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Substantial Increase in Anesthesia Assistance for Outpatient Colonoscopy and Associated Cost Nationwide

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BACKGROUND AND AIMS: The use of anesthesia assistance (AA) for outpatient colonoscopy has been increasing over the past decade, raising concern over its effects on procedure safety, quality, and cost. We performed a nationwide claims-based study to determine regional, patient-related, and facility-related patterns of anesthesia use as well as cost implications of AA for payers.

METHODS: We analyzed the Premier Perspective database to identify patients undergoing outpatient colonoscopy at over 600 acute-care hospitals throughout the United States from 2006 through 2015, with or without AA. We used multivariable analysis to identify factors associated with AA and cost.

RESULTS: We identified 4,623,218 patients who underwent outpatient colonoscopy. Of these, 1,671,755 (36.2%) had AA; the proportion increased from 16.7% in 2006 to 58.1% in 2015 ($P < .001$). Factors associated with AA included younger age (odds ratios [ORs], compared to patients 18-39 years old: 0.94, 0.82, 0.77, 0.72, and 0.77 for age groups 40-49 years, 50-59 years, 60-69 years, 70-79 years, and ≥80 years, respectively); and female sex (OR, 0.96 for male patients compared to female patients; 95% CI, 0.95-0.96). Black patients were less likely to receive AA than white patients (OR, 0.81; 95% CI, 0.81-0.82), although this difference decreased with time. The median cost of outpatient colonoscopy with AA was higher among all payers, ranging from $182.43 (95% CI, $180.80-$184.06) higher for patients with commercial insurance to $232.62 (95% CI, $222.58-$242.67) higher for uninsured patients.

CONCLUSIONS: In an analysis of a database of patients undergoing outpatient colonoscopy throughout the United States, we found that the use of AA during outpatient colonoscopy increased significantly from 2006 through 2015, associated with increased cost for all payers. The increase in anesthesia use mandates evaluation of its safety and effectiveness in colorectal cancer screening programs.

Keywords: Endoscopy; Sedation; Propofol; Cost.

See editorial on page 2434.

In the United States, nearly all patients undergoing outpatient colonoscopy receive sedation, though there has been a well-documented shift in the last decade in the method of sedation being used.[1–3] Many gastroenterologists are now using anesthesia assistance (AA) to achieve deep sedation, most often with propofol, for patients undergoing colonoscopy as opposed to conscious sedation (CS) with narcotics and benzodiazepines. In addition to being associated with increased cost,[2–4] this widespread practice has been associated with a possible increase in overall complication rates,[5,6] including aspiration pneumonia risk,[6,7] without being shown to increase overall colonoscopy quality indicators such as adenoma detection[8–10] and cecal intubation rates.[10,11]

Previous studies have assessed various geographic, patient-related, and facility-related predictors of the use of AA using claims data from commercial insurers and

Abbreviations used in this paper: AA, anesthesia assistance; CI, confidence interval; CS, conscious sedation; CPT, Current Procedural Terminology; GEE, generalized estimating equation; HCPCS, Healthcare Common Procedure Coding System; ICD-9, International Classification of Diseases–Ninth Revision; OR, odds ratio.

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Medicare,[2–6,8,12] but data on hospital-based endoscopy, which have represented between 19% and 57% of screening colonoscopies in the Medicare population in prior analyses,[2,6] have been limited. In these prior studies, use of AA has generally been found to be highest in the Northeast compared with other regions in the United States, but results on patient-related factors such as age and race have been mixed. We aimed to use data from the Premier Perspective database, which contains data on inpatient hospital admissions and outpatient procedures from a representative sample of more than 600 acute-care hospitals throughout the United States, to assess recent trends in regional, patient-related, and facility-related factors associated with the use of AA for outpatient colonoscopy and associated cost implications across payers.

What You Need to Know

Background

The widespread practice of anesthesia assistance use during outpatient colonoscopy has been associated with increased cost and possible increase in complication rates without a documented improvement in common quality indicators. We used a nationwide, hospital-based database to assess recent trends in regional, patient-related, and facility-related factors associated with anesthesia assistance use for outpatient colonoscopy and associated cost across payers.

Findings

The use of anesthesia assistance for outpatient colonoscopy has more than tripled from 2006 to 2015 and is associated with increased cost across all payers. Black patients were less likely to receive anesthesia assistance as compared with white patients, but this difference has decreased in recent years.

Implications for patient care

Anesthesia assistance during outpatient colonoscopy has increased at a rapid rate, contributing to the increasing cost of outpatient colonoscopy. Practitioners should continue to scrutinize this practice given its cost implications and potential safety concerns.

Materials and Methods

Data Source

We analyzed data from the Perspective database (Premier, Charlotte, NC), a voluntary, fee-supported database containing a representative sample of more than 600 acute-care hospitals throughout the United States that was originally developed to measure resource utilization and quality of care. Hospitals contribute data on inpatient hospital admissions and outpatient procedures, including patient demographics, clinical characteristics, and type of procedure performed as well as billed services rendered during these visits. In addition to clinical and demographic data, Perspective collects data on all drugs used during a patient's visit. Hospitals within the database are predominantly small to midsize (79% with <400 beds, 15% with 400–600 beds, and 7% with >600 beds), nonteaching facilities (73% nonteaching), located in urban centers (74% urban), and have a widespread geographic distribution (12% Northeast, 23% Midwest, 47% South, 18% West). Data in the Perspective database undergo a rigorous quality control process and have been used in several outcome studies.[13–21]

Cohort Selection and Ascertainment of Anesthesia Use

We identified all outpatient colonoscopies of patients 18 years of age and older between the years 2006 and 2015 using Current Procedural Terminology (CPT) codes (45378–45386 and 45391–45392) and Healthcare Common Procedure Coding System (HCPCS) codes (G0105 and G0121). For patients with more than 1 outpatient colonoscopy during the study period, only the index colonoscopy was included. Standard charge and hospital charge description texts were then searched for words *propofol* and *diprivan*, the drug commonly used for sedation during anesthesia assisted colonoscopy and its brand name. Those patient files that contained either word in both the standard charge description and the hospital charge description were considered AA cases. Those that contained the drug name in 1 charge description and not the other were manually reviewed to determine if they qualified as AA or CS. All those files that did not contain either propofol or its brand name in the charge description were classified as CS. Finally, we identified additional AA cases using CPT code (00810) and HCPCS code (J3490).

Clinical and Demographic Characteristics

Demographic data analyzed included age, sex, race (white, black, Hispanic, or other), insurance status (Medicare, Medicaid, commercial, uninsured, or other, which includes workers' compensation and other government payers), Elixhauser comorbidity score, year of colonoscopy, and indication for colonoscopy. Indication for colonoscopy was characterized as either screening/ surveillance or diagnostic based on review of International Classification of Diseases–Ninth Revision (ICD-9) diagnosis and procedure codes. ICD-9 procedure codes 45.23, 45.24, and 48.23 along with ICD-9 diagnosis codes V12.71, V12.72, V16.0, V18.51, V76.41, V76.49, V76.50, V76.51, V76.89, V76.9, V82.89, and V82.9 were used to identify screening or surveillance procedures. All other procedures were characterized as diagnostic. There were

536 patients with unknown sex that were excluded from the analysis. The hospitals at which the colonoscopies were performed were characterized by location (urban or rural), region (Northeast, Midwest, South, or West), and teaching status (teaching or nonteaching).

Statistical Analysis of Predictors of Anesthesia Use

The distributions of those undergoing colonoscopy with and without AA were calculated by age group, gender, race, insurance status, Elixhauser comorbidity score, indication for colonoscopy, and by the facility-related factors (location, region, and teaching status). The unadjusted risk ratio for colonoscopy with AA was then calculated using generalized estimating equations (GEE) with the modified Poisson regression approach, accounting for hospital-level clustering. We used multivariable logistic regression including all covariables to determine factors independently associated with AA use. Results are reported with odds ratios (ORs) and 95% confidence intervals (Cis). *P* values were calculated from Cochran-Armitage trend tests. The results from the adjusted model were reported without accounting for hospital-level clustering, which could not be performed due to the prohibitive computational demands related to the large number of patients in the model.

Cost Analysis

The Perspective database captures cost data through an itemized log of all services billed to the patient during a hospital admission or outpatient visit. Cost represents the monetary value to perform a service while charges represent what a hospital bills for the service. We directly analyzed the cost of the outpatient visit for colonoscopy. We used multivariable quantile regression modeling stratified by insurance to determine the difference in median cost between AA and CS cases, adjusting for year, patient Elixhauser comorbidity score, and hospital region, location, and type. Median as opposed to mean cost was used as cost data tends to be left-skewed. Patients with insurance types other than commercial, Medicare, Medicaid, and no insurance were not included in the analysis, and 1321 patients with missing cost data were also excluded from the cost analysis. All analyses were performed with SAS version 9.4 (SAS Institute, Cary, NC).

Results

We identified 4,623,218 unique patients who underwent outpatient colonoscopy in 606 hospital-based facilities during the years 2006 to quarter 1 of 2015. Of these, 1,671,755 (36.2%) underwent colonoscopy with AA. 195,563 cases with AA (11.7%) were identified using both CPT/HCPCS codes and billing files for propofol use, 1,429,937 (85.5%) were identified by billing files only, and 46,255 of the AA cases (2.8%) were identified from CPT/HCPCS codes only, indicating either that propofol was not used in these AA cases or that the CPT/HCPCS code was submitted separately from the hospital billing record. The age group that underwent the most outpatient colonoscopies in the cohort were those 50–59 years of age, who represented 35.9% of the total cohort. Black patients represented 9.0% of the sample. The majority of patients had their colonoscopies at urban hospitals (83.2%), and 42.3% had colonoscopies in the South. Characteristics of the patient cohort as well as facility-related characteristics are displayed in Table 1. The proportion of colonoscopies with AA more than tripled over the course of the study period, from 16.7% in 2006 to 58.1% in 2015 ($P < .001$).

In our multivariable model (Table 2), colonoscopy with AA was associated with younger age (OR for $\geq$80 years of age compared with 18–39 years of age, 0.77; 95% CI, 0.76–0.78). AA was also associated with female sex (OR for male sex compared with female sex, 0.96; 95% CI, 0.95–0.96); Medicare insurance (OR, 1.06; 95% CI, 1.06–1.07), Medicaid insurance (OR, 1.12; 95% CI, 1.11–1.13), or no insurance (OR, 1.03; 95% CI, 1.01–1.04) compared with those with commercial insurance; diagnostic procedure (OR, 1.17; 95% CI, 1.17–1.18) compared with screening or surveillance procedure; and higher comorbidity score (OR for 1 comorbid condition, 1.52; 95% CI, 1.51–1.53; OR for $\geq$2 comorbid conditions, 2.00; 95% CI, 1.99–2.01).

With regard to facility-related factors, subjects were less likely to have AA if their colonoscopy was performed at a hospital in a rural area as compared with an urban area (OR, 0.93; 95% CI, 0.92–0.93) and if the colonoscopy was performed at a teaching hospital as compared with a nonteaching hospital (OR, 0.85; 95% CI, 0.84–0.85). The South was the region most likely to use AA when compared with the Northeast (OR, 1.57; 95% CI, 1.56–1.58). The Midwest (OR, 0.77; 95% CI, 0.76–0.77) and West (OR, 0.55; 95% CI, 0.55–0.56) were less likely to have patients undergoing outpatient colonoscopy with AA as compared with the Northeast. Figure 1 displays the trends in AA use over time by facility-related characteristics. There was a marked rise in AA use in the Northeast and South compared with the more modest and limited rise in the Midwest and West. Additionally, while there was a difference detected on multivariable analysis between teaching and nonteaching hospitals and between rural and urban hospitals, these differences have decreased in recent years.

Black patients were less likely to undergo colonoscopy with AA than white patients were (OR, 0.81; 95% CI, 0.81–0.82). The data for Hispanic race was not available in and after 2011 Quarter 3 due to updated Health Insurance Portability and Accountability Act guidelines in the Perspective database (after 2011 Quarter 3, Hispanic patients were categorized as "Other"). When we evaluated race restricting the analysis to years 2006–2010, Hispanic ethnicity was not

Table 1. Univariate Analysis of Characteristics Associated With Outpatient Colonoscopy with Conscious Sedation vs Anesthesia Assistance From 2006 to 2015 (N = 4,623,218)

Characteristic	Conscious sedation n	Conscious sedation %	Anesthesia assistance n	Anesthesia assistance %	Unadjusted RR (95% CI)
Total	2,951,463	63.8	1,671,755	36.2	
Age					
18–39 *y*	195,054	60.4	127,959	39.6	Referent
40–49 *y*	299,962	62.4	180,622	37.6	0.95 (0.93–0.97)[a]
50–59 *y*	1,082,221	65.2	576,990	34.8	0.88 (0.84–0.92)[a]
60–69 *y*	791,770	63.5	455,513	36.5	0.92 (0.89–0.96)[a]
70–79 *y*	440,557	63.8	250,066	36.2	0.91 (0.87–0.96)[a]
≥80 *y*	141,899	63.8	80,605	36.2	0.91 (0.86–0.97)[a]
Sex					
Female	1,614,460	63.1	944,828	36.9	Referent
Male	1,337,003	64.8	726,927	35.2	0.95 (0.94–0.97)[a]
Race					
White	2,077,686	62.7	1,237,628	37.3	Referent
Black	257,250	61.6	160,414	38.4	1.03 (0.91–1.16)
Hispanic	53,912	72.8	20,102	27.2	0.73 (0.54–0.99)[a]
Other	562,615	68.9	253,611	31.1	0.83 (0.67–1.03)
Insurance status					
Commercial	1,668,964	65.9	863,756	34.1	Referent
Medicare	976,428	61.9	602,038	38.1	1.12 (1.06–1.18)[a]
Medicaid	153,564	57.9	111,772	42.1	1.24 (1.12–1.36)[a]
Uninsured	56,827	61.0	36,360	39.0	1.14 (0.98–1.34)
Other	95,680	62.3	57,829	37.7	1.10 (0.95–1.29)
Year					
2006	279,504	83.3	56,068	16.7	Referent
2007	280,321	80.7	67,017	19.3	1.15 (1.01–1.32)[a]
2008	350,728	77.7	100,612	22.3	1.33 (1.09–1.63)[a]
2009	330,897	73.3	120,388	26.7	1.60 (1.26–2.02)[a]
2010	335,358	69.3	148,322	30.7	1.84 (1.42–2.36)[a]
2011	361,539	64.6	197,787	35.4	2.12 (1.63–2.75)[a]
2012	363,035	57.8	265,113	42.2	2.53 (1.93–3.31)[a]
2013	338,300	51.3	321,331	48.7	2.92 (2.22–3.82)[a]
2014	261,136	44.6	324,960	55.4	3.32 (2.51–4.38)[a]
2015	50,645	41.9	70,157	58.1	3.48 (2.62–4.61)[a]
Indication					
Screening/surveillance	2,240,561	64.5	1,232,889	35.5	Referent
Diagnostic	710,902	61.8	438,866	38.2	1.08 (1.03–1.13)[a]
Comorbidity					
0	1,842,558	70.3	778,096	29.7	Referent
1	667,252	59.4	456,612	40.6	1.37 (1.26–1.49)[a]
≥2	441,653	50.3	437,047	49.7	1.68 (1.51–1.86)
Hospital location					
Urban	2,479,033	64.4	1,369,059	35.6	Referent
Rural	472,430	61.0	302,696	39.1	1.10 (0.88–1.36)
Region					
Northeast	346,446	63.3	200,563	36.7	Referent
Midwest	917,444	71.1	373,085	28.9	0.79 (0.54–1.15)
South	1,048,383	53.6	908,158	46.4	1.27 (0.94–1.71)
West	639,190	77.1	189,949	22.9	0.62 (0.42–0.93)[a]
Teaching hospital					
No	1,839,163	62.5	1,103,351	37.5	Referent
Yes	1,112,300	66.2	568,404	33.8	0.90 (0.72–1.13)

Unadjusted RR was estimated from generalized estimating equations accounting for hospital-level clustering.
CI, confidence interval; RR, risk ratio.
[a]*P* value <.05

associated with AA (OR, 1.00; 95% CI, 0.98–1.02). The prevalence of AA over time stratified by race is shown in Figure 2, and suggests that the difference in AA use between white and black patients has decreased in the most recently available years.

The overall median cost of outpatient colonoscopy with AA was $983.52 (interquartile range, $530.70–$1135.07) compared with $762.02 (interquartile range, $668.61–$1450.19) for outpatient colonoscopy with CS. The results of the multivariable cost analysis stratified by

Table 2. Multivariate Analysis of Characteristics Associated With Outpatient Colonoscopy With Anesthesia Assistance vs Conscious Sedation

Characteristic	Adjusted odds ratio (95% CI)
Age	
18–39 *y*	Referent
40–49 *y*	0.94 (0.93–0.95)[a]
50–59 *y*	0.82 (0.82–0.83)[a]
60–69 *y*	0.77 (0.77–0.78)[a]
70–79 *y*	0.72 (0.72–0.73)[a]
≥80 *y*	0.77 (0.76–0.78)[a]
Sex	
Female	Referent
Male	0.96 (0.95–0.96)[a]
Race	
White	Referent
Black	0.81 (0.81–0.82)[a]
Hispanic	—
Other	0.96 (0.95–0.96)[a]
Insurance status	
Commercial	Referent
Medicare	1.12 (1.11–1.13)[a]
Medicaid	1.06 (1.06–1.07)[a]
Uninsured	1.03 (1.01–1.04)[a]
Other	0.95 (0.94–0.96)[a]
Year	
2006	Referent
2007	1.20 (1.18–1.21)[a]
2008	1.47 (1.45–1.49)[a]
2009	1.86 (1.84–1.88)[a]
2010	2.21 (2.18–2.23)[a]
2011	2.76 (2.73–2.79)[a]
2012	3.74 (3.70–3.78)[a]
2013	4.75 (4.70–4.80)[a]
2014	5.99 (5.92–6.05)[a]
2015	6.66 (6.56–6.76)[a]
Indication	
Screening/surveillance	Referent
Diagnostic	1.17 (1.17–1.18)[a]
Comorbidities	
0	Referent
1	1.52 (1.51–1.53)[a]
≥2	2.00 (1.99–2.01)[a]
Hospital location	
Urban	Referent
Rural	0.93 (0.92–0.93)[a]
Region	
Northeast	Referent
Midwest	0.77 (0.76–0.77)[a]
South	1.57 (1.56–1.58)[a]
West	0.55 (0.55–0.56)[a]
Teaching hospital	
No	Referent
Yes	0.85 (0.84–0.85)

OR was estimated from logistic regression model including age, gender, race, insurance, year, indication, comorbidity, hospital location, region, and teaching status, without accounting for hospital-level clustering.
Hispanic ethnicity was not available in and after 2011 Q3.
CI, confidence interval; OR, odds ratio.
[a]*P* value <.05

insurance are displayed in Table 3. The median cost of outpatient colonoscopy with AA was $182.43 (95% CI, $180.80–$184.06) higher for patients with commercial insurance, $197.98 (95% CI, $192.20–$203.75) higher for patients with Medicaid, $204.81 (95% CI, $202.53–$207.08) higher for patients with Medicare, and $232.62 (95% CI, $222.58–$242.67) higher for uninsured patients. Outpatient colonoscopy in a rural hospital was associated with significantly higher median cost when compared with outpatient colonoscopy in an urban hospital for all types of insurance.

Discussion

In this analysis of national data from hospital-based endoscopy units throughout the United States, we found that the use of AA has increased substantially over time and continues to increase in more recent years. These findings are consistent with previous nationwide studies of anesthesia use in outpatient gastrointestinal endoscopy. Our finding of a more than tripling in the use of AA from 16.7% in 2006 to 58.1% in 2015 exceeds the forecast of Inadomi et al[3] in 2010, who predicted that the use of AA would be 53.4% for outpatient colonoscopy by 2015. This higher than expected increase in AA is likely multifactorial in etiology, including higher patient satisfaction ratings, shorter recovery times, and shorter patient turnaround times that have been documented with the use of propofol sedation as compared with CS.[11] These benefits are undoubtedly important to both patients and practitioners but must be weighed against the documented disadvantages of colonoscopy with propofol sedation, namely the suggestion of an increased risk of aspiration pneumonia[7] and the certain increase in associated cost.[2–4]

National societies have recognized the trend in AA use and the tradeoffs faced by providers who may consider potential patient safety concerns along with cost and patient satisfaction. The 2018 American Society for Gastrointestinal Endoscopy guidelines for sedation in gastrointestinal endoscopy[22] recognize, in detail, the added cost of AA for outpatient colonoscopy without an added safety benefit, and subsequently recommend with moderate-quality evidence that AA with propofol sedation be considered for complex endoscopic procedures or medically complex patients. With low-quality evidence, American Society for Gastrointestinal Endoscopy recommends propofol sedation for endoscopic procedures when it is "expected to improve patient safety, comfort, procedural efficiency, and/or successful procedure completion." The Centers of Medicare and Medicaid Services also made a recent update to the coding and billing of gastrointestinal endoscopy services in January 2017. CS services are now coded separately from the endoscopy itself, so payment for this gastroenterologist-provided service is no longer included in the allowances for an endoscopy procedure.[23] The implication for endoscopists is that procedures performed with AA, a service that is already billed separately, now have a small reduction in relative value units as the code for the procedure no longer includes the allowance for sedation. Procedures performed with CS now require a separate code for the endoscopist-

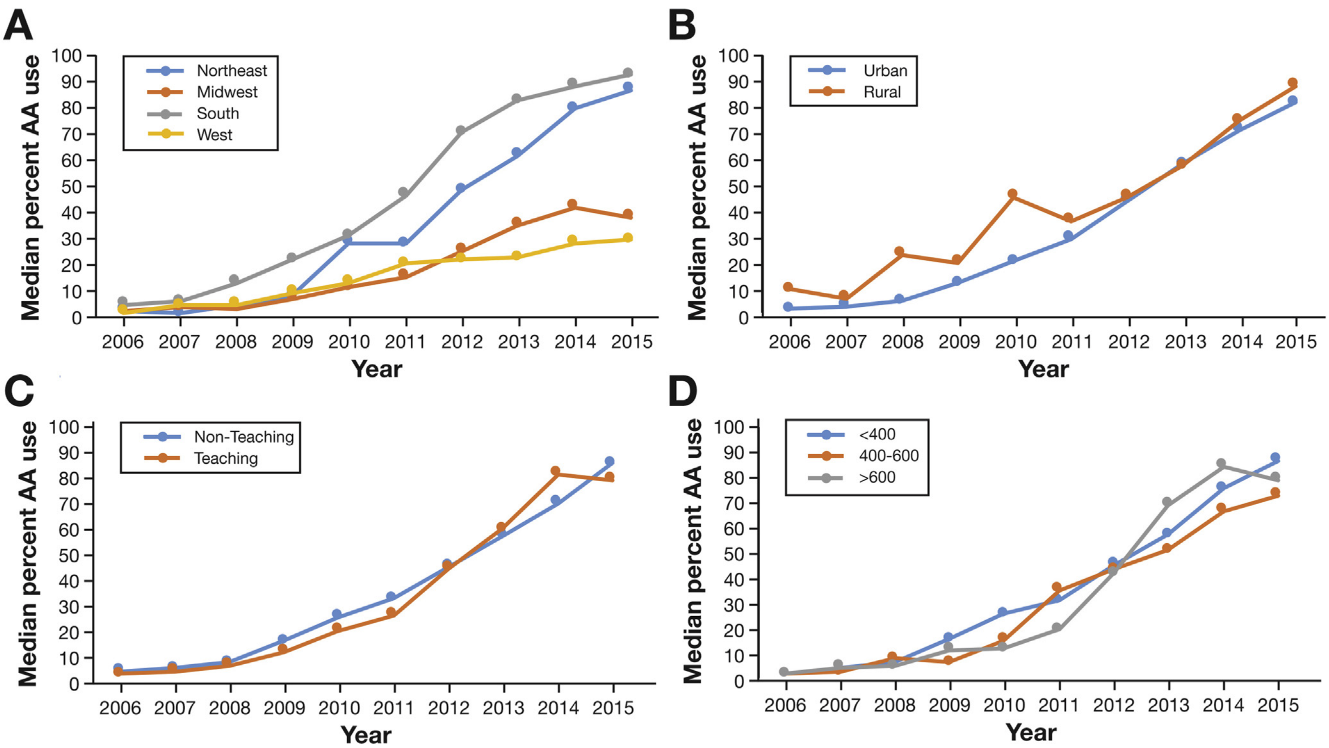

Figure 1. Temporal trends in anesthesia assistance (AA) use by hospital characteristics: (*A*) region, (*B*) location, (*C*) type, and (*D*) volume (as measured by bed size).

provided sedation but do not differ in relative value units. Our analysis included colonoscopies through 2015; future studies will be needed to determine the effect of these recent guideline and payer policy changes.

We found that while black patients were less likely to undergo outpatient colonoscopy with AA than white patients, this difference has decreased in recent years. This finding of a disparities in patient uptake of medical innovations based on racial, socioeconomic, and other markers of social resources has been widely documented in the medical literature[24] and likely accounts for the initial racial disparity documented in this database. Few of the existing nationwide studies on anesthesia use and gastrointestinal endoscopy have included race as a variable, and those studies that included race have demonstrated mixed conclusions. Inadomi et al[3] performed an ecological analysis of race and found that regions with a higher percentage of black patients had lower rates of AA. Similarly, Khiani et al[2] found that black patients were significantly less likely to have screening colonoscopies with anesthesiologist involvement. However, Dominitz et al,[8] found black race to be an independent predictor for greater use of AA as compared with white patients. Similar to our findings, Dominitz et al additionally analyzed Hispanic race and found no significant difference with white patients in AA use.

Previous studies have consistently found that anesthesia use during outpatient colonoscopy varies significantly by region of the country, and the Northeast has been the region with the highest use of AA in many of these studies.[2–5,8,12] We also found this significant variation in anesthesia use by region, though the South was found to have a higher proportion of AA during outpatient colonoscopy as compared with the Northeast. This conflicting finding may be secondary to a potentially higher representation of the state of Florida in the sample of southern hospitals in the Perspective database, as multiple prior studies have found rates of AA use in Florida to be similar to those in the Northeast.[5,8] Our findings may indicate that the use of AA is rising faster in Florida as compared with other areas of the country. It also appears that AA use for outpatient colonoscopy has been increasing at a faster pace in the Northeast and South regions of the country compared with the Midwest and West, where the pace appears to have slowed and potentially plateaued in recent years.

Our study found a higher likelihood of AA at nonteaching hospitals as compared with teaching hospitals (although this difference may also be decreasing over time), which to our knowledge, is the first such distinction made among studies evaluating anesthesia use and colonoscopy. Many nonteaching hospitals in the community setting may be more similar to ambulatory surgical centers than their teaching hospital counterparts, where previous studies have shown AA use to be higher, and may be staffed by gastroenterologists from local private practice groups, who have also been shown to have increasing use of AA for outpatient clinic-based colonoscopy.[8]

Outpatient colonoscopy with AA was associated with significantly higher median cost compared with colonoscopy with CS among all payers. The increase in median cost ranged from $182.43 in patients with commercial

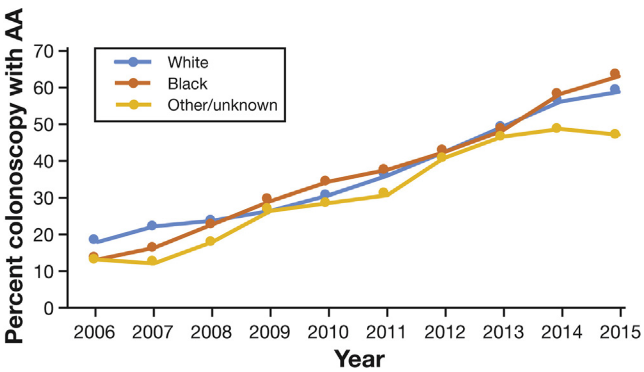

Figure 2. Anesthesia assistance (AA) for outpatient colonoscopy by race and year. All *P* values $<.001$.

insurance to $232.62 in uninsured patients, which exceeds the finding of Khiani et al,[2] who reported an average increase of $103.00 in the cost to Medicare for colonoscopies with anesthesiologist involvement. In our analysis, rural hospital location was independently associated with higher median cost of outpatient colonoscopy, which may reflect lower procedural volume and associated decreased distribution of the cost of the procedure.

Although our study is strengthened by its large and geographically diverse sample size, we recognize several limitations. Given the large sample size analyzed, some of the statistically significant associations found in our study may not carry meaningful clinical significance, such as the small absolute differences in AA use noted between the genders and among age groups. AA was identified in our study using both CPT and HCPCS codes as well as by search of the charge databases for the agents propofol and Diprivan as almost all outpatient colonoscopies performed with propofol sedation are done so with assistance from an anesthesiologist. However, nonanesthesiologist administered propofol sedation is an uncommon but existing option in some settings with limited access to anesthesiology resources.[25,26] The Perspective database predominantly contains patients treated at small to midsize hospitals throughout the United States, whereas many outpatient colonoscopies are additionally performed at larger hospitals and ambulatory surgical centers. As such, our results may not be generalizable to the entire U.S. population. Our analysis of the Hispanic ethnicity variable was limited by the lack of data after 2010 due to updated Health Insurance Portability and Accountability Act regulations on the Perspective database. We were therefore able to complete only a limited analysis of this patient-related variable. Finally, while GEE was used in the univariate analysis to account for hospital level clustering, we were unable to use GEE in the multivariate analysis due to the computational demands associated with this analysis given our large sample size. As such, our multivariate analysis does not account for hospital level clustering, but this would be unlikely to affect the risk estimates more than marginally.

In conclusion, in a large, nationwide, hospital-based sample, we found that the use of AA for outpatient colonoscopy has more than tripled from 2006 to 2015 with an associated increase in median cost of the procedure across all payers. Black patients were less likely to receive AA as

Table 3. Quantile Regression for Median Cost (in Dollars) of Outpatient Colonoscopy, Stratified by Insurance (n = 4,468,388)

	Commercial n = 2,532,015	Medicare n = 1,577,968	Medicaid n = 265,222	Uninsured n = 93,183
Anesthesia				
CS	Ref	Ref	Ref	Ref
AA	182.43 (180.80–184.06)[a]	204.81 (202.53–207.08)[a]	197.98 (192.20–203.75)[a]	232.62 (222.58–242.67)[a]
Elixhauser comorbidity score				
0	Ref	Ref	Ref	Ref
1	68.31 (66.56–70.07)[a]	73.36 (71.16–75.55)[a]	77.40 (71.06–83.74)[a]	101.15 (89.62–112.69)[a]
≥2	143.08 (140.61–145.55)[a]	177.38 (174.84–179.92)[a]	152.61 (145.62–159.61)[a]	211.11 (194.59–227.64)[a]
Location				
Urban	Ref	Ref	Ref	Ref
Rural	123.92 (121.40–126.44)[a]	122.81 (119.53–126.10)[a]	45.39 (36.96–53.83)[a]	23.27 (8.84–37.70)[a]
Region				
Northwest	Ref	Ref	Ref	Ref
Midwest	–132.67 (–135.20 to –130.14)[a]	–132.69 (–136.37 to –129.02)[a]	–96.33 (–103.24 to –89.42)[a]	–60.47 (–74.95- –45.99)[a]
South	–136.56 (–139.18 to –133.94)[a]	–129.98 (–133.70 to –126.25)[a]	–47.27 (–55.16 to –39.38)[a]	36.16 (22.61–49.70)[a]
West	2.71 (–0.21 to 5.62)	35.56 (31.31–39.81)[a]	56.37 (47.33–65.41)[a]	180.87 (160.07–201.67)[a]
Teaching				
Nonteaching	Ref	Ref	Ref	Ref
Teaching	72.47 (71.14–73.79)[a]	48.28 (46.32–50.25)[a]	–22.55 (–27.96 to –17.14)[a]	48.65 (39.29–58.01)[a]

Values are median (95% confidence interval).
Quantile regression models were fitted for median cost including year, comorbidity, hospital location, region, teaching status, and anesthesia use stratified by insurance using interior point algorithm with sparsity method for 95% confidence intervals. A total of 1321 patients with missing cost data were excluded. Patients who had other insurance were not analyzed.
AA, anesthesia assistance; CS, conscious sedation.
[a]*P* value $<.05$.

compared with white patients, though this disparity has narrowed in recent years. This analysis represents 1 of the largest to date of its kind, providing more evidence that the dramatic shift in the use of AA in outpatient colonoscopy has continued at a rapid pace and that AA is a substantial driver of the increase in cost of outpatient colonoscopy. Through further elucidation of the independent predictors of AA use, which is largely a physician- or facility-level decision, we hope to assist practitioners in a much-needed evaluation of this practice given its substantial cost implications. Future studies should focus on the cost-effectiveness of outpatient colonoscopy with AA, as the higher patient satisfaction ratings and shorter recovery times must be weighed against the increased cost, slight increase in complication rate, and lack of improvement in common quality indicators.

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Conflicts of interest
The authors disclose no conflicts