Universal Health Insurance Coverage in Massachusetts Did Not Change the Trajectory of Arthroplasty Use or Costs

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Abstract

Background The state of Massachusetts enacted universal health insurance in 2006. However it is unknown whether the increased access to care resulted in changes to surgical use or costs.

Questions/purposes We asked the following related research questions: compared with the United States as a whole, how did the (1) number of cases (as a percentage of the overall population, to account for changes in the overall population during the time surveyed), (2) payer mix, and

(3) inpatient costs for arthroplasty change in Massachusetts after introduction of health insurance reform?

Methods We analyzed the use and cost of primary THAs and TKAs in Massachusetts using the State Inpatient Database (SID) between 2002 and 2011 compared with the Nationwide Inpatient Sample (NIS) during the same years. The SID captures 100% of inpatient procedures in Massachusetts, while the NIS is a nationally representative database of inpatient procedures for the United States. The SID and NIS are publicly available data sources from the Agency for Healthcare Research and Quality, and include information regarding procedure volumes, payer mixes, and costs. Inpatient costs were defined similarly in both databases by using hospital charges and an average cost-to-charge ratio that is unique for each hospital. The incidence of arthroplasties was calculated by dividing the procedure volume by the relevant population (either for Massachusetts or the entire country) based on public data from the United States Census bureau.

Results The incidence of THAs and TKAs performed in Massachusetts increased steadily throughout the study period, and paralleled a similar increase in the United States as a whole. In Massachusetts, the incidence of THAs increased by 59% between 2002 and 2011, and the incidence of TKAs likewise increased by 80%. The trends for the incidence in total joint arthroplasties were similar to those for Massachusetts for the United States as a whole. The period of health insurance reform in Massachusetts was associated with a greater proportion of patients covered by Medicaid, Commonwealth Care, or Health Safety Net for THAs and TKAs. By 2011, universal health insurance in Massachusetts covered 2.45% of primary THAs and 2.77% of primary TKAs. Coverage for Medicaid in Massachusetts increased from 3.23% and 3.04% of THAs and TKAs in 2002 to 4.06% and 4.34% respectively

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in 2011. On average, Medicaid coverage was greater for TKAs in Massachusetts than across the United States during the study period. The introduction of health insurance reform had a minimal effect on the cost of total joint arthroplasties in Massachusetts. Although the costs of total joint arthroplasties in the United States were higher than those in Massachusetts, this difference narrowed substantially from 2002 to 2011, with the Massachusetts cost trending upward and the overall United States cost trending downward.

Conclusions Despite extending insurance coverage to the entire state of Massachusetts, there was little change in actual utilization trends for joint replacement.

Clinical Relevance The enactment of universal health insurance coverage in Massachusetts appears to have been a nonevent insofar as the use and cost of total hip and knee surgeries is concerned in the state. Factors other than health insurance reform appear to be driving the growth in demand for arthroplasties in Massachusetts and are likely to do so as well in the United States under the Affordable Care Act of 2010.

Introduction

A total joint arthroplasty (TJA) is a cost-effective, international standard of care for relieving pain resulting from degenerative joint disease [6, 15, 22]. For various reasons, including aging of the “Baby Boomer” generation, national trends in obesity, and perhaps the recognized success of the procedures, the demand for TJAs in the United States is projected to increase in the coming decade [12, 14]. Furthermore, with more than a million TJAs performed annually in the United States [14], there has been increased attention focused on the leverage that these procedures exert on overall healthcare economy [5, 26]. An emerging strategy to manage the cost of TJAs is to develop integrated healthcare delivery models such as bundled payments [2, 8, 17].

In addition, healthcare reform legislation in the United States, first enacted at the state level, and more recently implemented at the federal level, aims not only to contain the rising cost of medical spending, but also to improve access to healthcare services by mandating citizens to obtain health insurance [20, 21, 23]. In 2006, Massachusetts became the first state to enact mandatory universal health insurance. The Massachusetts legislation expanded the eligibility criteria for Medicaid and created new categories of statewide insurance known as Commonwealth Care and the Health Safety Net. Before 2006, 13.6% of adults in Massachusetts 20 to 64 years old were uninsured [24]. By 2011, insurance coverage expanded to

98% of the population of Massachusetts [20]. As a result, healthcare reform in Massachusetts is regarded in health-care policy circles as the model for the Affordable Care Act of 2010 [20, 21, 23].

It is too early to judge the effect of mandatory insurance provisions of the Affordable Care Act on health care at a national level, because the majority of these have taken effect in the last year. However, the effect of universal health insurance coverage has been studied in Massachusetts as a model system for certain types of essential medical services such as emergent care and preventive care [11, 19]. For instance, universal coverage in Massachusetts modestly decreased the use of emergency department services and shifted care patterns to primary care physicians [19]. However, less is known regarding how healthcare reform affected the use of elective procedures such as TJAs [3], and it is uncertain how expanded health coverage that accompanies the Affordable Care Act of 2010 will affect the use and cost of orthopaedic procedures in the United States.

We therefore sought to determine how government-mandated, universal health insurance in Massachusetts, which was enacted in 2006, affected the use and cost for primary TJAs in that state compared with the United States. We addressed the following related research questions: compared with the United States as a whole, how did the (1) number of cases (as a percentage of the overall population, to account for changes in the population during the period surveyed), (2) payer mix, and (3) inpatient costs for arthroplasty change in Massachusetts after the introduction of health insurance reform?

Materials and Methods

We analyzed the use and cost of primary THAs and TKAs in Massachusetts using the State Inpatient Database (SID) between 2002 and 2011 compared with those of the Nationwide Inpatient Sample (NIS) during the same years. The SID and NIS are publicly available data sources from the Agency for Healthcare Research and Quality [1]. The SID contains 100% of inpatient procedures for individual states, whereas the NIS, representing 20% of all hospital stays, is the largest, statistically representative data set for inpatient procedures in the United States. We also used the statistical trend files provided by the Healthcare Cost and Utilization Project (HCUP) to properly adjust for the slight year-to-year variances in the sampling methods used by the survey, as previously described [13].

Patient demographics (including age, sex, race/ethnicity) and payment source (such as Medicare, or private insurance) are among the 100+ data elements in the NIS and SID databases. Disease diagnoses and surgical

procedures performed (if any) were recorded using the International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM). Primary TJAs were identified based on their ICD-9-CM codes, 81.51 for primary THA and 81.54 for primary TKA. Population data were obtained from the United States Census Bureau to calculate the incidence of arthroplasty by age, gender, and year.

Specific to Massachusetts, we studied the use of universal insurance, including Massachusetts Commonwealth Care or Health Safety Net as primary or secondary payer. Surgery rates were calculated separately for age, sex, race, year, and time (2002–2006 versus 2007–2011).

The total hospital charge for each discharge was part of each record from the NIS or SID survey. The HCUP has developed a set of companion files (2001 and onward) called the “Cost-to-Charge Ratio” that allow the total hospital charges to be converted to an estimated cost for that institution. These ratios and the cost data used by HCUP were obtained from the annual hospital accounting reports collected for the Center for Medicare & Medicaid Services. For a particular hospitalization in which a THA or TKA was performed, the exact cost to that hospital is unknown. Thus, the hospital cost at the state and the national level is estimated using the overall cost conversion ratio for that hospital. This is only the institutional cost associated with the hospitalization. The costs associated with a surgeon’s service, the service of other physicians (such as infection specialists and anesthesiologists), postacute care, or subsequent expenses in physical therapy were not included in these data.

The estimated cost for the hospitalization was adjusted by the Consumer Price Index for medical care, which is published monthly by the Bureau of Labor Statistics [25] (Series CUSR0000SAM). All dollar amounts in this report were adjusted by the Consumer Price Index to January 2014. Each year, approximately 15% to 20% of hospitals, owing to state regulation or other reasons, did not provide cost data to allow for determination of the cost-to-charge ratio. The HCUP did provide a “group” average conversion factor in many cases where hospital-specific conversion factors were not available. For a few remaining hospitals for which neither hospital-specific nor group-level conversion factor was available, an estimated conversion value was calculated based on the conversion factors from other hospitals in the same NIS sampling stratum.

From the Massachusetts SID data, we examined the demographic profile (age, sex, race) of the patients undergoing TJAs and especially the payers used (such as Medicare, Medicaid, private insurance, and Commonwealth Care) each year. The rate or incidence of TJAs is

calculated by matching the number of TJAs performed for each age-sex-race group to the corresponding intracensus population estimates from the United States Census Bureau. Similar calculations using the NIS yielded the corresponding nationwide TJA rates. These rates were compared using a Poisson regression model with the corresponding population as the “offset” parameters. The model included age, sex, race, state (Massachusetts, United States), and calendar year as covariates. The Poisson regression allowed evaluation of (1) the trends in the incidence of TJAs from 2002 to 2011; (2) change in the rate between before 2007 and after 2007 in Massachusetts; and (3) difference in use between Massachusetts and the United States. Obviously, Massachusetts is part of the United States, so the two data sets are not entirely independent.

We examined patients undergoing TJAs in Massachusetts whose surgeries were covered by Commonwealth Care or Health Safety Net as the payer. Although Medicare and private health insurance are expected to remain the predominant payers for TJAs, how the Massachusetts-related programs provided access to TJAs would be of special interest. Elderly individuals with limited financial means who qualify for public assistance typically have the state assume payment for their Medicare premium. In those cases, Medicare, although paid for by public funds, is still the primary payer. We examined the frequency, proportion, and the demographic characteristics of the patients who had one of these programs as the payers for their TJA.

We also examined the charges and the approximate cost for TJAs in the United States and in Massachusetts. We compared charges and cost in Massachusetts between patients claiming Affordable Care Act programs as the payer and patients using other payers. Hospital charges often are skewed with a heavy tail dominated by complex cases or patients requiring a more intensive level of pre- or postoperative care. We used quantile regression techniques to analyze the charge and cost differences and focused the comparison on the difference in the median charge or cost rather than the mean values typically used in standard normal data regression models. Quantile regression is an alternative statistical analysis to least squares regression that aims to quantify the median and dispersion about the median using nonparametric numerical methods. The quantile regressions on charges and cost were adjusted for age, sex, race, Diagnosis-Related Group severity level, source of payment, type of admission, and the calendar year of the surgery. These analyses were conducted using SAS® Version 9.4 statistical software) (SAS® Institute Inc, Cary, NC, USA).

Results

The incidence of THAs and TKAs performed in Massachusetts increased steadily throughout the study period, and paralleled a similar increase in the United States as a whole (Fig. 1). In Massachusetts, the incidence of THAs increased by 59%, from 7.4 procedures per 10,000 population (95% CI, 7.2–7.6 procedures/10,000) in 2002 to 11.7 (95% CI, 11.5–12.0 procedures/10,000) in 2011, and the incidence of TKAs in Massachusetts likewise increased by 80%, from 10.8 procedures per 10,000 population (95% CI, 10.5–11.0 procedures/10,000) in 2002 to 19.4 (95% CI, 19.1–19.7 procedures/10,000) in 2011. The trends for the incidence in TJAs were similar to those of Massachusetts for the United States as a whole (Fig. 1). In 2002, approximately 7.0 THAs were performed per 10,000 in the United States population (95% CI, 6.98–7.04 procedures/10,000) and this national incidence increased by 40% to 9.8 (95% CI, 9.76–9.83 procedures/10,000) by 2011. TKAs across the nation experienced a more substantial 69% increase from 12.2 (95% CI, 12.15–12.23 procedures/10,000) in 2002 to 20.65 (95% CI, 20.60–20.70 procedures/10,000) in 2011. Massachusetts and the United States showed statistically significant ($p < 0.001$) temporal changes to the incidence of THAs and TKAs as a function of the calendar year (Fig. 1). The introduction of universal insurance in Massachusetts in 2006 was associated with a slight, but statistically significant change in the trend for THAs ($p < 0.001$) but not for TKAs ($p = 0.3$). In Massachusetts, the change in incidence with time for THAs was 1.05 procedures per 10,000 population per calendar year (95% CI, 1.04–1.06) before 2006, and 1.06 (95% CI, 1.05–1.07) afterward. The change in incidence with time for TKAs was 1.10 procedures per 10,000 population per calendar year (95% CI, 1.09–1.11) before 2006, and 1.04 (95% CI, 1.03–1.04) afterward.

The period of health insurance reform in Massachusetts was associated with a greater proportion of patients covered by Medicaid, Commonwealth Care, or Health Safety Net for THAs and TKA (Table 1). Coverage for Medicaid in Massachusetts increased from 3.23% and 3.04% of THAs and TKAs in 2002 to 4.06% and 4.34% of THAs (Table 2) and TKAs (Table 3) in 2011, respectively. In 2011, Medicaid covered 3.86% and 3.24% of primary THAs (Table 2) and TKAs (Table 3) across the United States. By 2011, Universal Health Insurance in Massachusetts covered 2.45% of primary THAs and 2.77% of primary TKAs. Medicare and private health insurance continued to represent the two largest payers for THAs and TKAs. In Massachusetts, private insurance was the primary payer for 42% of THAs (Table 2) and 37% of TKAs (Table 3). In the United States, the corresponding fractions were 38% (THA) (Table 2) and 37% (TKA) (Table 3), respectively. In the United States and in Massachusetts,

Fig. 1A–B The incidences of primary (A) THAs and (B) TKAs were generally insensitive to the period before and after 2006 when universal health insurance coverage was mandated in Massachusetts compared with the United States. MA = Massachusetts; US = United States; M = male; F = female.

there was a gradual decrease in the proportion paid by Medicare and a corresponding increase in payment by private insurance from 2002 to 2011.

The introduction of health insurance reform had a minimal effect on the cost of TJAs in Massachusetts. Although the costs of TJAs in the United States were higher than those in Massachusetts, this difference narrowed substantially from 2002 to 2011, with the Massachusetts cost trending upward and the overall United States cost trending downward (Fig. 2). In 2002, the median cost of primary THA in Massachusetts was USD 13,000 (interquartile range [IQR], USD 11,000–15,000) compared with USD 23,000 (IQR, USD 19,000–29,000) in the United States. By 2011, the median cost in Massachusetts increased to USD 16,000 (IQR, USD 14,000–19,000). The median cost for a THA in the United States in 2011 was USD 17,000 (IQR, USD 14,000–22,000). A similar pattern was observed for primary TKA. The cost of TJAs for those paid by the Massachusetts universal insurance programs did not appear to be substantially different from TJAs paid by other payers. The number of these

Table 1. THAs and TKAs reimbursed by Payer in Massachusetts

Payer category	Primary payer	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Total
Other	Commonwealth Care	0	0	0	0	1	73	183	229	266	343	1095
	Health Safety Net (2009+)	0	0	0	0	0	0	0	13	41	38	92
	Other government payment	47	66	91	86	82	90	83	92	97	93	827
	Other nonmanaged care plan	18	17	11	15	18	7	34	0	2	1	123
	Workers compensation plan	133	123	150	162	170	192	212	211	215	215	1783
No charge	Free care	69	84	81	91	109	56	37	25	3	4	559
Self-pay	Self-pay	16	20	16	22	13	21	21	7	19	14	169
Private	Auto insurance plan	0	3	2	1	2	2	4	9	4	8	35
	Blue Cross	509	604	696	703	764	853	828	822	856	851	7486
	Blue Cross, managed care	1417	1632	1995	2337	2701	2909	2978	3391	3403	3345	26,108
	Commercial	429	480	518	580	600	649	679	662	726	845	6168
	Commercial, managed care	169	181	220	223	267	239	280	311	347	441	2678
	Exclusive provider plan	0	4	5	8	12	24	8	12	12	5	90
	Health maintenance organization	1750	1957	2033	2114	2131	2312	2457	2787	3123	3428	24,092
	Other preferred provider organization and managed care	294	329	360	346	337	389	476	453	395	403	3782
	Point of service plan	3	23	58	37	62	53	49	65	100	71	521
	Medicaid	319	338	371	369	407	444	445	501	529	497	4220
Medicaid	Medicaid, managed care	93	115	150	205	221	281	348	372	386	463	2634
	Medicare	5959	7062	7692	7865	8134	8387	8439	8560	9165	9468	80,731
Medicare	Medicare, managed care	1978	1724	1655	1808	1827	1894	2102	2211	2453	2138	19,790
Unknown	Missing/unknown	4	3	1	0	0	1	2	0	1	1	13
Total		13,207	14,765	16,105	16,972	17,858	18,876	19,665	20,733	22,143	22,672	182,996

universal insurance cases was relatively small. In 2002, the inpatient cost of TJAs was higher in the United States overall than in Massachusetts but decreased with time between 2002 and 2011. In contrast, the median cost of a TJA increased in Massachusetts with time and was comparable to the United States median by 2011.

Discussion

Healthcare reform in the United States, including the requirement for mandatory health insurance, is viewed as fundamentally altering the historical healthcare delivery paradigms for TJAs [3]. The target population for universal health insurance coverage includes young patients who earn too much to qualify for Medicaid but who are unable or unwilling to obtain private insurance. In this study, we sought to explore questions related to how changes in insurance coverage alone are likely to affect the use and cost of TJAs. Iorio et al. [9] argued that mandatory insurance coverage would lead to less access to care because of reduced economic incentives for surgeons to perform surgery, especially in response to the economic downturn of 2009 to 2010. However, historical trend data crossing two recessions, including the recent

economic downturn, strongly suggest that use of TJAs is highly correlated to the national health expenditure [14], which is projected to increase owing to the provisions of the Affordable Care Act. The results of the current study suggest that, at least in Massachusetts, the overall effect of this legislation on the use of TJAs appears to have been relatively slight. We observed that the cost of TJAs increased in Massachusetts, which is consistent with the state legislation that, by design, did not include fiscal constraints on health care until 2011. Overall, the Massachusetts experience provides a useful basis for planning how the Affordable Care Act is likely to affect the use of TJAs after its mandatory health insurance provisions are implemented in 2014. The Massachusetts experience can inform projections regarding the influence of the Affordable Care Act in terms of the use of TJAs; our results suggest that use and costs of these procedures are unlikely to change much because of the expanded coverage. However, insofar as most patients undergoing TJAs were either elderly or disabled (and so covered under Medicare) or employed (and so covered under private insurance), we caution readers against generalizing our results to other procedures more likely to be performed on young, healthy patients who may be less likely or unwilling to obtain health insurance.

Table 2. Payment sources for primary THAs in Massachusetts and in the United States (2002–2011)*

Primary payer	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Total
Massachusetts											
Other	0.86	0.94	1.10	1.18	0.94	1.43	2.14	2.09	2.23	2.56	1.62
No charge	0.70	0.65	0.64	0.64	0.70	0.34	0.18	0.13	0.01	0.01	0.37
Self-pay	0.12	0.19	0.12	0.18	0.09	0.13	0.12	0.04	0.12	0.07	0.12
Private	36.47	38.09	39.56	40.55	42.14	42.08	41.70	44.33	44.69	44.79	41.77
Medicaid	3.23	3.00	3.15	3.67	3.57	4.17	3.76	3.95	4.22	4.06	3.72
Medicare	58.60	57.10	55.42	53.78	52.56	51.84	52.08	49.47	48.71	48.50	52.39
Unknown	0.2	0.3	0.2	0	0	0.1	0.01	0	0	0	0.00
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
US											
Other	2.20	1.93	2.20	1.97	2.41	2.39	3.14	2.48	2.39	2.54	2.39
No charge	0.05	0.06	0.08	0.13	0.18	0.17	0.09	0.09	0.13	0.20	0.12
Self-pay	0.57	0.62	0.88	0.81	0.75	0.87	0.78	0.86	0.83	0.67	0.77
Private	36.34	34.86	36.28	36.25	37.46	38.28	38.91	38.75	39.85	38.37	37.71
Medicaid	3.00	3.02	3.13	3.24	3.52	2.91	3.46	3.45	4.03	3.86	3.40
Medicare	57.80	59.43	57.37	57.53	55.52	55.22	53.45	54.21	52.63	53.87	55.43
Unknown	0.04	0.08	0.05	0.07	0.16	0.16	0.17	0.16	0.14	0.49	0.17
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

* Percent of payment by primary payer group.

Table 3. Payment sources for primary TKAs in Massachusetts and in the United States (2002–2011)*

Primary payer	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Total
Massachusetts											
Other	1.98	1.73	1.87	1.79	1.87	2.21	2.88	2.96	3.16	3.35	2.48
No charge	0.39	0.51	0.41	0.47	0.55	0.27	0.19	0.12	0.01	0.02	0.27
Self-pay	0.12	0.09	0.08	0.10	0.06	0.10	0.10	0.03	0.07	0.06	0.08
Private	33.20	33.29	34.55	35.36	36.26	37.73	38.14	39.06	37.91	39.33	36.87
Medicaid	3.04	3.12	3.29	3.19	3.48	3.64	4.19	4.37	4.08	4.34	3.76
Medicare	61.24	61.24	59.79	59.09	57.77	56.04	54.49	53.46	54.78	52.90	56.55
Unknown	0.04	0.01	0	0	0	0	0.01	0	0	0	0.00
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
US											
Other	3.45	3.33	3.37	2.94	3.29	3.42	4.05	3.57	3.19	3.39	3.41
No charge	0.05	0.02	0.05	0.10	0.12	0.12	0.06	0.08	0.08	0.12	0.08
Self-pay	0.35	0.33	0.49	0.42	0.44	0.42	0.55	0.54	0.35	0.38	0.43
Private	33.21	33.17	33.61	34.18	35.57	36.93	38.34	37.99	39.33	37.80	36.45
Medicaid	2.44	2.71	2.62	2.63	2.72	2.40	2.68	2.74	3.11	3.24	2.76
Medicare	60.44	60.29	59.81	59.60	57.73	56.57	54.14	54.86	53.80	54.51	56.67
Unknown	0.06	0.14	0.05	0.14	0.13	0.15	0.18	0.23	0.14	0.56	0.19
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

* Percent of payment by primary payer group.

This study has limitations. The databases we used, the NIS and SID, although well suited for tracking inpatient procedures at a state and local level, are not ideal for

longitudinal followup; therefore, outcome studies are not possible using these data sources. There was a slight interdependence of the NIS and Massachusetts SID

Fig. 2A–B Inpatient costs (USD 2014) of primary (A) THAs and (B) TKAs were generally insensitive to the time before and after 2006 when universal health insurance coverage was mandated in Massachusetts compared with the United States. The vertical axis for both figures has units of 10,000 USD 2014. MA = Massachusetts; US = United States.

datasets, however because Massachusetts is a relatively small state, it has only a slight contribution to the national use of TJAs. Furthermore, because both inpatient databases are based on administrative coding, the NIS and SID are limited to the use of ICD-9-CM codes for inpatient procedures and diagnoses. These administrative codes have been shown to be reasonably accurate for identifying the reimbursement for billed procedures [10], but less reliable for optional diagnoses, which we did not consider here.

Clinical outcomes such as ROM or laboratory test values are not captured in either of these databases. Our assessment of costs was derived by converting hospital charges to costs using hospital-specific charge-to-cost ratios. Although these ratios are compiled for individual hospitals by the federal government specifically for the purposes of health economic assessments of inpatient procedures in the United States, the reader should be aware that these estimates reflect only the cost burden to the hospital, and do

not reflect other direct costs, such as professional fees, nor do they include indirect costs for the patient associated with the surgery, such as caregiver costs, medications, or loss of wages. In addition, postdischarge costs can account for up to 40% of the total cost of care and cannot be assessed in the databases used here, particularly because there is substantial variation in postdischarge destination. Notwithstanding these limitations, the NIS and SID are specifically designed by HCUP to inform national and state health policy. These databases are considered nationally representative (for NIS) or all-inclusive (for SID). Another limitation of this study is its focus on primary hip and knee procedures. Although the methods we used can be adapted to study revision hip and knee surgeries, these procedures were beyond the scope of the current study. Last, although the period under study coincided with a severe economic recession, we previously showed [14] that this downturn had a negligible effect on the overall rate of use of arthroplasties.

In the current study, data from Massachusetts during the period we studied support that mandatory insurance coverage contributed to the increase in the rate of arthroplasty use in that state, but the overall contribution was relatively modest. Use of TJAs clearly increased in Massachusetts after the introduction of health reform in 2006, but it also had increased in the rest of the country. Thus, factors other than healthcare reform appear to be driving the growth in demand for arthroplasties in Massachusetts and are likely to do so as well in the United States with the Affordable Care Act. Although previous studies have examined the use of TJAs in the United States at a national level [4, 5, 12–14, 26], one study examined trends in arthroplasties after the transition in healthcare reform in Massachusetts [7]. Ellimoottil et al. [7] studied the rates of inpatient surgery in Massachusetts between 2003 and 2010 in comparison with two control states, New York and New Jersey, in which health reform had not been implemented. Ellimoottil et al. [7] investigated the increase in what they termed discretionary procedures, including hip and knee arthroplasties, back surgery, transurethral prostate resection, and inguinal hernia repair. They concluded that discretionary procedures increased 9% after health reform in Massachusetts. Their data showed statistically significant ($p < 0.05$) growth of 14% in knee arthroplasties and a trend ($p = 0.05$) in growth of 12% in hip arthroplasties. Our study differs from that of Ellimoottil et al. [7] in several respects, including a broader study period (2002–2011 in our study versus 2003–2010 in their study), different choice of control populations (United States national data in our study versus control states in the Northeast in their study), consideration of patients of all ages (versus 19–64 years), and different statistical models to analyze the change in rate of surgery before and after reform. These methodologic differences preclude a direct

comparison between our results and those of Ellimoottil et al. [7], except that we also show that knee arthroplasties, in contrast to hip arthroplasties, showed a significant increase in the rate of use after the introduction of reform in Massachusetts. Although statistically significant, the overall magnitude of increase is, as we have discussed (Fig. 1B), relatively modest and follows the same growth trend as the rest of the United States during the same period. We observed no significant effect of health reform on the overall use of THAs in Massachusetts, consistent with the findings of Ellimoottil et al. [7].

Regarding payer mix, we detected a slight but perceptible increase in the coverage of hip and knee arthroplasties by Medicaid and universal health insurance in Massachusetts after the adoption of health reform. When compared with other types of insurance such as private and Medicare, the magnitude of these changes in postreform insurance is relatively slight. However, even if healthcare reform has changed access to health insurance, it is questionable whether access to insurance results in improved access to care by the economically disadvantaged members of society. If the prototypical person not covered before health reform was young and working in jobs that did not offer insurance, we would expect little change in the rate of TJAs. Despite growth in procedure rates among younger persons, the mean age of TJA recipients remains older than 60 years. Researchers have found that the newly insured in Massachusetts under Medicaid and state-subsidized private insurance after the introduction of health reform faced cost-related obstacles in obtaining care [16]. A similar concern was raised regarding cost pressures potentially resulting in reduced access to arthroplasties as physicians consider opting out of Medicare and Medicaid owing to reduced reimbursement by these health plans [9], although this has not occurred to any meaningful degree.

One key aspect of health reform, separate from insurance coverage, is to reduce the growth in health expenditures, either at a state or national level. In this regard, the costs for arthroplasties on a per-surgery basis in Massachusetts have increased with time after the introduction of reform. Admittedly, health reform in Massachusetts followed a cautious and incremental approach, starting in 2006 with mandatory health insurance coverage, but with strong cost reduction provisions only enacted starting in 2012 [18]. Thus, the period we studied, up to 2011, may be insufficient to capture the effect, if any, on the health reform legislation on the cost of arthroplasties in Massachusetts. The contrast in procedure costs trends between Massachusetts and the rest of the country is striking and reflects the overall movement in health care to reduce the cost of orthopaedic surgery. What the data from Massachusetts show is that it may be difficult to generalize the cost implications of health reform from a state level to a

national level. Furthermore, the United States cost data do not support the hypothesis that national health reform legislation is necessary to limit the growth of procedure costs, because the deceleration can be explained only by organic self-limited cost reduction in this (2002–2011) period, before implementation of the Affordable Care Act in 2014.

Overall, we find it difficult to apply the lessons of Massachusetts to the country as a whole. The data in support of national health reform legislation resulting in either improved access to care or reductions in the rate of arthroplasties across the United States are less than compelling using the Massachusetts experience after 2006 as a guide. On the contrary, health reform legislation in 2006, up to 2011, appears to have been a nonevent insofar as the use and cost of THAs and TKAs is concerned in Massachusetts. We caution against overgeneralization of these findings to other procedures, including hip and knee revision surgeries.

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