Predictors of Functional Change in a Skilled Nursing Facility Population

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Abstract

Background and Purpose—Inability to obtain sufficient gains in function during a skilled nursing facility (SNF) stay impacts patients' functional trajectories and susceptibility to adverse events. The purpose of this study was to identify predictors of functional change in patients temporarily residing in a SNF following hospitalization.

Methods—One hundred forty patients admitted to a single SNF from the hospital who had both evaluation and discharge measures of physical function documented were included. Data from the Minimum Data Set 3.0 and electronic medical record were extracted to record clinical and demographic characteristics. The Short Physical Performance Battery (SPPB) was administered by rehabilitation therapists at evaluation and discharge. The SPPB consists of a balance tests, gait speed, and a timed five-time sit-to-stand.

Results and Discussion—The Patient Health Questionnaire (PHQ-9©) Screening Tool for Depression was the only significant predictor of change in gait speed over a SNF stay. Eighty-seven percent of patients achieved a clinically meaningful change in the SPPB of 1 point from evaluation to discharge, with 78% demonstrating a clinically meaningful change of 0.1 meters/second (m/s) on gait speed. However, 69% of patients demonstrated SPPB scores of 6 points and 57% ambulated <0.65 meters/second at the time of discharge from the SNF, which indicates severe disability.

Conclusions—Poor physical function following a SNF stay places older adult at significant risk for adverse events including rehospitalization, future disability, and institutionalization. Understanding the predictors of functional change from evaluation to discharge may direct efforts

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towards developing innovative and effective interventions to improve function trajectories for older adults following an acute hospitalization.

INTRODUCTION

For many older adults, a skilled nursing facility (SNF) stay is required to address functional deficits following hospitalization. Considerable evidence exists for hospital-associated deconditioning[1] including rapid loss of muscle mass and strength[2] that contribute to slower gait speed[3] and difficulty performing activities of daily living (ADLs).[4,5] In fact, older adults who are hospitalized are 60 times more likely to develop disability over time than those who are not.[6] Unfortunately, current SNF practices across multiple disciplines do not adequately address deficits in function,[7,8] which may directly contribute to low community discharge rates of 37%.[9] While many factors play a role in the need for institutionalization (e.g., psychosocial, environmental), the low percentage of community discharge from the SNF is highly correlated with inability to regain sufficient function at discharge.[10] Similarly, for those patients who return home from a SNF, poor trajectories of functional recovery can adversely increase risk of re-hospitalization[11] or death.[12,13] However, the functional profiles of patients in the SNF at evaluation and, perhaps more importantly, at discharge has not been shown. Thus a gap exists between our knowledge of the capacity for patients in the SNF to sufficiently change in functional status to a level that potentially reduces risk for hospitalization,[14] death,[13,15] or future disability,[16] and the most responsive, targeted interventions to improve the trajectory of functional recovery following a SNF stay. The purpose of this study was to identify predictors of functional change from evaluation to discharge in SNF residents. Recognizing drivers and predictors of functional change and trajectory during the vulnerable post-acute phase will identify potential targets for future intervention that induce adequate responsiveness to functional change.

METHODS

Data were collected prospectively from a single SNF in the Denver Metro area from January, 2015, until March, 2016. Data were included if the patient received physical therapy services. SNFs are required to assess and report resident's physical, mental status, clinical conditions, current and changes in functional status, as well as preferences for care through collection of the Minimum Data Set (MDS Version 3.0). For residents in a SNF, MDS data were gathered at admission to the SNF, throughout the stay, and at discharge from skilled services.[17] Demographic and clinical data were collected from the MDS, nursing electronic medical records (EMR), and rehabilitation EMR.

Demographics and Clinical Characteristics

Demographic and clinical data collected included age, sex, body mass index (BMI), hospital length of stay (LOS) in days, SNF LOS in days, fall history in the past month, fall history with a fracture in the past 6 months, total therapy minutes, pain as it impacts daily activities,

pain as it impacts sleep, the presence of malnutrition, a diagnosis of dementia, and admitting diagnoses (variables extracted from the MDS are outlined in Table 1, Appendix). The Functional Comorbidity Index (FCI) was extracted from diagnoses indicated in the MDS and calculated (Table 2, Appendix). The FCI counts the number of diagnoses that are associated with physical function.[18] The Brief Interview for Mental Status (BIMS) was calculated and indicates 3levels of cognitive status: 0–7 points indicates severe cognitive impairment, 8–12 moderate cognitive impairment, and 13–15 suggests the patient is cognitively intact.[19] The BIMS consists of 7 questions pertaining to recall, temporal orientation, and attention.[19] The Patient Health Questionnaire (PHQ-9©) Screening Tool for Depression assessed the frequency of items which then indicates the severity of depressive symptoms.[20] The Braden Scale for Predicting Pressure Sore Risk screens and risk-stratifies patients in terms of potential to develop pressure wounds.[21] The scale is composed of 6 subscales including sensory perception, skin moisture, activity, mobility, nutritional status, and friction and shear.[21] The Barthel ADL Index (BI) assesses a patient's ability to perform basic ADL tasks such as bowels and bladder control, grooming, toilet use, feeding, transfers, mobility, dressing, stairs, and bathing.[22] The BI is considered predicative of functional recovery and mortality.[23] The BI was extracted from the MDS using the mapping technique provided by Wojtusiak et al., though modified to the MDS Version 3.0 (Table 3, Appendix). [24] Admitting diagnoses were classified as a Medicare priority included: joint arthroplasty, pneumonia, congestive heart failure, chronic obstructive pulmonary disease, hip fracture, cerebral vascular disease, and myocardial infarction. Medicare priority diagnoses have been shown to place patients at significantly increased risk for rehospitalization and are targeted by Medicare as areas of high healthcare costs.[25]

Functional Outcome Measures

The Short Physical Performance Battery (SPPB) was administered by rehabilitation therapists at evaluation and discharge. The SPPB is a well-accepted global measure of lower extremity function consisting of three sections: static balance assessment, gait speed, and a 5-time sit-to-stand test.[16,26] Each section is scored on an ordinal 0–4 scale with scores ranging from 0 to 12, where a higher score indicates greater functional ability.[16,26] SPPB scores are strong predictors of disability, institutionalization, and morbidity in older adults. Additionally the SPPB demonstrates good sensitivity to change.[27] The SPPB is reliable based on intra class correlation coefficients (ICC) >0.97 across 3 raters in the SNF and a research team member. Gait speed has also been shown to independently predict risk of disability, higher health care utilization, and increased mortality.[28] Gait speed was measured by the time, using a stopwatch to measure to the nearest hundredth of a second, it took to walk a 4-meter path.

Statistical Analyses

Descriptive statistics were calculated on demographic, clinical, and function variables. The response variable in the linear regression model was the changes in either SPPB or gait speed, controlling for sex, age, and respective functional scores at evaluation. Explanatory variables of interest included: comorbidities (FCI),[18] cognition (BIMS),[29] depression (PHQ-9©),[30,31] BI (subjective ADL report),[32], Braden Score,[21] dementia diagnosis, malnutrition diagnosis,[33] Medicare priority diagnoses (coded as the patient having one or

not),[25] pain that impacts sleep or activity,[34,35] falls history in the past month,[36,37] falls history with fracture,[36,38] SNF LOS, hospital LOS, total therapy minutes (physical, occupational, and speech therapy), and BMI.[36] These potential predictors have been thought to impact physical function and ADLs in older adults (as referenced above) and are potentially modifiable risk-factors for poor functional recovery. To determine which predictors were significant contributors to change in function from evaluation to discharge, each predictor of interest was entered into the initial model separately, while controlling for age, sex, and functional score at evaluation. If the predictor was significant at the $p<0.10$ level, then the variable was included in the final model. A similar process for analysis was used in logistic regression to determine predictors of severe disability at discharge (SPPB 6 points)[16] and slow gait speed at discharge (<0.65 m/s).[39] All analyses were run in SAS 9.3, SAS Inc., Cary, NC. A two-sided p-value of 0.05 was designated for statistical significance in the final models.

RESULTS

Demographic, Clinical, and Functional Characteristics

Data were collected on 158 patients admitted from the hospital. For subjects with multiple admissions (N=16 had two admissions and N=2 had three admissions), only the earliest admission for which there was both an evaluation and discharge SPPB score were kept. This resulted in a sample of N=140 subjects. Demographic and clinical data are presented in Table 1. The patient population was largely female (68%) with a mean age of 78.5 (10.0) years. On average patients were classified as minimally depressed (3.0 (2.9) on the PHQ-9© with 99% categorized as having minimal or mild depression with scores 10), cognitively intact (13.2 (2.5) on the BIMS) with only 8% of the population having a diagnosis of dementia, low risk for pressure ulcers (17.9 (2.3) on the Braden Score), minimal functional comorbidities (1.4 (1.4) on FCI), and moderate ADL limitation (47.5 (19.7) on the BI). Admitting diagnoses that were considered Medicare priorities constituted 34% of the population with the majority being admitted following a joint arthroplasty (57%). Falls in the past month occurred in 49% of the population with 16% of the population experiencing a fall with a fracture in the past 6 months. Pain impacted the sleep or activity of 47% of patients. At discharge 11.4% of patients were re-admitted to the hospital with 86% returning to community settings (i.e., home or assisted living) and <1% to institutional settings (i.e., long-term care).

Functional data are presented in Table 2. At evaluation patients demonstrated 2.5 (2.2) points on the SPPB and 0.4 (0.2) m/s on gait speed. Average scores on the SPPB and gait speed improved at discharge to 5.4 (2.5) points and 0.6 (0.2) m/s, respectively. The average change from evaluation to discharge on the SPPB was 2.8 (2.2) points and 0.2 (0.2) m/s for gait speed. A majority of patients (87%) achieved a clinically meaningful change in the SPPB of 1 point[40] from evaluation to discharge, with 78% demonstrating a clinically meaningful change of 0.1 m/s on gait speed.[40] However, 69% patients demonstrated SPPB scores indicative of severe disability (6 points)[16] with 57% ambulating at slow gait speeds (<0.65 m/s)[39] at the time of discharge from the SNF.

Statistical Modeling and Predictors

For the models of change in SPPB (Table 3), severe disability (Table 5), and slow gait speed (Table 6), none of the variables met the a priori criterion for inclusion in a final model and as such, there was no final model. For the model of change in gait speed (discharge minus initial evaluation), the final model included only the PHQ-9© (p=0.04) (Table 4). Controlling for age and gender, for each one-point increase on the PHQ-9©, there was a 0.02 decrease in gait speed change (β=−0.02 [0.01]). The overall model was significant (p0.003) and had an adjusted R^2=0.19.

DISCUSSION

The predictor variables assessed in this study have been shown to impact functional recovery in other older adult populations. However, we found that no single predictor significantly contributed to functional recovery in the SNF population. On the other hand, a significant finding was the level of disability patients present with at discharge from the SNF. Over 86% of patients were discharged to community settings and, ideally, should have demonstrated at or near functional capacity to adapt and re-integrate into community settings. The proportion discharged to the community is much larger than Medicare reports of 37%, although large variation across the United States may account for the significantly lower nationwide average.[9] However despite the high percentage of community discharges, 72% of patients demonstrated SPPB scores indicative of severe disability (6 points)[16] with 64% demonstrating slow gait speeds (<0.65 m/s)[39] at the time of discharge from the SNF. Acceptable levels of function for community-dwelling older adults include SPPB score of 10 and a gait speed of 1.0 m/s.[26,39] Lenze et al. demonstrated similar deficits in gait speed at SNF discharge as patients averaged 0.39 meters/second,[41] which is less than half of the 1.0 m/s necessary for community ambulation.[39] The low level of function demonstrated by patients in the SNF at discharge, in conjunction with the high rate of community discharge, is concerning given the inverse relationship between physical function and adverse events including increased healthcare costs and utilization,[42–45] hospital readmissions,[46] and long-term disability,[16,42–45,47,48] all of which can potentially lead to costly institutionalization.[45] These results suggest the strong need to transform rehabilitation and interdisciplinary practices to emphasize and support optimal return of function during and after a SNF stay.

Our findings reflect that for every point increase on the PHQ-9© (i.e., increased frequency of depressive symptoms), the change in gait speed was lessened by 0.02 seconds. Every 5 points lower a patient scores on PHQ-9© is associated with a 0.1 m/s on the change in gait speed, which is a clinically meaningful change in gait speed[40] that potentially reduces risk for rehospitalization,[14] functional decline, falls,[49] and death.[15,49] Several studies have supported the association between depression and disability in the older adult population.[30] While debate exists regarding the causal direction of this relationship (i.e., poor function predicts the likelihood of depressive symptoms or vice versa),[50,51] Wang et al. collected data on 2,581 community-dwelling older adults and demonstrated that depressive symptoms were strongly associated with poor functional outcomes and increased rates of functional declines over a follow-up period averaging 3.4 years (range 0–7).[31] Liu et al. showed that depressive symptoms were associated with lower levels of ADL function; however, both depressive

symptoms and function improved after receiving post-acute services.[52] The association between depressive symptoms and slow gait speed at SNF discharge is particularly concerning for this vulnerable, post-acute population as slow gait is associated with higher risk of developing further ADL disability, rehospitalization, and institutionalization in older, community-dwelling adults both with and without baseline ADL disability.[42,44,53] Depression is an important modifiable factor when considering risk stratification and, thus, may be a potential target for early intervention upon SNF admission. Yet, depression is often significantly undertreated in older adult populations, which may contribute to continued disability or delayed functional recovery. Increased awareness by physical therapists that symptoms of depression often mimic manifestations of physical frailty (i.e., weakness and fatigue) may lead to earlier referrals to a physician and subsequent treatment.[54]

Strengths and Limitations

This study contains considerable strengths with a number of limitations. Notably, to the authors' knowledge this is the first publication to characterize the longitudinal functional status of the SNF population and explore potential predictors of functional change. The knowledge gleaned from this study provides an impetus to explore current SNF clinical practices to advance care and provide the data necessary to reform post-acute care policies. Limitations of the study include the small sample size from 1 facility, which limits generalizability. To address this, future studies will explore data across multiple, diverse facilities. Additionally, by using EMR data, we faced missing data due to inconsistencies with clinical recording and location of information. Variables that would describe the nature of the SNF stay and potential complications (e.g., infection, abnormal laboratory values) were not collected, yet those conditions may have impacted functional outcomes. Given the low adjusted R^2 for the gait speed model and the failure of all predictors of interest to achieve statistical significance in the 3 other models, we are potentially missing important variables or more accurate measures of identified variables. Functional change, especially in the acute phase, is likely attributed to multiple factors and interactions, making it a complex domain to investigate.[31] While depression was a significant predictor, the data collected could not definitely identify which patients were being actively treated for depression. Another limitation is the lack of data regarding prior-hospital functional status, which may have greatly impacted the functional score at SNF evaluation. Finally, the length of this particular study lacked long-term follow-up regarding functional status beyond the SNF stay. Variables may have predicted sustainability, further improvement or decline in functional status beyond the SNF stay and, thus, future research in this area is warranted. This is consistent with current post-acute practices that do not extend data points beyond the isolated stay.[55,56]

CONCLUSION

The potential for a poor trajectory of functional recovery following a SNF stay places older adults at risk for increased healthcare utilization and costs, as well as adverse events including rehospitalization, future disability or institutionalization. Understanding the predictors of functional change may direct future research and quality improvement efforts towards more effective interventions to improve function trajectories from a SNF episode of

care and beyond. Our study indicated depressive symptoms may play a critical role in functional trajectories, which suggests a strong emphasis is needed to address these symptoms early and rigorously.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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Table 1

Demographic and clinical data gathered from a single SNF.

Demographic Characteristics	Mean (SE) or N (%)
Age, y (n=140)	78.5 (10.0) *80 (49–99)
Female (n=140)	97 (69%)
Body mass index, kg/m² (n=135)	27.0 (5.9) *26.3 (14–49)
Skilled nursing facility length of stay, d (n=137)	17.0 (10.8) *14 (1–70)
Hospital length of stay, d (n=135)	4.4 (3.5) *4 (0–27)
Discharge location (n=140)	
Home	110 (78.6%)
Assisted living	10 (7.1%)
Long term care	1 (0.7%)
Hospital	16 (11.4%)
Other	3 (2.1%)
Discharge to a community setting (n=140)	120 (86%)
Clinical Characteristics	**Mean (SE) or N (%)**
Functional comorbidity index (n=136)	1.7 (1.4)
The Patient Health Questionnaire Depression Scale (n=134)	3.0 (2.9) *2.5 (0–11)
Brief Interview for Mental Status (n=122)	13.2 (2.5)
Braden Scale (n=137)	17.9 (2.3)
Barthel Activities of Daily Living Index (n=85)	47.3 (9.7)
Total therapy minutes (n=138)	1293 (793) *1056 (151–4533)
Medicare priority diagnosis upon admission (n=140)	
Congestive heart failure	2 (1.4%)
Pneumonia	7 (5.0%)
Joint arthroplasty	27 (19.3%)
Hip fracture	6 (4.3%)
Myocardial infarction	1 (0.7%)
Congestive obstructive pulmonary disease	4 (2.9%)
Non-Medicare priority diagnosis	93 (66.4%)
Dementia diagnosis (n=136)	11 (8%)
Malnutrition (n=137)	0 (0%)
Pain that impacts sleep or activity (n=101)	47 (47%)
Fall in the past month (n=134)	65 (49%)
Fall with fracture in the past 6 months (n=133)	21 (16%)

*
Median (Range)

Table 2

Functional data gathered at evaluation and discharge in a single SNF.

Function Outcome	Evaluation Mean (SE) Median (Range)	Discharge Mean (SE) Median (Range)	Change Mean (SE) Median (Range)
Short Physical Performance Battery (SPPB)	2.5 (2.2) (n=139)	5.4 (2.5) (n=127)	2.8 (2.2) (n=127)
Gait speed m/s	0.4 (0.2) 0.4 (0.0–1.0) (n=93)	0.6 (0.2) 0.6 (0.1–1.3) (n=117)	0.2 (0.2) 0.2 (−0.4–0.7) (n=86)
	Evaluation N (%)	**Change N (%)**	**Clinically Meaningful Difference at Discharge [*] N (%)**
Severe disability on SPPB (6 points)	132 (95%)	88 (69%)	[*]110 (87%)
Slow gait of <0.65 m/s	79 (85%)	67 (57%)	**67 (78%)

[*] 1 point on the SPPB or 0.1 m/s on gait speed, respectively

Table 3

Initial models predicting change in SPPB from evaluation to discharge from the SNF.

*Model	Predictor of Interest	Parameter Estimate (SE)	p-value	Model R^2
1	Body mass index, kg/m^2	−0.02 (0.03)	0.43	0.20
2	Skilled nursing facility length of stay, d	−0.03 (0.02)	0.14	0.17
3	Hospital length of stay, d	−0.01 (0.05)	0.90	0.15
4	Functional comorbidity index	0.04 (0.13)	0.74	0.19
5	The Patient Health Questionnaire Depression Scale	−0.02 (0.07)	0.74	0.15
6	Brief Interview for Mental Status	−0.01 (0.08)	0.91	0.13
7	Braden Scale	0.15 (0.10)	0.14	0.17
8	Barthel Activities of Daily Living Index	−0.02 (0.03)	0.53	0.23
9	Total therapy minutes	−0.00 (0.00)	0.71	0.15
10	Medicare priority diagnosis upon admission	−0.03 (0.38)	0.93	0.15
11	Dementia diagnosis	−0.31 (0.76)	0.69	0.15
12	Pain that impacts sleep or activity	−0.40 (0.43)	0.36	0.20
13	Fall with fracture in the past 6 months	0.07 (0.51)	0.90	0.16
14	Fall in the past month	−0.36 (0.38)	0.34	0.15

*
Each model controlled for age, sex, and evaluation value of the SPPB

**
No predictors were significant at the p<0.10 level

Table 4

Initial models predicting change in gait speed from evaluation to discharge from the SNF.

*Model	Predictor of Interest	Parameter Estimate (SE)	p-value	Model R^2
1	Body mass index, kg/m^2	0.00 (0.00)	0.46	0.20
2	Skilled nursing facility length of stay, d	−0.00 (0.00)	0.44	0.15
3	Hospital length of stay, d	0.01 (0.01)	0.35	0.16
4	Functional comorbidity index	0.00 (0.02)	0.95	0.18
5	The Patient Health Questionnaire Depression Scale	−0.02 (0.01)	**0.04	0.19
6	Brief Interview for Mental Status	0.00 (0.01)	0.99	0.18
7	Braden Scale	0.00 (0.01)	0.77	0.15
8	Barthel Activities of Daily Living Index	0.00 (0.00)	0.27	0.15
9	Total therapy minutes	−0.00 (0.00)	0.52	0.15
10	Medicare priority diagnosis upon admission	0.01 (0.05)	0.86	0.14
11	Dementia diagnosis	0.12 (0.10)	0.23	0.16
12	Pain that impacts sleep or activity	0.00 (0.05)	0.95	0.15
13	Fall with fracture in the past 6 months	−0.01 (0.06)	0.93	0.15
14	Fall in the past month	0.01 (0.05)	0.76	0.14
FINAL	The Patient Health Questionnaire Depression Scale	−0.02 (0.01)	0.04	0.19

*
Each model controlled for age, sex, and evaluation value of gait speed

**
Significant at the p<0.10 level for inclusion in the final model

Table 5

Initial logistic models predicting the odds of severe disability (6 points on the SPPB) at discharge.

*Model	Predictor of Interest	Odds Ratio (95% CI)	p-value
1	Body mass index, kg/m^2	1.0 (0.9–1.1)	0.73
2	Skilled nursing facility length of stay, d	1.0 (1.0–1.1)	0.31
3	Hospital length of stay, d	1.0 (0.8–1.1)	0.53
4	Functional comorbidity index	0.9 (0.7–1.3)	0.72
5	The Patient Health Questionnaire Depression Scale	1.1 (0.9–1.3)	0.30
6	Brief Interview for Mental Status	1.1 (0.9–1.4)	0.23
7	Braden Scale	0.9 (0.7–1.2)	0.60
8	Barthel Activities of Daily Living Index	1.0 (0.9–1.1)	0.74
9	Total therapy minutes	1.0 (1.0–1.0)	0.30
10	Medicare priority diagnosis upon admission	1.5 (0.6–3.9)	0.36
11	Dementia diagnosis	1.0 (0.1–6.6)	0.98
12	Pain that impacts sleep or activity	1.4 (0.5–4.0)	0.51
13	Fall with fracture in the past 6 months	0.8 (0.2–2.8)	0.75
14	Fall in the past month	1.4 (0.6–3.4)	0.49

*
Each model controlled for age, sex, and evaluation value of the SPPB

Table 6

Initial logistic models predicting the odds of slow gait speed (<0.65 m/s) at discharge.

*Model	Predictor of Interest	Odds Ratio (95% CI)	p-value
1	Body mass index, kg/m^2	1.0 (0.9–1.1)	0.66
2	Skilled nursing facility length of stay, d	1.1 (1.0–1.2)	0.10
3	Hospital length of stay, d	0.9 (0.7–1.1)	0.16
4	Functional comorbidity index	1.2 (0.8–2.0)	0.37
5	The Patient Health Questionnaire Depression Scale	1.2 (0.9–1.5)	0.16
6	Brief Interview for Mental Status	0.9 (0.7–1.2)	0.64
7	Braden Scale	0.9 (0.7–1.2)	0.46
8	Barthel Activities of Daily Living Index	1.0 (0.9–1.0)	0.41
9	Total therapy minutes	1.0 (1.0–1.0)	0.23
10	Medicare priority diagnosis upon admission	0.9 (0.3–2.7)	0.85
11	Dementia diagnosis	1.3 (0.1–11.7)	0.82
12	Pain that impacts sleep or activity	0.6 (0.2–2.0)	0.45
13	Fall with fracture in the past 6 months	0.7 (0.2–2.8)	0.58
14	Fall in the past month	0.9 (0.3–2.7)	0.88

*
Each model controlled for age, sex, and evaluation value of gait speed