

# Associations Between Preoperative Physical Therapy and Post-Acute Care Utilization Patterns and Cost in Total Joint Replacement

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**Background:** Health-care costs following acute hospital care have been identified as a major contributor to regional variation in Medicare spending. This study investigated the associations of preoperative physical therapy and post-acute care resource use and its effect on the total cost of care during primary hip or knee arthroplasty.

**Methods:** Historical claims data were analyzed using the Centers for Medicare & Medicaid Services Limited Data Set files for Diagnosis Related Group 470. Analysis included descriptive statistics of patient demographic characteristics, comorbidities, procedures, and post-acute care utilization patterns, which included skilled nursing facility, home health agency, or inpatient rehabilitation facility, during the ninety-day period after a surgical hospitalization. To evaluate the associations, we used bivariate and multivariate techniques focused on post-acute care use and total episode-of-care costs.

**Results:** The Limited Data Set provided 4733 index hip or knee replacement cases for analysis within the thirty-nine-county Medicare hospital referral cluster. Post-acute care utilization was a significant variable in the total cost of care for the ninety-day episode. Overall, 77.0% of patients used post-acute care services after surgery. Post-acute care utilization decreased if preoperative physical therapy was used, with only 54.2% of the preoperative physical therapy cohort using post-acute care services. However, 79.7% of the non-preoperative physical therapy cohort used post-acute care services. After adjusting for demographic characteristics and comorbidities, the use of preoperative physical therapy was associated with a significant 29% reduction in post-acute care use, including an \$871 reduction of episode payment driven largely by a reduction in payments for skilled nursing facility (\$1093), home health agency (\$527), and inpatient rehabilitation (\$172).

**Conclusions:** The use of preoperative physical therapy was associated with a 29% decrease in the use of any post-acute care services. This association was sustained after adjusting for comorbidities, demographic characteristics, and procedural variables.

**Clinical Relevance:** Health-care providers can use this methodology to achieve an integrative, cost-effective, patient care pathway using preoperative physical therapy.

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Arthritis is the most common cause of disability in the United States<sup>1</sup>. Approximately 50 million U.S. adults have physician-diagnosed arthritis, causing nearly one

in three working-age adults to report physical activity limitations. In 2003, the direct medical costs of arthritis were estimated to be \$81 billion, with an additional \$47 billion in lost

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earnings and indirect costs, resulting in a total estimated cost of \$128 billion per year<sup>1</sup>. The inflation-adjusted cost of hospitalizations for osteoarthritis almost tripled from 1997 to 2011, growing from \$5.1 billion to \$14.8 billion<sup>2</sup>. Total joint replacement surgery has emerged as the treatment of choice for end-stage arthritis of the hip or knee. The estimated growth rate from 2005 to 2030 is projected to be 174% (572,000 patients) for total hip arthroplasty and 673% (3.48 million patients) for total knee arthroplasty<sup>3</sup>.

As the volume of arthroplasties expands within the framework of increasing health-care costs, providers are under mounting pressure to identify the most cost-effective method of delivering high-quality, value-based health care<sup>4</sup>. The current Diagnosis Related Group (DRG) payment system has facilitated efficiencies in the hospital-based, acute-care phase of total joint replacement, resulting in a decreased length of stay from 9.1 days in 1990 to 3.7 days in 2008<sup>5,6</sup>. The decreased length of stay has been associated with increased costs in the post-acute care period. A recent study suggests that variation in post-acute care spending was the largest contributor to variation in Medicare spending across geographic regions in the United States<sup>7</sup>. Post-acute care spending accounted for 73% of the variation in spending, and the next largest category, inpatient spending, accounted for 27% of variation in total spending across regions. Controlling variations in post-acute care spending is a major opportunity to decrease the total episode-of-care costs of total joint replacement, and preoperative physical therapy use has been identified as a possible mechanism to decrease post-acute care utilization<sup>8</sup>.

The purpose of this study was to investigate the association between preoperative physical therapy and post-acute care utilization and the effect that preoperative physical therapy has on the total episode-of-care cost after total joint replacement within a hospital referral cluster in central and southwest Ohio.

## Materials and Methods

An observational cohort comparison study design was used to evaluate the associations between preoperative physical therapy and post-acute care use of skilled nursing facility and home health agency resources within the DRG 470 Limited Data Set. Data used for this study were supplied by the Research Data Assistance Center (ResDAC) as part of the Centers for Medicare & Medicaid Services (CMS) Innovation Center Bundled Payment Initiative<sup>9,10</sup>. Files included all claims for payments related to inpatient, outpatient, home health agency, skilled nursing facility, carrier, and durable medical equipment for Medicare Fee-for-Service beneficiaries within a thirty-nine-county hospital referral cluster in central and southeast Ohio. Institutional review board approval was obtained for this study.

Data analysis was carried out by defining an episode of care that started at hospitalization for DRG 470 and included all care for the following ninety days from discharge. We isolated unique hospitalizations for DRG 470 occurring in 2008 and 2009. We excluded patients with end-stage renal disease, those enrolled in a Medicare Advantage program during the ninety days after surgery, and those with no claims detail for the thirty days prior to or ninety days after hospitalization. We also excluded patients with ankle replacement, lower-extremity fractures as an indication, revision arthroplasties, and unicompartamental knee replacements. We used Medicare claims data to identify both preoperative physical therapy and post-acute care usage patterns on a patient level. Using all claims for Medicare beneficiaries after a hospitalization

for primary, elective total hip or knee replacement (anchor event), we constructed a ninety-day episode of care and identified post-acute care use. For patients with multiple anchor events during the time frame, we selected the first event. To categorize patient comorbid disease, we used the Agency for Healthcare Research and Quality (AHRQ) Clinical Classification System (CCS)<sup>11</sup>. Patients were characterized as having a CCS comorbid condition if they had a listed diagnosis on the index hospitalization that was listed in one of the 228 categories within the system.

To understand the effect of resources available to beneficiaries during the pre-acute and post-acute periods, we used the United States Department of Agriculture 2013 Urban Influence Codes (UICs) when classifying patients as urban or rural using their county of residence. This coding, as well as the Rural-Urban Commuting Area (RUCA) scheme, is usually preferred over other rural-urban demarcations because they better capture access to a local health-care infrastructure. The nine-point UICs were dichotomized into urban (UICs 1-4) and rural (UICs 5-9)<sup>12</sup>. To quantify total costs of care, we used payments taken directly from the CMS claims, including payments from CMS, secondary payers, and the beneficiaries; these were reduced by payments for disproportionate share and graduate medical education at the hospital level.

## Definitions of Preoperative Physical Therapy and Post-Acute Care

Use of preoperative physical therapy was determined by identifying billed physical therapy within thirty days prior to admission for surgery. The Current Procedural Terminology (CPT) billing codes CPT 97001: Physical Therapy Evaluation and CPT 97535: Self-Care/Home Management Training were used to identify patients receiving preoperative physical therapy. These codes constituted the majority of physical therapy delivered during the thirty days prior to the anchor event. Patients with at least one billed encounter using these CPT codes were deemed as having had preoperative physical therapy.

Post-acute care was defined as the use of a skilled nursing facility, home health agency, or inpatient rehabilitation during the ninety days after discharge from the hospital. Home health agency services included any approved billed service to CMS from a home health agency and included skilled-nursing care, home health aides, physical therapy, speech therapy, occupational therapy, and medical social services. To be categorized as a recipient of post-acute care, the patient required at least one billed day within a Medicare-defined skilled nursing facility, one visit from a home health agency, or at least one day of billed inpatient rehabilitation use.

## Statistical Analysis

To determine the associations between preoperative physical therapy and post-acute care on a univariate basis, we evaluated the relationship using chi-square statistics. Because patient age and comorbid disease could confound the association between preoperative physical therapy and post-acute care use, we first used bivariate analysis to identify associations that were both significant and clinically important associations between patient attributes and both preoperative physical therapy and post-acute care utilization. Because post-acute care use is the outcome of interest, we then used multivariate techniques to control for patient demographic characteristics, comorbid disease, type of procedure, and rural or urban residence to evaluate the independent effect of each of these patient attributes, identified as significant in either post-acute care use or preoperative physical therapy, on post-acute care use. The model used all significant associations identified on a univariate basis in a stepwise logistic regression; variables with a p value of  $\leq 0.05$  were selected. Using the results of the multivariate model, we summed the predicted probabilities for post-acute care use across two cohorts of patients, those receiving preoperative physical therapy and those not receiving preoperative physical therapy, and compared them with the observed rate using observed-to-predicted ratios. Ninety-five percent confidence intervals were then constructed around the observed-to-predicted ratios to determine the significance of the findings. These predicted rates of

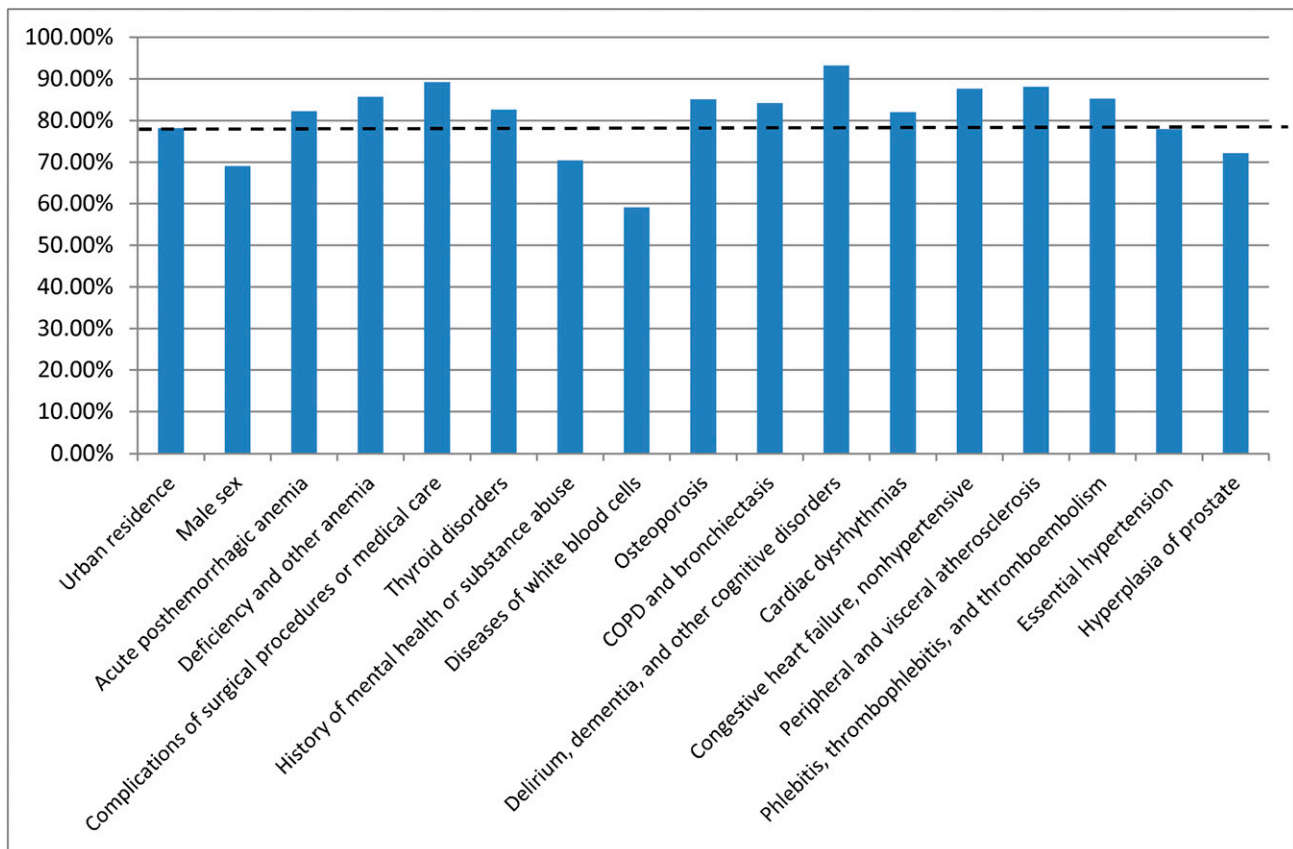


Fig. 1  
A bar graph showing the comorbid diseases and demographic characteristics for the percentage of patients who used post-acute care services after total joint replacement. The dashed line indicates the mean usage of post-acute care. COPD = chronic obstructive pulmonary disease.

post-acute care use were then compared with the observed rates of post-acute care use in each cohort.

We approached this analysis by using all variables found to have both a significant association ( $p \leq 0.05$ ) with post-acute care use and clinical relevance.

Because the payments for the episode of care were non-normally distributed, we trimmed the payment data set and excluded patients with the highest 5% of payments to avoid violating the conventions of linear regression. This trimmed data set was used to compare costs in the preoperative physical therapy group compared with the non-preoperative physical therapy group. A linear regression was used on this database to evaluate the independent effect of preoperative physical therapy on the total cost of care, including all AHRQ CCS categories, rural or urban residency, sex, and age as independent variables, while excluding those variables that did not reach conventional levels of significance.

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One author (J.G.) received travel reimbursement from OhioHealth Research Institute.

### Results

A total of 4733 index cases were available through the DRG 470 Limited Data Set for analysis across the hospital referral cluster for 2008 and 2009 using the inclusion and exclusion criteria previously listed. The mean age (and standard deviation) of the group was  $71.2 \pm 8.8$  years, and 65.1% of the cohort were female.

### Preoperative Physical Therapy and Post-Acute Care Associations

Table I displays the post-acute care utilization for the cohort of patients overall and by preoperative physical therapy use. Overall, 77.0% of patients used some type of post-acute care services. In the cohort of patients receiving preoperative physical therapy, only 54.2% used some type of post-acute care services. For patients without preoperative physical therapy, 79.7% used post-acute care services. A significantly lower rate of post-acute care use was found in patients receiving preoperative physical therapy ( $p < 0.0001$ ).

Figure 1 displays the significant associations ( $p \leq 0.05$ ) among demographic characteristics, AHRQ CCS-defined comorbid illness, and post-acute care utilization. Three of the comorbid states in Figure 1 were associated with decreased post-acute care use, including history of mental health or substance abuse, diseases of the white blood cells, and hyperplasia of the prostate; all other comorbid disease were associated with an increase in post-acute care use. The frequency of post-acute care use was significantly lower in male patients ( $p < 0.0001$ ) and significantly higher in patients with urban residence ( $p < 0.0002$ ). A significantly older mean age ( $p < 0.0001$ ) was found for patients using any post-acute care (72.1 years) compared with patients not using post-acute care (68.3 years).

**TABLE I Distribution of Post-Acute Care Utilization Overall and by Preoperative Physical Therapy Use**

|   | Overall*†<br>(N = 4733) | Patients Receiving<br>Preoperative Physical<br>Therapy*† (N = 498) | Patients Not Receiving<br>Preoperative Physical<br>Therapy*† (N = 4235) | P Value |
|---|-------------------------|--|---|---------|
| Use of any post-acute care services   | 3646 (77.0%)            | 270 (54.2%)  | 3376 (79.7%)  | <0.0001 |
| Use of skilled nursing facility within<br>ninety days post-discharge          | 2004 (42.3%)            | 155 (31.1%)  | 1849 (43.7%)  | <0.0001 |
| Use of home health service within<br>ninety days post-discharge               | 2621 (55.4%)            | 201 (40.4%)  | 2420 (57.1%)  | <0.0001 |
| Use of inpatient rehabilitation facility<br>within ninety days post-discharge | 183 (3.9%)              | 10 (2.0%)  | 173 (4.1%)  | 0.027   |

\*The values are given as the number of patients, with the percentage in parentheses. †The total percentage is more than 100% because of the mixed use of options.

Figure 2 displays the significant associations between patient comorbid disease and the use of preoperative physical therapy. Factors that did not reach significance included age, male sex, and urban residence. The mean age was 71.2 years in both groups of patients receiving and not receiving preoperative physical therapy. The rate of preoperative physical therapy was 11.0% in urban patients compared with 9.84% in rural patients and 11.0% in male patients compared with 10.3% in female patients, and none of these rates were significantly different.

The results of our multivariate analysis are displayed in Table II. The odds ratios are reported for the logistic regression analysis of all 4733 patients using the previously described stepwise model. Demographic variables, including age, sex, and urban status, remained associated with post-acute care use in the model as well as the listed comorbidities and complications of care.

The significant demographic and comorbid variables in the model ( $p < 0.05$ ), displayed in Table II, were used to create predicted rates of post-acute care use in patients receiving

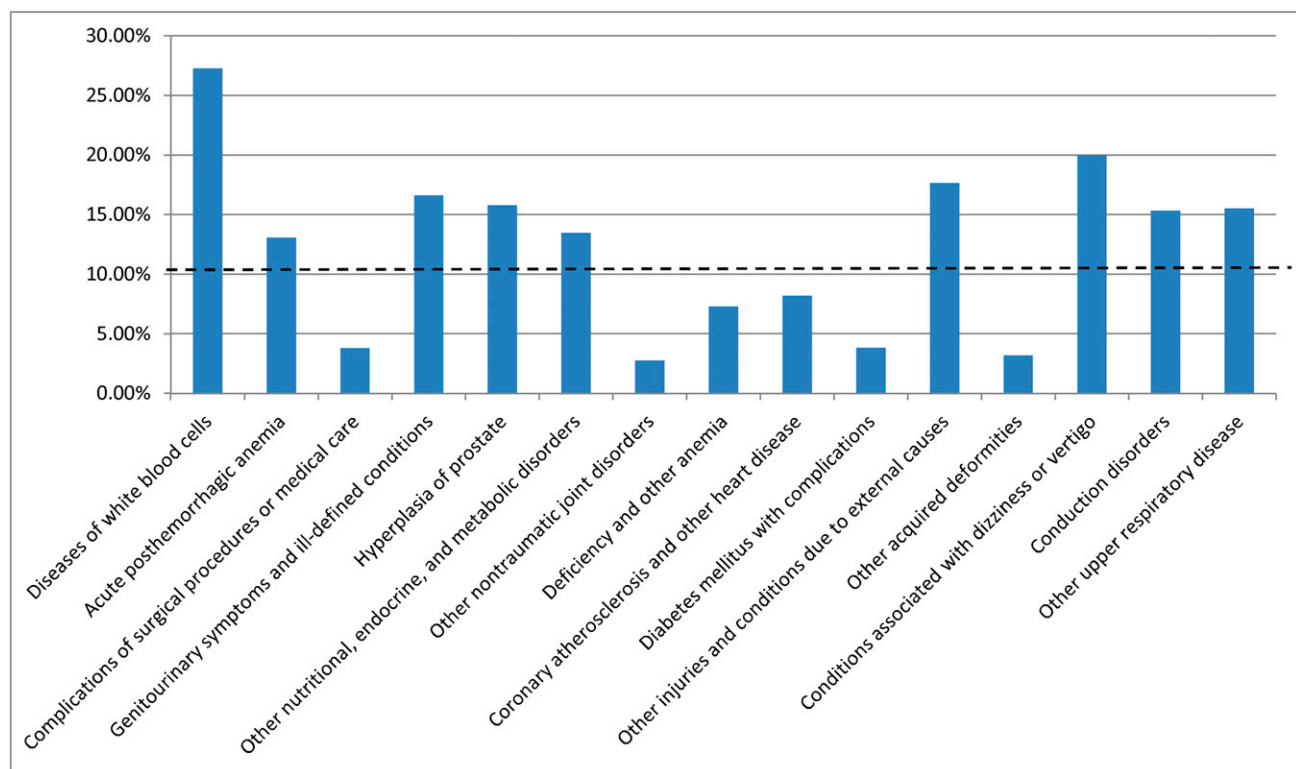


Fig. 2

A bar graph showing the comorbid diseases for the percentage of patients who had used preoperative physical therapy before total joint replacement. The dashed line indicates the mean usage of preoperative physical therapy.

**TABLE II Logistic Regression Analysis Using a Stepwise Selection of Variables Associated with Post-Acute Care Use**

| Patient Attribute  | Odds Ratio for the Use of Post-Acute Care* |
|--|--|
| Male sex   | 0.54 (0.47 to 0.63)                        |
| Hip surgery  | 0.85 (0.73 to 0.99)                        |
| Age  | 1.05 (1.04 to 1.05)                        |
| Acute posthemorrhagic anemia                             | 1.83 (1.57 to 2.13)                        |
| Deficiency and other anemia                              | 2.24 (1.74 to 2.88)                        |
| Complications of surgical procedures or medical care     | 2.58 (1.74 to 3.81)                        |
| Diseases of white blood cells                            | 0.46 (0.29 to 0.73)                        |
| Chronic obstructive pulmonary disease and bronchiectasis | 1.84 (1.38 to 2.47)                        |
| Delirium, dementia, and other cognitive disorders        | 2.69 (1.07 to 6.79)                        |
| Congestive heart failure, nonhypertensive                | 2.03 (1.19 to 3.46)                        |
| Peripheral and visceral atherosclerosis                  | 2.08 (1.18 to 3.64)                        |
| Urban residence  | 1.33 (1.12 to 1.58)                        |
| Other nontraumatic joint disorders                       | 1.59 (1.00 to 2.52)                        |

\*The values are given as the odds ratio, with the 95% confidence interval in parentheses.

**TABLE III Observed, Predicted, and Observed/Predicted Rates of Post-Acute Care Use in Patients with and without Preoperative Physical Therapy**

| Presence of Preoperative Physical Therapy | No. of Cases | Observed Rate of Post-Acute Care Use | Predicted Rate of Post-Acute Care Use | Observed/Predicted Ratio* |
|---|--------------|--------------------------------------|---------------------------------------|---------------------------|
| No  | 4235         | 79.7%                                | 77.1%                                 | 1.03 (0.85 to 1.25)       |
| Yes                                       | 498          | 54.2%                                | 76.3%                                 | 0.71 (0.52 to 0.98)       |

\*The values are given as the ratio, with the 95% confidence interval in parentheses.

**TABLE IV Payment Differences in Patients with or without Preoperative Physical Therapy, Trimmed Data at the 95th Percentile of Total Payments**

| Costs                     | Overall* (N = 4500) | No Preoperative Physical Therapy* (N = 4023) | Preoperative Physical Therapy* (N = 477) | Difference* | P Value |
|---------------------------|---------------------|--|--|-------------|---------|
| Episode of care           | \$19,818            | \$19,911                                     | \$19,040                                 | \$871       | 0.005   |
| Hospitalization           | \$10,033            | \$10,054                                     | \$9858                                   | \$196       | 0.007   |
| Hospitalization physician | \$2070              | \$2068                                       | \$2086                                   | −\$18       | 0.419   |
| Skilled nursing facility  | \$3090              | \$3206                                       | \$2113                                   | \$1093      | <0.001  |
| Rehospitalization         | \$811               | \$744  | \$1384                                   | −\$640      | <0.001  |
| Total outpatient          | \$689               | \$657  | \$967                                    | −\$310      | <0.001  |
| Home health agency        | \$1645              | \$1701                                       | \$1173                                   | \$528       | <0.001  |
| Inpatient rehabilitation  | \$330               | \$349  | \$176                                    | \$173       | 0.025   |
| Ambulatory surgery center | \$19                | \$20   | \$16                                     | \$4         | 0.581   |
| Durable medical equipment | \$143               | \$145  | \$125                                    | \$20        | 0.195   |

\*The values are given as the mean payment.



preoperative physical therapy compared with patients not receiving preoperative physical therapy. Table III displays the observed and predicted rates and observed/predicted ratio across the two groups with 95% confidence intervals (95% CIs) constructed around the observed rate. Because the 95% CI around the observed rate in the group receiving preoperative physical therapy does not include 1.0 (unity), the observed and predicted rates are significantly different ( $p < 0.05$ ); the absolute difference is a 29% reduction in post-acute care use in the group that received preoperative physical therapy.

Given the skewed distribution of payments, to reliably determine the effect of preoperative physical therapy on the cost of care, we trimmed total payments at the 95th percentile (\$41,113) for the episode of care, including only cases below this total cost of care. The results of the comparison between costs of care in the preoperative physical therapy or non-preoperative physical therapy cohorts are displayed in Table IV. The unadjusted reduction in costs associated with preoperative physical therapy was significant ( $p = 0.005$ ) at \$871, with the most cost reduction occurring in payments to skilled nursing facilities, home health agencies, and inpatient rehabilitation facilities. To understand the effect of adjusted costs, we used a linear regression model including all demographic, comorbid, and location-of-residence data. The results of this analysis demonstrated a \$1215 reduction in payments associated with preoperative physical therapy after adjustment for all significant variables.

## Discussion

Our study demonstrates a significant reduction in post-acute care use associated with use of physical therapy during the preoperative period for total joint replacement surgery. Patients in our study receiving preoperative physical therapy showed a 29% reduction in post-acute care use, resulting in an adjusted cost reduction of \$1215 driven largely by reduced payments for skilled nursing facility and home health agency care. To our knowledge, this is the first empirical evaluation (and demonstration) of the association between preoperative physical therapy and post-acute care use in the literature. Previous studies have suggested that preoperative physical therapy, also known as “prehabilitation,” is one variable in a comprehensive total joint replacement care pathway that may improve the value of care for patients. In a national survey of health-care leaders across Canada, Landry et al. evaluated the factors that affect and mediate the demand for rehabilitation services after total joint replacement<sup>8</sup>. The overall results of that study indicated that the demand for skilled services after total joint replacement is increasing and that new, innovative approaches to care are needed to align the increasing demand with supply. Prehabilitation was noted as a possible mechanism to reduce overall rehabilitation demand after total joint replacement. It is unclear whether this was due to the physiologic or psychologic effects of preoperative physical therapy, and the current literature on the results and efficacy of preoperative physical therapy is mixed and inconsistent<sup>13-29</sup>.

With an average preoperative physical therapy cost of \$100 per patient, preoperative physical therapy use in the current

study was generally limited to one or two sessions and was not dose dependent. This suggests that the value of preoperative physical therapy was primarily due to patient training on post-operative assistive walking devices, planning for recovery, and managing patient expectations, and not from multiple, intensive training sessions to develop strength and range of motion. This is important to note, as some Medicare Administrator Contractor audits of medical necessity before total joint replacement have required three months of preoperative physical therapy use before arthroplasty. This requirement may be focused on evaluating medical necessity, an approach that has a limited evidence base and does not take into consideration the degree of osteoarthritis severity<sup>30</sup>. Our evaluation of preoperative physical therapy is focused on the episode of care and the relationship between limited physical therapy services and the reduction of post-acute care use. Although we were not able to directly stratify preoperative physical therapy use with osteoarthritis disease severity, our trigger event was defined by an orthopaedic surgeon recommending surgery, which is a selection bias for advanced osteoarthritis. In this setting, preoperative physical therapy appears to provide value within the structure of a standardized preoperative joint replacement education and planning program, in which physical therapists may play an important role. Preoperative physical therapy use in our study may have also been a marker of existing clinical care pathways for patients undergoing total joint replacement; these clinical care pathways have generally been shown to be cost-effective but often have ignored post-acute care costs<sup>31,32</sup>. The process of engaging the patient prior to surgery and providing education or physical conditioning fits well with a patient-centered approach to health-care delivery.

The strengths of this study included the ability to evaluate all care delivered during the episode of care, which was afforded by having data across the continuum as provided by CMS. The data represented 169 hospitals in a geographically diverse area including both urban and rural settings in the state of Ohio. The methods used to determine the independent effect of preoperative physical therapy on post-acute care utilization included logistic and linear regression and yielded consistent results in terms of effect.

There were limitations to this study. As an observational study design, bias for the non-random use of preoperative physical therapy may potentially confound its contribution to our estimates of post-acute care use. After logistic risk adjustment to remove potential confounding effects of demographic characteristics, type of surgery, and presence of comorbid disease, we nevertheless found that the association between preoperative physical therapy and reduced post-acute care use remained strong. We verified this association via re-estimating the logistic regression model (with matching weights) on a propensity score-based matched subsample and found the same association between preoperative physical therapy and post-acute care use (data not included here). We also evaluated differences in preoperative physical therapy use across comorbid states, and they were similar to the comorbid differences associated with post-acute care use.

Another limitation may have been our focus; we evaluated care patterns in Medicare Fee-for-Service patients only, and, as such, the results may not be generalizable to commercial or managed care populations. The total payments of care were used as the cost of care in this study, but the actual costs to the providers of care may be different from total payments.

This analysis was performed within the framework of the CMS Bundled Payment Initiative, as part of an evaluation of opportunities to improve the care of patients undergoing hip or knee replacement surgery within our health system and to develop evidenced-based, cost-effective health-care delivery systems.

The appropriate utilization of post-acute care was not defined in this study. Wasielewski et al. found that the preoperative medical and physical patient morbidity influenced the postoperative results in patients undergoing total knee arthroplasty, with increasing comorbidities resulting in increased costs and lower outcome scores<sup>33</sup>. Hansen et al. used a preoperative risk assessment tool to identify patients at risk for unintended postoperative recovery pathways after total joint replacement<sup>16</sup>. Patients were considered at risk if the screening interview revealed malnutrition or recent unintended weight loss, uncontrolled medical conditions, less than thirty minutes of daily physical activity, smoking, or excessive alcohol use. The preoperative optimization protocol for these patients was based on the results of the screening examination and included preoperative physical activity education and resources when appropriate. Nearly half of the seventy-eight patients in the study by Hansen et al.<sup>16</sup> were at risk in one or more categories, and their preoperative education and resource allocation method was effective at reducing an unintentional postoperative recovery course, including prolonged recoveries and medical complications after surgery.

In summary, our data suggest that preoperative physical therapy use can decrease post-acute care utilization and the total episode-of-care cost for patients who undergo total joint replacement surgery. Total episode-of-care cost reductions were substantial with preoperative physical therapy use, with an estimated CMS payment reduction of approximately \$1215 per patient. These data are clinically relevant and can be used in the development of cost-effective and value-based total joint replacement programs. More research is needed to understand the optimal allocation of resources between preoperative and

postoperative care in specific populations of patients with total joint replacement. As payments in health care move from a fee-for-service basis to more global payments that require some risk sharing by providers, the ability to manage populations across the continuum to high-quality outcomes at low cost will be imperative<sup>34</sup>. ■

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