The Impact of New Hospital Orthopaedic Surgery Programs on Total Joint Arthroplasty Utilization

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Background: Utilization of arthroplasty is increasing, but there are little data exploring the causes of this increase. The objective of this study was to examine the relationship between new programs for arthroplasty of the lower extremity joints and the utilization of arthroplasty.

Methods: We identified twenty-four markets (hospital referral regions) that experienced the entry of new physician-owned specialty hospitals, using 1991 to 2005 Medicare data. We matched each market with a new specialty hospital to two different control markets (one market with a new arthroplasty program in a general hospital and one market without a new arthroplasty program), using a propensity score that accounted for market supply and demand for orthopaedic surgery and the regulatory environment. We compared the utilization of arthroplasty of the lower extremity joints (total hip arthroplasty and total knee arthroplasty) in each group of markets over a five-year window, extending from two years before to three years after the entry of new orthopaedic surgery programs.

Results: The twenty-four markets with new specialty orthopaedic hospitals had higher utilization of arthroplasty at baseline (10.9 arthroplasties per 1000 Medicare beneficiaries per year) and follow-up (12.7 per 1000 beneficiaries) compared with the twenty-four markets with new arthroplasty programs in general hospitals (9.7 and 11.4, respectively) and the twenty-four markets with no new programs (9.9 and 11.3), although the differences were not significant ($p > 0.05$). Growth in the utilization of arthroplasty was similar in markets with new specialty hospitals before (an increase of 0.63 procedure per 1000 beneficiaries per year) and after the entry of new specialty hospitals (an increase of 0.39) compared with markets with new surgery programs in general hospitals (an increase of 0.24 before and 0.43 after) and markets with no new programs (an increase of 0.38 before and 0.33 after the entry of new specialty hospitals) ($p > 0.05$ for all comparisons).

Conclusions: The utilization of arthroplasty is increasing at similar rates in markets with and without new arthroplasty programs.

The development of total joint arthroplasty constitutes a historic medical advance that has allowed millions of adults worldwide to remain physically active with aging¹. In the United States alone, an estimated 400,000 adults undergo total joint arthroplasty annually, with mortality rates of well below 1% for elective procedures. Over the last twenty years, arthroplasty volume has increased by an estimated 5% to 10% annually²⁻⁵ and corresponding spending has increased by 10% to 15% annually⁶. Despite indisputable evidence that arthroplasty benefits patients^{7,8}, there is growing concern over what is widely perceived to be unsustainable

growth in the utilization of arthroplasty and the associated spending.

As spending related to arthroplasty has grown, policy makers, providers, and payers have become increasingly interested in understanding the underlying causes of this growth in order to develop rational policies for ensuring appropriate utilization. Some of the growth in arthroplasty seems to be explained by an aging of the population⁹⁻¹¹ and changing patient and provider preferences for surgery and thus may not be a cause for undue concern¹⁰. However, there is also concern that increased use of arthroplasty may reflect physician-induced

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demand, whereby physicians have both financial incentive and means to increase the use of these highly reimbursed procedures¹²⁻¹⁴. Concern over physician-induced demand has accelerated in recent years with the expansion of physician-owned specialty hospitals, where physicians have the opportunity both to receive payment for performing operative procedures and also to share in any profits generated by the hospital where the treatment is rendered.

While there is a growing body of literature supporting the existence of physician-induced demand in the areas of radiographic imaging^{15,16}, spinal surgery^{17,18}, and cardiac care¹⁹, to the best of our knowledge, no published study has specifically explored the role of physician-induced demand in total joint arthroplasty.

The objective of this study was to examine the impact of new arthroplasty programs on the utilization of arthroplasty (i.e., total hip arthroplasty or total knee arthroplasty). We used Medicare administrative data to identify all U.S. health-care markets that experienced the entry of new physician-owned specialty orthopaedic hospitals between 1993 and 2003. We then matched each market with one or more new specialty hospitals to two different types of control markets, a market that experienced entry of a new arthroplasty program at a general hospital and a market that experienced no entry of a new arthroplasty program during the study period. In this analysis, we examined whether utilization of major joint arthroplasty (total hip arthroplasty and total knee arthroplasty) increased in markets experiencing the entry of new specialty orthopaedic hospitals compared with the two types of control markets.

Materials and Methods

Data

We used a 100% sample of Medicare Provider and Analysis Review (MedPAR) Part-A data files to identify all hospitals performing primary or revision total hip or total knee arthroplasty during the years 1991 to 2005, with use of International Classification of Diseases, Ninth Revision Clinical Modification (ICD-9-CM) procedure codes (81.51 for primary total hip arthroplasty, 81.53 for revision total hip arthroplasty, 81.54 for primary total knee arthroplasty, and 81.55 for revision total knee arthroplasty). The MedPAR data contain an array of information collected from discharge abstracts for all hospitalizations of fee-for-service Medicare beneficiaries and have been validated and extensively used in prior health-services research assessing orthopaedic care²⁰⁻²². Prior studies have suggested that Medicare beneficiaries constitute between 60% and 75% of all joint replacement recipients^{5,23}. Key data elements include patient demographics, primary and secondary diagnoses and procedures, admission source (e.g., an outside hospital or the emergency department), admission and discharge dates, the Medicare beneficiary number for each patient, the hospital to which each patient was admitted as represented by the unique Medicare identifier for each hospital, the zip code of residence for each patient, and the address and zip code for each hospital.

We obtained additional hospital-level information such as teaching status (i.e., membership in the Council of Teaching Hospitals) and for-profit or not-for-profit status by linking the MedPAR data to the 2000 American Hospital Association (AHA) Survey²⁴. We obtained population-level sociodemographic information by merging hospital zip-code-level data with 2000 U.S. Census data.

Identification of Hospital Markets

We assigned each hospital performing total hip arthroplasty or total knee arthroplasty to one of 306 unique hospital referral regions, using hospital zip codes based on algorithms available from the *Dartmouth Atlas of Health Care*²⁵. Hospital referral regions represent distinct regional markets for medical care. We obtained an array of additional market-level information related to supply and demand for orthopaedic care, including total enrollment in health maintenance organizations, and the supply of medical care available in each market, including the number of hospital beds per square mile and the supply of orthopaedic surgeons and primary care doctors, from information compiled in the *Dartmouth Atlas of Health Care*²⁵. We identified forty-two markets with new orthopaedic specialty hospitals by first identifying all sixty-six physician-owned specialty orthopaedic hospitals in the MedPAR data using lists that we and others developed previously²⁶. After excluding five hospitals in two markets that performed only spinal surgery and performed no total hip or total knee arthroplasties during the study period, we identified the year that each specialty hospital began operation—defined as the first year that each hospital performed at least one major joint arthroplasty (either total hip arthroplasty or total knee arthroplasty) on a Medicare beneficiary. We excluded all thirty specialty hospitals in sixteen markets that opened prior to 1993 or after 2003 in order to ensure that we had at least two years of data both before and after the entry of the specialty hospital for the analyses described below. Thus, our final sample consisted of twenty-four markets that experienced the entry of new physician-owned specialty hospitals between 1993 and 2003.

For each market, we defined the year when the orthopaedic specialty hospital began operation as year 0. To fully assess the impact of each new specialty orthopaedic hospital on orthopaedic utilization, we made an a priori decision to examine changes in orthopaedic utilization in the two years prior to the opening of the orthopaedic specialty hospital (years -2 and -1) and the three years immediately after the opening of the orthopaedic specialty hospital (years 0, +1, and +2). Thus, our analysis focused on a five-year window surrounding the opening of each orthopaedic specialty hospital.

After identifying all markets with new specialty hospitals, we matched each market with a new specialty orthopaedic hospital with two different categories of control markets, using a propensity score method²⁷. The first category of control markets consisted of markets that experienced entry of a new arthroplasty program at a general hospital at year 0. The second category of control markets consisted of markets that did not experience entry of any new arthroplasty programs during

the two years preceding or three years following the opening of the specialty hospital.

Our matching process was based on eight hospital referral region-level variables that captured the supply and demand for orthopaedic care, relative affluence, and the regulatory environment within each market. Six market-level variables were obtained from data available from the *Dartmouth Atlas of Health Care*: the total number of Medicare enrollees, the percentage of the population enrolled in managed care, the percentage of the population that was white, the per capita number of orthopaedic surgeons, the number of staffed hospital beds per square mile, and the annual population growth between 1995 and 2005. The seventh matching variable was the concentrated disadvantage index for each market; the disadvantage index is a measure of affluence that can be calculated for a geographic region (i.e., zip code, census tract, or hospital referral region) by aggregating four variables for the region (the poverty rate, percentage of households headed by women, percentage of joblessness among men, and percentage of residents employed in professional or managerial positions) that are typically obtained from the U.S. Census and combined into a single measure with positive values corresponding to greater disadvantage (poverty) and negative values corresponding to less disadvantage within a given geographic area²⁸. The eighth matching variable was a novel measure that we created in an effort to capture the regulatory environment within each hospital referral region. We were forced to develop this measure de novo because, to the best of our knowledge, there is no existing measure that captures the regulatory environment within health-care markets with regard to orthopaedic care. Thus, we calculated the percentage of the population that voted for the Democratic presidential candidate in the presidential election most proximate to the year when the specialty hospital opened; this measure was calculated with use of data obtained from the Federal Election Commission web site (www.fec.gov) and accounted for the fact that many hospital referral regions cross state boundaries. While we recognize that this measure is novel, we believe that it has strong face validity, particularly given that specialty hospital openings have been concentrated in a limited number of southern and western states that have taken a more laissez-faire approach to hospital regulation. Moreover, a prior study has demonstrated that more liberal state legislatures typically impose greater regulation on their health-care markets, while more conservative legislatures provide less regulation²⁹.

We used a propensity score method to calculate the probability of a specialty hospital opening in each of the three categories of markets: (1) markets with new specialty hospitals, (2) markets with new orthopaedic programs in general hospitals, and (3) markets with no new orthopaedic programs. Propensity scores were calculated with use of logistic regression to estimate the likelihood that each market would have a new specialty hospital (i.e., “propensity”), as a function of the eight hospital referral region-level characteristics. Thus, each market with a new specialty hospital was matched to two different control markets by selecting the control markets with

the closest propensity score. This resulted in the development of twenty-four sets of three markets each (see Appendix); each set contained a market with a new specialty hospital (opened in year 0), a market without entry of any new orthopaedic program between years -2 and +2, and a market with a new orthopaedic program at a general hospital that began operation in year 0.

Statistical Analysis

After creating the three sets of matched markets, we began by calculating the overall rate of total joint arthroplasties per 1000 Medicare enrollees who were sixty-five years of age or older for the entire United States. We compared changes in the utilization of total joint arthroplasty in the three groups of markets over the five-year study period. We then calculated the rate of total joint arthroplasties per 1000 Medicare enrollees who were sixty-five years of age or older for each of the matched hospital referral regions. The numerator was the total number of primary and revision total hip arthroplasties and total knee arthroplasties performed on Medicare enrollees sixty-five years of age or older who lived within each hospital referral region during each year. The denominator was the total number of Medicare enrollees who resided within each hospital referral region during the same calendar year.

We calculated standardized arthroplasty rates for the entire United States and each study market for each year, using direct standardization that adjusted for differences in age in years (sixty-five to sixty-nine, seventy to seventy-four, seventy-five to seventy-nine, eighty years and older) and sex of the populations across markets³⁰. We calculated the mean standardized arthroplasty rates for each of the three categories of markets (new specialty hospitals, new orthopaedic programs, and no new programs) for the five-year study period (year -2 to year +2) and plotted the results with general trend lines, using cubic polynomial regression. We applied separate multivariate linear regression models, accounting for the repeated measures within markets nesting in sets, to assess the significance of the procedural utilization rates per 1000 Medicare enrollees and the rates of change, across the three types of markets between year -2 and year +2. The first-order autoregressive correlation (AR[1]) matrix structure was chosen for both the procedural utilization rates per 1000 Medicare enrollees and the rates of change. Other correlation matrix structures (unstructured, heterogeneous Toeplitz, and heterogeneous first-order autoregressive) were also explored and compared with use of model-fitting statistics. Although the unstructured correlation matrix outperformed AR(1) in the rates-of-change model by the model-fitting statistics, we decided to use AR(1) because of its simplicity, and the results were robust to these assumptions.

Both models accounted for trends in time by including the calendar year as a continuous variable. To capture the potential impact of entries of physician-owned specialty orthopaedic hospitals, an indicator variable was introduced to mark the opening of the specialty hospitals. For each set, it took 0 in year -2 and year -1, and 1 in year 0 to year 2. The

TABLE I Characteristics of the Matched Markets for Year 0

	Markets with New Specialty Hospitals* (1)	Markets with New Orthopaedic Programs in General Hospitals* (2)	Markets with No New Orthopaedic Programs* (3)	P Value	
				Comparison of Column 1 and Column 2	Comparison of Column 1 and Column 3
No. of Medicare enrollees	125,510 (95,303)	149,812 (100,782)	140,235 (139,280)	0.41	0.62
Proportion of population that was white	0.73 (0.18)	0.71 (0.20)	0.73 (0.17)	0.64	0.96
Proportion of population enrolled in an HMO†	0.09 (0.12)	0.11 (0.13)	0.09 (0.10)	0.43	0.96
No. of staffed hospital beds per square mile	0.34 (0.36)	0.41 (0.21)	0.38 (0.32)	0.37	0.69
Orthopaedic surgeons per 100,000 population	6.05 (1.37)	5.72 (1.03)	6.18 (1.50)	0.34	0.78
Concentrated disadvantage index	0.09 (1.39)	0.34 (1.51)	0.51 (1.18)	0.53	0.13
Proportion of annual population growth	0.01 (0.01)	0.01 (0.01)	0.01 (0.01)	0.79	0.95
Proportion of population voting for Democratic party	0.41 (0.06)	0.42 (0.04)	0.43 (0.11)	0.30	0.55

*The values are given as the mean with the standard deviation in parentheses. †HMO = health maintenance organization.

interaction between the indicator variable and the three types of markets was included as well.

To ensure the robustness of our findings, we conducted a number of sensitivity analyses. First, we limited our analyses to more successful specialty hospitals defined as the hospitals that performed an average of at least 100 arthroplasties (total hip arthroplasty and total knee arthroplasty) per year during years 0 through +2. Second, we examined the impact of new orthopaedic programs separately for primary and revision total hip arthroplasty and total knee arthroplasty. This research was approved by the University of Iowa institutional review board.

Source of Funding

This study was performed with funding from the National Institutes of Health and the Robert Wood Johnson Foundation. There was no funding from commercial sources. Likewise, none of the investigators had funding from or an affiliation with a specialty orthopaedic hospital. The funding sources played no role in the study design, data analysis, or results interpretation.

Results

The overall standardized rate of total joint arthroplasty increased from 7.64 procedures per 1000 Medicare enrollees

TABLE II Utilization of Major Joint Replacement per 1000 Medicare Beneficiaries in Markets with New Specialty Hospitals, New Orthopaedic Programs in General Hospitals, and No New Orthopaedic Programs

Year	Markets with New Specialty Hospitals* (1)	Markets with New Orthopaedic Programs in General Hospitals* (2)	Markets with No New Orthopaedic Programs* (3)	P Value	
				Comparison of Columns 1 and 2	Comparison of Columns 1 and 3
-2	10.86 (3.37)	9.73 (3.03)	9.89 (2.47)	0.28	0.24
-1	11.49 (3.58)	9.97 (3.06)	10.27 (2.84)	0.14	0.18
0	11.93 (3.90)	10.53 (3.42)	10.65 (3.01)	0.21	0.20
+1	12.66 (4.00)	11.14 (3.78)	11.11 (3.17)	0.18	0.12
+2	12.70 (3.70)	11.39 (3.58)	11.32 (2.99)	0.23	0.17

*The values in parentheses are the standard deviation.

Fig. 1

Standardized procedural utilization rates per 1000 Medicare enrollees by year in markets with new specialty hospitals, markets with new orthopaedic programs or hospitals, and markets with no new orthopaedic program or hospital.

in 1993 to 10.92 procedures per 1000 enrollees in 2005—a total increase of 42.9% and an average increase of 3.3% per year. The characteristics of the matched markets with new specialty orthopaedic hospitals, new orthopaedic programs in general hospitals, and no new orthopaedic programs were generally similar with respect to most important attributes during year 0, suggesting that our matching of markets was successful (Table I). In particular, the size of the markets (e.g., number of Medicare enrollees), population growth, and the supply of orthopaedic surgeons appeared relatively similar across market types. Of note, markets that experienced the entry of new specialty hospitals had a somewhat lower disadvantage index (i.e., somewhat less poverty) than markets with new orthopaedic

dic programs in general hospitals and those with no new orthopaedic program, although this difference was not significant.

Markets with new specialty orthopaedic hospitals had higher utilization of major joint arthroplasty both at baseline and follow-up, although this difference was not significant (Table II); the results were similar when primary and revision total hip arthroplasty and total knee arthroplasty were examined separately (see Appendix). All three categories of markets experienced growth in the utilization of major joint arthroplasty (Fig. 1) during the five-year study period. Utilization of major joint arthroplasty in markets with new specialty hospitals increased from 10.86 procedures per 1000 Medicare enrollees in year -2 to 12.70 in year +2 (a 16.9% increase),

TABLE III Growth in Utilization of Major Joint Replacement in Markets Before and After the Entry of New Orthopaedic Programs

	Markets with New Specialty Hospitals* (1)	Markets with New Orthopaedic Programs in General Hospitals* (2)	Markets with No New Orthopaedic Programs* (3)	P Value	
				Comparison of Columns 1 and 2	Comparison of Columns 1 and 3
Increase in joint replacement utilization between years -2 and -1 (1)	0.63 (0.95)	0.24 (0.71)	0.38 (0.98)	0.38	0.08
Increase in joint replacement utilization between years 0 and +2 (2)	0.39 (0.71)	0.43 (0.60)	0.33 (0.65)	0.75	0.79
P value (comparison of rows 1 and 2)	0.32	0.36	0.83		

*The values are given as the mean number of procedures (per 1000 Medicare beneficiaries), with the standard deviation in parentheses.

Fig. 2

Changes in total joint arthroplasty utilization per 1000 Medicare enrollees in successive years in markets with new specialty hospitals, markets with new orthopaedic programs or hospitals, and markets with no new orthopaedic program or hospital (higher values correspond to higher year-to-year growth in utilization).

while utilization in markets with new orthopaedic programs in general hospitals increased from 9.73 in year -2 to 11.39 procedures in year +2 (a 17.1% increase) and utilization in markets with no new orthopaedic programs increased from 9.89 procedures in year -2 to 11.32 in year +2 (a 14.5% increase); these differences were not significant ($p = 0.97$ for

markets with new specialty hospitals compared with markets with new programs in general hospitals, and $p = 0.45$ for markets with new specialty hospitals compared with markets with no new programs).

Looking at our results from a somewhat different perspective, the rate of growth in orthopaedic utilization did not

Fig. 3

Utilization of total joint arthroplasty among markets with high-volume specialty hospitals.

accelerate after the opening of new orthopaedic programs in specialty hospitals or general hospitals (years 0 to +2) (Table III and Appendix) compared with the years prior to the opening of the new programs (years -2 and -1). Likewise, the rates of growth in arthroplasty utilization were similar across all three categories of markets (Fig. 2). The results from the multivariate linear regression models were similar.

To ensure the robustness of our findings, we repeated our analyses while limiting our sample to new specialty hospitals performing an average of at least 100 procedures per year (seven markets with specialty hospitals and fourteen corresponding control markets). These analyses suggested that larger specialty hospitals tended to enter markets with lower utilization of arthroplasty at baseline (Fig. 3) but failed to demonstrate that entry of new specialty hospitals led to a significant acceleration in the utilization of major joint arthroplasty compared with either markets with new orthopaedic programs in general hospitals or markets with no new orthopaedic programs. Additional sensitivity analyses examining the impact of new specialty hospitals on primary and revision total hip arthroplasty and total knee arthroplasty separately yielded similar results (see Appendix).

Discussion

We found that the utilization of total hip and knee arthroplasty increased by 42.9% in the United States between 1993 and 2005. This growth in utilization was consistent across markets with new specialty orthopaedic hospitals, new arthroplasty programs in general hospitals, and markets without any new arthroplasty programs. Likewise, there was no evidence that the rate of growth in the utilization of arthroplasty accelerated in markets that experienced the entry of new orthopaedic programs compared with markets that did not experience the entry of new orthopaedic programs.

Several of our study findings merit further discussion. First, our finding that total hip and knee arthroplasty utilization increased by 42.9% between 1993 and 2005 confirms the results of prior studies that have examined trends in arthroplasty utilization^{2,31,32}. While an average growth rate of 3% per year seems relatively modest, the aggregate 42.9% growth in standardized utilization of arthroplasty translates into an additional 3.3 procedures performed per 1000 Medicare beneficiaries in 2005 (and subsequent years) compared with 1993 utilization rates. Extending this increase in utilization across thirty-four million Medicare beneficiaries could be expected to translate into an increase of approximately 112,200 major joint arthroplasties being performed per year at a cost of \$1.4 billion per year (assuming payment of \$13,000 per procedure)³³. Whether the benefits of additional arthroplasties (e.g., improved patient quality of life) outweigh the costs (financial and otherwise) is beyond the scope of this study but is important to consider.

Second, our finding that the rates of growth in the utilization of arthroplasty of lower extremity joints were no higher in markets that experienced the entry of new physician-owned specialty hospitals compared with markets with new orthopaedic programs in general hospitals and markets with

no new programs is also important. A number of prior studies have found evidence that the entry of new physician-owned specialty cardiac hospitals and orthopaedic hospitals were associated with increases in the utilization of cardiac procedures and spine surgeries, respectively^{17,19,34}. Our study differed from those prior studies in a number of important ways. For example, our study focused on different procedures (i.e., arthroplasty) than those examined in prior studies. In addition, in contrast to prior studies, we deliberately matched markets with new physician-owned specialty hospitals to control markets with respect to factors related to the underlying supply and demand for arthroplasty. It is also important to note that our study examined the average impact of new specialty hospitals entering multiple markets. It is possible that, within some markets, specialty hospitals led to a dramatic increase in joint replacement utilization, while in other markets the impact was more muted. In fact, we previously conducted a highly detailed analysis focusing on the entry of specialty hospitals in three distinct health-care markets and found that the growth in arthroplasty volumes in the new specialty hospitals was highly variable as was the impact of the specialty hospitals on competing general hospitals³⁵. We expect that these factors contributed to our different findings with regard to the impact of new specialty hospitals on utilization.

Third, the finding that growth in the utilization of arthroplasty was similar in markets both with and without new arthroplasty programs highlights the regulatory challenges to reducing utilization of costly health-care procedures. Prior studies focusing on certificate-of-need regulation have found that these state-level regulatory programs have had a limited impact on controlling health-care spending and utilization of procedures³⁶⁻³⁸. Our analysis suggests that growth in arthroplasty utilization, which is not commonly regulated through certificate-of-need programs, occurs even in the absence of new arthroplasty programs. Thus, our study provides further evidence that regulatory policies that limit entry of new surgical programs are unlikely to be effective at reducing growth in costly procedural areas of medicine.

Fourth, we believe that our findings of growth in the utilization of arthroplasty across all markets highlights the need for additional investigation to better understand the patient and provider factors driving this growth and to better develop methodologies for defining arthroplasty appropriateness at the patient level. Investigation of these issues is currently hampered by several factors including the lack of a national joint arthroplasty registry. As a testimony to the scientific and policy importance of such a registry, the Agency for Healthcare Research and Quality recently issued a \$12 million request for applications to support the development of a national joint registry. In addition, and in part because of the lack of a national joint arthroplasty registry to inform guideline development, the precise indications for joint arthroplasty remain ill defined compared with comparably costly and commonly performed procedures including coronary artery bypass grafting, percutaneous coronary intervention, or implantable cardioverter defibrillator placement³⁹⁻⁴¹.

The study has a number of limitations that are important to acknowledge. First, we relied on Medicare administrative data and thus were only able to assess utilization of joint arthroplasty among Medicare beneficiaries. Our findings should be generalized to the non-Medicare population with caution. Second, our study was limited to a comparison of three matched groups, each consisting of twenty-four health-care markets, and thus did not address the impact of new orthopaedic programs in all U.S. health-care markets. Third, our study focused specifically on the impact of new orthopaedic programs on the utilization of arthroplasty of lower extremity joints and did not address other orthopaedic procedures including spinal surgery or arthroscopy that may be of interest. Fourth, while our matching of hospital markets using year-0 characteristics appeared successful, markets may have changed in subsequent years resulting in less perfect matching over time. While our models included a measure of time to account for this, it is important to recognize this potential degradation in market matching. Nevertheless, we chose not to adjust for changes in market characteristics after time 0 because such changes are not likely independent of the opening of specialty hospitals. For example, markets may have an increase in the number of orthopaedic surgeons because a specialty hospital has opened. Likewise, our analysis may have been confounded by unmeasured differences between our three groups of hospital markets. Fifth, our analysis was conducted at the hospital level, and our lack of physician-level claims data limited our ability to examine whether the entry of new specialty hospitals was associated with an influx of new orthopaedic surgeons into hospital markets or whether the entry of new specialty hospitals merely resulted in existing orthopaedic surgeons shifting from one hospital to another. This is an important avenue for further study. Sixth, while we explored multiple methods for matching markets with and without new orthopaedic surgery programs with similar results, it is important to acknowledge that other methods for matching markets may have yielded

slightly or even significantly different results. Likewise, it is important to point out that our use of presidential voting as a proxy for a market's regulatory environment is somewhat nontraditional for orthopaedic research even if it is justified on the basis of the political science literature²⁹.

In summary, we found evidence that growth in the utilization of total hip and total knee arthroplasty was similar among markets with new physician-owned specialty hospitals, markets with new arthroplasty programs in general hospitals, and markets with no new arthroplasty programs. Our study does not support the concept that the entry of new orthopaedic programs in physician-owned specialty hospitals or general hospitals leads to increased utilization of arthroplasty above and beyond the increases that are occurring throughout the United States.

Appendix

Tables listing the markets with new orthopaedic specialty hospitals and utilization of total hip arthroplasty and total knee arthroplasty in these markets are available with the electronic version of this article on our web site at jbjs.org (go to the article citation and click on "Supporting Data"). ■

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