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RESEARCH ARTICLE

Use of Physical Therapy Following Total Knee Replacement Surgery: Implications of Orthopedic Surgeons' Ownership of Physical Therapy Services

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Objective. To examine whether the course of physical therapy treatments received by patients who undergo total knee replacement (TKR) surgery differs depending on whether the orthopedic surgeon has a financial stake in physical therapy services.

Data. Sample of Medicare beneficiaries who underwent TKR surgery during the years 2007–2009.

Study Design. We used regression analysis to evaluate the effect of physician self-referral on the following outcomes: (1) time from discharge to first physical therapy visit; (2) episode length; (3) number of physical therapy visits per episode; (4) number of physical therapy service units per episode; and (5) number of physical therapy services per episode expressed in relative value units.

Principal Findings. TKR patients who underwent physical therapy treatment at a physician-owned clinic received on average twice as many physical therapy visits (8.3 more) than patients whose TKR surgery was performed by a orthopedic surgeon who did not self-refer physical therapy services ($p < .001$). Regression-adjusted results show that TKR patients treated at physician-owned clinics received almost nine fewer physical therapy service units during an episode compared with patients treated by nonself-referring providers ($p < .001$). In relative value units, this difference was 4 ($p < .001$). In contrast, episodes where the orthopedic surgeon owner does not profit from physical therapy services rendered to the patient look virtually identical to episodes where the TKR surgery was performed by a surgeon nonowner.

Conclusions. Physical therapists not involved with physician-owned clinics saw patients for fewer visits, but the composition of physical therapy services rendered during each visit included more individualized therapeutic exercises.

Key Words. Use of physical therapy, self-referral, total knee replacement surgery

The number of total knee replacement (TKR) surgeries, also known as total knee arthroplasty, has grown substantially over the past two decades. Approximately 350,000 TKR procedures were performed in 2002, but this number increased to around 500,000 by 2007 and jumped even more to 719,000 by 2010 (Mahomed et al. 2005; Li et al. 2013; Centers for Disease Control and Prevention 2014). Notably, the growth of TKRs is especially rapid among persons aged 40–64 years who account for 40 percent of all initial procedures (Weinstein et al. 2013; Losina et al. 2015). Recent evidence indicates the most significant driver of increased demand for TKR surgery is the dramatic increases in overweight and obese adults in the U.S. population (Derman, Fabricant, and David 2014).

Although demand for TKR surgery grew rapidly over this time period, Medicare surgeon per-case reimbursement for TKR measured in real dollars fell from approximately \$3,000 in 1995 to \$1,560 in 2009 (Derman, Fabricant, and David 2014). Surgeons who specialize in TKR procedures also tend to perform total hip replacement (THR) surgery, so a reduction in the fee-for-knee replacements may induce these physicians to perform more THR procedures. Yet the surgeon per case reimbursement for THR surgery measured in real dollars also declined from \$2,840 to \$1,460 between 1995 and 2009. Thus, the surgeon's reimbursement for both procedures fell by about 48 percent, though some of the reductions may have been offset by greater productive efficiency, in part made possible through new technology and techniques.

Orthopedic surgeons, faced with income reductions from performing joint replacement procedures, may attempt to offset such losses. This could be accomplished by performing a greater number of the surgical procedure whose fee has been cut, and/or they may also expand their scope of practice to include ancillary services (Mitchell, Hadley, and Gaskin 2000). Physician acquisition of ancillary services represents one type of self-referral arrangement, that is, the practice whereby physicians refer their patients to facilities in which the physician has an ownership interest or financial relationship (Mitchell 2007; Hillman and Goldsmith 2010). Although self-referral is generally illegal, the federal prohibition contains exceptions that permit physicians to self-refer under certain conditions. The most notable exception relates to in-office

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ancillary services; this provision enables physicians and group practices to integrate “designated health services” into their practice without violating the law (Mitchell 2007; Hillman and Goldsmith 2010).

Numerous studies have documented increased frequency of use, greater use of services per episode, and higher expenditures that occur after physicians incorporate ancillary services into their practices. Much of this research has focused on the consequences of self-referral on use of advanced imaging technologies (Gazelle et al. 2007; Baker 2010; Hughes, Bhargavan, and Sunshine 2010; Medicare Payment Advisory Commission 2010; Shreibati and Baker 2011). The consensus is that self-referral arrangements result in increased use of advanced imaging and higher costs per episode of care in comparison to situations where patients are referred to independent radiologists. While patient convenience is often cited as one justification for self-referral, some evidence refutes this contention, as few advanced imaging procedures are performed on the same day as the related office visit (Medicare Payment Advisory Commission 2010; Sunshine and Bhargavan 2010). To our knowledge, only three recent articles have examined how self-referral affects use of other ancillary services, in particular clinical laboratory testing, anatomic pathology services, and intensity modulated radiation therapy (Bishop, Federman, and Ross 2010; Mitchell 2012, 2013).

Receipt of physical therapy following TKR surgery is regarded as the standard of care. Thus, acquisition of physical therapy services represents another potential source of revenue for orthopedic surgeons who specialize in knee and hip replacement surgeries. An orthopedic surgeon who has a financial stake in physical therapy services has financial incentives to maximize the amount of revenue derived from physical therapy performed on each patient, so long as physical therapy services yield a positive margin to the practice. Revenues derived from physical therapy services rendered to each patient following TKR surgery represent a source of additional income for each orthopedic surgeon owner. This additional income is not available to surgeons who have not established ownership in physical therapy services.

Research dating back to the 1990s found that physician self-referral arrangements for physical therapy results in increased use of services, higher episode costs, and lower quality of care (Mitchell and Scott 1992; Swedlow et al. 1992; Mitchell and Sass 1995). More recently, the General Accountability Office (2014) conducted an analysis of Medicare claims records to examine the effect of physician self-referral arrangements involving physical therapy. The GAO found that self-referring physicians referred more beneficiaries for physical therapy, but these patients received fewer physical therapy

treatments than their counterparts treated by non-self-referring providers. One explanation for the GAO findings is that self-referring physicians send lower acuity patients for physical therapy, and this may account for why such patients receive a less intensive course of treatment. Alternatively, their findings may reflect greater incentives by independent physical therapists to induce demand and provide more procedures per episode. Because the GAO did not focus on specific health conditions or surgical procedures, it is unclear which explanation is driving the differences in practice patterns that emerged by self-referral status. Notably, the “dated” studies cited above did not control for either procedure type or health condition. Thus, to our knowledge, no study has examined whether the course of physical therapy treatments received by patients who undergo joint replacement surgery differs depending on whether the orthopedic surgeon has a financial stake in physical therapy services. This study addresses this significant gap in knowledge by analyzing a sample of Medicare beneficiaries who underwent TKR surgery. Medicare requires that all patients obtain a physician prescription for physical therapy to initiate treatment so beneficiaries cannot undergo physical therapy without a physician’s referral.

Conceptual Framework

The theory of demand inducement assumes that the consumer has relatively poor information about the quality and efficacy of medical care. The physician, acting as the patient’s agent, may induce demand by recommending treatment, the costs of which exceed the benefit to the patient. Dranove (1988) developed a comprehensive game theoretic model of demand inducement. The Dranove model recognizes that a physician’s ability to engage in demand inducement is contingent on a patient’s willingness to undergo additional treatments as well as the physician’s gain from recommending care that may have little effect on the patient’s condition. Inducement may be either direct or indirect. With direct inducement, the physician recommends treatments that the physician renders personally. In this case, the orthopedic surgeon recommends that more patients undergo joint replacement surgery. Indirect inducement occurs when the physician recommends a treatment delivered by another provider, but the physician does not personally provide the service. For example, the physician owner recommends that the patient undergo ancillary services (physical therapy, diagnostic imaging) which are part of the physician’s practice. Given the cost and capacity

constraints of physician labor, at some point indirect inducement via investment in ancillary services becomes a more attractive strategy than additional direct inducement.

The quality of care may also be affected by asymmetrical information. If patients are relatively ill informed about the efficacy of treatment, then physicians can increase their net return by “cheating” on the margin. For example, in the case of physical therapy, a physician might employ few or no physical therapists and instead substitute lower cost employees such as exercise physiologists and personal trainers to perform so-called physical therapy.

In this study, we test the following set of hypotheses:

Hypothesis 1: Financial incentives linked to self-referral will prompt orthopedic surgeons with ownership interests in physical therapy services to prescribe more visits for TKR patients.

Hypothesis 2: Given that physical therapy visits vary in the quantity of services provided, financial incentives linked to self-referral will prompt orthopedic surgeons with ownership interests in physical therapy services to prescribe more physical therapy service units per episode for TKR patients.

Hypothesis 3: A physician owner might shirk on quality and substitute lower cost unlicensed medical assistants to perform physical therapy rather than hire a licensed physical therapist. Our data do not identify the credentials of health care practitioners rendering physical therapy to the patients so we cannot examine this directly. But we indirectly examine this hypothesis by positing that patients treated at physician-owned practices receive a higher percentage of services not requiring the training and expertise of physical therapists. For example, “modalities” (or passive activities such as heat treatments) can easily be performed by unlicensed medical assistants as opposed to hands-on or patient-engaged physical therapy.

Description of Data

The data consist of a sample of Medicare beneficiaries who received any service from physician respondents to the 2008 Health System Change Health Tracking (HSC-HT) Physician Survey at any time during the three calendar years 2007–2009. The HSC-HT physician survey used the AMA Masterfile as its sampling frame to obtain a nationally representative random sample ($n = 4,720$) of nonfederal physicians who provided at least 20 hours of direct patient care. The survey was administered by mail with telephone follow-up; the weighted response rate was 62 percent. The linked sample included nearly 2 million elderly fee-for-service Medicare beneficiaries without end-stage

renal disease. For each, all Part A and Part B claims data for calendar years 2007–2009 were available. Linkage was accomplished using the National Provider Identifier (NPI), which was available from the HSC-HT survey sampling frame. Because of the indirect method of sampling beneficiaries, the sample was somewhat sicker than the overall elderly Medicare population in the traditional fee-for-service system. This is because patients who see a larger number of unique physicians have a greater probability of sample inclusion. Weights have been developed by HSC to make the beneficiary sample approximately nationally representative. The medical claims data contain information on the following items: date of service, type of procedure or services received, diagnosis codes, number of units of each service, amount paid by the insurer. Each database also includes basic demographic information for each insured individual. Claims include all physician and physical therapist line item services at the Healthcare Common Procedure Coding System (HCPCS) level that are billed to Medicare. Moreover, the data include tax identification numbers for each provider, a proxy for practice organizations, which enables us to distinguish episodes where the referring physician billed for physical therapy services.

METHODS

Construction of Episodes

Using claims from the inpatient, carrier (part B), hospital outpatient, and beneficiary summary files, we constructed episodes of care for Medicare patients who underwent a TKR. We selected all beneficiaries who underwent a single total knee replacement (DRG 470) in conjunction with HCPCS code 27447 (total knee arthroplasty) and who were discharged to home. To obtain a more homogeneous sample of patients, we excluded episodes if the patient had a knee replacement with multiple complicating conditions (DRG 469) or if the patient had bilateral TKR surgery; fewer than 20 episodes were excluded for either reason. Patients were also excluded if their first physical therapy visit occurred more than 30 days after discharge. Receipt of physical therapy within 30 days of discharge from the hospital is regarded as the standard of care following TKR surgery. In fact, empirical evidence (Bandholm and Kehlet 2012; den Hertog et al. 2012) demonstrates that the sooner that TKR patients begin a course of physical therapy following surgery, the better the outcomes (shorter hospital stays, more rapid return of muscle strength, and performance). To accurately assign self-referral status to each episode, we

excluded cases where physical therapy was rendered in multiple locations (i.e., hospital outpatient department and physician office).

For each beneficiary who met these criteria, we selected all their claims and sorted them in chronological order by date of service. Although claims for other services may have occurred during each episode, the relevant claims for this analysis were for physical therapy services related to the TKR surgery. The beginning of each episode was earmarked as the date of discharge after TKR surgery. Receipt of physical therapy services during each episode was identified by the presence of one or more claims with HCPCS codes in the 97001–97599 range. These codes identify physical medicine and rehabilitation services, including evaluations, modalities, therapeutic procedures, tests, and measurements. All subsequent physical therapy claims were considered part of each episode. We defined the termination point of each episode as the date of the last physical therapy visit followed by a 3-month clean period during which the patient received no physical therapy services.

Assignment of Self-Referral Status

Each claim record contains the tax identification number (an organization indicator) for each provider who submitted a claim to Medicare. In addition, each claim includes the specialty of the health care professional who performed and billed for each service. We used this information to earmark physical therapy services that were provided by physician practices. In general, if the orthopedic surgeon billed for and was listed as the performing provider of physical therapy services, the orthopedic surgeon was designated as a physician owner and the episode was classified as “self-referring.” Unfortunately, when a physician is listed as the performing provider of physical therapy services, the health care practitioner who actually rendered physical therapy treatments is unknown. Thus, physical therapy treatments might be provided by physical therapists, but they could also be performed by other nonphysician staff—such as an unlicensed medical assistant. If the provider specialty code on the claim lists “physical therapist or physical therapist assistant” and the physical therapist shares the same tax identification number as the orthopedic surgeon who performed the knee replacement procedure, then the surgeon was classified as a physician owner and the episode was designated as self-referring. In such situations, the physical therapist was most likely employed by the referring orthopedic surgeon or their practice organization.

The next step required establishing the criteria to distinguish “physician nonowners” and “non-self-referring” episodes. From the specialty codes listed for the billing and performing providers, we were able to identify physical therapy services that were performed and billed by either a physical therapist or physical therapist assistant. These episodes were classified as non-self-referring if the orthopedic surgeon who performed the TKR surgery did not have the same tax identification number as the physical therapist. We recognize for some non-self-referring episodes the patient had TKR surgery performed by an orthopedic surgeon who had established ownership in physical therapy services. Although we labeled these episodes as non-self-referring, we distinguished them from non-self-referring episodes where the orthopedic surgeon did not have a financial stake in physical therapy services.

Empirical Models and Analysis

We conducted two sets of comparisons to evaluate the effect of orthopedic surgeons having ownership in physical therapy services. First, we compared self-referring episodes where a physician owner performed the TKR surgery to non-self-referring episodes where a physician nonowner performed the TKR surgery. Second, we compared the two types of non-self-referring episodes where the key distinguishing feature was whether the orthopedic surgeon who performed the TKR surgery had ownership in physical therapy services. The latter comparisons provide a counterfactual that is rarely available with observational data; that is, do the referral patterns of physician owners differ depending on whether they benefited financially from prescribing physical therapy services.

We analyzed the following dependent variables: (1) time (in days) from discharge after TKR surgery to first physical therapy visit; (2) episode length in days; (3) number of physical therapy visits per episode; (4) number of physical therapy service units—defined as 15-minute increments that are used for billing of physical therapy services—per episode; and (5) quantity of physical therapy services per episode expressed in relative value units (RVUs). The fourth and fifth dependent variables can differ as physical therapy visits differ in terms of the quantity of services provided to patients. Table 1 contains a description of each dependent variable. For each of these measures, the null hypothesis assumes that there was no difference in the outcome of interest controlling for whether the episode was classified as “self-referral.” The null hypothesis was evaluated using a two-tailed test of difference between the

Table 1: Description of Outcome Variables

<i>Variable</i>	<i>Description</i>
Days from discharge to first physical therapy visit	The number of days from date of discharge from hospital to initiation of a course of physical therapy.
Episode length	The length of time, measured in days, from the first physical therapy visit following total knee replacement surgery to the last physical therapy visit.
Number of physical therapy visits per episode	Visits are defined by receipt of one or more physical therapy services on a specific date. For example, if a patient received physical therapy services on three different dates during the episode, the number of visits for this beneficiary is 3.
Number of physical therapy services per episode	The number of physical therapy service units per episode measures the count of the number of unique HCPCS codes in the range 97001–97599. These codes identify physical medicine and rehabilitation services including evaluations, modalities, therapeutic procedures, tests, and measurements. A HCPCS code may be billed multiple times for each visit as most physical therapy services are performed and billed in 15-minute increments. Together, these define the total number of service units.
Number of physical therapy RVUs per episode	The number of physical therapy services expressed in relative value units (RVUs). RVUs are a measure of value employed to determine payment for physician services and other health care practitioners under the Medicare program. The score reflects the complexity of each service.

means. For the first set of comparisons, we also performed confirmatory regression analysis to evaluate the effect of episode self-referral status on each outcome, while controlling for confounding factors (age, gender, Charlson comorbidity score, time period, and Medicare geographic locality payment area).

We employed two estimation approaches: least squares regression and hierarchical multilevel random effects generalized linear mixed model using Stata’s MEGLM routine. We used the second approach to address the hierarchical nature of our data as a portion of our patient sample was clustered within physician practices. The generalized linear mixed model assumes that the relationship between the mean of the dependent variable and the fixed and random effects can be modeled as a linear function, the variance is not a function of the mean, and that the random effects follow a normal distribution. Although the model has the flexibility to be adapted for nonnormal distributions, we did not specify alternative distributions.

RESULTS

We identified 3,771 TKR episodes of which 18.8 percent (709) met the criteria to be classified as self-referral. Of the 3,062 episodes deemed to be “non-self-referring,” 72.3 percent (2,215) were cases where the orthopedic surgeon who performed the knee replacement surgery did not have an ownership interest in physical therapy services. For the remaining 847 non-self-referring episodes, the orthopedic surgeon who performed the TKR procedure was identified as a physician owner; however, the patient received physical therapy treatments from an independent physical therapist. We cannot determine whether the choice of physical therapy practice in these cases was based primarily on patient choice or physician recommendation.

Table 2 reports unadjusted comparisons of physical therapy treatments received by TKR patients controlling for episode self-referral status. Comparisons of gender, race, age, and comorbidity scores by episode self-referral status show the two groups were quite similar. Although patients treated by orthopedic surgeon owners began physical therapy sooner after surgery than those seen by orthopedic surgeon nonowners, this difference was less than a day ($p < .001$). Episode duration was a week longer for patients who underwent therapy at a physician-owned practice ($p < .001$). TKR patients treated by an orthopedic surgeon owner received on average 8.3 more or twice as many physical therapy visits than patients whose TKR surgery was performed by an orthopedic surgeon nonowner ($p < .001$). On the other hand, TKR patients who went to a physician-owned clinic received 6.6 fewer physical therapy service units during an episode compared to patients treated by independent physical therapy practices ($p < .001$). When measured in RVUs, the difference in physical therapy services was much smaller, only three RVUs ($p < .001$). Nationally, providers received \$38.09 per RVU in 2008.

Regression-adjusted results (OLS and the hierarchical random effects models) are reported in Table 3. While the results are similar, the hierarchical random effects estimates are preferable as they account for the clustering of patients within physician practices. Except for time to first physical therapy visit, the self-referral effect for the other outcomes remained statistically significant ($p < .001$). Compared with the unadjusted results reported in Table 2, the magnitude of the self-referral effect was slightly smaller for visit count but larger for both actual and RVU service counts.

Table 4 reports results of the non-self-referring TKR episodes controlling for whether the orthopedic surgeon who performed the knee surgery had

Table 2: Unadjusted Differences in Physical Therapy Treatments Received by Total Knee Replacement (TKR) Patients Controlling for Episode Self-Referral Status

Variable	All Knee Replacement Episodes	All Self-Referral TKR Episodes	All Non-Self-Referral TKR Episodes	Difference between Self-Referral and Non-Self-Referral Episodes
Days from discharge to first physical therapy visit	4.93 (5.16)	4.39 (4.28)	5.11 (5.39)	−0.72*
Episode length (days)	47.68 (42.51)	53.37 (37.95)	45.85 (43.73)	7.52*
Number of physical therapy visits per episode	9.21 (9.09)	15.51 (9.26)	7.19 (8.04)	8.32*
Number of physical therapy services per episode	53.86 (36.03)	49.01 (33.90)	55.41 (36.56)	−6.40*
Number of physical therapy RVUs per episode	23.88 (15.37)	21.59 (14.06)	24.62 (15.69)	−3.03*
Patient age, years				
65–69	27.2%	27.8%	27.0%	0.8% points (N/S)
70–74	34.2%	33.7%	34.3%	−0.6% points (N/S)
75–79	23.6%	23.3%	23.7%	−0.4% points (N/S)
80 plus	15.0%	15.2%	15.0%	−0.2% points (N/S)
% Male	45.4%	42.7%	46.3%	−3.6% points (N/S)
% Nonwhite	4.3%	3.4%	4.6%	−1.2% points*
Comorbidity score	0.875	0.917	0.861	−0.056 (N/S)
Number of episodes	2,924	709	2,215	
Number of orthopedic surgeons	876	188	688	

Notes: Self-referred episodes include those where the orthopedic surgeon who performed the knee replacement also billed for the physical therapy services the patient received.
*Difference between the means by episode self-referral status is statistically significant at $p < .001$.

Table 3: Regression-Adjusted Differences in Physical Therapy Treatments Received by Total Knee Replacement Patients Controlling for Episode Self-Referral Status

<i>Dependent Variable</i>	<i>Ordinary Least Squares Self-Referral Effect Coefficient (SE)</i>	<i>Multilevel Random Effects Self-Referral Effect Coefficient (SE)</i>
Days from discharge to first physical therapy visit	-0.70* (0.19)	-0.56 (0.37)
Number of physical therapy visits per episode	8.30* (0.39)	7.30* (0.51)
Number of physical therapy services per episode	-6.27* (1.44)	-8.86* (2.29)
Number of physical therapy RVUs per episode	-2.97* (0.62)	-4.05* (0.97)
Number of episodes	2,924	2,924

Notes. Both models reported in this table control for patient age, gender, race, comorbidity index, and year. The second model controls for clustering of patients at the physician’s practice level using a multilevel random effects GLM model, while the first, using ordinary least squares regression, does not adjust for clustering. Self-referred episodes include those where the orthopedic surgeon who performed the TKR surgery also billed for the physical therapy services the patient received.
*Self-referral effect is statistically significant at $p < .001$.

a financial stake in physical therapy services. These comparisons show that episodes where the orthopedic surgeon owner does not profit from physical therapy services rendered to the patient look virtually identical to episodes where the TKR surgery was performed by a surgeon nonowner. Time to initiation of physical therapy occurred about 1 day sooner for patients whose TKR surgery was performed by a physician owner ($p < .05$). Episode duration was about 5 days longer for patients whose surgery was performed by an orthopedic surgeon owner ($p < .05$). However, none of the other differences was statistically significant. For example, the number of physical therapy visits per episode was about 7 if a surgeon owner performed the TKR procedure compared with 7.2 visits if the surgery was performed by a nonowner. Regression-adjusted results relayed a similar story.

The finding that self-referring episodes involved twice the number of visits but fewer physical therapy services units suggests that the composition of physical therapy treatments rendered to patients may differ by self-referral status. We compared the composition of physical therapy services received by patients controlling for episode self-referral status in order to make a crude assessment of the appropriateness of services rendered. (We did not distin-

Table 4: Unadjusted Differences for Non-Self-Referral Episodes in Physical Therapy Treatments Received by Total Knee Replacement (TKR) Patients

Variable	All Nonself-Referral TKR Episodes	Nonself-Referral Episodes Where TKR Was Performed by an Orthopedic Surgeon Owner	Non-Self-Referral Episodes Where TKR Was Performed by an Orthopedic Surgeon Nonowner	Difference Controlling for if Surgeon Had Ownership in Physical Therapy Services
Days from discharge to first physical therapy visit	4.86 (5.20)	4.23 (4.57)	5.11 (5.40)	−0.88*
Episode length (days)	44.69 (41.84)	46.86 (43.72)	41.66 (36.28)	5.20*
Number of physical therapy visits per episode	7.11 (8.16)	6.99 (8.48)	7.19 (8.04)	−0.20 (N/S)
Number of physical therapy services per episode	55.10 (36.86)	54.27 (37.65)	55.41 (34.56)	−1.14 (N/S)
Number of physical therapy RVUs per episode	24.46 (15.73)	24.05 (15.84)	24.61 (15.69)	−0.56 (N/S)
Patient age, years				
65–69	26.5%	25.2%	27.0%	−1.8% points (N/S)
70–74	34.5%	35.2%	34.3%	0.9% points (N/S)
75–79	24.0%	23.7%	24.7%	−1.0% points (N/S)
80 plus	15.0%	15.0%	15.0%	—
% Male	46.4%	46.7%	46.3%	0.4% points (N/S)
% Nonwhite	4.1%	3.0%	4.6%	−1.6% points (N/S)
Comorbidity score	0.865	0.875	0.861	0.014 (N/S)
Number of episodes	3,062	847	2,215	
Number of orthopedic surgeons	816	128	688	

*Difference between the mean controlling for whether the TKR surgery was performed by a physician with ownership in physical therapy services is statistically significant at $p < .05$.

guish the non-self-referring episodes by whether the TKR surgery was performed by an orthopedic surgeon owner because the two types of episodes were so similar.) We relied on the physical therapist member of our research team to provide clinical insights regarding the types of physical therapy treatments provided during each episode. These comparisons, shown in Table 5,

Table 5: Comparison of the Composition of Physical Therapy Services Received per Episode Measured as the Percentage of all Nonevaluation Physical Therapy Services

<i>HCPCS Code and Description as It Relates to the Course of Physical Therapy Following TKR Surgery</i>	<i>All Self-Referred TKR Episodes</i>	<i>All Non-Self-Referred TKR Episodes</i>	<i>Difference between Self-Referred and Non-Self-Referred Episodes</i>
Code 97110: therapeutic exercises to develop strength, endurance, range of motion, and flexibility; the sessions are tailored to each individual who receives direct one-on-one contact with the therapist	64.3% (29.6)	72.5% (26.1)	−8.2% points*
Code 97150: group therapy consists of simultaneous treatment of two or more patients who may or may not be performing the same activity	3.6% (10.2)	1.8% (7.1)	1.8% points*
Code 97530: functional activities designed to improve functional performance following TKR in a progressive manner	7.5% (21.0)	5.1% (17.1)	2.4% points*
Code 97140: manual therapy by a health care practitioner includes connective tissue massage, joint mobilization and manipulation, passive range of motion and therapeutic massage. Not used heavily in joint replacement rehabilitation other than to reduce swelling or inflammation	16.1% (20.3)	11.1% (15.3)	5.0% points*
Number of episodes	704	3,059	

Notes. Self-referred episodes include those where the surgeon who performed the TKR surgery also billed for the physical therapy services the patient received. Non-self-referred episodes include (1) cases where the TKR surgery was performed by an orthopedic surgeon owner of physical therapy services but the patient obtained physical therapy from an independent provider, and (2) cases where the TKR surgery was performed by an orthopedic surgeon nonowner of physical therapy services and the patient obtained physical therapy from an independent provider.

*Difference between the mean by episode self-referral status is statistically significant at $p < .001$.

indicate that more than 72 percent of the physical therapy services rendered during non-self-referring episodes consisted of individualized therapeutic exercises to develop, strength, endurance, range of motion, and flexibility (code 97110). In contrast, these services accounted for only 64 percent of all physical therapy treatments received by TKR patients seen by physician-owned practices. This 8.2 percentage point difference is highly significant ($p < .001$). Group exercises (code 97150) were used much more frequently in self-referring episodes: 3.6 percent for self-referring episodes compared with 1.8 percent for non-self-referring episodes ($p < .001$). This implies that self-referring episodes involved less individualized care. Further analysis of the composition of physical therapy services received per episode reveals that patients treated by self-referring practices received a higher proportion of services designed to improve functional performance (code 97530): 7.5 percent for self-referring episodes compared with 5 percent for non-self-referring episodes ($p < .001$). For TKR patients, code 97530 is frequently used to account for time spent to train the patient to get out of bed or to rise from a chair. Another notable difference was found for code 97140 defined as manual therapy by a health care practitioner including passive range of motion and massage. These services accounted for 16.1 percent of physical therapy services rendered during self-referring episodes compared with about 11 percent for non-self-referring episodes ($p < .001$). This procedure is generally used by therapists early in the postoperative recovery period to address swelling or limited range of motion due to muscle spasm or incision scarring.

DISCUSSION

To our knowledge, this is the first study to evaluate the implications of physician self-referral arrangements on the course of physical therapy received by Medicare patients who underwent a TKR. We found that patients who were referred to physical therapy, which was owned by the orthopedic surgeon who performed the TKR procedure, incurred on average 8.3 more physical therapy visits—more than twice the number received by patients whose surgery was performed by an orthopedic surgeon nonowner. Notably, if an orthopedic surgeon owner performed the TKR but the patient obtained physical therapy from an independent physical therapist, the patient's course of physical therapy included about 7 visits. This number was virtually the same as the count of visits incurred by patients who had TKR surgery performed by an orthopedic surgeon

nonowner. It appears that when orthopedic surgeon owners do not benefit financially from referring TKR patients for physical therapy, their patients received essentially the same bundle of physical therapy services as patients treated by surgeon nonowners.

On the other hand, regression-adjusted results show that TKR patients who had surgery performed by a nonowner physician received about nine more physical therapy treatment units per episode compared with TKR who obtained physical therapy at a physician-owned clinic ($p < .001$). When measured in RVUs, this regression-adjusted difference was four RVUs ($p < .001$). These results indicate that physical therapists not involved with self-referral arrangements saw patients for fewer visits, but the composition of services received was more intense. We investigated whether the composition of physical therapy services received differs by self-referral status. Our analysis revealed that patients treated by independent therapists received a higher proportion of individualized therapeutic exercises than those who underwent physical therapy at a physician-owned clinic. The longer visit duration that characterizes nonself-referring episodes can in part be attributed to the fact that individualized therapeutic exercises take longer to perform especially for individuals who just underwent surgery and are in pain. Furthermore, patients treated at physician-owned physical therapy practices received a higher proportion of group therapy than those seen by independent therapists. During group sessions, the therapist monitors multiple patients, so this finding implies that self-referral episodes involve less one-on-one interaction between the therapist and patient. We recognize that the training and skill set of physical therapy providers who work in physician-owned practices may differ from the training and skills of physical therapists who work in non-self-referring practices. We are not able to evaluate if such differences exist because claims records contain no information on the skills and training of individual physical therapy providers.

While our findings highlight striking differences in the course of physical therapy services received depending on whether the patient underwent treatment at a physician-owned physical therapy clinic, our study has some limitations. First, our analysis only focused on the subset of TKR beneficiaries who were discharged to home. The course of physical therapy following TKR surgery may differ for patients who obtain care in skilled nursing facilities or through home health agencies. Second, while physician financial incentives appear to result in a different course of physical therapy treatments, we cannot assess the relative quality of care provided in physician-owned versus independent physical therapy practices. That said, it does appear that patients

treated by therapists not involved in self-referral arrangements received therapy services that appear to be better suited to assist the patient to recover more rapidly. Third, we cannot evaluate the role of demand inducement that may affect the practice patterns of both independent therapists and their counterparts who work at physician-owned practices. Fourth, we cannot account for the possibility that patients self-select between physician owners and nonowners, such that unobserved patients characteristics differ between the two sets of surgeons. That said, we view this possibility as an unlikely explanation because patients generally are not aware that the treating surgeon may have ownership in ancillary services to which they refer their patients. Finally, we cannot dismiss the possibility of unmeasured patient differences that might confound our comparisons.

In conclusion, we found that TKR patients treated at physician-owned practices incurred twice as many physical therapy visits as TKR patients who obtained care from independent physical therapy practices. However, TKR patients treated by independent therapists received a more intensive course of treatment. Moreover, for these patients it appears the composition of physical therapy services received was in accordance with the course of physical therapy typically prescribed for a patient who is recovering from joint replacement surgery. More insights on quality of care could be gleaned from further analysis if Medicare altered the claims form to include (1) an indicator of the type of health care professional who performed physical therapy and (2) the functional capacity of the patient at each visit.

Policy Implications

Our findings corroborate prior research on self-referral involving physical therapy but also self-referral arrangements for other types of designated health services (clinical laboratory, anatomic pathology, advanced imaging, and radiation therapy). The consensus of this literature is that self-referral results in increased use of services and higher health care expenditures. In our application, physical therapy after TKR surgery is the accepted standard of care, so our focus was on the intensity and composition of physical therapy after TKR surgery.

One solution is to eliminate the in-office ancillary services exception in the federal self-referral prohibition that permits physicians to continue to self-refer under certain conditions. While this action has been endorsed by leading health policy experts (Emanuel et al. 2012), it is unlikely to occur due to the

political climate in Congress coupled with intense opposition from many physician specialty organizations.

Another recommendation is to prohibit physicians from billing for physical therapy services and only reimburse physical therapy services performed by licensed physical therapists or physical therapy assistants. Although this would not shut down self-referral arrangements, it would mean that physicians could no longer bill for physical therapy services performed by unlicensed medical assistants. However, the movement toward alternative payment models that change the payment environment may also alter physician financial incentives—to a point. They may reverse the incentive to provide more services at greater cost, although the incentive to substitute lower skilled staff to deliver physical therapy treatments in order to enlarge the margin on services may still persist. One such alternative payment arrangement is bundled payment, which creates incentives to provide the most cost-effective care to patients. TKR is one of the DRGs covered by Bundled Payment for Care Improvement (BPCI), the voluntary but rapidly growing pilot program administered by the Centers for Medicare and Medicaid Innovation (CMMI). Of note, CMMI recently announced a new bundling pilot program that focuses on hip and knee replacements. The Comprehensive Care for Joint Replacement (CCJR) is similar to one of the BPCI models, but this initiative is not voluntary. It will be required of hospitals in 25 metropolitan areas, covering about 25 percent of all lower extremity joint replacements, nationally.

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of this article:

Appendix SA1: Author Matrix.