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Inpatient Rehabilitation Outcomes Following Lower Extremity Fracture in Patients with Pneumonia

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Abstract

Background—Pneumonia is a common comorbidity among hospitalized older adults and may impede functional restoration and increase medical cost. Medicare reimbursement rates for patients receiving inpatient medical rehabilitation services are higher for individuals who have comorbid pneumonia. We examined the impact of comorbid pneumonia on outcomes for patients with lower extremity fracture receiving inpatient medical rehabilitation services.

Methods—Secondary data analysis of medical records obtained from 919 inpatient rehabilitation facilities in the United States. The sample included 153,241 patients who received inpatient rehabilitation services following lower extremity fracture in 2005–2007. We used multivariable linear regression to evaluate the independent effects of pneumonia on length of stay and discharge functional status (FIM instrument) and logistic regression models to explore discharge to home versus not home.

Results—Pneumonia was a comorbidity for 4,265 (2.8%) of the patients with lower extremity fracture. The multivariable models indicated that patients with no payment-eligible comorbidity experienced shorter lengths of stay ($b = -0.44$; 95% confidence interval [CI] = $-0.60, -0.28$ days), higher discharge functional status ratings ($b = 1.84$; 95% CI = 1.42, 2.25 points), and higher odds of home discharge (OR = 1.19; 95% CI = 1.09, 1.29) compared to patients with pneumonia.

Conclusions—Our findings suggest that comorbid pneumonia is associated with poorer rehabilitation outcomes (length of stay, discharge functional status, and discharge setting) among patients receiving inpatient rehabilitation services for lower extremity fracture.

Keywords

Post-acute care; disability; comorbidity; evaluation; outcomes

INTRODUCTION

Lower extremity fractures – hip fractures, in particular – are a common reason for hospitalization in older adults and are associated with high morbidity and mortality.¹ These

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Conflict of Interest:

The authors declare no conflicts of interest.

fractures often occur in older adults who have comorbid conditions (e.g., diabetes).¹ Comorbidities can affect the recovery process and lead to longer lengths of stay and a lower likelihood of returning home².

Pneumonia is a potential complication, in older adults who experience a hip fracture or other lower extremity fractures and are receiving inpatient medical rehabilitation.³ Pneumonia can compound disability, inhibit functional restoration, and increase medical costs. In 2002, the Centers for Medicare and Medicaid Services (CMS) introduced a prospective payment system for inpatient medical rehabilitation facilities to help control costs.² Rehabilitation facilities receive reimbursement based on projected resource use (costs) for a given patient. The rate is determined by the patient's primary medical diagnosis, age, and level of functional status at admission.⁴ Each patient is assigned to a case-mix group (CMG) and this CMG is used to establish the prospective payment rate. The base rate can be adjusted based on several factors, including the presence of comorbid conditions that likely increase the resources needed to attain a desired level of recovery or independence.

Medicare's comorbidity payment system consists of a 4-tier classification: tier 1 represents high cost, tier 2 represents medium cost, tier 3 is for low cost, and the final tier level includes patients with no payment-eligible comorbidities (non-tier).⁵ Little research has been done to examine the validity of specific condition-comorbidity combinations within the CMS comorbidity tier classification system.

The purpose of our study was to examine the impact of pneumonia as a comorbidity for patients with lower extremity fracture (hip, pelvis, or femur) who received inpatient medical rehabilitation services following acute care hospitalization. We examined length of stay, discharge functional status, and discharge setting (home versus not home). This information is also relevant to establishing the validity of the comorbidity tier system developed by CMS.

METHODS

Data source and study sample

The data were obtained from 919 inpatient rehabilitation units and facilities that subscribed to the Uniform Data System for Medical Rehabilitation (UDS_{MR}) in 2005–2007. All information was derived from the items included in the Inpatient Rehabilitation Facility-Patient Assessment Instrument (IRF-PAI).^{4,5} The IRF-PAI was developed by the CMS to determine eligibility for prospective payment and includes 54 items. The sample included patients receiving inpatient rehabilitation services for lower extremity fracture (ICD-9 codes 820.0 – 820.9, and 821.0 – 821.3) during the 3-year study period. Approximately 85% of cases were hip fractures, 9% pelvis fractures, and 6% femur fractures. The initial sample contained 166,777 cases. Patients were excluded if the admission was not an initial rehabilitation stay ($n = 6,562$), they were not between the ages of 20 and 100 years old ($n = 645$), the duration from fracture to rehabilitation facility admission was greater than 30 days ($n = 5,183$), or length of stay was greater than 30 days ($n = 1,146$). The final sample contained 153,241 cases, representing 92% of the original cohort.

Dependent Variables

Length of stay—Rehabilitation length of stay was recorded as the total number of days spent in the medical rehabilitation unit or facility.

Discharge functional status—The functional status items in the IRF-PAI are from the Functional Independence Measure (FIM instrument),⁴ and include 18 items covering 6

domains: self-care, sphincter control, transfer, locomotion, communication, and social cognition. Items are scored on a 7-point scale, ranging from complete dependence (level 1) to complete independence (level 7) with a potential total score range of 18 to 126. Functional status ratings can be grouped into Motor and Cognition domains.^{13,14,15} The FIM items were administered by trained personnel within 36 hours of both admission and discharge. FIM ratings were used as a continuous variable in all analyses. The reliability, validity, and responsiveness of the functional status items have been widely investigated with intraclass correlation coefficients consistently > 0.85 .⁸

Discharge setting—The IRF-PAI contains 14 different discharge settings, including home, transitional care, skilled nursing facility, long-term care, and acute care hospital. For our analysis, discharge setting was dichotomized as home versus not home.

Independent Variable

The independent variable of interest was pneumonia comorbidity. It was coded as a dichotomous variable (yes/no) for descriptive summaries and combined with the 4-level tier variable to create five unique categories for the multivariable analyses. The IRF-PAI allows up to 10 comorbidity codes for each patient. Patients with an ICD-9 code for pneumonia (480.0 – 487 or 506) within any of the 10 comorbidity variables were classified as positive for pneumonia. The primary diagnoses for these ICD-9 codes included viral pneumonia; pneumococcal pneumonia; other bacterial pneumonia; pneumonia due to other specified organism; pneumonia in infectious diseases classified elsewhere; bronchopneumonia, organism unspecified; pneumonia, organism unspecified; influenza with pneumonia; and bronchitis and pneumonitis due to fumes and vapors. Within these primary diagnoses there are 30 sub ICD-9 code and diagnoses. In the Medicare prospective payment system for inpatient medical rehabilitation, all pneumonia ICD-9 codes are considered tier 3 comorbidities. Patients with pneumonia who also had other tier 2 or tier 1 eligible comorbidities (e.g., presence of tracheotomy) were coded as the latter, higher paying tier, for the multivariable analyses of rehabilitation outcomes.

Covariates

Sociodemographic variables included age in years, sex, race/ethnicity (black, white, Hispanic, other), and marital status (married, not married). Medical factors included sum of non-pneumonia comorbidities (range, 0 – 10), duration to rehabilitation admission (days), admission or discharge functional status (FIM instrument ratings), and length of stay (days) in select models.

Statistical Analysis

Unadjusted descriptive summaries of patient characteristics and outcomes were stratified by pneumonia status and examined by univariate statistics (t-tests and chi-square tests). We used multivariable linear regression to evaluate the independent effects of pneumonia on length of stay and discharge functional status. We used logistic regression to examine the dichotomous outcome of discharge to home versus not home. The five-level pneumonia/tier variable was dummy-coded for inclusion in the multivariable models; pneumonia served as the reference category in all three models. We controlled for patient age, sex, race/ethnicity, sum of non-pneumonia comorbidities, and functional status (admission or discharge as appropriate) in all three outcome models. Length of stay was included in both the discharge functional status and home discharge models and marital status was added to the home discharge model as proxy for social support. Lastly, we used the three regression models to estimate and plot mean lengths of stay and discharge functional status (FIM) ratings, as well as probabilities of home discharge for patients with pneumonia and each of the four tier

comorbidity categories for all patients with lower extremity fractures. SPSS (v20) software was used for all statistical tests with $p < 0.01$ indicating statistical significance.

RESULTS

Pneumonia was listed as a comorbidity for 4,265 or 2.8% of the 153,241 patients with lower extremity fracture. Approximately 12% ($n = 507$) of patients with pneumonia had other comorbidities that placed them into the higher-paying tier 1 or 2 levels. Table 1 shows that all sociodemographic characteristics, clinical factors, and unadjusted outcomes demonstrated statistically significant ($p < .01$) differences between the pneumonia yes/no groups with one exception. There was not a statistically significant difference between lower extremity fracture patients with pneumonia and without pneumonia for marital status. In general, patients with pneumonia tend to be older, be delayed in getting to rehabilitation, have more total comorbidities, be more functionally impaired at admission and discharge, and experience longer lengths of stay. They are also more likely to be male, more likely to be white, and less likely to be discharged home.

As expected, mortality during rehabilitation was quite low. The rates ranged from 0.1% in the no tier group to 0.4% in tier 2 and pneumonia groups. Regression coefficients (b) and odds ratios (ORs) for the four tier levels relative to pneumonia from the multivariable (adjusted) models are displayed in Table 2. Estimated group means for length of stay and discharge functional status (FIM) ratings, and group probabilities for home discharge are presented in Figures 1, 2, and 3, respectively. The pneumonia group experienced significantly longer lengths of stay (13.1 vs. 12.7 days), lower discharge FIM ratings (85.4 vs. 87.2), and lower probability of home discharge (61.8% vs. 65.8%) compared to the non-tier group after adjusting for age, sex, race, comorbidity sum, duration since fracture, and other relevant variables (see Table 2). There were no significant differences between the pneumonia group and the aggregate of the other tier 3 comorbidities in terms of discharge FIM ratings and odds of home discharge. The mean length of stay in the pneumonia group was significantly shorter (approximately 0.4 days) than in the combined (non-pneumonia) tier 3 category after adjusting for age, sex, race comorbidity sum, duration since fracture and admission functional status.

DISCUSSION

We studied the impact of pneumonia on inpatient rehabilitation outcomes among persons with lower extremity fracture in the context of the comorbidity tier system developed by CMS. After controlling for relevant patient characteristics and clinical factors, patients in the pneumonia group demonstrated poorer outcomes including longer lengths of stay, lower discharge functional status, and lower percentage of discharge to home, compared to patients without pneumonia (see Table 2).

We also compared patients with lower extremity fractures in the pneumonia tier group to patients with other tier 3 comorbidities (e.g., diabetes). The sub-group of patients with pneumonia experienced equivalent discharge functional status ratings and odds of home discharge. Patients with comorbid pneumonia, however, averaged slightly shorter lengths of stay compared to other tier 3 patients and this difference was statistically significant.

The payment received by an inpatient medical rehabilitation facility for a patient with lower extremity fracture plus a tier 3 comorbidity such as pneumonia is approximately 11% greater than the payment for the same patient with no tier comorbidity (Federal Register Vol. 71, No. 160/Friday, August 18, 2006). While our findings support the need for a comorbidity tier reimbursement system, there are important policy questions that remain to be addressed.

For example, is the amount of increased reimbursement for pneumonia (and other tier 3 comorbidities) consistent with the increased resources necessary to achieve improved outcomes. In the past, these judgments have been made largely based on outcomes associated with an episode of care. The current prospective payment system for inpatient medical rehabilitation was developed using length of stay as a proxy for cost.⁷ The purpose of increasing reimbursement for patients with pneumonia (and other tier level comorbidities) is to provide additional services during their treatment in the belief that these services will improve their functional status and reduce their length of stay for that episode of care. Our study did not address the issue of the cost-benefit of the tier 3 comorbidity reimbursement. This remains an important topic for future research. It is important for two reasons. First, hospital acquired pneumonia is predominantly a problem of older adults.⁹ Age and the presence of multiple comorbid conditions are primary risk factors for developing hospital acquired pneumonia.^{10, 11} The aging demographics of the U.S. population mean that more older (> 75 years) adults will be experiencing hip fractures and potentially developing pneumonia in the next two decades.

The second factor contributing to the need for additional research is the changing health care system. The Affordable Care Act, and other components of health care reform, place an increased emphasis on outcomes and cost across the continuum of care and away from the current focus on individual episodes of care.¹² What occurs during the acute care and inpatient rehabilitation experience has implications for downstream outcomes and costs. For example, our study found 61.8% of patients with pneumonia were discharged home compared to 65.8% of patients without pneumonia, after adjusting for relevant covariates (e.g., age). The long-term cost for persons discharged to institutions versus discharged home will be substantial. In the current system the tier reimbursement for comorbid conditions is focused on reducing costs for the rehabilitation-related episode of care only (e.g., length of stay), not the downstream costs.

Within the Affordable Care Act¹² there is a focus on outcomes and cost across the continuum of health care service delivery, including prevention, acute care and post-acute care. The ideal situation would be to prevent hip fractures; and, if they do occur to prevent the development of pneumonia and other comorbidities. In a more integrated service delivery model, respiratory care professionals would be important members of rehabilitation care teams and have a role in screening patients prior to admission to inpatient rehabilitation facilities. Respiratory care professional would also have an important role in helping to prevent and manage pneumonia in post-acute care environments. Such a service delivery model could help reduce discharges to institutional settings, including hospital readmissions. While isolated examples of this integrated team model approach across the service delivery continuum exist, more research is needed to document their effectiveness and demonstrate their compatibility with health care reform.

Our study has both limitations and strengths. The information in the Uniform Data System for Medical Rehabilitation database is obtained through medical records and observations, so it is possible that coding and reporting errors can occur. We used ICD-9 codes from patient records to categorize our primary independent variable (pneumonia), and it has been suggested that reliance on these codes may lead to under reporting of severity or intensity of complications. We lacked data on many factors preceding admission to rehabilitation, including prior disability status and medical conditions. We also do not have data to examine what happened after the inpatient rehabilitation stay. Our study was limited to the variables and methods of data collection available in the Uniform Data System for Medical Rehabilitation and we did not have access to potentially important variables (e.g., educational level) that may have influenced our outcomes.

A strength of this study is the use of a large national sample, which provides useful information regarding the role of pneumonia in recovery from lower extremity fracture in patients receiving inpatient rehabilitation services. To our knowledge, this is the first study to examine the effect of comorbid pneumonia on rehabilitation outcomes following lower extremity fracture.

CONCLUSIONS

The findings of our study indicate that patients receiving inpatient medical rehabilitation following a lower extremity fracture and who have comorbid pneumonia demonstrate longer lengths of stay, poorer functional status, and are less likely to be discharged home than patients who do not have pneumonia. Our results suggest that the additional resources for patients with comorbid pneumonia included in the tier reimbursement system are appropriate. Further investigation is required, however, to better align the allocation of tier comorbidity resources with patient centered long-term outcomes and to document reductions in cost.

References

1. Deutsch A, Granger CV, Fiedler RC, et al. Outcomes and reimbursement of inpatient rehabilitation facilities and subacute rehabilitation programs for Medicare beneficiaries with hip fracture. *Med Care*. 2005; 43(9):892–901. [PubMed: 16116354]
2. Carter, GM.; Paddock, SM. Preliminary Analyses of Changes in Coding and Case Mix Under the Inpatient Rehabilitation Facility Prospective Payment System. Santa Monica, CA: RAND Corporation; 2004.
3. Mandell LA, Wunderink RG, Anzueto A, Bartlett JG, Campbell GD, Dean NC, Dowell SF, File TM Jr, Musher DM, Niederman MS, Torres A, Whitney CG. Infectious Diseases Society of America/ American Thoracic Society consensus guidelines on the management of community-acquired pneumonia in adults. *Clin Infect Dis*. 2007 Mar 1; 44(Suppl 2):S27–72. [PubMed: 17278083]
4. UB Foundation Activities. The IRF-PAI Training Manual. 2004. irfpaimanual040104 pdf
5. Carter, GM.; Buntin, MB.; Hayden, O., et al. Analysis for the initial implementation of the inpatient rehabilitation facility prospective payment system. Santa Monica, CA: RAND Corporation; 2002. Report No.: Document MR-1500-CMS; NTIS Order Number ADA404816
6. Granger CV, Markello SJ, Graham JE, Deutsch A, Reistetter TA, Ottenbacher KJ. The Uniform Data System for Medical Rehabilitation report of patients with lower extremity joint replacement discharged from rehabilitation programs in 2000 – 2007. *Am J Phys Med Rehabil*. 2011; 90(3):177–189. [PubMed: 21297397]
7. Stineman MG, Escarce JJ, Goin JE, Hamilton BB, Granger CV, Williams SV. A case-mix classification system for medical rehabilitation. *Med Care*. 1994; 32(4):366–379. [PubMed: 8139301]
8. Susan J, Zubair L, Josph S. Reliability, validity, and responsiveness of the lower extremity measure for patients with a hip fracture. *J Joint Bone Surg*. 2000; 82:955–955.
9. Marrie TJ, Huang JQ. Epidemiology of community-acquired pneumonia in Edmonton, Alberta: an emergency department-based study. *Can Respir J*. 2005; 12(3):139. [PubMed: 15875065]
10. McEachern R, Campbell GD Jr. Hospital-acquired pneumonia: Epidemiology, etiology, and treatment. *Infect Dis Clin North Am*. 1998; 12:761–779. [PubMed: 9779389]
11. Niederman MS, Craven DE, Bonten MJ, et al. Guidelines for the management of adults with hospital-acquired, ventilator-associated, and healthcare associated- pneumonia. *Am J Respir Crit Care Med*. 2005; 171:388–416. [PubMed: 15699079]
12. 111TH Congress Patient Protection and Affordable Care Act; 3-23-2010; Washington, DC: Government Printing Office; 2010.

Figure 1.

Predicted means (standard errors) for lengths of stay across the five comorbidity groups. Estimates were obtained from the linear regression model, which controlled for age, sex, race, comorbidity sum, duration since fracture, and admission FIM. The reported values were derived by grand-mean centering continuous variables and selecting female and white for the two categorical variables.

Figure 2.

Predicted means (standard errors) for discharge FIM ratings across the five comorbidity groups. Estimates were obtained from the linear regression model, which controlled for age, sex, race, comorbidity sum, duration since fracture, admission FIM, and length of stay. The reported values were derived by grand-mean centering continuous variables and selecting female and white for the two categorical variables.

Figure 3.

Predicted probabilities (standard errors) for home discharge across the five comorbidity groups. Estimates were obtained from the logistic regression model, which controlled for age, sex, race, marital status, comorbidity sum, duration since fracture, discharge FIM, and length of stay. The reported values were derived by grand-mean centering continuous variables and selecting female, white, and unmarried for the three categorical variables.

Table 1

Characteristics and outcome measures for patients receiving inpatient rehabilitation services for lower extremity fracture by pneumonia comorbidity.

	Total	Pneumonia		p-value
		No	Yes	
N	153,241	148,976	4,265	
Age, yrs	78 (12.1)	77.9 (12.1)	79.7 (11.0)	<.001
Female	71.9%	72.2%	61.8%	<.001
White	87.6%	87.5%	89.8%	<.001
Married	39.5%	39.5%	39.6%	.863
Duration to admit, days	6.0 (4.0)	5.9 (3.9)	7.8 (5.0)	<.001
Comorbidity sum	7.5 (2.6)	7.5 (2.6)	7.8 (1.8)	<.001
Comorbidity group				<.001
No tier	79.6%	81.8%	0.0%	
Pneumonia	2.5%	0.0%	88.1%	
Tier 3	12.3%	12.6%	0.0%	
Tier 2	4.2%	4.1%	10.2%	
Tier 1	1.5%	1.5%	1.6%	
FIM total admission	62.1 (15.7)	62.2 (15.7)	56.4 (16.1)	<.001
FIM total discharge	87.5 (19.6)	87.7 (19.4)	80.1 (21.8)	<.001
Length of stay, days	13.0 (5.3)	13.0 (5.3)	14.2 (5.7)	<.001
Home discharge	67.6%	67.9%	55.2%	<.001

Group values are reported as means (standard deviations) and column percentages. Bivariate tests of significance were performed using independent t-tests for continuous variables and chi-square tests for categorical variables.

Results of linear and logistic regression models showing the effects of tier comorbidity classification relative to pneumonia on length of stay, discharge FIM, and home discharge.

Table 2

	Length of stay ¹			Discharge FIM ²			Home discharge ³		
	b	95% CI		b	95% CI		OR	95% CI	
No tier	-0.44	-0.60	-0.28	1.84	1.42	2.25	1.19	1.09	1.29
Pneumonia	ref			ref			ref		
Tier 3	0.39	0.22	0.56	0.12	-0.33	0.56	1.02	0.93	1.11
Tier 2	0.74	0.55	0.94	-1.86	-2.37	-1.35	1.20	1.09	1.33
Tier 1	0.79	0.53	1.04	-3.81	-4.47	-3.15	0.88	0.77	1.00

¹Controlling for age, sex, race, comorbidity sum, duration since fracture, and admission FIM.

²Controlling for age, sex, race, comorbidity sum, duration since fracture, admission FIM, and length of stay.

³Controlling for age, sex, race, marital status, comorbidity sum, duration since fracture, discharge FIM, and length of stay.