



## Trajectories in functional recovery for patients receiving inpatient rehabilitation for unilateral hip or knee replacement



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### ABSTRACT

The purpose of this study was to explore trajectories of recovery in patients with lower extremity joint replacements receiving post-acute rehabilitation. A retrospective cohort design was used to examine data from the Uniform Data System for Medical Rehabilitation (UDSMR<sup>®</sup>) for 7434 patients with total knee replacement (TKR) and 4765 patients with total hip replacement (THR) who received rehabilitation from 2008 to 2010. Functional Independence Measure (FIM)<sup>™</sup> instrument ratings were obtained at admission, discharge, and 80–180 days after discharge. Random coefficient regression analyses using linear mixed models were used to estimate mean ratings for items within the four motor subscales (self-care, sphincter control, transfers, and locomotion) and the cognitive domain of the FIM instrument. Mean improvements at discharge for motor items ranged from 1.16 (95% confidence interval [CI]: 1.14, 1.19) to 2.69 (95% CI: 2.66, 2.71) points for sphincter control and locomotion, respectively. At follow-up mean motor improvements ranged from 2.17 (95% CI: 2.15, 2.20) to 4.06 (95% CI: 4.03, 4.06) points for sphincter control and locomotion, respectively. FIM cognition yielded smaller improvements: discharge = 0.47 (95% CI: 0.46, 0.48); follow-up = 0.83 (95% CI: 0.81, 0.84). Persons who were younger, female, non-Hispanic white, unmarried, with fewer comorbid conditions, and who received a TKR demonstrated slightly higher functional motor ratings. Overall, patients with unilateral knee or hip replacement experienced substantial improvement in motor functioning both during and up to six months following inpatient rehabilitation.

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## 1. Introduction

Lower extremity joint replacement, including THR and TKR, is the third most common impairment category among Medicare beneficiaries admitted to inpatient rehabilitation facilities (IRFs) in the United States (MedPAC, 2012). With the expanding number of older adults in the U.S. population, there will be an increased number of older persons with total hip and knee replacement receiving various forms of post-acute rehabilitation services in the coming decade (USBJD, 2008).

Patients with joint replacement receiving inpatient rehabilitation usually show substantial improvements in functional performance from admission to discharge (Herbold, Bonistall, & Walsh, 2011; Johanson, Cohen, Snyder, McKinley, & Scott, 2009; Khan, Ng, Gonzalez, Hale, & Turner-Stokes, 2008; Lieberman & Friger, 2006; Mahomed, Davis, & Hawker, 2008; Tian et al., 2012; Vincent & Vincent, 2007; Vincent, Vincent, Lee, & Alfano, 2006). Unlike acute injuries or trauma, such as stroke or hip fracture, joint replacement is typically an elective procedure, where the patients expect to achieve better physical functioning following surgery and rehabilitation. Relatively few studies, however, have compared longer-term functional outcomes between total hip and TKR patients following inpatient rehabilitation (Buntin et al., 2005; DeJong, Tian, & Smout, 2009a). Understanding patient characteristics and clinical factors associated with favorable and unfavorable outcome patterns is important as the setting for providing post-acute services changes with the introduction of accountable care

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organizations and bundled payment systems (Sood, Huckfeldt, Escarce, Grabowski, & Newhouse, 2011).

The purpose of this study was to model the trajectories of functional outcomes in a national sample of patients admitted to rehabilitation facilities in the United States with primary diagnoses of unilateral hip or knee replacement. Functional assessments were obtained at admission, discharge, and 80–180 days following discharge. We hypothesized that, after controlling for covariates, patients with total hip and knee replacements would demonstrate improved functional outcomes at discharge and at three to six-month follow-up, and that improvement in functional outcomes would be similar for the two impairment groups.

## 2. Materials and methods

### 2.1. Data source

This study was a secondary analysis of data submitted by rehabilitation facilities across the United States to the UDSMR. The UDSMR is the largest non-federal data registry in the U.S. containing both patient and facility level information submitted by individual facilities for reimbursement purposes (Granger et al., 2010). A subset of UDSMR facilities also collect follow-up data on patients via telephone interview at 80–180 days post discharge. For this study, we used data from patients in the UDSMR database with complete information related to functional status at admission, discharge and follow-up.

### 2.2. Study sample

We included records for patients who received rehabilitation services between 2008 and 2010. Our cohort was limited to cases with a primary impairment of unilateral hip replacement (rehabilitation impairment category 08.51) or unilateral knee replacement (rehabilitation impairment category 08.61). These criteria resulted in an eligible study sample of 13,033 patient records. We excluded patients if this was not their initial rehabilitation stay ( $n = 299$ ); time since surgery was greater than 45 days ( $n = 136$ ); rehabilitation length of stay was greater than 45 days ( $n = 1$ ); or admission to IRFs was from non-acute settings ( $n = 119$ ). Also excluded were patients who died during their inpatient rehabilitation stay ( $n = 46$ ); were less than 18 years old ( $n = 3$ ); had experienced rehabilitation program interruption ( $n = 46$ ); or were not living in community settings prior to admission to IRFs ( $n = 54$ ). Records with missing information related to the living status of patients at discharge (living with someone vs. alone,  $n = 130$ ) were also excluded. These criteria resulted in a final study sample of 12,199 records, representing approximately 93% of the eligible records.

### 2.3. Independent variable

Each patient's joint replacement status was categorized as TKR or THR and indicated as admission, discharge or follow-up. Persons with THR served as the reference category for all analyses.

### 2.4. Dependent variables

The dependent variables included the mean ratings for the self-care, sphincter control, transfer, and locomotion sub-scales of the motor domain of the FIM instrument. Self-care contains six items, transfer has three items, the sphincter control and locomotion sub-scales each contain two items. The FIM cognition domain includes five items. Performance on each item in the FIM instrument is rated on a scale of 1–7. Table 1 shows the level of functional independence that defines the numerical rating in terms of

**Table 1**

Functional performance criteria<sup>a</sup> for rating individual FIM instrument items.

Rating	Performance criteria	Category
7	Complete independence (timely, safely)	High
6	Modified independence (device)	
5	Supervision (subject = 100%)	Medium
4	Minimal assistance (subject $\geq 75\%$ )	
3	Moderate assistance (subject $\geq 50\%$ )	Low
2	Maximal assistance (subject $\geq 25\%$ )	
1	Total assistance (subject $< 25\%$ )	

Dashed lines indicate thresholds we used in creating broader categories (low, mid, high) of functional independence to facilitate interpretation and discussion of clinically meaningful transitions.

<sup>a</sup> Adapted from the Inpatient Rehabilitation Facility-Patient Assessment Instrument (IRF-PAI) available on Centers for Medicare and Medicaid Services website: <https://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/InpatientRehabFacPPS/IRFPAL.html>.

assistance required. To facilitate interpretation and discussion functional recovery over time using the FIM instrument, Table 1 also shows how we defined three broad categories of independence (high, medium, and low) representing clinically meaningful transitions. Assessments of functional status were conducted at admission, discharge, and 80–180 days following discharge. Admission and discharge data collection occurred in the facilities and were done by staff credentialed by the UDSMR. The follow-up ratings were obtained through telephone interviews by trained clinical staff. The validity and reliability of the FIM instrument, including data collection by phone interview, are well established (Ottenbacher, Hsu, Granger, & Fiedler, 1996; Segal, Gillard, & Schall, 1996; Smith, Illig, Fiedler, Hamilton, & Ottenbacher, 1996).

### 2.5. Covariates

Sociodemographic variables included age in years (categorized as  $< 65$ , 65–75, 75–85, and  $> 85$ ); gender; race/ethnicity (white or nonwhite); marital status (married versus not married); length of stay was the total number of days spent in the medical rehabilitation unit or hospital. Length of follow-up was the number of days between discharge and the next reassessment of functional independence. Number of comorbid conditions (comorbid sum) was calculated as the total number of comorbidities reported for each patient (range: 0–10).

### 2.6. Data analysis

Sociodemographic and clinical characteristics at admission and mean ratings for individual items within each of four functional subscales of the FIM motor subscales and FIM cognition domain over time were stratified by joint replacement status and examined through descriptive statistics. Comparisons across joint replacement status and patient characteristics were evaluated using chi-square tests and *t*-tests for categorical and continuous variables, respectively. Repeated-measures analysis of variance and post hoc tests were applied to mean item ratings for all five functional measures.

To account for the repeated assessments within each patient and variation among patients, random coefficient regression analyses (linear mixed models) were used to estimate mean ratings for individual items within the four motor subscales (self-care, sphincter control, transfers, and locomotion) and for the cognitive domain. Because the correlation of mean ratings between admission and discharge was higher than between admission and follow-up, AR (1) (autoregressive process with order 1) was specified as the covariance structure within patients.

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