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Utilization of Anesthesia Services During Outpatient Endoscopies and Colonoscopies and Associated Spending in 2003-2009

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Context The frequency with which anesthesiologists or nurse anesthetists provide sedation for gastrointestinal endoscopies, especially for low-risk patients, is poorly understood and controversial.

Objective To quantify temporal comparisons and regional variation in the use of and payment for gastroenterology anesthesia services.

Design, Setting, and Patients A retrospective analysis of claims data for a 5% representative sample of Medicare fee-for-service patients (1.1 million adults) and a sample of 5.5 million commercially insured patients between 2003 and 2009.

Main Outcome Measures Total number of upper gastrointestinal endoscopies and colonoscopies, proportion of gastroenterology procedures with associated anesthesia claims, payments for gastroenterology anesthesia services, and proportion of services and spending for gastroenterology anesthesia delivered to low-risk patients (American Society of Anesthesiologists physical status class 1 or 2).

Results The number of gastroenterology procedures per million enrollees remained largely unchanged in Medicare patients (mean, 136 718 procedures), but increased more than 50% in commercially insured patients (from 33 599 in 2003 to 50 816 in 2009). In both populations, the proportion of procedures using anesthesia services increased from approximately 14% in 2003 to more than 30% in 2009, and more than two-thirds of anesthesia services were delivered to low-risk patients. There was substantial regional variation in the proportion of procedures using anesthesia services in both populations (ranging from 13% in the West to 59% in the Northeast). Payments for gastroenterology anesthesia services doubled in Medicare patients and quadrupled in commercially insured patients.

Conclusions Between 2003 and 2009, utilization of anesthesia services during gastroenterology procedures increased substantially. Anesthesia services are predominantly used in low-risk patients and show considerable regional variation.

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THE CONTINUOUS INCREASE IN spending on medical care has triggered a debate concerning which services and procedures provide adequate value and which do not, and therefore represent potential areas to reduce cost.[1] The use of anesthesiologists, nurse anesthetists, or both during gastrointestinal endoscopies has been identified as one such potential area.[2] Under current payment guidelines for gastrointestinal endoscopies, if intravenous sedation is needed, the endoscopist has to administer it with support of a nurse, and the sedation component is included in the professional fee. Involvement of an anesthesiologist or nurse anesthetist, which implies an additional payment, is only justified for procedures performed on high-risk patients.[3-5]

Recent data from a large insurer in the United States, however, suggest that the proportion of colonoscopy and upper gastroenterology procedures with anesthesia service was 24% in 2007 and is projected to increase to 53% by 2015.[6] Given the high volume of gastrointestinal endoscopies, the additional payment for anesthesia services can be substantial. For example, Cohen and Benson[7] estimated that total payment would amount to as much as $8 billion per year if anesthesia services were used for all 20 million endoscopic procedures. It is unknown at this point what drives the increase in anesthesia use during endoscopies and to what degree the increase reflects potentially discretionary spending, which may present an opportunity to reduce cost.

We analyzed insurance claims data for Medicare fee-for-service and a large

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commercially insured sample between 2003 and 2009 to examine temporal comparisons in the use of gastroenterology procedures, the proportion of those procedures assisted by a separate anesthesiologist or nurse anesthetist, and the payments for gastroenterology anesthesia services. In addition, we evaluated regional variation in gastroenterology anesthesia use and estimated the potentially discretionary proportion of gastroenterology anesthesia, defined as services delivered to low-risk patients (American Society of Anesthesiologists [ASA] physical status class 1 or 2).

METHODS

Study Design and Population

We conducted a retrospective analysis of insurance claims data for Medicare and commercially insured patients for the years between 2003 and 2009. We used the Medicare Limited Data set, a nationally representative 5% sample, to represent the beneficiaries in the fee-for-service program, and the Thomson Reuters MarketScan data set, which includes claims from approximately 150 commercial health plans serving larger companies, to represent nearly 40 million commercially insured individuals. The MarketScan data contain approximately 20% of the population that is covered by employer-sponsored insurance. MarketScan national weights were constructed based on the Medical Expenditures Panel Survey, and these weights can be used to generate national estimates.[8] The study was approved by the RAND institutional review board.

Our study sample consisted of all patients who received outpatient upper gastrointestinal endoscopies and colonoscopies as identified based on *Current Procedural Terminology*, edition 4 (CPT-4) codes (upper gastrointestinal endoscopy: codes 43234-43259; colonoscopy: codes 45378-45392, G0105, G0120, and G0121). We excluded patients younger than 18 years because of the different decision criteria for anesthesia use, and patients for whom we did not have complete claims data for the 6 months before the respective endoscopy.

Outcome Measures

Our outcomes of interest were (1) the number of upper endoscopies and colonoscopies, (2) the proportion of gastroenterology procedures that used anesthesia services, (3) the average and aggregate payment for gastroenterology anesthesia services, and (4) the proportion of anesthesia services and payments provided to low-risk patients, defined as ASA physical status class 1 or 2. Because the sample size varied over time, unweighted number of procedures or aggregate payment is presented as rates per million enrollees to describe temporal comparisons. The number of procedures or aggregate payment in any given year was divided by the number of enrollees in the sample for that year, including those without a gastroenterology procedure. Outcomes were evaluated by calendar year and by geographic region. We used the consumer price index to adjust all US dollar figures to 2009 dollars.[9]

Anesthesia Service Use

Anesthesia services were identified using 2 anesthesia CPT-4 codes (code 00740 for anesthesia service associated with upper gastrointestinal endoscopies and code 00810 for colonoscopy-associated anesthesia service). Gastroenterology procedures were linked to anesthesia service records, using unique patient identifiers and dates of service.

Estimation of Clinical Need for Anesthesia Services

To mirror current coverage policies, we approximated patient need for anesthesia services during endoscopy based on the ASA physical status classification.[3-5] We labeled patients with an ASA physical status level 3 (severe systemic disease) or higher as having a clinical indication for anesthesia coverage during gastroenterology procedures; conversely, in low-risk patients with ASA physical status levels 1 and 2, the anesthesia service use was considered to be potentially discretionary.

In 14.1% of the commercial anesthesia service claims (unweighted n=277 203), ASA physical status classification was coded explicitly on the insurance claims with a physical status modifier. For the remaining commercially insured and Medicare patients, we developed a statistical model to predict ASA physical status level of 3 or higher, because we could not identify an existing approach to determine anesthesia risk based on claims data.

Using the subset of procedures with coded ASA physical status levels, we constructed a multivariate logistic model to estimate a patient's probability of having an ASA physical status level of 3 or higher at the time of a given procedure as a function of age, sex, comorbid medical conditions, and presence of an inpatient admission during the 3 months before the procedure. We forced cardiopulmonary conditions into the model that are important contributors to anesthesia risk (cardiac arrest, congestive heart failure, chronic obstructive pulmonary disease, coronary artery disease, asthma, and cystic fibrosis). Then, we used a backward stepwise selection method (with $P \leq .10$) to identify additional conditions that were significant predictors of ASA physical status level, based on major disease categories defined by Clinical Classification Software developed by the US Agency for Healthcare Research and Quality.[10]

The following additional conditions were selected by the stepwise regression—cerebrovascular disease, hypertension, peripheral artery diseases, anemia, gastrointestinal bleeding, inflammatory bowel disease, hepatobiliary disease, pancreatic disease, diabetes, dementia, human immunodeficiency virus, renal failure, cancer, and psychiatric disorder. In addition, we classified all patients with a diagnosis of sleep apnea in the prior 6 months as having an ASA physical status level of 3 or higher, because sleep apnea is an important risk factor for respiratory compromise dur-

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Table 1. Patient Characteristics[a]

Characteristics	Medicare Fee-for-Service Patients: With Anesthesia Service Use (n = 302 263)	Medicare Fee-for-Service Patients: Without Anesthesia Service Use (n = 836 027)	*P* Value	Commercially Insured Patients: With Anesthesia Service Use (n = 1 573 726)	Commercially Insured Patients: Without Anesthesia Service Use (n = 3 933 556)	*P* Value
Age group, %, y						
18-35	0.55	0.51		8.77	8.01	
36-45	1.62	1.55		13.59	12.85	
46-55	4.52	4.56		38.85	39.74	
56-65	14.52	14.96	<.001	38.79	39.40	<.001
66-75	47.65	48.09		NA	NA	
76-85	27.38	26.44		NA	NA	
>85	3.76	3.88		NA	NA	
Female sex, %	56.62	56.45	.11	55.46	55.28	<.001
No. of chronic conditions, median (IQR)	3 (2-5)	3 (1-5)	<.001	1 (0-2)	1 (0-2)	<.001

Abbreviations: IQR, interquartile range; NA, not applicable.
[a]Unweighted.

ing sedation and regarded as requiring anesthesia supervision.[11] All comorbid conditions were defined based on *International Classification of Diseases, Ninth Revision, Clinical Modification* diagnosis codes on claims within the 6 months before each procedure.

We used the estimated coefficients from the regression model to predict the probability of having an ASA physical status level of 3 or higher for patients without a coded ASA physical status level. The probability predictions of all patients without a coded ASA physical status level were summed to generate the expected number of patients with an ASA physical status level of 3 or higher. We then rank-ordered these patients by their predicted probability and assigned an ASA physical status level of 3 or higher to this expected number of patients with the highest predicted probabilities.

Payment Estimates

The payment estimates for anesthesia services include both insurer payments to anesthesiologists or nurse anesthetists and co-payments or deductibles from patients, which correspond with the allowed charge variable in the Medicare claims data and the payment variable in the MarketScan data. In patients who underwent more than 1 upper gastrointestinal endoscopy or colonoscopy in the same quarter (Medicare) or on the same date (MarketScan), we could not assign anesthesia use unambiguously to 1 procedure. Thus, calculations of average payment per procedure and the proportion of anesthesia use among low-risk patients were based on patients with only 1 upper gastrointestinal procedure or 1 colonoscopy in a specific quarter (Medicare) or on a specific date (MarketScan), which accounted for 33.4% (2009) to 44.3% (2003) of all procedures in the Medicare sample and 85.1% (2009) to 92.0% (2003) in the commercially insured sample.

Statistical Analysis

A significance level $\alpha = .05$ was used throughout the analysis. Comparison of means was performed using *t* tests or regressions. The significance of the relationship between categorical variables (eg, age group) and dichotomous outcomes (presence or absence of anesthesia service) was tested using χ^2 tests or logistic regressions. Confidence intervals of potentially discretionary use and payments were estimated using the bootstrap method with 50 replications. The results in the main text are unweighted; estimates weighted to the national level are shown in eTable 1, eTable 2, eTable 3, eFigure 1, and eFigure 2 (http://www.jama.com). Unweighted statistics on the commercially insured sample with anesthesia service use and recorded ASA physical status level are shown in eTable 4 and eTable 5.

RESULTS

Patient Demographics and Overall Anesthesia Service Use

In our 2 samples, a total of 6.6 million unique patients (Medicare fee-for-service sample, 1.1 million; and commercially insured sample, 5.5 million) had either an upper gastrointestinal endoscopy or a colonoscopy as outpatients during the period between 2003 and 2009 (TABLE 1). Overall, 26.6% of Medicare patients and 28.6% of commercially insured patients received anesthesia services. No substantial difference exists in age, sex, and number of chronic conditions between patients with and without anesthesia services.

Utilization of and Payment for Anesthesia Service Use, 2003-2009

A total of 2.2 million gastroenterology procedures were performed on Medicare beneficiaries and 7.0 million gastroenterology procedures were performed on commercially insured patients between 2003 and 2009. Although the number of gastroenterology procedures per million enrollees per year remained largely unchanged in Medicare patients, with a mean of

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136 718, the number of gastroenterology procedures per million enrollees per year increased more than 50% in commercially insured patients, from 33 599 in 2003 to 50 816 in 2009 (TABLE 2). The proportion of procedures using anesthesia services increased at a similar rate for commercially insured patients (13.6% to 35.5%) and Medicare patients (13.5% to 30.2%).

The proportion of procedures with anesthesia services varied substantially by geographic region (Table 2). Patterns were similar for Medicare and commercially insured patients, with the lowest use in the West region (Medicare sample, 14.0%; and commercially insured sample, 12.6% in 2009) and the highest use in the Northeast region (47.5% and 59.0% in 2009, respectively).

Overall, the proportion of anesthesia services delivered to low-risk (predicted ASA physical status level of 1 or 2) patients was more than two-thirds in the Medicare population, and more than three-quarters among the commercially insured population (Table 2). This proportion decreased over time from 78.6% (95% CI, 77.9%-79.2%) in 2003 to 64.1% (95% CI, 63.2%-64.6%) in 2009 in the Medicare fee-for-service population, whereas it remained constant in the commercially insured patients (86.5%; 95% CI, 85.8%-86.9% in 2003 and 83.9%; 95% CI, 83.7%-84.0% in 2009).

Annual payments for anesthesia services among Medicare patients almost doubled in real terms, from $2.2 million in 2003 to $4.2 million in 2009 per 1 million enrollees (TABLE 3). Annual payments per 1 million commercially insured patients increased more than 4-fold from 2003 ($1.9 million) to 2009 ($8.4 million). The cost per procedure payment for anesthesia services remained stable in real terms for Medicare patients ($147.20 in 2003 and $150.20 in 2009) and increased by 13.6% for commercially insured patients ($447.10 in 2003 and $508.70 in 2009).

The number of procedures with anesthesia services for low-risk patients increased substantially in the Medicare population during the study period (FIGURE 1). For this group, the number of procedures per 1 million enrollees increased from 13 989 (95% CI, 13 867-14 098) in 2003 to 25 069 (95% CI, 24 721-25 265) in 2009. Annual payments per 1 million enrollees for such potentially discretionary anesthesia services increased by approximately 8% per year (from $1.69 [95% CI, $1.67-$1.71] million in 2003 to $2.65 [95% CI, $2.63-$2.68] million in 2009).

The increase in the number of procedures with anesthesia services for low-risk patients was more pronounced in commercially insured patients (FIGURE 2), from 3938 (95% CI, 3908-3957) to 15 108 (95% CI, 15 077-15 143) per 1 million enrollees. The associated payments per 1 million enrollees increased more than 4-fold during the study period (from $1.69 [95% CI, $1.68-$1.70] million to $7.05 [95% CI, $7.04-$7.06] million).

Weighted to the national level, annual spending on gastroenterology anesthesia services is estimated to have more than tripled during the period be-

Table 2. Comparison of Utilization of Anesthesia Services During Gastroenterology Procedures, 2003-2009[a]

Utilization	2003	2004	2005	2006	2007	2008	2009
Total procedure volume per million enrollees							
Medicare fee-for-service patients	132 000	138 420	141 073	139 954	139 748	136 191	129 639
Upper gastroenterology	45 358	48 136	48 648	49 960	49 691	49 861	49 802
Colonoscopy	86 643	90 284	92 425	89 994	90 057	86 330	79 837
Commercially insured patients	33 599	37 678	44 102	46 872	47 608	48 465	50 816
Upper gastroenterology	10 778	11 918	13 356	14 739	14 697	15 269	16 680
Colonoscopy	22 822	25 760	30 746	32 132	32 911	33 196	34 136
Proportion of procedures with anesthesia services, %							
Medicare fee-for-service patients	13.5	16.6	19.2	21.6	24.0	26.6	30.2
Northeast	21.6	27.6	31.8	35.7	39.1	43.5	47.5
Midwest	9.6	11.9	13.4	14.8	16.1	17.6	21.2
South	14.1	17.0	20.1	23.0	26.0	29.3	33.1
West	6.8	7.8	8.7	10.0	11.2	11.7	14.0
Commercially insured patients	13.6	17.8	23.5	25.2	27.7	32.7	35.5
Northeast	25.7	35.1	38.5	43.9	47.8	57.4	59.0
Midwest	12.8	16.5	19.2	20.5	22.0	23.6	25.9
South	11.6	16.3	25.4	26.6	30.2	34.2	38.1
West	11.3	12.0	11.5	10.6	11.0	11.1	12.6
Proportion of anesthesia services considered potentially discretionary, % (95% CI)							
Medicare fee-for-service patients	78.6 (77.9-79.2)	69.6 (68.5-70.4)	70.5 (69.7-71.0)	67.7 (67.0-68.2)	65.9 (65.2-66.7)	66.4 (65.7-67.0)	64.1 (63.2-64.6)
Commercially insured patients	86.5 (85.8-86.9)	84.4 (84.0-84.9)	85.3 (85.0-85.5)	85.2 (84.9-85.3)	84.0 (83.8-84.1)	84.4 (84.2-84.5)	83.9 (83.7-84.0)

[a] Unweighted.

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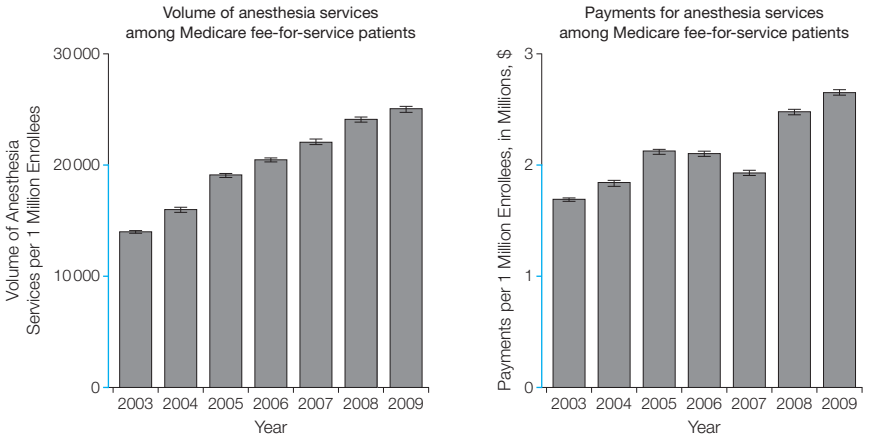
Table 3. Comparison of Payments for Anesthesia Services During Gastroenterology Procedures, 2003-2009[a]

Payments	2003	2004	2005	2006	2007	2008	2009
Total payments for anesthesia services per million enrollees (in millions)							
Medicare fee-for-service patients	2.2	2.7	3.0	3.1	3.0	3.8	4.2
Commercially insured patients	1.9	2.9	4.2	4.7	5.3	7.1	8.4
Proportion of payments associated with potentially discretionary anesthesia services, % (95% CI)							
Medicare fee-for-service patients	77.9 (77.1-78.6)	68.6 (67.4-69.4)	69.8 (68.8-70.3)	66.8 (66.0-67.6)	65.1 (64.3-65.9)	65.6 (64.9-66.3)	63.3 (62.7-64.0)
Commercially insured patients	87.1 (86.5-87.5)	85.1 (84.7-85.8)	85.9 (85.6-86.1)	85.9 (85.6-86.1)	84.7 (84.5-84.9)	85.2 (85.0-85.4)	84.1 (83.9-84.2)
Average payments for anesthesia service per gastroenterology procedure (95% CI, in 2009 dollars)[b]							
Medicare fee-for-service patients	147.20 (146.60-147.90)	148.00 (147.40-148.60)	145.90 (145.20-146.50)	138.60 (138.10-139.20)	121.20 (120.80-121.60)	144.20 (143.80-144.60)	150.20 (149.80-150.60)
Commercially insured patients	447.10 (445.20-449.10)	449.10 (447.50-450.70)	426.00 (424.90-427.10)	425.40 (424.50-426.40)	432.60 (431.60-433.50)	488.50 (487.40-489.60)	508.70 (507.60-509.80)

[a] Unweighted.
[b] All payments are adjusted to 2009 US dollars using consumer price index.

Figure 1. Volume of Potentially Discretionary Anesthesia Service Use and Associated Payments Among Medicare Fee-for-Service Patients During 2003-2009



Unweighted, per 1 million enrollees. Error bars indicate 95% CIs. The blue portions of the y-axes indicate 0 to 20 000 in the first graph and $0 to $2 million in the second graph.

tween 2003 and 2009, increasing from $0.4 billion in 2003 to $1.3 billion in 2009 (eTable 3). The estimated utilization of gastroenterology anesthesia services provided to low-risk patients reached 3.1 million procedures in 2009 (eFigure 1), with 1.2 million procedures for Medicare patients and 1.9 million procedures for commercially insured patients. The estimated associated spending (eFigure 2) amounted to $1.1 billion in 2009 (Medicare sample, $129.0 million; and commercially insured sample, $944.9 million).

COMMENT

Our study represents the first attempt to our knowledge to quantify spending on outpatient gastroenterology associated anesthesia service use on a national level based on nationally representative samples, including both Medicare fee-for-service and commercially insured patients. We demonstrated that the number of gastroenterology procedures per 1 million enrollees increased by more than 50% in commercially insured patients but remained essentially unchanged in Medicare patients during the study period. The proportion of gastroenterology procedures using anesthesia services doubled in both populations, from approximately 14% in 2003 to more than 30% in 2009. We found substantial regional variation in gastroenterology anesthesia use and most of that use was for low-risk patients. Both findings suggest that a substantial share of the spending for gastroenterology anesthesia may be considered potentially discretionary.

The increase in spending was attributable mainly to increased use; the in-

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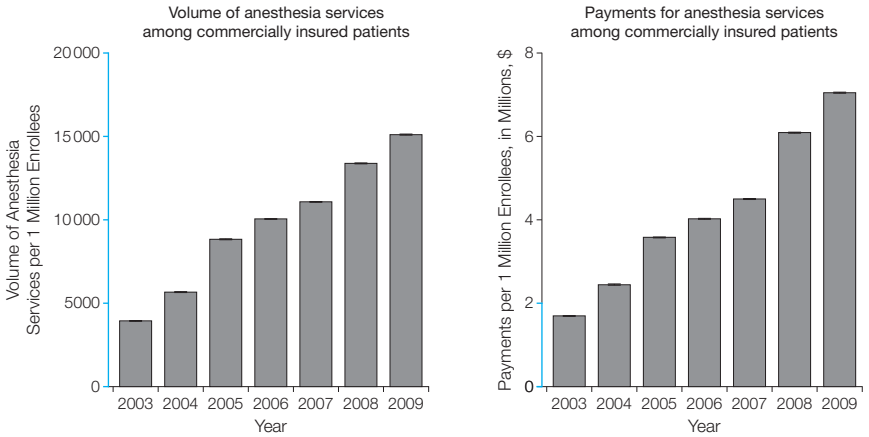
flation-adjusted cost per procedure payment for gastroenterology anesthesia service remained largely unchanged for Medicare and showed only a slight increase for commercial insurance. Our estimates are similar in magnitude to those derived by others from smaller samples. Cohen[12] reported an increase in the proportion of gastrointestinal endoscopies with anesthesia services from 22% in 2003 to 38% in 2006 based on the Medicare claims data for fee-for-service patients. Inadomi et al[6] described trends in anesthesia service use for a single insurance carrier and found that 9% of procedures in 2003 but 25% in 2009 used anesthesiologists or nurse anesthetists.

Our study is the first to our knowledge to stratify anesthesia use during gastrointestinal endoscopies by predicted ASA physical status classification, and to quantify the payments associated with use among low-risk patients. Our results suggest that the majority of gastroenterology-related anesthesia services are provided to low-risk patients and can be considered potentially discretionary based on current payment policies. Supporting the hypothesis of potentially discretionary use, we observed substantial regional variation in anesthesia service use, with a nearly 4-fold difference in use between the lowest-use and highest-use regions. This variation is unlikely to be fully explained by regional differences in patient risk. A similar pattern has previously been reported in smaller studies.[6] Similarly, Aisenberg et al[13] showed that use of anesthesia services for colonoscopies was more common in areas in which insurer payment policies were favorable, indicating that payment policies rather than clinical need drives decision making about anesthesia use.

This increased use of anesthesia services has been partly attributed to the adoption of propofol, which by virtue of a short half-life and rapid onset of action is thought to be more convenient and to offer a more consistent level of sedation than regimens previously used, but in the United States "should be administered only by persons trained in the administration of general anesthesia."[14,15] Insurers' payment policies and marketing by the anesthesiology community have also been cited as drivers of increased use.[13]

Figure 2. Volume of Potentially Discretionary Anesthesia Service Use and Associated Payments Among Commercially Insured Patients During 2003-2009



Unweighted, per 1 million enrollees. Error bars indicate 95% CIs. The blue portions of the y-axes indicate 0 to 20 000 in the first graph and $0 to $2 million in the second graph.

Our data estimate that use of anesthesia services for low-risk patients during gastrointestinal endoscopies may have increased steadily to more than $1.1 billion per year at the national level. Because anesthesia use is projected to increase further, addressing such potentially discretionary use represents a sizeable target for cost savings. This is particularly true because the number of colonoscopies is likely to increase in the coming years. Recent studies have shown that more than 50% of privately insured and more than 60% of publicly insured adults aged 50 to 65 years have never had a screening colonoscopy, despite current guidelines recommending the procedure.[16] In addition, the passage of the Patient Protection and Affordable Care Act of 2010 will provide coverage to an estimated 32 million individuals. The Affordable Care Act has specific provisions for coverage of preventive services recommended by the US Preventive Services Task Force, including screening colonoscopies.[17]

The use of anesthesia service may be valuable to the low-risk patients who prefer deep sedation or general anesthesia during a gastroenterology procedure due to psychological reasons. However, prior literature has demonstrated that in low-risk patients, sedation administered by nonanesthesiologists is safe or offers patient satisfaction comparable with sedation administered by an anesthesiologist or nurse anesthetist.[14,18] In fact, the only published randomized clinical trial on the topic shows that endoscopist-administered sedation during colonoscopies results in higher patient satisfaction and fewer adverse effects than anesthetist-administered sedation.[19]

Our study has several limitations. Most importantly, we base our determination of anesthesia use for low-risk patients on a statistical model, because ASA physical status level coding was present for only a small proportion of the patients in our sample. However, prior estimates of the proportion of low-risk patients among those receiving gastrointestinal endoscopies have been higher than our estimate. For example, according to the Clinical and Outcome Research Initiative data,[20] a large national gastroenterology procedure registry, 12% of its population had an ASA physical status level of 3 or higher. Thus, it seems likely that we have overestimated patient risk and thus underestimated

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the proportion of patients who are at low risk. We also emphasize that we cannot determine actual clinical need for anesthesia service in individual patients, but our goal was to estimate the rate of anesthesia services among low-risk patients in a large sample. In addition, our analysis did not include procedures performed in inpatient settings, or among patients younger than 18 years, enrolled in Medicare managed care, eligible for Medicaid but not Medicare, or who paid out of pocket; therefore, our estimates cannot be readily generalized to these populations. Our calculation, based on 2009 data, showed that approximately 17% of the adult population was not captured in our analysis.[21-26]

CONCLUSIONS

Between 2003 and 2009, the number of gastroenterology procedures and utilization of anesthesia services increased considerably. Substantial regional variation and the fact that most anesthesia was provided for low-risk patients suggest that much of the spending can be considered potentially discretionary. Realizing such opportunities continues to be a pressing requirement, because the nation's health care costs are projected to reach more than 17% of the gross domestic product in 2011.[27] As both colonoscopy rates and use of anesthesia during gastrointestinal endoscopies are projected to increase in the coming years, the overall cost of colonoscopy screening programs will be closely scrutinized by payers and policy makers.

Author Contributions: Drs Liu and Mattke had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.
Study concept and design: Liu, Waxman, Mattke.
Acquisition of data: Liu, Waxman, Main.
Analysis and interpretation of data: Liu, Waxman, Main, Mattke.
Drafting of the manuscript: Liu, Waxman, Mattke.
Critical revision of the manuscript for important intellectual content: Liu, Waxman, Main, Mattke.
Statistical analysis: Liu, Waxman, Main.
Obtained funding: Liu, Mattke.
Study supervision: Mattke.
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Online-Only Material: eTables 1 through 5, eFigures 1 and 2, and Author Video Interview are available at http://www.jama.com.
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