

Original Article

Effects of Hospital-Based Physical Therapy on Hospital Discharge Outcomes among Hospitalized Older Adults with Community-Acquired Pneumonia and Declining Physical Function

Sun Jung Kim¹, Joo Hun Lee², Boram Han³, Julia Lam⁴, Elizabeth Bukowy⁵, Avinash Rao⁴, Jordan Vulcano⁶, Anelia Andreeva⁶, Heather Bertelson⁶, Hyun Phil Shin⁷, Ji Won Yoo^{8*}

¹Department of Health Policy and Management, University of Michigan School of Public Health, Ann Arbor, Michigan, USA

²Department of Communication and Mass Media, Hanyang University College of Social Sciences, Seoul, Korea

³Department of Medicine, Kosin University College of Medicine, Busan, Korea

⁴Department of Medicine, University of Wisconsin School of Medicine and Public Health

⁵Chicago College of Osteopathic Medicine, Midwestern University, Downers Grove, Illinois, USA

⁶Department of Internal Medicine, Aurora Health Care, Milwaukee, Wisconsin, USA

⁷Department of Internal Medicine, Kyung Hee University College of Medicine, Seoul, Korea

⁸Department of Internal Medicine, Cleveland Clinic Foundation, Cleveland, Ohio, USA

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ABSTRACT: To examine whether hospital-based physical therapy is associated with functional changes and early hospital readmission among hospitalized older adults with community-acquired pneumonia and declining physical function. Study design was a retrospective observation study. Participants were community-dwelling older adults admitted to medicine floor for community-acquired pneumonia ($n = 1,058$). Their physical function using Katz activities of daily living (ADL) Index declined between hospital admission and 48 hours since hospital admission (Katz ADL Index 6→5). The intervention group was those receiving physical therapy for ≥ 0.5 hour/day. Outcomes were Katz ADL Index at hospital discharge and all-cause 30-day hospital readmission rate. The intervention and control groups did not differ in the Katz ADL Index at hospital discharge ($p = 0.11$). All-cause 30-day hospital readmission rate was lower in the intervention than in control groups (OR = 0.65, $p = 0.02$). Hospital-based physical therapy has the benefits toward reducing 30-day hospital readmission rate of acutely ill older adults with community-acquired pneumonia and declining physical function.

Key words: hospitalization, patient outcome assessment, physical therapy, pneumonia

Functional decline in older adults is common and occurs in up to one-third of recently hospitalized older adults [1]. The hospital environment accelerates the reduction of functional reserve implicated factors include forced immobilization, disorientation due to unfamiliar hospital environments, and frequent orders not to eat by mouth [2-6]. In fact, hospitalized older adults spend more than 70%

of their time lying in bed due to acute medical conditions, despite having the ability to walk [4].

Functional decline during or after hospitalization is associated with adverse health outcomes, prolonged hospital stays due to more frequent occurrences of hospital complications, such as delirium; and more frequent episodes of early hospital readmissions and even higher long-term mortality rate [7-12].

*Correspondence should be addressed to: Ji Won Yoo, MD, MS, Department of Medicine, University of Wisconsin School of Medicine and Public Health, 1020 N 12th St., # 301, Milwaukee, WI 53233, USA. Email: yoo36@wisc.edu

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To reduce or delay functional decline during or after hospitalization, physical therapy (PT) has been utilized as an independent rehabilitation measure and a component of multidisciplinary care [14-16]. PT to restore functional reserve has been applied to certain acute illness, such as stroke and hip fracture, with excellent rehabilitation potential in both acute and post-acute hospital settings [13, 14]. There is evidence of dose-dependent effects of PT on functional recovery in a post-acute care setting [16, 17].

However, few studies have investigated the effects of PT on functional changes when applied to common acute medical illnesses aside from stroke and hip fracture [13, 14]. Other studies have evaluated the hospital outcomes of hospital-based PT when applied to pneumonia.

This study attempts to fill this gap by focusing on vulnerable older adults admitted for community-acquired pneumonia whose physical function declined between hospital admission and 48 hours since hospital admission to determine whether hospital-based PT is beneficial for this population in terms of physical and hospital-related outcomes.

MATERIALS AND METHODS

Study Subjects

The study site was a 350-bed metropolitan teaching hospital in the Ohio state of the United States. The present study was a retrospective observation study. The study period was 22 months (July 2007 to April 2009). Figure 1 presents the study participant selection strategy. Inclusion criteria were (1) community-dwelling adults age 65 or older; (2) admission to medicine floor with principal diagnosis of pneumonia (International Classification of Disease, Ninth Revision, Clinical Modification [ICD-9-CM]: 480.8, 480.9, 481, 482.0 – 487.0, 038.0 – 038.9, 518.81 or 518.84); (3) functional decline between hospital admission and 48 hours since hospital admission. Exclusion criteria were (1) hospital length of stay (LOS) of 2 days or less ($n = 108$), (b) healthcare-associated pneumonia [either from a residential facility or recent hospitalization in the last 14 days) ($n = 92$), (c) data missing during matching process ($n = 77$), or (d) deceased in hospital ($n = 31$). Functional decline was assessed using the Katz Activities of Daily Living (ADL) Index which is the most common measurement of activities of daily living functioning in hospitalized older medical patients [18]. A score of 0 represents total dependence and 6 represents total independence. Nursing staff completed the Katz ADL Index two times - at hospital admission and 48 hours since hospital admission. Functional decline was defined when participants score Katz ADL Index 6 at hospital admission (fully independent) and Katz ADL

Index 5 at 48 hours since hospital admission (newly disabled).

We estimated that a sample of 516 participants in each group was needed for each disease in order to detect a substantial change in the Katz Index (mean difference = 0.6; standard deviation = 1.4) with a power of 80% and significance level of 5% (two-tailed).

The final sample comprised 1,058 patients with pneumonia (524 and 534 in the intervention and control groups, respectively). The study was approved by the institutional review board at Cleveland Clinic Health System. The requirement for individual subject consent was waived because the study relied on existing administrative and clinical data.

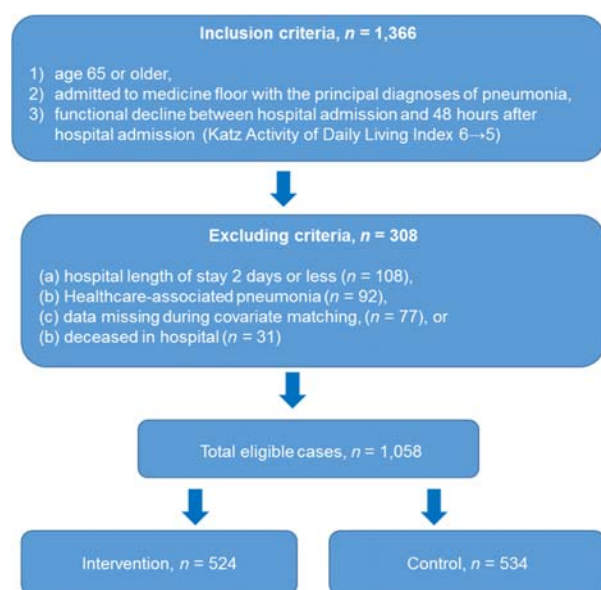


Figure 1. Selection strategy for study participants.

Intervention vs. Control

We examined the LOS across all PT hours summed together. We added the total PT hours and divided the sum by the LOS. Patients did not need to receive all therapies to be included in these analyses. To compare our findings with those from previous studies on the relationship between therapy and outcomes, we defined patients receiving PT for ≥ 0.5 hours/day as the intervention group [17, 19]. The control group did not receive any PT during their hospital stay. Therapy staff was not aware of assignment of group assignment or study objective. Covariates between intervention and control groups were matched.

Table 1. Subject characteristics by study groups

Covariates	Intervention <i>n</i> = 524	Control <i>n</i> = 534	<i>P</i>	
Age, median (interquartile range)	86.2 (79.1 - 93.7)	85.3 (78.5 - 94.2)	0.45	
Female	310, 59.2%	327, 61.2%	0.58	
Non-Whites	160, 30.5%	165, 31.0%	0.77	
Education year, median (interquartile range)	9.7 (7.7 - 10.8)	10.1 (8.1 - 11.3)	0.26	
Severity of illness	Mild	68, 12.9%	85, 16.0%	0.18
	Moderate	130, 24.9%	129, 24.1%	
	Major	193, 36.9%	186, 34.9%	
	Extreme	133, 25.3%	137, 25.0%	
Cognitive impairment	151, 28.8%	161, 30.2%	0.46	
Charlson comorbidity index, median (interquartile range)	3.45 (2.30 - 5.38)	3.41 (2.24 - 5.49)	0.63	
Hospital length of stay (interquartile range)	5.36 (4.31 - 6.79)	5.59 (4.44 - 7.62)	0.39	

Main Outcomes: Katz ADL Index at Hospital Discharge and All-cause 30-day Hospital Readmission Rate

The Katz ADL index was assessed again by the nursing staff at hospital discharge. Thirty-day readmission rate was captured from electronic medical record which could identify study participants' hospital admission status throughout all local health systems. We defined hospital readmission when hospital readmission was unplanned with any cause within 30-day of hospital discharge.

Table 2. Unadjusted Katz Activity of Daily Living Index at Hospital Discharge and All-cause 30-day Hospital Readmission Rate

Outcomes	Intervention <i>n</i> = 524	Control <i>n</i> = 534	<i>p</i>
Katz Activities of daily living Index at hospital discharge	Mean (95% confidence intervals)		0.07
	4.89 (3.91 - 5.63)	4.23 (3.65 - 5.30)	
All-cause 30-day hospital readmission rate	%, <i>n</i>		0.03
	11.2%, 59/524	16.3%, 87/534	

Covariates

Age, gender, ethnicity, education, severity of illness, cognitive impairment, the Charlson Comorbidity Index (CCI), and hospital length of stay were included as covariates. The All Patient Refined Diagnostic Related Group (APR-DRG) classification system was used to estimate the severity of illness. APR-DRG has been widely used for assessing severity of illness and

reimbursement for hospital care. APR-DRG data were gathered from the department of operation, which was unaware of the study, based on the 3M Health Information System. CCI has been validated to reflect the magnitude of comorbidities in acute hospital settings [20]. Cognitive impairment was determined using the Mini-Cog assessment which has been validated elsewhere [21]. Hospital nursing staff performed the Mini-Cog assessment at 48 hours since hospital admission

Statistical Analysis

Bivariate comparisons of covariates between intervention and control subjects were examined using chi-square tests (categorical data) and either the *t*-test or Mann-Whitney *U* test (continuous data), as appropriate. All reported *p*-values were two-tailed and *p* < 0.05 was considered statistically significant.

We analyzed the outcomes as follows: We measured unadjusted outcomes by study groups. We used generalized linear models (GLM) with a log link function and gamma distribution to fit the skewed Katz ADL Index [22] and used the multivariate regressions to compute parameter estimates and *p*-values. Multivariate logistic regressions of all-cause 30-day hospital readmission rate were performed to compute estimates, odds ratios, *p*-values. SAS version 9.3 (SAS Institute Inc., Cary, NC, USA) was used for all analyses.

RESULTS

Table 1 presents the subject characteristics by study groups. There were no significant differences between intervention and control groups on all covariates. Unadjusted Katz ADL Index at hospital discharge and all-cause 30-day hospital readmission rate is shown in Table 2. The Katz ADL Index at hospital discharge did not differ between the intervention (mean 4.89; 95% confidence intervals 3.91 - 5.63) and the control (mean 4.23; 95% confidence intervals 3.65 - 5.30; *p* = 0.07). All-cause 30-day hospital readmission rate was lower for the intervention (11.2%, 59/524) than the control (16.3%, 87/534; *p* = 0.03). In Table 3, the Katz ADL Index did not differ between the intervention and control groups (*p* = 0.11). Cognitive impairment and complex comorbidity (higher CCI) were associated with impaired physical function (lower Katz ADL Index) at hospital discharge. In Table 4, all-cause 30-day hospital readmission rate was lower for the intervention than the control (estimate = -0.09; OR = 0.65; *p* = 0.02). Higher severity of illness, cognitive impairment, and complex comorbidity (higher CCI) were associated with higher all-cause 30-day hospital readmission rate.

Table 3. Multivariate Regressions of Katz Activity of Daily Living Index at Hospital Discharge

Covariates	Parameter estimates	p	
Age	Reference = 65 - 74		
	75 - 84	- 0.27	0.33
	≥ 85	- 1.18	0.01
Gender	Reference = Male		
	Female	0.36	0.21
Ethnicity	Reference = Whites		
	Non-Whites	- 0.40	0.19
Education	Reference = < High school graduate		
	≥ High school graduate	0.08	0.74
Severity of illness	Reference = Mild		
	Moderate	0.15	0.62
	Major	- 1.16	0.07
	Extreme	- 2.08	< 0.001
Cognitive impairment	Reference = No		
	Yes	- 1.43	0.003
Charlson comorbidity index	Reference = 0 - 1		
	2 - 3	- 0.94	0.058
	≥ 4	- 3.15	< 0.001
Study groups	Reference = Control		
	Intervention	0.62	0.11

DISCUSSION

We examined whether physical therapy for hospitalized older adults is associated with functional changes and early hospital readmission rate. To the best of our knowledge, this study is the first to focus on vulnerable older adults with pneumonia and declining function. Hospital-based PT was associated with reductions in early hospital readmission rate.

Although several previous studies have confirmed functional responses to hospital-based PT [13-15, 19], these were limited to stroke and hip fracture patients. Our study contributes to the literature by providing evidence that PT reduces progressive functional decline, even in common acute illness (pneumonia). The progression of functional decline during or after hospitalization is subject to “traction effects” because there are multiple contributing factors that are difficult to disentangle [23]. Home-based PT plays the role of a “buffer or breaker pedal” to counter these traction effects among acutely ill older adults [19].

Additional effects of hospital-based PT might include “delayed and spillover effects.” Hospital-based PT reduces vulnerability to other episodes of acute illnesses, and consequently reduces the early hospital readmission rate. Bodilsen et al. reported that functional performance in older adults was more vulnerable to decline than muscle strength during hospital stay and during post-discharge recovery [24]. This implies that the effects of hospital-

based PT may persist and stabilize functional changes during and after hospitalization. However, this effect should be examined directly in the future by measuring the relationship between hospital-based PT and indicators of functional reserve.

Our findings have several theoretical and practical implications. Increased utilization of hospital-based PT may have system-wide benefits for hospitals. Medicare launched a performance-based payment system for certain medical conditions (heart failure, pneumonia, and acute myocardial infarction) in 2013. Thirty-day hospital readmission, also known as the “revolving door phenomenon,” is one of the core performance indicators linked to hospital reimbursement from Medicare [25]. Reduction of 30-day hospital readmission rates would improve performance indicators, and thus also improve the financial status of hospitals. However, certain precautions should be carefully considered prior to the application of PT. PT for subjects with major cardiovascular diseases, such as acute myocardial infarction, might not be practical, even with a fair restoration potential [9, 19, 24]. The little or no functional benefits of hospital-based PT could be explained by premature length of hospital-based PT. The length of exposure to hospital-based PT could be too short to present the functional benefits by hospital-based PT. Important next steps will be to determine how to optimize the PT outcomes such as extension to home-based PT after hospital discharge and dose-response relationship between the intensity of PT and functional outcomes.

Despite the above contributions, this study has several limitations. First, inter-observer bias might have occurred. Physical function was assessed by different nursing staff (hospital and home health care staff). Second, we matched covariates between the intervention and control groups by using two different data sources (hospital administration and clinical data). Missing data during the matching process was a noteworthy issue (5.6%, 77/1,366). Third, the relatively (not statistically) higher ADL score in the intervention group compared to the control group could be selection bias. Our data were not able to capture premorbid (baseline) ADL score. Physicians tend to refer patients with better functional status for PT services than those with poorer function status. Finally, we were able to capture service time of PT, but unable to capture the specific therapy modality (i.e., gait/bed transfer and muscle strengthening). Thus, the relationship between specific therapy modalities and either hospital or discharge outcomes was not examined. However, we believe that omitting this is not problematic as Jette et al. observed that there was no clear pattern in rehabilitation therapy for patients receiving acute care in hospitals and that the ultimate goal of rehabilitation was on functional recovery [26].

Table 4. Multivariate Logistic Regressions of All-cause 30-day Hospital Readmission Rate

Covariates		Estimates	Odds ratio	p
Age	Reference = 65 - 74			
	75 - 84	0.06	1.22	0.18
	≥ 85	0.29	2.08	< 0.001
Gender	Reference = Male			
	Female	- 0.07	0.74	0.08
Ethnicity	Reference = Whites			
	Non-Whites	0.08	1.32	0.054
Education	Reference = < High school graduate			
	≥ High school graduate	0.04	1.14	0.27
Severity of illness	Reference = Mild			
	Moderate	0.15	1.71	0.02
	Major	0.18	1.86	0.004
	Extreme	0.42	2.70	< 0.001
Cognitive impairment	Reference = No			
	Yes	0.37	2.19	< 0.001
Charlson comorbidity index	Reference = 0 -1			
	2 - 3	0.04	1.26	0.15
	≥ 4	0.22	1.73	0.01
Study groups	Reference = Control			
	Intervention	- 0.09	0.65	0.02

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