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Increased Utilization of Total Joint Arthroplasty After Medicaid Expansion

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Background: The expansion of state Medicaid programs under the U.S. Affordable Care Act has led to a dramatic increase in the number of Americans with health insurance coverage. Prior analyses of a limited number of states have suggested that greater utilization of total hip arthroplasty (THA) and total knee arthroplasty (TKA) should be expected after Medicaid expansion. The purpose of our study was to examine whether increased utilization of THA and TKA occurred across a broader range of states after Medicaid expansion.

Methods: We analyzed administrative data from the Healthcare Cost and Utilization Project from 9 states (Arkansas, Arizona, Colorado, Iowa, Massachusetts, Maryland, Nevada, New York, and Vermont) that expanded Medicaid in 2014 and 2 states that did not expand Medicaid (Florida and Missouri). We included patients who were 18 to 64 years of age and had a primary THA or TKA from 2012 to 2015 with Medicaid as the primary payer. Other payers (including dual-eligible Medicaid and Medicare beneficiaries) were excluded. We performed multivariable regression modeling with the number of Medicaid-insured THAs or TKAs as the dependent variable and the interaction between the state Medicaid expansion status and year as the main policy independent variable, with adjustment for community characteristics.

Results: Among all 11 states, there were 39,452 total joint arthroplasties (42% THA and 58% TKA) funded by Medicaid from 2012 to 2015. After adjusting for community characteristics, within expansion states, compared with 2013, THA and TKA increased 15% in 2014 ($p < 0.0001$) and 23% in 2015 ($p < 0.0001$) within expansion states. Within non-expansion states, compared with 2013, there were significant utilization decreases of 18% in 2014 ($p < 0.0001$) and 11% in 2015 ($p = 0.0002$).

Conclusions: Medicaid expansion was associated with significant increases in Medicaid-funded THA and TKA utilization in 9 states. As additional states consider expanding Medicaid programs and as alternative health reforms that increase insurance eligibility are debated, surgeons, administrators, and policymakers should prepare for a surge in the utilization of THA and TKA.

The expansion of Medicaid coverage from the U.S. Affordable Care Act (ACA) dramatically increased the number of insured Americans. There have been reports of improvements in self-reported general health[1-3] and reductions in racial and ethnic health disparities[4,5]. The effect of the ACA on orthopaedic surgery utilization was shown by Crocker et al.[6], who reported a 15% increase per quarter in elective total hip arthroplasty (THA) and total knee arthroplasty (TKA) in Kentucky, Maryland, and New Jersey during the first year of Medicaid expansion. Dy et al. reported even larger increases in the proportion of THAs and TKAs funded by Medicaid in Illinois after Medicaid expansion[7]. There were no

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differences during the same time period in Missouri, a geographically contiguous state that did not expand Medicaid[7].

At this time, 37 states have implemented Medicaid expansion. However, the recent literature has highlighted its impact on orthopaedic surgery utilization in only 4 states[6,7]. A broader analysis of the impact of Medicaid expansion on surgical utilization would inform efforts by physicians, policymakers, and other stakeholders to ensure adequate access to orthopaedic care. This is particularly salient during a time in which proposed health-care reforms include continued expansion of government-funded insurance programs, such as Medicaid and Medicare. In the current study, our purpose was to determine whether Medicaid expansion was associated with changes in the utilization of THA and TKA across a larger group of states. We compared the utilization of THA and TKA from 2012 to 2015 in 9 states that expanded Medicaid to 2 states that did not expand Medicaid, hypothesizing that there would be an increase in the rate of utilization among Medicaid beneficiaries in the former group of states due to unmet need among the previously uninsured.

Materials and Methods

The study examined administrative data from 2012 to 2015 in order to allow for comparison of the rates before and after the date of Medicaid expansion in these expansion states (January 1, 2014). We used the State Inpatient Databases (SIDs), maintained by the Healthcare Cost and Utilization Project (HCUP), from the following states: Arkansas, Arizona, Colorado, Iowa, Massachusetts, Maryland, Nevada, New York, and Vermont (expansion states); and Florida and Missouri (non-expansion states). Missouri data were received from the Hospital Industry Data Institute (HIDI) incorporated with the Missouri Hospital Association. The SID and the HIDI database include all-payer inpatient discharges (at the admission level) from acute-care community hospitals within each state. These states and years were selected on the basis of SID data availability.

Cohort Assembly

We identified THAs and TKAs using the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) and International Classification of Diseases, Tenth Revision, Procedure Coding System (ICD-10-PCS) procedure codes (see Appendix A). Revision THA and TKA cases were not included. In this study, these orthopaedic procedures are referred to as the index procedures. We limited the cohort to index procedures performed in adults who were 18 to 64 years of age and whose index procedures were paid by Medicaid. These criteria excluded those who were dually eligible for Medicaid and Medicare. To reduce confounding due to THA and TKA potentially being used in polytrauma settings, patients who underwent multiple orthopaedic procedures (>1 THA or TKA during the same hospitalization), patients who underwent craniotomies, and patients who were diagnosed with spina bifida were excluded (see Appendix A). Finally, because the main health policy variable is the state Medicaid expansion status, hospitalizations in which the patient was not a resident of the hospital state were excluded.

Dependent Variable

The dependent variable was the annual number of hospitalizations for THA or TKA with Medicaid as the primary payer.

Offset Variable

Modeling count data from states requires the use of an offset variable to take into account the varying populations per state. As the dependent variable was the number of THAs and TKAs paid by Medicaid for patients who were 18 to 64 years of age, the offset variable was the natural log of the state's adult, non-dual-eligible, Medicaid enrollees in each year. Data concerning eligible persons were obtained from the American Community Survey of the U.S. Census[8,9].

Covariates

Community Characteristics

To adjust for potential differences in the prevalence of musculoskeletal disease, we estimated the overall burden of musculoskeletal disease within the state by dividing the number of admissions with Major Diagnostic Category (MDC) category 8 (representing musculoskeletal system and connective tissue disease hospitalizations) by the total number of discharges for each year and state. To adjust for potential economic differences among communities, we calculated the employment rate of each state from the number of employed individuals obtained from the U.S. Bureau of Economic Analysis divided by the census population per state and year[10]. These variables were merged with the inpatient discharge data by state and year.

Health Policy Variables

Each state was designated as an expansion state or a non-expansion state. The states in our study that expanded their Medicaid programs under the ACA were Arizona, Arkansas, Colorado, Iowa, Maryland, Massachusetts, Nevada, New York, and Vermont. The number of Medicaid beneficiaries who were 18 to 64 years of age in each state is included in Appendix B. Because Medicaid policies are state-specific, we included a state Medicaid enrollment variable (see Appendix C) to control for enrollment changes over time that may have strained the health-care system. The state Medicaid enrollment variable, which may range from 0 to 1, compares Medicaid enrollment for each state and year relative to its level in 2015.

Comparison with Other Payers

In order to facilitate the interpretation of our results, we tabulated the utilization of THA and TKA for individuals who were 18 to 64 years of age in the same states over the same time period but were insured through Medicare and private insurance (rather than Medicaid). Age-adjusted rates of THAs and TKAs were calculated by dividing the number of THA and TKA hospitalizations per payer, state, year, and age group by the total number of beneficiaries for that payer, state, year, and age group. We then created a weighting factor by dividing the number of people in each age group per state, year, and payer by the total number of people who were 18 to 64 years of age in each state, year, and payer. We then multiplied the crude rate by

the weight. The age-adjusted rate is summed across state, year, and payer. The denominators in each of these steps were acquired from the American Community Survey of the U.S. Census Bureau[8,9]. These rates for Medicare and private insurance were not included in the multivariable regression model described below, as our primary research question centered on the effect of Medicaid expansion on Medicaid-funded utilization of THA and TKA.

Statistical Analysis

The number of cases per 100,000 Medicaid beneficiaries was reported for all states and by expansion status. The main analysis was conducted as a difference-in-difference analysis using a multivariable Poisson regression model, as the dependent variable was count data. The natural log of Medicaid enrollees per state and year was used as an offset in the model. A difference-in-difference analysis relies on the assumption that the 2 groups (experimental and control) have similar (parallel) trends in the outcome of interest prior to the intervention[11]. In our analysis, the outcome of interest was the utilization of TKA and THA among Medicaid beneficiaries and the intervention was Medicaid expansion on January 1, 2014. The control group was the non-expansion states and the experimental group was the expansion states. An interaction between the expansion status of each state and the year was used to determine the relationship between expansion status and changes in utilization of TKAs and THAs after Medicaid expansion. In the pre-intervention phase (2012 and 2013), significant differences between the interaction term "expansion state × 2012" and "expansion state × 2013" would indicate a difference in trends prior to Medicaid expansion. If this were to occur, the parallel trends assumption would be violated and a different analytic method would be needed. In the post-intervention year 1 (2014), significant differences between the terms "expansion state × 2014" and "expansion state × 2013" would reflect the effect that the intervention (Medicaid expansion) had on the utilization of TKAs and THAs. In the post-intervention year 2 (2015), significant differences between the terms "expansion state × 2015" and "expansion state × 2013" would reflect any further effect that the intervention (Medicaid expansion) had on the utilization of TKAs and THAs relative to the last pre-intervention year (2013).

All regression models were adjusted for the community and health policy covariates described above as Medicaid eligibility is determined by state-level factors. The interaction term was used to identify a divergence of Medicaid procedures between the expansion and non-expansion states over time. If this interaction term was found to be significant, differences in the levels for the interaction between expansion and non-expansion states in each year were evaluated to determine the direction and magnitude of the effect. To facilitate the interpretation of the results, the log of the odds of the parameter estimate from the interaction term was used to calculate an odds ratio (OR) for year-to-year comparisons. All analyses were conducted using SAS version 9.4 (SAS Institute).

Results

We analyzed a total of 39,452 total joint arthroplasties (42.1% THA and 57.9% TKA) in 11 states from 2012 to 2015 (Table I; see also Appendix D). The majority (61%) of THAs and TKAs were performed in women, and the median patient age was 55.0 years (interquartile range [IQR], 49.0 to 59.0 years) (Table I). Among the expansion states, the unadjusted mean number of THAs and TKAs per 100,000 Medicaid beneficiaries was 138.5 before Medicaid expansion (2012 to 2013) and 190.7 after Medicaid expansion (2014 to 2015) (Fig. 1, trend line). Among the non-expansion states, the unadjusted number of THAs and TKAs per 100,000 Medicaid beneficiaries was 179.5 from 2012 to 2013 and 121.1 from 2014 to 2015 (Fig. 1, trend line). The age-adjusted rates of THAs and TKAs per 100,000 beneficiaries in each insurance plan, by state, are included in Table II. The values in Table II for privately insured and Medicare-insured beneficiaries were not analyzed further, as the current study is focused on changes in utilization among Medicaid beneficiaries.

The multivariable regression model identified a significant association for the primary or policy variable of interest: the interaction of expansion status and year. After adjusting for community characteristics, we observed an increase in the utilization of THAs and TKAs in 2014 and 2015 in expansion states ($p < 0.0001$ for each; see Appendix E). Compared with 2013, Medicaid-funded THAs and TKAs increased in expansion states by 15% in 2014 ($p < 0.0001$) and 23% in 2015 ($p < 0.0001$) (Table III). Within non-expansion states, compared with 2013, there were significant year-to-year decreases of 18% in 2014 ($p < 0.0001$) and 11% in 2015 ($p = 0.0002$) in THA and TKA utilization (Table III).

Discussion

Our results demonstrate that Medicaid expansion was associated with increased utilization of THAs and TKAs among Medicaid beneficiaries in expansion states, corroborating prior findings from Crocker et al.[6] and Dy et al.[7] in other states. Our difference-in-differences analysis showed significant increases in THA and TKA utilization among Medicaid beneficiaries. THA and TKA utilization did not increase during the same timeframe in non-expansion states, but instead significantly decreased. Crocker et al. used a similar time series analysis to show an increase in THA and TKA utilization in the first year after Medicaid expansion in Kentucky, Maryland, and New Jersey[6]. Dy et al. showed an increase in the proportion of THAs and TKAs funded by Medicaid within Illinois after expansion that persisted into the second year after policy implementation[7]. Our analysis demonstrates increases in THA and TKA utilization in 9 additional states (Arkansas, Arizona, Colorado, Iowa, Massachusetts, Maryland, Nevada, New York, and Vermont), reinforcing the notion that there was a widespread increase in THA and TKA utilization associated with Medicaid expansion. Williamson et al. previously analyzed the utilization of 10 common orthopaedic surgical procedures in New York after Medicaid expansion, but did not show a per-capita increase in utilization. Subgroup analysis isolating THAs and TKAs was not reported[12]. The effect that we and others

TABLE I Demographic Characteristics of Populations Undergoing THA or TKA from 2012 to 2015 in 11 U.S. States Among Adults Who Were 18 to 64 Years of Age

Characteristic	Expansion States*	Non-Expansion States†
No. of cases		
All years (2012 to 2015)	31,921	7,531
2012 to 2013	11,664	3,574
2014 to 2015	20,257	3,957
No. of cases per 100,000 Medicaid beneficiaries		
All years (2012 to 2015)	167.6	143.2
2012 to 2013	138.5	179.5
2014 to 2015	190.7	121.1
Percentage of THA among all cases		
All years (2012 to 2015)	41.3	45.6
2012 to 2013	39.9	45.6
2014 to 2015	42.1	45.5
Percentage of women among all cases		
All years (2012 to 2015)	60.5	62.6
2012 to 2013	62.6	62.6
2014 to 2015	59.4	62.5
Age† *(yr)*		
All years (2012 to 2015)	55 (49 to 59)	54 (48 to 59)
2012 to 2013	54 (48 to 59)	54 (48 to 59)
2014 to 2015	55 (50 to 60)	54 (49 to 59)

*The expansion states are Arkansas, Arizona, Colorado, Iowa, Massachusetts, Maryland, Nevada, New York, and Vermont. †The non-expansion states are Florida and Missouri. ‡The values are given as the median, with the IQR in parentheses.

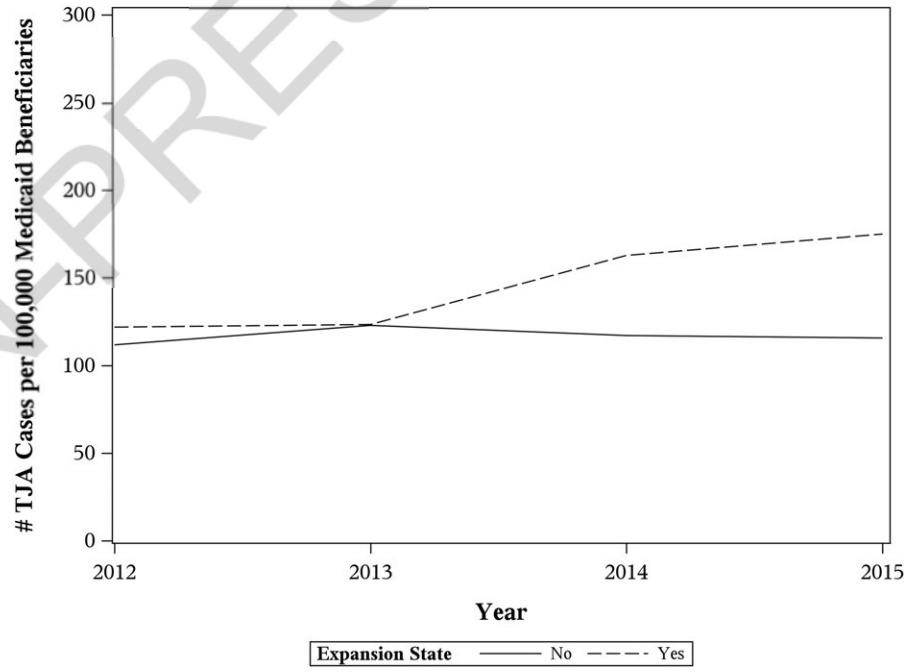

Fig 1

Unadjusted mean number of total joint arthroplasties (TJAs) per 100,000 Medicaid beneficiaries before (2012 to 2013) and after (2014 to 2015) Medicaid expansion.

TABLE II Age-Adjusted Rates of THAs and TKAs per 100,000 Beneficiaries, Categorized by Primary Payer and Based on State Population in Each Year

State	Primary Payer	Calendar Year			
		2012	2013	2014	2015
Arkansas*	Medicare	740.39	653.20	699.43	677.31
	Medicaid	138.27	125.97	144.30	146.74
	Private	190.86	216.26	230.85	258.84
Arizona*	Medicare	837.43	812.73	793.44	806.34
	Medicaid	163.53	155.94	205.33	220.57
	Private	225.05	240.05	239.07	219.84
Colorado*	Medicare	809.33	845.60	875.40	991.40
	Medicaid	135.93	138.65	253.96	256.99
	Private	271.16	276.19	275.56	265.44
Florida	Medicare	745.67	772.71	792.76	842.90
	Medicaid	96.86	108.10	98.44	99.36
	Private	184.19	192.90	198.75	202.48
Iowa*	Medicare	906.82	943.56	1,028.01	1,055.78
	Medicaid	157.66	183.20	251.58	229.81
	Private	312.36	325.40	328.78	348.65
Massachusetts*	Medicare	795.96	866.24	829.40	905.52
	Medicaid	103.40	105.80	139.99	143.99
	Private	230.49	227.14	246.39	252.45
Maryland*	Medicare	724.78	755.73	726.56	735.34
	Medicaid	145.73	126.60	205.26	206.54
	Private	198.99	198.83	198.38	201.80
Missouri	Medicare	895.63	911.60	904.94	941.84
	Medicaid	163.27	177.05	192.07	184.35
	Private	277.18	287.25	278.53	274.77
Nevada*	Medicare	640.62	652.05	651.72	643.75
	Medicaid	116.77	116.93	178.58	197.84
	Private	159.62	168.77	159.47	162.78
New York*	Medicare	597.55	622.00	629.97	687.73
	Medicaid	105.99	113.85	130.22	147.98
	Private	177.91	188.28	189.63	200.70
Vermont*	Medicare	452.37	451.88	503.85	556.11
	Medicaid	188.69	135.67	129.73	170.54
	Private	197.85	231.06	210.09	230.28

*These states underwent Medicaid expansion in 2014.

found has been demonstrated beyond orthopaedic surgery, as Medicaid expansion-related surges in health services have been seen for outpatient primary care, surgical specialist evaluation, and inpatient surgical admissions[13-16].

Health-care reform continues to be a topic of intense debate within the United States. Platforms to increase access to care have included proposals to continue expansion of state Medicaid programs, to broaden the federal government's Medicare program, or to provide universal health care. These types of reforms would likely have a similar effect on health-care resource utilization as we have seen in our analysis, but on a much larger scale. THA and TKA are life-changing interventions with a high track record of success that currently represent a large cost center for insurers. Surgeons, health-care administrators, and policymakers should prepare for increases in demand for THA and TKA (and presumably other highly effective elective surgical procedures) after policies that expand insurance eligibility. This preparedness is critical to maintain access to orthopaedic surgery, as a surge in THA and TKA demand has also been demonstrated as Americans become newly eligible for Medicare[17]. Inadequately meeting demand for THA and TKA may lead to increases in the eventual cost of care and prolonged

TABLE III Pairwise Comparison of Interaction Terms*

	2012		2013		2014	
	OR†	P Value	OR†	P Value	OR†	P Value
Expansion states						
2013	0.95 (0.91 to 0.98)	0.0039				
2014	1.09 (1.05 to 1.14)	<0.0001	1.15 (1.11 to 1.20)‡	<0.0001		
2015	1.16 (1.12 to 1.21)	<0.0001	1.23 (1.18 to 1.27)‡	<0.0001	1.06 (1.03 to 1.09)	<0.0001
Non-expansion states						
2013	0.93 (0.87 to 1.00)	0.0393				
2014	0.76 (0.70 to 0.82)	<0.0001	0.82 (0.76 to 0.87)‡	<0.0001		
2015	0.82 (0.76 to 0.88)	<0.0001	0.89 (0.83 to 0.94)‡	0.0002	1.08 (1.02 to 1.16)	0.0136

*The main independent variable in the multivariable regression model was expansion status × year, which was used to determine whether states experienced a significant change in THA and TKA after Medicaid expansion based on their expansion status. In the multivariable regression model, the terms expansion × 2014 and expansion × 2015 were significantly different compared with the reference term (expansion × 2013) (see Appendix E). †The values are given as the OR, with the 95% confidence interval in parentheses. ‡These ORs for expansion and non-expansion states compare 2014 with 2013 and 2015 with 2013 (2013 was the last year prior to expansion).

waiting times for surgery and may have effects on individual productivity due to worsening pain. Furthermore, our results supported the need to ensure that increased demand does not lead to widening in disparities in orthopaedic care. There are existing wide variations in delivery of orthopaedic care for Medicaid beneficiaries[18], with numerous secret-shopper studies demonstrating difficulty in scheduling outpatient appointments both before and after implementation of Medicaid expansion[19]. Beyond this, Medicaid beneficiaries travel further for care[18,20] and have a higher risk of postoperative complications and greater resource utilization after THA and TKA[21,22]. Within this context, our findings demonstrate the importance of planning appropriately for a surge in demand for Medicaid-funded THA and TKA after policies that increase access to insurance coverage.

Although administrative data are an imperfect source for clinical outcomes data, we constructed our analysis to examine a policy-level outcome (THA and TKA utilization). We were unable to discern whether other factors, such as patient characteristics, disease severity, or health-care system-level barriers to care delivery, contributed to the utilization. However, it is unlikely that these factors changed during the short period of time in this study and concurrently with Medicaid expansion. We were also limited by having only 2 non-expansion states. At the initiation of the project, our laboratory did not have access to additional non-expansion states during the same timeframe (2012 to 2015). It is possible that the inclusion of additional non-expansion states would have shown a lesser relative impact of expansion on the utilization of THA and TKA. Further study into trends in the utilization in non-expansion states is warranted as more data become available. The limitations of difference-in-difference analysis methods must also be noted. This method of analysis relies on the assumption of parallel trends: that is, both groups (expansion states and non-expansion states) had common trajectories prior to Medicaid expansion. Although the pre-expansion data that we analyzed were limited to 2 years, we believe that the assumption of parallel trends has been satisfied, as evidenced by a lack of significance of the expansion state × year variable in 2012 when compared with 2013, the last year prior to Medicaid expansion. Difference-in-difference models also rely on the assumption of common shocks, which assumes that unobservable or unmodeled events affect both groups equally. This assumption cannot be tested directly and is a potential source of confounding, should any unobservable events have occurred. Although unobserved time-dependent trends may also be driving some of the differences in utilization that we observed, we are unaware of any other major policy changes that affected the states examined in our analysis. Although we have demonstrated increased utilization of THAs and TKAs among Medicaid beneficiaries, we are unable to discern why this is occurring (i.e., whether this increase is due to the arthritis status and/or stage of new patients entering the Medicaid population via expansion plans or whether there is a fundamental change occurring among existing Medicaid beneficiaries). Due to the nature of Medicaid expansion, it is possible that the individuals insured by Medicaid expansion could have been previously uninsured (such as those who did not qualify for Medicaid, but did not have employer-sponsored insurance) or lost their employer-sponsored insurance and changed to an expansion plan. Because of the limitations of administrative data research, we were unable to track which of these occurrences (or others) were contributing to changes in Medicaid enrollment. This may have implications regarding the rationale for increasing utilization of THAs and TKAs and is an area for further investigation using alternate research methodologies. Because of the limits of the data available, we were also unable to evaluate the demographic and behavioral factors among new Medicaid beneficiaries that are driving the changes in utilization that we have demonstrated. For example, understanding whether patients undergoing Medicaid-funded THA or TKA

are more likely to be older or shifting from other insurance plans would be helpful for policymakers. Unfortunately, we do not have the ability to address these questions with our analysis.

Medicaid expansion was associated with increased utilization of Medicaid-funded THA or TKA in the 9 states that we analyzed. These increases in demand should be considered by surgeons, administrators, and policymakers for appropriate resource allocation. The potential implications regarding access to orthopaedic care should also be considered to avoid exacerbating existing disparities in delivery of care.

Appendix

eA Supporting material provided by the authors is posted with the online version of this article as a data supplement at jbjs.org (http://links.lww.com/JBJS/G317). ■

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