



Association of Affordable Care Act-related Medicaid expansion with variation in utilization of surgical services

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ABSTRACT

Background: We aim to understand how Medicaid expansion under the ACA has affected utilization of surgical services.

Methods: The State Inpatient Databases were used to compare utilization of a broad array of surgical procedures among nonelderly adults (aged 19–64 years) in a multistate population that experienced ACA-related Medicaid expansion to one that did not. We performed a difference-in-differences (DID) analysis to determine the effect of Medicaid expansion on utilization of surgical services from 2012 to 2014.

Results: There were 259,061 cases identified in the Medicaid expansion population and 261,269 in the control population. In the expansion group, there was a smaller decrease in utilization - by a margin of 21.68 cases per 100,000 individuals ($p < 0.001$). Percent of surgical patients covered by Medicaid increased among the expansion group from 12.00% to 15.48% (DID = 3.93%; $p < 0.001$).

Conclusions: Year one of Medicaid expansion under the ACA was associated with a modest but statistically significant difference in utilization of surgical services as well as an increase in percent of surgery patients covered by Medicaid.

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Introduction

One of the primary mechanisms for improving health care access in the Patient Protection and Affordable Care Act of 2010 (ACA) involves expansion of Medicaid coverage to all adults 18–64 years of age whose income falls below 138% of the federal poverty limit.¹ The impact of this provision, however, is limited by a 2012 Supreme Court decision which gave state legislatures discretionary power to determine whether to expand Medicaid in their respective state.² To date, 32 states as well as the District of Columbia have opted to do so, with increased Medicaid eligibility implemented in most jurisdictions by January 2014.³ Early data suggest that the ACA may

indeed have led to improved access to care among low-income adults, such as having a personal physician or ability to afford needed care, though details of its effect on utilization of health care services remain largely unknown.^{4–6}

Because the ACA seeks to lower systemic costs by improving access to timely care, a crucial question becomes whether expanding coverage will drive individuals to seek out care that may have been previously neglected. This question is relevant not only to health outcomes for patients, but also for understanding potential stresses on the provider side due to influx of new participants into the system. Furthermore, recognizing changes in composition of payer status following Medicaid expansion is important to both providers and policymakers alike.

Answering these questions regarding utilization are particularly relevant with respect to resource-intensive encounters such as inpatient surgical episodes. Previous studies have suggested

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that while rates of elective procedures such as hernia repair or transurethral prostate resection may be influenced by increased insurance coverage, more pressing surgeries such as oncologic procedures or appendectomies may not be as sensitive to such changes.^{7–12} In the current study, we utilize a state-specific, population-based database to compare the effect of ACA-related Medicaid expansion on insurance coverage and thereafter determine whether utilization of surgical procedures has been differentially affected by Medicaid expansion in states participating in that component of the ACA. We hypothesized that Medicaid expansion would be associated with a higher degree of Medicaid coverage amongst surgery patients, and additionally that surgical utilization would have increased in response to Medicaid expansion.

Methods

Data

Data from the State Inpatient Databases (SID) were abstracted between January 1, 2012 and December 31, 2014. The SID includes inpatient discharge data collected via federal–state partnerships as part of the Healthcare Cost and Utilization Project of the Agency for Healthcare Research and Quality (AHRQ). Because we used publicly available deidentified data, this analysis was exempt from review by the Partners HealthCare Institutional Review Board.

Study population

The study population included patients aged 19–64 years who underwent procedures listed in [Appendix Table 1](#). These procedures were classified as either “discretionary” or “nondiscretionary.” Discretionary procedures were those for which there could be a larger degree of patient or provider variation with respect to medical management alternatives, procedure necessity, or timing. On the basis of prior studies and clinical judgment, that group was defined to include transurethral resection of the prostate, inguinal hernia repair, back surgery, knee replacement, and hip replacement.^{7,9,10,13} A nondiscretionary comparative group included surgeries that could be perceived as more clinically urgent and therefore less sensitive to insurance or preference. Specifically, this included oncologic procedures, hip fracture repair, acute appendectomy, and major cardiovascular procedures.

For the basis of our primary comparison, expansion and non-expansion states were identified ([Appendix Table 2](#)). Expansion states were defined as those that implemented ACA-associated Medicaid expansion by January 2014 (cases). Non-expansion states were defined as those that did not implement by this time (controls). We selected New York, New Jersey, and Colorado as three expansion states with accessible SID data during the time-frame of interest and deemed this our expansion group. Florida, North Carolina, and Wisconsin were selected as a non-expansion comparison group. At the time of our analysis, these states represented the most populous comparably sized state pairs with available SID data for the period of interest. In a manner similar to this, multiple prior studies of healthcare outcomes or trends have been conducted using state-based data sourced from the SID.^{14–16}

Outcome measures and covariates

Patient characteristics included age, race, sex, type of residence (urban vs. rural), median household income, and insurance status. Median household income and percent below federal

poverty level were assessed from linked county-level data. Individuals associated with counties that fell below the 25th income percentile were classified as “low income”; those in counties above the 75th percentile were classified with “high income.” Those residing in counties between the 25th and 75th percentiles were termed “intermediate income.” Insurance status was defined as Medicare, Medicaid, private, uninsured, or other.

The AHRQ defines measures of access to care to include having health insurance, having a usual source of care, not encountering difficulties when seeking care, and receiving care as soon as wanted.¹⁷ In the context of this study focusing on surgical care, we assessed access through the following metrics: 1) change in rate of Medicaid coverage in the time period following coverage expansion relative to prior; 2) change in utilization of surgical services, as assessed through the lens of selected index cases following Medicaid expansion; and 3) differences in payer composition in those undergoing the aforementioned surgeries in the post-expansion period relative to pre-expansion.

To facilitate investigation of the outcomes mentioned above, we calculated the number of cases performed for each respective surgical procedure within the control and expansion state groupings both before and after the expansion cutoff (January 2014). Given the progressive enrollment in insurance plans during the months preceding January 2014, we deemed 2013 to be a washout period in our analysis and compared 2012 to 2014.

Statistical analyses

Baseline patient characteristics were derived for all surgical procedures of interest, stratified according to expansion and non-expansion states. Unadjusted rates of surgical utilization and Medicaid coverage were calculated in both states before and after the expansion. Moreover, to determine the effect of implementation of Medicaid expansion on surgical utilization and variation in Medicaid coverage, we used a quasi-experimental study design known as difference-in-differences (DID) analysis.¹⁸ This statistical approach is often used to assess the impact of policy changes and, in short, compares an exposure group that has experienced a policy change to one that has not – both before and after the policy implementation of interest. In this manner, the background changes in outcomes are theoretically subtracted out. Here, we compared the difference in surgical utilization and Medicaid coverage in the Medicaid expansion group before and after the 2014 implementation of Medicaid expansion to that of a contemporaneous control group of a non-Medicaid expansion population during the same periods. We conducted the DID analysis by fitting generalized linear regression models for discretionary and nondiscretionary procedures as well as each procedure separately. For evaluation of surgical utilization, the dependent variable was the total number of procedures in each group per quarter per 100,000 individuals residing in the respective group of states, which was multiplied by 4 to represent the total number of annual procedures. For the assessment of Medicaid coverage, the dependent variable was proportion of Medicaid coverage. The models were adjusted for patient characteristics. We also included an interaction term for the group and expansion status (before vs. after), the coefficient of which was the DID estimator. In addition, a subgroup analysis was performed to assess the effect of Medicaid expansion in varying county-specific income groups using a separate DID analysis. In particular, we defined the counties in the top quartile of median household income as “high” income, those in the bottom quartile as “low,” and all others as “intermediate.” All analyses were performed using SAS 9.4 Software. The significance level for all analyses was set at $p < 0.05$.

Results

We identified a total of 259,061 cases in the Medicaid expansion population and 261,269 cases in our control population who underwent the defined procedures from January 1, 2012, through December 31, 2014 (with a washout period of January 1, 2013, through December 31, 2013). Table 1 displays the pre-reform and post-reform characteristics of each group. With respect to payer composition, prevalence of Medicaid patients increased among the expansion group from 12.00% to 15.48% versus 10.24% to 10.16% in the control group (DID = 3.93%; $p < 0.001$). Percent of patients without insurance decreased from 5.01% to 3.00% in the Medicaid expansion population, compared to a change from 5.81% to 4.73% in the control group (DID = -0.79%; $p < 0.001$).

In the Medicaid expansion group, surgical utilization decreased by 6.00 cases per 100,000 individuals from 2012 to 2014 (Fig. 1). This was in comparison to a decrease of 28.00 cases in the control state and corresponded to a DID of 21.68 cases per 100,000 ($p < 0.001$). Discretionary procedures increased by a rate of 19.61 cases per 100,000 in the expansion group versus a decrease of 7.45 cases per 100,000 among the controls (DID = 25.68; $p < 0.001$). Nondiscretionary surgery decreased by a greater margin after Medicaid expansion (-25.07 cases per 100,000) versus the control (-21.22 cases per 100,000), resulting in a significant DID ($p < 0.001$). Full details of changes in utilization by specific surgical procedure are shown in Table 2.

There was an association between Medicaid expansion and percent of surgical patients covered by Medicaid for both discretionary and nondiscretionary procedures (Table 3). For discretionary surgery in particular, the Medicaid expansion population saw percent of Medicaid patients increase from 9.26% to 12.63% compared to 8.65% to 8.61% among controls (DID = 3.63%; $p < 0.001$). Nondiscretionary surgery was associated with an increase in Medicaid coverage following coverage expansion, increasing from 18.10% to 23.07% among surgery patients in the

expansion group; this was in comparison to a change of 14.31% to 14.53% in the non-expansion group (DID = 4.98%; $p < 0.001$).

Medicaid expansion differentially affected patients on the basis of county-specific median household income (Fig. 2). Based on income data, the greatest difference in utilization for the overall set of discretionary and nondiscretionary procedures was among those counties of intermediate household income, with a DID of 17.25 cases per 100,000 favoring the Medicaid expansion population ($p < 0.001$). There was a lesser effect among the high-income (DID = 2.20 cases per 100,000; $p < 0.001$) and low-income counties (DID = 3.27 cases per 100,000; $p < 0.001$).

Discussion

In this study of the impact of ACA-related Medicaid expansion on utilization of surgical services, we observed a significantly different change in utilization across an array of subspecialties during the first year of policy implementation in a diverse sample of states that experienced Medicaid expansion compared to a similarly diverse collection of states that did not. Overall, there was comparatively higher utilization in the Medicaid expansion population by a margin of 21.68 cases per 100,000 individuals for the group of surgical procedures analyzed here. This was driven by increased utilization of discretionary surgery. There was a decrease in non-discretionary surgery in both populations, although the magnitude of decrease was, in fact, less among the controls. The proportion of surgery patients with Medicaid coverage increased from 12.00% to 15.48% after Medicaid expansion, while staying essentially stable in the non-expansion group. The level of uninsured in both expansion and control populations decreased during the study period, though this decrease was greater in the control group.

Our results are similar to observed changes in surgical utilization following pre-ACA Medicaid expansion passed in 2006 in Massachusetts, where reported rates of discretionary surgery

Table 1
Demographics of surgery patients before and after Affordable Care Act-related Medicaid expansion in control and Medicaid expansion groups, 2012–2014.

Characteristics	Percent of patients			
	Non-expansion group		Expansion group	
	Before reform	After reform	Before reform	After reform
Total	136,075	125,194	134,203	124,858
Age (years)				
<50	30.78	26.89	35.10	30.72
50 - 58	33.00	33.96	31.92	33.38
>58	36.22	39.15	32.98	35.90
Race				
White	77.40	76.36	67.55	69.36
Black	12.11	12.65	9.66	10.56
Hispanic	7.96	8.14	10.39	9.47
Other	2.53	2.86	12.39	10.61
Gender				
Male	49.45	49.85	50.03	50.77
Female	50.55	50.15	49.97	49.23
Residence				
Rural	6.60	5.71	3.42	2.82
Urban	93.40	94.29	96.58	97.18
Household income				
Low	24.56	24.79	22.18	22.01
Intermediate	52.21	51.75	51.19	51.59
High	23.22	23.46	26.63	26.40
Insurance				
Medicaid	10.24	10.16	12.00	15.48
Medicare	14.27	14.65	9.35	9.90
Private insurance	60.82	62.71	64.11	61.96
No insurance	5.81	4.73	5.01	3.00
Other	8.86	7.75	9.54	9.67

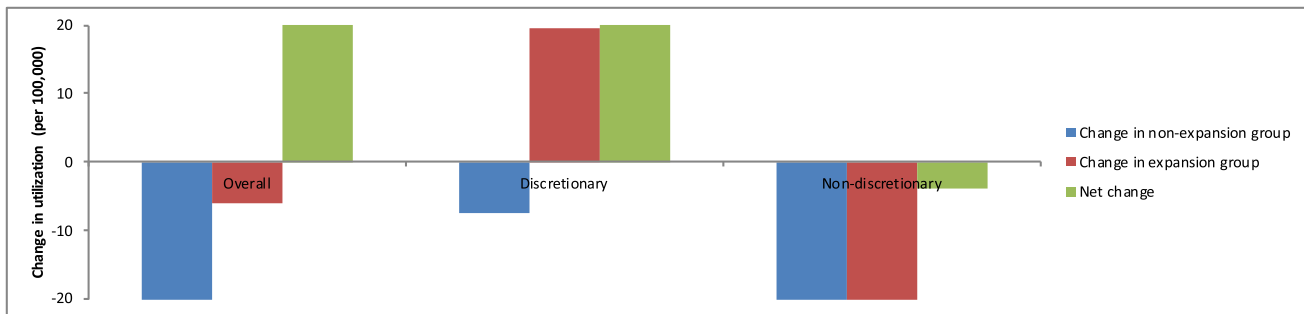


Fig. 1. Changes in surgical utilization by category following Affordable Care Act-related Medicaid expansion in control and Medicaid expansion groups, 2012–2014.

increased as non-discretionary surgery declined in the immediate aftermath of coverage expansion.⁷ This phenomenon may occur due to patients who truly require non-discretionary surgical services being more likely to pursue them regardless of insurance status, while the decision to proceed with discretionary or elective procedures may be more sensitive to insurance coverage. Consistent with that notion, 2001 Medicaid expansion in New York was associated with no significant increase in overall utilization of surgical cancer care.⁸ Reduction in non-discretionary surgical services following insurance expansion may be due to increased access to primary care and other services that lessen demand for critical surgical interventions through more effective long term management of chronic conditions (e.g. longitudinal cardiac care resulting in early detection of an aortic aneurysm that facilitates medical management or elective repair over emergent surgery).¹⁹

Indeed, in the context of the findings presented here, there is some evidence of “pent up” demand for primary care and elective surgical services relative to ACA implementation.^{6,20,21} Pent up demand refers to a spike in utilization of certain medical services after insurance is acquired, which often declines with time as an individual retains coverage.^{22–24} Early data from Minnesota illustrate this upfront spike in healthcare service consumption, as predicted probability of office visits among new ACA enrollees peaked at 28% at initial enrollment and downtrended to 21.6% by month six.²⁵ Encouragingly, a coincident decrease in ED visits has occurred among this and other newly insured populations.²⁶ Taken together, these trends may signify more efficient and appropriate receipt of care as more patients are seen in the longitudinal rather

than acute setting.

Beyond service utilization, it is noteworthy to recognize changes in payer composition demonstrated here, in particular the appearance that a proportion of new Medicaid enrollees may have been previously covered by private insurance plans rather than having been uninsured. Recognized in prior literature as a “crowd out effect” resulting from public insurance expansion, a possible motivation among such enrollees could be lower cost-sharing associated with Medicaid in comparison to certain private plans – particularly high deductible or lower quality policies.^{27–29} This becomes particularly attractive to patients facing high-cost services such as surgery and may also explain why the greatest increase in surgical utilization occurred among intermediate income counties, given they would likely contain the highest proportion of individuals transitioning from private insurance to Medicaid. In other words, increased utilization associated with the crowd out effect could conceivably be most prominent in the intermediate income group. While this explanation remains primarily hypothesis-generating and would need to be explored in subsequent studies, there has been some evidence of the crowd out phenomenon in response to ACA. For example, crowd out of private insurance accounted for 30–40% of the increase in Medicaid coverage observed in Connecticut.⁵ Unfortunately, our data do not provide the granularity necessary to determine the exact proportion of new Medicaid enrollees who were previously insured, and this information is also not yet known at the national level.¹ Similarly, we cannot fully explain why our population did not experience the decrease in uninsured rates that has been observed nationwide in

Table 2

Change in the rate of individual surgical procedures following Affordable Care Act-related Medicaid expansion in control and Medicaid expansion groups, 2012–2014.

Surgical Procedure	Surgical utilization rate (per 100,000 individuals)						Difference in differences	p-value
	Non-expansion group			Expansion group				
	Before reform	After reform	Net change	Before reform	After reform	Net change		
Overall	703.00	675.00	-28.00	639.00	633.00	-6.00	21.68	<.0001
Discretionary	506.07	498.62	-7.45	441.00	460.62	19.61	25.68	<.0001
Knee replacement	151.99	156.16	4.16	124.38	133.84	9.46	4.70	<.0001
Inguinal hernia repair	0.11	0.16	0.05	0.16	0.11	-0.05	-0.10	<.0001
Transurethral resection prostate	4.07	2.88	-1.20	4.89	3.89	-0.99	0.22	<.0001
Hip replacement	128.40	141.66	13.26	111.10	125.72	14.62	1.01	<.0001
Back surgery	221.50	197.77	-23.73	200.48	197.05	-3.42	19.80	<.0001
Non-discretionary	197.37	176.15	-21.22	197.65	172.58	-25.07	-4.00	<.0001
Hip fracture repair	0.32	0.30	-0.02	0.19	0.15	-0.04	-0.02	<.0001
Appendectomy	93.25	73.47	-19.78	110.44	85.51	-24.92	-5.19	<.0001
CABG	68.99	69.65	0.67	52.36	54.60	2.24	1.46	<.0001
Radical cystectomy	0.93	0.95	0.01	0.74	0.69	-0.05	-0.06	<.0001
Esophagectomy	0.72	0.64	-0.09	0.54	0.55	0.01	0.10	<.0001
Pancreatotomy	1.83	2.03	0.20	1.80	1.83	0.03	-0.16	<.0001
Colectomy	15.51	15.02	-0.50	13.30	13.30	0.00	0.45	<.0001
Lung surgery	9.50	8.67	-0.83	8.64	8.74	0.10	0.96	<.0001
Uterine surgery	6.32	5.43	-0.89	9.63	7.20	-2.43	-1.54	<.0001

Table 3

Change in percent of Medicaid coverage among surgery patients following Affordable Care Act-related Medicaid expansion in control and Medicaid expansion groups, 2012–2014.

Surgery type	Medicaid coverage (%)						Difference in differences	p-value
	Non-expansion group			Expansion group				
	Before reform	After reform	Net change	Before reform	After reform	Net change		
Overall	10.24	10.16	−0.08	12.00	15.48	3.48	3.93	<.0001
Discretionary	8.65	8.61	−0.04	9.26	12.63	3.37	3.63	<.0001
Non-discretionary	14.31	14.53	0.22	18.10	23.07	4.97	4.98	<.0001

response to the ACA, though we hypothesize there may be a relatively longer lag time before previously uninsured patients reach the point of undergoing surgery.³⁰

Our study has certain additional limitations. First, utilization data are considered from six states; as such, findings reported here may not necessarily be generalizable to the entire country. This includes an inability to determine if there were significant procedure-specific trends within certain states that would explain larger shifts observed in utilization of, for example, back surgery or radical prostatectomy. We have attempted to minimize the influence of this limitation by including multiple states in each group. Second, there is some degree of baseline dissimilarity in our comparison states in terms of geography, demographics, uninsured rate, and physician concentration. Additionally, there was prior non-ACA related Medicaid expansion in New York and Wisconsin. Ultimately, these differences were not deemed significant enough to necessitate exclusion of any states. Third, we were unable to consider certain clinical factors that may have influenced surgical volume independent of policy changes. For example, due to the nature of our database, we were not able to fully account for emergence of novel therapies competing with transurethral resection of the prostate, nor were we able to account for shifts in severity of clinical presentation for the typical benign prostatic hyperplasia patient. Fourth, we are unable to discern whether increased discretionary procedures were clinically appropriate. While increased utilization of discretionary procedures may be a byproduct of previously omitted care, it remains possible that newly insured individuals are receiving low-value or inappropriate discretionary surgery. Fifth, we utilize an inpatient database for this study; as a result, the utilization rates here do not account for the totality of procedures in the outpatient and ambulatory surgery center settings. This consideration is of particular significance for procedures such as inguinal hernia repair that are more commonly performed on an elective, outpatient basis. Sixth, our analysis does not capture surgical utilization trends prior to 2012. Notably, however, percent of uninsured in expansion and non-expansion states are known to

have dropped by the same margin from 2010 through 2013, with significant separation in coverage trends coming only after Medicaid enrollment was broadened in 2014 in expansion states alone.³¹ As such, we believe that our study appropriately captures the inflection point of interest for this policy implementation. Furthermore, we attempted to control for pre-ACA surgical utilization trends in that such trends would have hopefully affected both expansion and non-expansion groups in a relatively similar manner, thereby leaving Medicaid expansion as the primary variable uniquely affecting our expansion group. Lastly, and perhaps most importantly, our study only considers the first year post-Medicaid expansion. More longitudinal and recent data are needed to better delineate durable effects of the ACA on surgical trends. Though improved primary care access can prevent avoidable surgery, individuals recently introduced to health care services may also take more than a year (the time frame of our study) to complete a full workup or medical management cycle that ultimately end with operative intervention. Additionally, while recent evidence suggests that the ACA has been associated with increased coverage and more timely care for common surgical conditions, there may arise some resource limitations as year two of Medicaid expansion has been associated with low income patients facing increased wait times and difficulty securing appointments.^{32,33} This illustrates the complex interaction that access to care, primary care services, and resource constraints will play on surgical utilization trends going forward.

In conclusion, this analysis of the effect of ACA-related Medicaid expansion on utilization of surgical services has demonstrated a modest but statistically positive effect of policy implementation, in particular with respect to discretionary procedures. There was a benefit in reduction of uninsured rates amongst our study population following expansion, as well as an increased number of individuals covered by Medicaid. It is conceivable this may have resulted from certain newly eligible individuals abandoning previously held low quality private insurance coverage in favor of Medicaid.

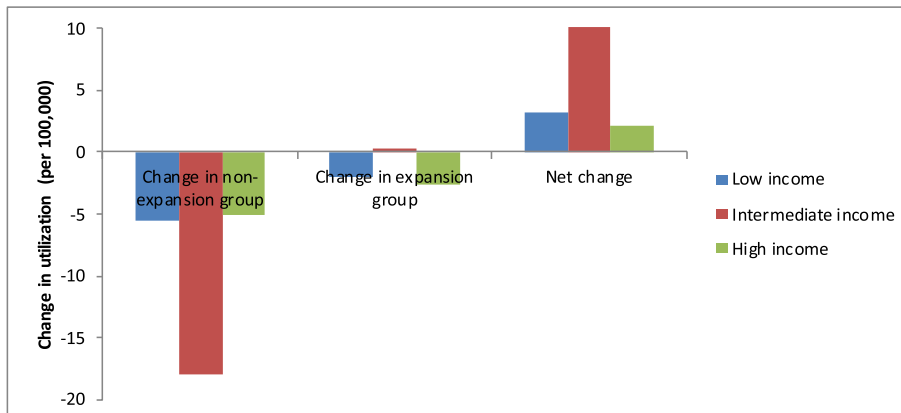


Fig. 2. Changes in surgical utilization by socioeconomic category following Affordable Care Act-related Medicaid expansion in control and Medicaid expansion groups, 2012–2014.

While ours and other early findings related to the ACA indicate higher Medicaid enrollment and overall reduction in uninsured rates, longer term data are needed to discern whether the increased coverage and access associated with this policy result in better care rather than simply more care. This involves not only providing accessible, high quality surgical care but also coordinating with medical services to better manage potential surgical conditions or avoid preventable surgery altogether. As such, though the ultimate effects of the ACA are yet to be seen, enabling more effective and appropriate surgical utilization continues to hold the potential to aid further development of value-based health care in the United States.

Declaration of competing interest

Quoc-Dien Trinh reports consulting fees from Bayer, Astellas, and Janssen. All other authors have nothing to disclose.

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Appendix

Appendix Table 1
ICD-9 Procedure and Diagnosis Codes

	ICD-9-CM Procedure code	ICD-9-CM Diagnosis code (if applicable)	Reference (if applicable)
Discretionary			
Knee replacement	81.54, 81.55		Ellimoottil et al. ⁷
Inguinal hernia repair	53.0, 53.1, 53.17		Ellimoottil et al. ⁷
Transurethral resection prostate	60.2, 60.29		Ellimoottil et al. ⁷
Hip replacement	79.10, 79.15, 79.30, 79.35, 78.55, 81.51, 81.52	(Excluding) 820, 820.3, 820.31, 820.32, 820.8820.9	Ellimoottil et al. ⁷
Back surgery	03.0, 03.1, 03.2, 03.21, 03.4 03.5, 80.5, 80.50, 81.0, 03.01–03.09, 80.50–80.59, 81.00–81.08		Ellimoottil et al. ⁷
Nondiscretionary			
Hip fracture repair	79.10, 79.15, 79.30, 79.35, 78.55, 81.51, 81.52	820, 820.3, 820.31, 820.32, 820.8820.9	Ellimoottil et al. ⁷
Appendectomy	47.0, 47.01, 47.09		Ellimoottil et al. ⁷
CABG	35.10–35.29, 36.10–36.19		Finks et al. ³²

Appendix Table 1 (continued)

	ICD-9-CM Procedure code	ICD-9-CM Diagnosis code (if applicable)	Reference (if applicable)
Radical cystectomy	57.7, 57.71, 57.79	188, 188.0–188.9	
Esophagectomy	42.4, 42.40, 42.41, 42.42	150, 150.0–150.9	Ellimoottil et al. ⁷
Pancreatectomy	52.6, 52.7, 52.51, 52.52, 52.53, 52.49	157, 157.0–157.9	Ellimoottil et al. ⁷
Colectomy	45.7, 45.8, 48.5, 48.6, 45.71–45.83, 48.61–48.69	153, 154, 153.0–153.9, 154.0–154.8	Ellimoottil et al. ⁷
Lung surgery	32, 32.2–32.5, 32.20–32.59	162, 162.0–162.9	Ellimoottil et al. ⁷
Uterine surgery	68.3, 68.9, 68.30–68.79	182, 182.0–182.8	Ellimoottil et al. ⁷

Appendix Table 2
Groupings of states by participation in ACA Medicaid expansion

ACA-Related Medicaid Expansion States
1) Alaska *
2) Arizona
3) Arkansas
4) California
5) Colorado
6) Connecticut
7) Delaware
8) District of Columbia
9) Hawaii
10) Idaho *
11) Illinois
12) Indiana *
13) Iowa
14) Kentucky
15) Louisiana *
16) Maine *
17) Maryland
18) Massachusetts
19) Michigan *
20) Minnesota
21) Montana *
22) Nebraska *
23) Nevada
24) New Hampshire *
25) New Jersey
26) New Mexico
27) New York
28) North Dakota
29) Ohio
30) Oregon
31) Pennsylvania *
32) Rhode Island
33) Utah *
34) Vermont
35) Virginia *
36) Washington
37) West Virginia
ACA-Related Medicaid Non-Expansion States
1) Alabama
2) Florida
3) Georgia
4) Kansas
5) Mississippi
6) Missouri
7) North Carolina
8) Oklahoma
9) South Carolina
10) South Dakota
11) Tennessee

Appendix Table 2 (continued)

ACA-Related Medicaid Expansion States

-
- 12) Texas
 - 13) Wisconsin
 - 14) Wyoming
-

* Expanded after policy implementation date of January 2014 and/or are pending expansion.

References

1. Blumenthal D, Collins SR. Health care coverage under the Affordable Care Act—a progress report. *N Engl J Med*. 2014;371(3):275–281.
2. Law Review Harvard. National federation of independent business v. Sebelius: the patient protection and affordable care Act. *Harv Law Rev*. 2012;126(1):72–82.
3. The Henry J. Kaiser Family Foundation. *Status of State Action on the Medicaid Expansion Decision*. The Henry J. Kaiser Family Foundation; 2017. Updated January 1, 2017. Accessed March 19, 2017 <http://kff.org/health-reform/slide/current-status-of-the-medicaid-expansion-decision>.
4. Sommers BD, Gunja MZ, Finegold K, Musco T. Changes in self-reported insurance coverage, access to care, and health under the affordable care Act. *J Am Med Assoc*. 2015;314(4):366–374.
5. Sommers BD, Kenney GM, Epstein AM. New evidence on the Affordable Care Act: coverage impacts of early medicaid expansions. *Health Aff*. 2014;33(1):78–87.
6. Wherry LR, Miller S. Early coverage, access, utilization, and health effects associated with the affordable care Act medicaid expansions: a quasi-experimental study. *Ann Intern Med*. 2016;164(12):795–803.
7. Ellimoottil C, Miller S, Ayanian JZ, Miller DC. Effect of insurance expansion on utilization of inpatient surgery. *JAMA Surg*. 2014;149(8):829–836.
8. Al-Refaie WB, Zheng C, Jindal M, et al. Did pre-affordable care Act medicaid expansion increase access to surgical cancer care? *J Am Coll Surg*. 2017.
9. Birkmeyer JD, Sharp SM, Finlayson SR, Fisher ES, Wennberg JE. Variation profiles of common surgical procedures. *Surgery*. 1998;124(5):917–923.
10. Birkmeyer JD, Reames BN, McCulloch P, Carr AJ, Campbell WB, Wennberg JE. Understanding of regional variation in the use of surgery. *Lancet*. 2013;382(9898):1121–1129.
11. Card DE, Dobkin C, Maestas N, National Bureau of Economic Research. The impact of nearly universal insurance coverage on health care utilization and health evidence from Medicare. In: *NBER Working Paper Series Working Paper 10365*. Cambridge, MA: National Bureau of Economic Research; 2004. <http://papers.nber.org/papers/W10365>.
12. Mort EA, Weissman JS, Epstein AM. Physician discretion and racial variation in the use of surgical procedures. *Arch Intern Med*. 1994;154(7):761–767.
13. Weinstein JN, Bronner KK, Morgan TS, Wennberg JE. Trends and geographic variations in major surgery for degenerative diseases of the hip, knee, and spine. *Health Aff*. 2004. Suppl Variation:VAR81–89.
14. Basu J, Mobley LR. Do HMOs reduce preventable hospitalizations for Medicare beneficiaries? *Med Care Res Rev*. 2007;64(5):544–567.
15. Nathan H, Cameron JL, Choti MA, Schulick RD, Pawlik TM. The volume-outcomes effect in hepato-pancreato-biliary surgery: hospital versus surgeon contributions and specificity of the relationship. *J Am Coll Surg*. 2009;208(4):528–538.
16. Stavrakis AI, Ituarte PH, Ko CY, Yeh MW. Surgeon volume as a predictor of outcomes in inpatient and outpatient endocrine surgery. *Surgery*. 2007;142(6):887–899.
17. Agency for Healthcare Research and Quality. *National Healthcare Quality and Disparities Report*. In. Rockville, MD. 2016. July 2017.
18. Dimick JB, Ryan AM. Methods for evaluating changes in health care policy: the difference-in-differences approach. *J Am Med Assoc*. 2014;312(22):2401–2402.
19. Sommers BD, Maylone B, Blendon RJ, Orav EJ, Epstein AM. Three-year impacts of the affordable care Act: improved medical care and health among low-income adults. *Health Aff*. 2017. <https://doi.org/10.1377/hlthaff.2017.0293>.
20. Sommers BD, Blendon RJ, Orav EJ, Epstein AM. Changes in utilization and health among low-income adults after medicaid expansion or expanded private insurance. *JAMA Intern Med*. 2016;176(10):1501–1509.
21. Simon K, Soni A, Cawley J. The impact of health insurance on preventive care and health behaviors: evidence from the first two years of the ACA medicaid expansions. *J Policy Anal Manag*. 2017;36(2):390–417.
22. Eisert S, Gabow P. Effect of Child Health Insurance Plan enrollment on the utilization of health care services by children using a public safety net system. *Pediatrics*. 2002;110(5):940–945.
23. Baicker K, Finkelstein A. The effects of Medicaid coverage—learning from the Oregon experiment. *N Engl J Med*. 2011;365(8):683–685.
24. McWilliams JM, Meara E, Zaslavsky AM, Ayanian JZ. Use of health services by previously uninsured Medicare beneficiaries. *N Engl J Med*. 2007;357(2):143–153.
25. Fertig AR, Carlin CS, Ode S, Long SK. Evidence of pent-up demand for care after medicaid expansion. *Med Care Res Rev*. 2017;75(4):516–524.
26. Akosa Antwi Y, Moriya AS, Simon K, Sommers BD. Changes in emergency department use among Young adults after the patient protection and affordable care act's dependent coverage provision. *Ann Emerg Med*. 2015;65(6):664–672 e662.
27. Cutler DM, Gruber J. Does public insurance crowd out private insurance? *Q J Econ*. 1996;111(2):391–430.
28. Wagner KL. Medicaid expansions for the working age disabled: revisiting the crowd-out of private health insurance. *J Health Econ*. 2015;40:69–82.
29. Frean M, Gruber J, Sommers BD. Premium subsidies, the mandate, and medicaid expansion: coverage effects of the affordable care Act. *J Health Econ*. 2017;53:72–86.
30. French MT, Homer J, Gumus G, Hickling L. Key provisions of the patient protection and affordable care Act (ACA): a systematic review and presentation of early Research findings. *Health Serv Res*. 2016;51(5):1735–1771.
31. Cohen RA, Martinez ME, Zammitti EP. *Health Insurance Coverage: Early Release of Estimates from the National Health Interview Survey, January–March 2018*. Atlanta, GA: Centers for Disease Control and Prevention; 2018.
32. Miller S, Wherry LR. Health and access to care during the first 2 Years of the ACA medicaid expansions. *N Engl J Med*. 2017;376(10):947–956.
33. Loehrer AP, Chang DC, Scott JW, et al. Association of the affordable care Act medicaid expansion with access to and quality of care for surgical conditions. *JAMA Surg*. 2018. e175568.