.0	3.3	340	92.8	1.7	
Demographics													<0.001
Age in years													
65–74	34	61.0	6.0	204	58.7	2.3	37	32.5	5.2	136	55.6	2.8	
75–84	33	28.8	5.3	226	33.0	1.9	65	34.5	4.0	150	30.9	2.3	
85+	18	10.2	2.8	87	8.3	1.0	84	33.0	3.6	87	13.5	1.8	
Sex													0.072
Female	55	62.7	5.7	319	61.6	2.5	129	66.6	3.8	219	54.8	2.6	
Male	30	37.3	5.7	198	38.4	2.5	57	33.4	3.8	154	45.2	2.6	
Race and ethnicity													0.002
White, non-Hispanic	61	86.3	3.8	419	89.0	1.7	118	74.6	4.1	258	82.0	2.1	
Black, non-Hispanic	16	6.8	1.8	65	4.6	0.8	49	12.5	2.7	65	7.0	1.0	
Hispanic or Other	6	6.9	3.0	25	6.4	1.6	16	13.0	2.8	36	11.0	2.0	
Living arrangement													<0.001
Alone	34	38.6	6.5	156	28.4	2.3	59	33.2	4.3	120	29.8	2.6	
With spouse/partner and maybe others	31	35.2	6.3	291	60.4	2.2	64	40.4	5.3	187	56.7	2.5	
With others only	20	26.2	6.7	70	11.1	1.5	63	26.4	3.7	66	13.5	2.0	
Socioeconomic status													<0.001
Education													
High school degree or equivalent or less	52	54.7	7.0	180	33.7	2.7	118	67.3	4.0	149	34.6	2.9	
Some college or vocational training	16	17.6	4.7	110	20.1	1.9	37	19.1	3.4	75	23.5	2.8	
College degree	16	27.7	7.0	218	46.2	2.6	29	13.6	2.5	134	41.9	2.9	
Medicaid													<0.001
Yes	15	23.1	6.7	37	7.0	1.3	49	25.9	3.9	55	14.2	2.4	
No	64	76.9	6.7	462	93.0	1.3	130	74.1	3.9	293	85.8	2.4	
Health status													<0.001
Hospitalization in prior year													
Yes	74	86.5	5.0	102	17.7	1.5	103	59.7	5.1	302	79.0	2.6	
No	11	13.5	5.0	415	82.3	1.5	83	40.3	5.1	71	21.0	2.6	
Total number of self-reported conditions (0 to 9)	81	3.53	0.26	512	2.65	0.07	183	3.49	0.16	364	3.17	0.11	<0.001
Dementia or Alzheimer's													<0.001
Yes	3	1.0	0.7	18	2.2	0.6	37	15.4	3.1	30	5.9	1.2	
No	82	99.0	0.7	498	97.8	0.6	148	84.6	3.1	343	94.1	1.2	
Activities of daily living													<0.001
Impairments present	30	34.4	6.7	73	11.7	1.6	109	56.7	4.0	133	30.8	3.0	
Impairments absent	53	65.6	6.7	432	88.3	1.6	71	43.3	4.0	218	69.2	3.0	
Instrumental activities of daily living													<0.001
Impairments present	36	36.1	6.6	76	11.8	1.6	131	67.9	3.8	158	37.8	3.2	
Impairments absent	45	63.9	6.6	428	88.2	1.6	50	32.1	3.8	190	62.2	3.2	
Depression													<0.001
Present	13	12.9	4.1	53	11.0	1.6	52	25.8	3.9	75	18.7	2.3	
Absent	72	87.1	4.1	462	89.0	1.6	134	74.2	3.9	293	81.3	2.3	
Anxiety													<0.001
Present	16	17.9	4.5	45	8.5	1.4	33	19.9	3.4	62	15.9	1.9	
Absent	68	82.1	4.5	468	91.5	1.4	152	80.1	3.4	302	84.1	1.9	

SE, standard error.

^a P values determined by Rao-Scott F adjusted chi-square statistic for categorical variables or F test statistic for continuous variables.

Table 3

Multivariable logistic regression analyses of rehabilitation characteristics, demographics, and health status of community-dwelling Medicare beneficiaries aged 65 years and older who received rehabilitation in the past year with mortality status (1=deceased; 0=living) serving as the outcome.

	Model 1, N = 1188		Model 2, N = 1161		Model 3, N = 1146		Model 4, N = 1119		Model 5, N = 1071	
	OR	95% CI ^a								
<i>Patient-reported improvement (ref = improved)</i>										
Got worse	7.19	1.42–36.45	8.45	1.63–43.77	15.16	2.48–92.64	17.81	2.34–135.30	15.69	1.84–133.45
Stayed about the same	2.41	1.25–4.66	2.13	1.12–4.03	2.30	1.22–4.36	2.37	1.19–4.69	2.02	0.94–4.34
<i>Rehabilitation site (ref = outpatient rehab services)</i>										
Inpatient rehab services in past year			9.75	3.26–29.16	4.78	1.39–16.40	4.85	1.32–17.84	2.88	0.71–11.76
Home rehab services in past year			6.70	2.43–18.43	4.21	1.37–12.92	3.00	0.93–9.66	1.48	0.54–4.00
Multiple rehab sites in past year			4.32	1.69–11.07	2.94	0.99–8.72	2.65	0.82–8.64	1.47	0.51–4.27
<i>Rehabilitation characteristics</i>										
Main condition for rehabilitation (ref = fracture, sprain, or other injury or hip, knee, or other joint replacement)										
Other musculoskeletal condition					1.06	0.30–3.82	1.04	0.26–4.17	0.91	0.24–3.39
Stroke or transient ischemic attack					5.53	1.50–20.42	6.05	1.62–22.66	3.41	0.76–15.24
Heart attack, heart condition, or vascular disease					6.02	2.39–15.13	5.12	1.84–14.28	4.15	1.41–12.17
Other					3.92	1.47–10.47	3.82	1.33–10.98	3.40	1.16–10.00
Total months of rehab services in past year (ref = 4+ months)										
Less than 1 month					0.67	0.29–1.56	0.59	0.24–1.46	0.72	0.25–2.08
1–3 months					0.53	0.22–1.26	0.51	0.22–1.19	0.70	0.27–1.84
<i>Interview Type</i>										
Proxy interview, Yes							2.26	0.76–6.70	1.14	0.25–5.22
<i>Demographics</i>										
Age in years (ref = 65–74)										
75–84							1.39	0.59–3.26	1.37	0.50–3.71
85+							1.70	0.80–3.59	1.81	0.75–4.35
Sex, male							1.99	0.88–4.47	2.79	1.08–7.23
Race and ethnicity (ref = white, non-Hispanic)										
Black, non-Hispanic							0.82	0.43–1.58	0.81	0.44–1.50
Hispanic or Other							0.72	0.23–2.22	0.71	0.22–2.29
Living arrangement (ref = with spouse/partner and maybe others)										
Alone							2.49	1.16–5.34	2.68	1.07–6.70
With others only							2.52	0.97–6.59	2.02	0.73–5.61
<i>Health status</i>										
Hospitalization in the prior year, yes									1.16	0.57–2.35
Total number of self-reported conditions (0 to 9)									1.16	0.92–1.46
Dementia, present									0.67	0.18–2.52
Activities of daily living, impairments present									2.81	1.51–5.22
Instrumental activities of daily living, impairments present									1.93	0.86–4.34
Depression, present									0.92	0.37–2.25

Multivariable logistic regression models included: Model 1: Self-reported improvement in functioning status; Model 2: Model 1 + rehabilitation site; Model 3: Model 2 + rehabilitation characteristics; Model 4: Model 3 + proxy interview status and all demographic variables; and Model 5: Model 4 + health status variables.

Only rehabilitation, socioeconomic status, and health status variables that were associated with mortality in the bivariate analyses at a p value of 0.10 or less were included in these models.

^a Intervals based on 95% Wald confidence limits.

Additionally, multivariable logistic regression analyses of the association of demographic characteristic and health status covariates with mortality stratified by whether NHATS participants received rehabilitation services in the prior year was conducted (Table 5). Living alone and impairments in ADLs were associated with mortality among those who received rehabilitation services (OR=2.48, 95% CI: 1.06–5.83 and OR=2.61, 95% CI: 1.33–5.12, respectively), but not with mortality in those who did not receive rehabilitation services (OR=1.04, 95% CI: 0.66–1.64 and OR=1.63, 95% CI: 0.94–2.84, respectively).

Discussion

Of the approximately 6.4 million Medicare beneficiaries (weighted sample size) who received rehabilitation services, 27.0% reported no improvement in functioning while receiving rehabilitation and 4.2% were deceased at the one-year follow-up interview (compared to 2.9% of those who did not receive rehabilitation services). In partial support of the hypothesis, those who reported worsening in function had increased odds for mortality at the one-year follow-up interview. With the exception of sensitivity analyses that excluded proxy informants, those who reported that functioning

stayed the same, however, did not have an increased odds for mortality. Mortality was 4–9 fold higher in older adults who had received rehabilitation services in nursing home or inpatient, in-home, or multiple rehabilitation settings when compared to older adults who had received only outpatient rehabilitation services. Rehabilitation site's association with mortality, however, did not persist in multivariable analyses. These differences in mortality were likely driven in part by the differences in patient populations these settings serve with the analyses indicating that older adults receiving rehabilitation services in the outpatient setting had less medical comorbidity and functional impairment compared to those receiving services in nursing home or inpatient or in-home settings.

Although patient-reported outcomes are being increasingly utilized to engage patients in their care, track outcomes, prioritize treatment objectives, and enhance their care,^{8–11} relatively little is known about patient-reported outcomes specific to rehabilitation efforts.^{5,31} The study's finding that patient-reported worsening in functioning while receiving rehabilitation services was associated with mortality – even after accounting for demographics and health status – provides evidence of the potential role that patient-reported outcomes may have in rehabilitation care. Patient-reported health status is important in representing the patient's perspective, and worse self-reported

Table 4

Multivariable logistic regression analyses of rehabilitation characteristics, demographics, and health status of community-dwelling Medicare beneficiaries aged 65 years and older who received rehabilitation in the past year with mortality status (1=deceased; 0=living) serving as the outcome with proxy informants excluded.

	Rehab participants N = 1000	
	OR	95% CI ^a
<i>Patient-reported improvement (ref = improved)</i>		
Got worse	31.93	3.48–293.12
Stayed about the same	2.29	1.001–5.24
<i>Rehabilitation site (ref = outpatient rehab services)</i>		
Inpatient rehab services in past year	3.39	0.76–15.19
Home rehab services in past year	1.21	0.37–3.94
Multiple rehab sites in past year	1.80	0.61–5.33
<i>Rehabilitation characteristics</i>		
Main condition for rehabilitation (ref = fracture, sprain, or other injury or hip, knee, or other joint replacement)		
Other musculoskeletal condition	0.84	0.19–3.72
Stroke or transient ischemic attack	2.99	0.44–20.44
Heart attack, heart condition, or vascular disease	3.97	1.11–14.25
Other	4.31	1.20–15.50
Total months of rehab services in past year (ref = 4+ months)		
Less than 1 month	1.77	0.54–5.86
1–3 months	1.64	0.52–5.16
<i>Demographics</i>		
Age in years (ref = 65–74)		
75–84	1.79	0.60–5.32
85+	2.30	1.06–5.01
Sex, male	4.85	1.66–14.20
Race and ethnicity (ref = white, non-Hispanic)		
Black, non-Hispanic	0.63	0.26–1.54
Hispanic or Other	0.89	0.28–2.78
Living arrangement (ref = with spouse/partner and maybe others)		
Alone	3.54	1.32–9.52
With others only	2.58	0.87–7.70
<i>Health status</i>		
Hospitalization in the prior year, yes	0.96	0.46–2.01
Total number of self-reported conditions (0 to 9)	1.33	1.03–1.72
Dementia, present	0.60	0.08–4.47
Activities of daily living, impairments present	2.68	1.43–5.05
Instrumental activities of daily living, impairments present	2.20	0.95–5.12
Depression, present	1.14	0.41–3.18

^a Intervals based on 95% Wald confidence limits.

health previously has been associated with disability,²³ hospitalization,³² and mortality after accounting for sociodemographics, health status, and health behaviors.³³ Patient-reported outcomes can be used to more fully engage patients in their care and treatment planning.⁸ More systematically incorporating rehabilitation patients' assessment of their progress while receiving rehabilitation thereby may help articulate patient treatment goals (and better align them with the goals of the rehabilitation clinicians) and enhance engagement in the rehabilitation process.

Rehabilitation characteristics such as the rehabilitation primary condition, setting, and duration in multivariable analyses were examined. That rehabilitation patients with a musculoskeletal injury or joint replacement appear to have a lower mortality risk (even after accounting for demographics and health status) suggests that rehabilitation outcomes may differ across primary rehabilitation conditions. This finding is consistent with prior research showing that outcomes can vary by condition.^{34–36} Although the mortality rate varied across rehabilitation settings (higher among older adults receiving rehabilitation in only nursing home or inpatient and only in-home settings compared to those who received only outpatient rehabilitation services), there was no association with rehabilitation setting and mortality status in the multivariable analyses. This suggests that the differences in mortality across rehabilitation settings

Table 5

Multivariable logistic regression analysis of demographics and health status of community-dwelling Medicare beneficiaries aged 65 years and older with mortality status (1=deceased; 0=living) serving as the outcome, stratified by whether they received rehabilitation in the past year.

	Rehab Participants N = 1110		Non-Rehab Participants N = 4881	
	OR	95% CI ^a	OR	95% CI ^a
<i>Interview type</i>				
Proxy interview, Yes	1.31	0.33–5.23	1.59	0.94–2.71
<i>Demographics</i>				
Age in years (ref = 65–74)				
75–84	1.47	0.62–3.49	2.44	1.31–4.57
85+	1.51	0.61–3.74	5.65	3.39–9.40
Sex, male	2.34	1.01–5.41	1.81	1.18–2.76
Race and ethnicity (ref = white, non-Hispanic)				
Black, non-Hispanic	0.84	0.47–1.50	1.32	0.89–1.97
Hispanic or Other	0.66	0.15–2.80	0.75	0.35–1.63
Living arrangement (ref = with spouse/partner and maybe others)				
Alone	2.48	1.06–5.83	1.04	0.66–1.64
With others only	1.81	0.64–5.12	0.97	0.60–1.57
<i>Health status</i>				
Hospitalization in the prior year, yes	1.85	0.99–3.49	2.16	1.42–3.28
Total number of self-reported conditions (0–9)	1.20	0.95–1.53	1.14	1.002–1.30
Dementia, present	0.63	0.20–1.96	1.06	0.60–1.86
Activities of daily living, impairments present	2.61	1.33–5.12	1.63	0.94–2.84
Instrumental activities of daily living, impairments present	3.68	1.61–8.38	2.70	1.76–4.15
Depression, present	0.76	0.33–1.75	1.91	1.25–2.92

^a Intervals based on 95% Wald confidence limits.

are at least in part due to differences in demographics and the health status of patients in these different clinical settings. Assessing the association of the duration of rehabilitation services with mortality is complicated and nuanced. For example, patients may have a short duration of rehabilitation if they either progress rapidly in meeting their treatment goals or, conversely, are not showing sufficient improvement in achieving their treatment goals.

Male sex, living alone and ADL impairment also exhibited greater odds in multivariable analyses that rehabilitation patients would be deceased. Male sex and living alone have been associated with an increased risk of mortality in older adults,^{21,37} and social isolation may have a comparable risk for premature mortality as physical activity and obesity.³⁸ Likewise, ADL impairment has been associated with increased mortality.¹⁹ In the sample, however, living alone and ADL impairment were associated with mortality in those who received rehabilitation services in the prior year, but not in the general population of older adults. This suggests that having support in the community and being able to attend to self-care needs may be especially important for older adults going through the rehabilitation process. Consequently, male older adult rehabilitation patients with no reported improvement in functioning, cardiovascular disease as their primary rehabilitation condition, and ADL impairment who live alone may represent an especially at-risk group for mortality.

While the findings suggest that many do not perceive a benefit in functioning while receiving rehabilitation services and are at increased risk for death, rehabilitation services delivered in inpatient, SNF, and in-home settings nonetheless have shown promise in potentially reducing mortality rates. For example, among hospitalized patients with pneumonia - after accounting for age and medical comorbidities—those who received early rehabilitation services had a lower risk for mortality.³⁹ Among SNF residents—after accounting for demographics, medical comorbidity and functional impairment, and

facility-level characteristics—those who received a higher intensity of rehabilitation services had a lower risk of mortality and a shorter length of stay.⁴⁰ Additionally, a randomized control trial of an innovative in-home rehabilitation intervention involving occupational and physical therapy reduced mortality in older adults.⁴¹ In consideration of the findings indicating a differential mortality across conditions and rehabilitation sites and that many rehabilitation patients perceive no improvement in functioning, more work is needed to understand the rehabilitation process such as which patients and conditions are best suited for rehabilitation and how does the type, intensity, and setting of rehabilitation services impact outcomes for different patients. For example, perhaps identification of which patients are most appropriate for and likely to benefit from rehabilitation services could be better determined. Better identification of those most and least likely to benefit from rehabilitation services may help appropriately target resources and enhance treatment planning. An improved understanding of the rehabilitation process thereby would help generate novel and innovative rehabilitation interventions.

Strengths of this study include use of the NHATS dataset, which allowed an examination of a national sample of older adult Medicare beneficiaries and contains contemporary information on rehabilitation services and patient-reported outcomes. Additionally, this study evaluated the association that patient-reported improvement and rehabilitation characteristics have with mortality among community-dwelling older adults who had received any rehabilitation services in the prior year, a topic for which relatively little is known.

The study has several limitations as well. First, NHATS data are obtained by self-report, which has some considerable limitations including possible issues with recall bias that may systematically affect the results. For example, perhaps older adults who were more medically ill at the time of the 2015 interview (and thereby at higher risk for becoming deceased by the 2016 follow-up interview) may have been more likely to report unfavorable rehabilitation outcomes due to their current medical status rather than accurately describing their function as impacted by the rehabilitation process. Older adults, however, have been shown to be able to accurately report their use of rehabilitation services over the past year.⁴² Second, the relatively small sample size impacts the study's ability to identify potential differences in participant characteristics and to examine subgroups of participants (e.g., such as stratifying participants by rehabilitation settings) and thereby results in a heterogeneous group of rehabilitation patients. Third, the study was unable to examine the timing of mortality status with rehabilitation status in more granular detail because NHATS does not contain the dates for when rehabilitation services were received. Fourth, mortality may be underestimated as some rehabilitation patients may have died prior to the 2015 NHATS interview. To address these two limitations, future studies could use administrative data (e.g., Medicare claims data) to obtain more precise estimates of mortality among older adults who receive rehabilitation services. Fifth, it is unclear how the patient-reported variable is associated with clinician assessments of function. Sixth, inpatient and nursing home rehabilitation settings were not examined separately as they were grouped together in the NHATS questionnaire. Seventh, although derived from a nationally representative cohort of older adults Medicare beneficiaries, the sample of older adults who received rehabilitation services should not be considered to be nationally representative of all older adults who receive these services. Eighth, the study's ability to investigate the primary conditions of rehabilitation was limited in that the data did not differentiate elective (e.g., scheduled knee replacement) from non-elective procedures (e.g., hip replacement after traumatic fall), which can have widely divergent mortality outcomes. Finally, some contextual factors (e.g., inpatient rehabilitation facility characteristics, psychosocial factors such as having a caregiver present), type of rehabilitation

provided (e.g., physical, occupation, speech therapy), or the intensity of rehabilitation (e.g., number and duration of sessions) that may affect rehabilitation outcomes were not examined.

Conclusion

In this sample of community-dwelling older adults who reported receiving rehabilitation services, that nearly 3 in 10 reported no improvement in functioning while receiving rehabilitation and 4.2% (representing a weighted sample of 268,175 Medicare beneficiaries) were deceased at the one-year follow-up warrant further consideration. For example, investigation into why so many older adults did not improve during rehabilitation (e.g., was it due to lack of motivation for or engagement in rehabilitation or other factors such as decreased resilience or poorly controlled pain?) could help identify ways to optimize the rehabilitation process. Additionally, would more systematically incorporating patient-reported outcomes during rehabilitation services enhance the rehabilitation process (e.g., patient feedback may inform treatment modifications) or help predict mortality as well as other outcomes such as functional impairment? Another consideration is that older adults living alone who receive rehabilitation services have an increased risk for mortality. Would complementing rehabilitation services with community-based aging services potentially ameliorate this risk? Future studies also should consider examining the association of patient-reported measures of functioning with clinician assessments of functioning, and the extent to which patient-reported measures are associated with clinical outcomes even after accounting for rehabilitation clinician assessments. Investigation of these issues could have important clinical implications for the millions of older adults who receive rehabilitation services yearly.

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