

A Population-based Analysis of Outpatient Colonoscopy in Adults Assisted by an Anesthesiologist

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Background: The use of propofol to sedate patients for colonoscopy, generally administered by an anesthesiologist in North America, is increasingly popular. In the United States, regional use of anesthesiologist-assisted endoscopy appears to correlate with local payor policy. This study's objective was to identify nonpayor factors (patient, physician, institution) associated with anesthesiologist assistance at colonoscopy.

Methods: The authors performed a population-based cross-sectional analysis using Ontario health administrative data, 1993-2005. All outpatient colonoscopies performed on adults were identified. Hierarchical multivariable modeling was used to identify patient (age, sex, income quintile, comorbidity), physician (specialty, colonoscopy volume), and institution (type, volume) factors associated with receipt of anesthesiologist-assisted colonoscopy.

Results: During the study period, 1,838,879 colonoscopies were performed on 1,202,548 patients. The proportion of anesthesiologist-assisted colonoscopies rose from 8.4% in 1993 to 19.1% in 2005 ($P < 0.0001$). In the hierarchical model, patients in low-volume community hospitals were five times more likely to receive anesthesiologist-assisted colonoscopy than patients in high-volume community hospitals (odds ratio 4.9; 95% confidence interval 4.4-5.5). Less than 1% of colonoscopies in academic hospitals were anesthesiologist-assisted. Compared to gastroenterologists, surgeons were more likely to perform an-

esthesiologist-associated colonoscopy (odds ratio 1.7; 95% confidence interval 1.1-2.6).

Conclusions: In Ontario, rates of anesthesiologist-assisted colonoscopy have risen dramatically. Institution type was most strongly associated with this practice. Further investigation is needed to determine the most appropriate criteria for the use of anesthesiology services during colonoscopy.

SEDATION is typically used for colonoscopy because it may cause moderate discomfort. Until recently, standard practice has been to use intravenous benzodiazepines and/or narcotics for this purpose. Propofol was licensed for use in Canada in the early 1990s; its use for sedation, including for colonoscopy, has become increasingly popular since its introduction.^{1,2} This shift towards propofol may be attributable to its deep sedative effect, rapid onset of action, and short recovery time, resulting in greater patient and endoscopist satisfaction with the procedure while increasing the efficiency of endoscopy units.³⁻⁵

However, the risk of respiratory depression may be higher with propofol and, unlike benzodiazepines and narcotics, there are no reversal agents. For these reasons, there is agreement among North American gastroenterology associations⁶ that an individual with formal training in the administration of propofol and Advanced Cardiac Life Support certification should be designated to be dedicated solely to this task. In North America, where endoscopy training programs do not typically provide additional training in the administration of propofol⁶ and medicolegal and local practice considerations may limit nonanesthesiologists in this practice,⁷ anesthesiologists are primarily responsible for administering this drug. A recent American survey found that anesthesiologists and certified registered nurse anesthetists are involved when propofol is used in approximately 70% and 18% of endoscopies, respectively.¹ When propofol is used in Canada, it is administered exclusively by anesthesiologists because there are no Canadian certified registered nurse anesthetists.⁷

In the United States, use of anesthesiologist-assisted endoscopy appears to be principally driven by regional payor policies.⁸ American gastroenterology associations agree that routine anesthesiologist assistance with endoscopy is not warranted for average-risk patients⁸; historically, most insurance carriers concurred, limiting coverage for anesthesiologist-assisted endoscopy to high-risk patients.⁸ Recently however, some payors have begun to provide reimbursement for anesthesiologist-assistance when propofol is administered. Not surprisingly, the use of propofol and anesthesiologist-assisted endos-

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‡‡ Gastroenterology Societies Reach Consensus on Recommendations for Sedation during Endoscopic Procedures. Washington, DC, 2004. Available at: <http://www.gastro.org/wmspage.cfm?parm1=371>; accessed September 1, 2008.

copy is greatest in regions, such as the Mid-Atlantic States,¹ where payor policy is most favorable.⁸

Canada has single-payor healthcare systems in each province that allow anesthesiologists to bill for assistance with colonoscopy in an unregulated fashion (*i.e.*, the payor reimburses the practice without limits or restrictions). In Ontario, unlike the United States since the institution of the Resource Based Relative Value Scale, endoscopists are remunerated at the same rate regardless of whether an anesthesiologist assists with sedation. Furthermore, Ontario does not limit the delivery of anesthesia services for endoscopy by setting (*i.e.*, if the procedure is performed in a hospital or in an endoscopy facility outside of hospital).

Evaluation of this practice in the Canadian context provides an opportunity to determine the patient, physician, and institution factors associated with and changes in the patterns of anesthesiologist-assisted colonoscopy independent of the regional payor influences observed in the United States. Therefore, we performed a population-based analysis to describe the pattern of use of anesthesiologist-assisted colonoscopy in Ontario, Canada from 1993 to 2005 and to identify associated patient, physician, and institution factors.

Materials and Methods

The research ethics board at the Sunnybrook Health Sciences Centre in Toronto, Ontario, Canada approved the study.

Data Sources

The study was conducted at the Institute for Clinical Evaluative Sciences, which contains the health records for all 12.4 million residents of Ontario. These records are held in administrative databases that are linked by an encrypted version of each resident's provincial health plan number.

For this study, we used the databases from the following programs: Canadian Institute for Health Information, the Ontario Health Insurance Plan (OHIP), the Registered Persons Database and the Institute for Clinical Evaluative Sciences Physician Database. The Canadian Institute for Health Information databases contain clinical,

demographic, and administrative data for all hospital discharges (Discharge Abstract Database) and for same-day procedures, including endoscopy, (Same Day Surgery) since April 1, 1988. OHIP holds physician billing claims for services, including procedures and consultation visits, since July 1, 1991. The Registered Persons Database has maintained age, sex, postal code information, and vital statistics for all Ontario residents with a valid OHIP number in Ontario since 1991. The Institute for Clinical Evaluative Sciences Physician Database provides physician specialty.

Defining the Study Cohort

By using the OHIP database, we identified all adults over 19 yr of age in Ontario who had at least one outpatient colonoscopy in either a hospital or in a non-hospital setting between April 1, 1993 and March 31, 2006. We defined colonoscopy as insertion of the colonoscope to or beyond splenic flexure as outlined by the OHIP fee codes in table 1. There is a separate OHIP fee code for flexible sigmoidoscopy (Z580); therefore, our definition of colonoscopy should capture all complete and incomplete colonoscopies.

Definition of Anesthesiologist-assisted Colonoscopy

The OHIP fee code suffix was used to distinguish physician claims for administration of anesthesia from those for the procedure itself. The physician performing the procedure (the endoscopist) uses OHIP procedure codes with an "A" suffix. If a second physician administers the anesthesia for the same procedure, either OHIP procedure codes or general anesthesia codes are used with a "C" suffix. The endoscopist is not allowed to bill separately for the administration of anesthesia; therefore, a billing code with a "C" suffix indicates that a second physician assisted with the procedure solely for this purpose, although the nature of the agent administered cannot be determined from the administrative data. The billing codes submitted by the physician administering anesthesia need not exactly match those submitted by the endoscopist. Therefore, we defined anesthesiologist-assisted colonoscopy broadly as any endoscopy-related or general anesthesia code with a "C" suffix billed within 1 day of the date of colonoscopy. See

Table 1. Ontario Health Insurance Plan Physician Fee Codes Used in the Analysis

Service Rendered	Ontario Health Insurance Plan Fee Code
Insertion of colonoscope to descending colon	Z555A
Insertion of colonoscope to splenic flexure	Z555A + E740A
Insertion of colonoscope to hepatic flexure	Z555A + E740A + E741A
Insertion of colonoscope to cecum	Z555A + E740A + E741A + E747A
Insertion of colonoscope to terminal ileum	Z555A + E740A + E741A + E747A + E705A
Anesthesia provided for colonoscopy	Endoscopy procedure code with a "C" suffix (<i>e.g.</i> , Z555C) or anesthesia supportive care code, E003C
Procedure performed outside hospital	E749

table 1 for the codes described above. We excluded the few patients who had another nonendoscopic procedure that would require the administration of anesthesia during this same narrow window of time.

Factors Examined

Patient Factors. At the date of colonoscopy, we collected data on patient age, sex, comorbidity, and median neighborhood income quintile. We measured comorbidity by using the validated Johns Hopkins case-mix system.^{§§⁹⁻¹²} Ontario inpatient (Discharge Abstract Database) and outpatient (OHIP) diagnosis codes from the year before colonoscopy were used to estimate case-mix by using the Johns Hopkins algorithm. Specifically, we adjusted for comorbidity by using Aggregated Diagnosis Groups, which are clinically meaningful groupings of diagnoses that are similar in terms of disease severity and anticipated duration. Comorbidity was categorized by the number of Aggregated Diagnosis Groups (0, 1-3, 4-5, 6-7, and 8 or more). Median annual neighborhood household income at the level of enumeration area, obtained from Statistics Canada, was linked to patient postal code. This strategy has been used by others to impute socioeconomic status.^{13,14}

Physician (Endoscopist) Factors. Physician specialty was categorized as gastroenterology, surgery, internal medicine, and other practitioners. The other practitioner category comprised all other specialties, including family physicians and general practitioners. For each year of the study, physicians were assigned to colonoscopy volume quintiles on the basis of the mean annual number of colonoscopies that they performed in the preceding 5 yr.

Institution Factors. We classified colonoscopy setting as hospital or nonhospital. In 2005, 15% of colonoscopies were performed in nonhospital settings.¹⁵ Nonhospital endoscopy settings in Ontario are highly varied, ranging from a single room adjoining a physician's office to larger, ambulatory endoscopy facilities staffed by multiple endoscopists. Unlike American ambulatory endoscopy centers, Ontario nonhospital facilities are not currently regulated and are only minimally reimbursed (\$22.35CAN) for overhead costs (salaries, equipment, rent) related to colonoscopy. Hospitals, by contrast, are accredited and receive adequate funding from the government to cover the nonphysician related endoscopy costs.

Outpatient colonoscopy was defined as occurring in a hospital if there was a Same Day Surgery record without an overlapping record in the Discharge Abstract Database, whereas it was defined as occurring in a nonhos-

pital setting if OHIP code E749 (for colonoscopies performed outside hospitals) was billed in the absence of a concurrent Discharge Abstract Database or Same Day Surgery record. Nonclassifiable colonoscopies were excluded from the cohort.

Hospitals were categorized as academic or community, and the latter were further categorized by case volume into low, medium, and high volume. The number of acute weighted (by expected hospital resource utilization) cases per hospital in fiscal year 2005^{|||} was used: low (fewer than 10,000 acute weighted cases), medium (10,000-25,000), and high (more than 25,000) volume. This measure of hospital volume was not limited to endoscopy and was intended to approximate overall hospital size. We also assigned hospitals to tertiles on the basis of the proportion of colonoscopies in 2005 that were anesthesiologist-assisted: low (less than 20% of colonoscopies were anesthesiologist-assisted), medium (21-80%), and high (more than 80%).

Data Analysis

The number of colonoscopies performed with or without the assistance of an anesthesiologist per fiscal year was determined over the study period. Patient, physician, and institutional characteristics are reported for anesthesiologist-assisted and unassisted colonoscopy. We examined the number and proportion of anesthesiologist-assisted colonoscopies by institution type in fiscal year 2005. Where appropriate, chi-square tests for independence and for trend were used to evaluate differences in proportions of categorical variables between anesthesiologist-assisted and unassisted colonoscopies in a univariate fashion and to test the trend in the proportion of anesthesiologist-assisted colonoscopies from 1993 to 2005.

We modeled the data by using multilevel hierarchical logistic regression incorporating up to three levels (patient, physician, and institution) to account for the clustering of patients within physicians and physicians within institutions. The patient and physician level variables listed in tables 2 and 3 are those that were included in the models; all were analyzed categorically as defined in these tables. We restricted these analyses to patients who had at least one procedure in fiscal year 2005. If an individual had more than one procedure in this time period, only the first colonoscopy was included to ensure that the patient was considered in the statistical analysis only once, thus avoiding further issues with clustering. For model stability, we also excluded colonoscopies performed at academic hospitals as less than 1% of colonoscopies performed in these institutions were anesthesiologist-assisted. As a result of the distribution of various covariates, the three-level model did not converge; however, it was possible to create two 2-level models (patients clustered within physician and patients clustered within institution). Attributes from the excluded level (either institution or physician) were as-

§§ The Johns Hopkins University ACG Case-Mix System. Johns Hopkins Bloomberg School of Public Health. Available at: <http://www.acg.jhsph.edu/>; accessed August 19, 2007.

||| Ontario Joint Policy and Planning Committee. 2005/6 Hospital Specific Rate Model Results. Toronto, Ontario, Canada: Ontario Joint Policy and Planning Committee, 2007. Available at: <http://www.jppc.org/new/files/excel/Rate%20Results%20Using%200506%20Data%20-%20Final.xls>; accessed September 1, 2008.

Table 2. Patient Characteristics by Receipt of Anesthesia for Outpatient Colonoscopy in Ontario Adults, 1993–2005

	Anesthesiologist-assisted Colonoscopy (n = 256,799)	Unassisted Colonoscopy (n = 1,582,080)	Total (n = 1,838,879)	P* Value
Age, n (%)				< 0.0001
19–50	72,425 (28)	491,922 (31)	564,347 (31)	
51–70	129,910 (51)	778,278 (49)	908,188 (49)	
70+	54,464 (21)	311,880 (20)	366,344 (20)	
Sex, n (%)				< 0.0001
Female	136,165 (53)	825,771 (52)	961,936 (52)	
Male	120,634 (47)	756,309 (48)	876,943 (48)	
Neighborhood income quintile, n (%)				< 0.0001
Low	43,904 (17)	234,376 (15)	278,280 (15)	
2	47,083 (18)	284,734 (18)	331,817 (18)	
3	50,525 (20)	303,842 (19)	354,367 (19)	
4	53,116 (21)	324,780 (21)	377,896 (21)	
High	54,962 (21)	402,485 (25)	457,447 (25)	
Unknown	7,209 (3)	31,863 (2)	39,072 (2)	
Comorbidity, no. of ADGs (%)				< 0.0001
0	975 (<1)	10,012 (1)	10,987 (1)	
1–3	53,398 (21)	358,490 (23)	411,888 (22)	
4–5	72,941 (28)	439,224 (28)	512,165 (28)	
6–7	62,220 (24)	369,503 (23)	431,723 (23)	
8+	67,265 (26)	40,4851 (26)	472,116 (26)	

* P values are calculated for overall comparison between groups.

ADG = aggregated diagnostic group.

signed to the patient level for each of these models. From these two 2-level models, we selected the one that provided a larger variance in the distribution of the cluster-specific random effects and a smaller value in the proportion of unexplained variation in the outcome attributable to differences between patients. These two criteria were used to select the model because they are strong indicators of the hierarchical structure of the data.¹⁶ P values less than 0.05 were considered significant. Analyses were conducted by using SAS v.9 (SAS Institute, Cary, NC) and MLwiN (Centre for Multilevel Modeling, Bristol, United Kingdom).

Results

From 1993 to 2005, a total of 1,202,548 patients had 1,838,879 outpatient colonoscopies. Of these, 256,799

(14%) colonoscopies were anesthesiologist-assisted. The total number of outpatient colonoscopies performed rose from 66,177 in 1993 to 264,304 in 2005 ($P < 0.0001$), with the proportion of anesthesiologist-assisted colonoscopies accounting for an increasingly larger share, from 8.4% in 1993 to 19.1% in 2005 ($P < 0.0001$) (fig. 1). During this time, the proportion of anesthesiologist-assisted colonoscopies was three times larger in hospital settings (15.2%) than in nonhospital settings (4.9%) ($P < 0.0001$).

Patient and physician characteristics of the study cohort are summarized in tables 2 and 3, respectively. In 2005, use of anesthesiologist-associated colonoscopy varied widely by institution type and volume; low-volume community hospitals were the greatest users (48% of colonoscopies), and academic hospitals almost never used it (< 1% of colonoscopies) (fig. 2). Eighty-five

Table 3. Physician Characteristics by Receipt of Anesthesia for Outpatient Colonoscopy in Ontario Adults, 1993–2005

	Anesthesiologist-assisted Colonoscopy (n = 256,799)	Unassisted Colonoscopy (n = 1,582,080)	Total (n = 1,838,879)	P Value*
Specialty, n (%)				< 0.0001
Gastroenterology	46,601 (18)	687,103 (43)	733,704 (40)	
Surgery	174,663 (68)	655,804 (41)	830,467 (45)	
Internal medicine	25,825 (10)	166,333 (11)	192,158 (10)	
Other practitioners†	9,710 (4)	72,840 (5)	82,550 (5)	
Volume quintile, n (%)				< 0.0001
Low	65,126 (25)	299,084 (19)	364,210 (20)	
2	64,347 (25)	303,639 (19)	367,986 (20)	
3	57,344 (22)	311,666 (20)	369,010 (20)	
4	34,719 (13)	334,241 (21)	368,960 (20)	
High	35,263 (14)	333,450 (21)	368,713 (20)	

* P values are calculated for overall comparison among groups.

† Other practitioners comprise all other specialties, including family physicians and general practitioners.

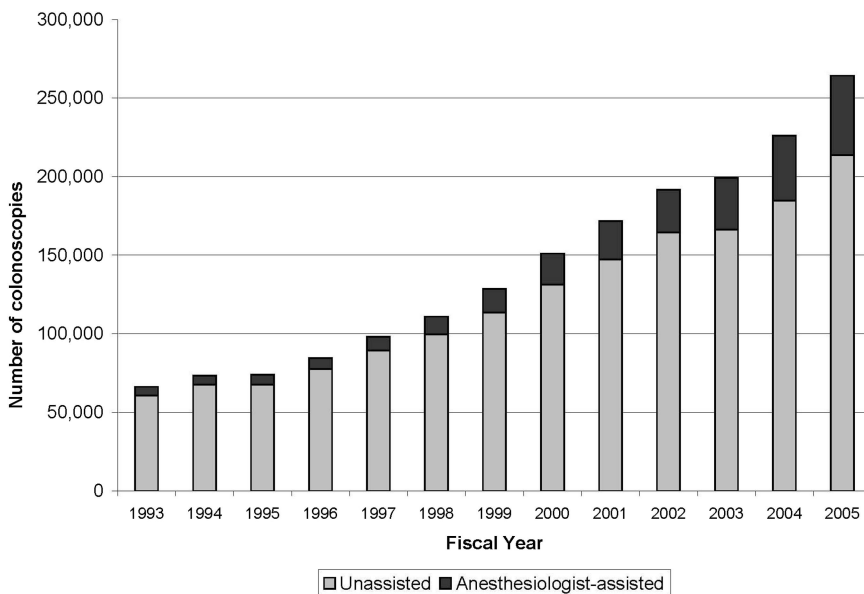


Fig. 1. The number of anesthesiologist-assisted and unassisted outpatient colonoscopies in adults by year in Ontario 1993–2005.

percent of hospitals were in either the highest (> 80% of colonoscopies done with anesthesia-assistance) or lowest tertile of anesthesiologist use (< 20% of colonoscopies done without anesthesiologist-assistance). All 14 academic hospitals were in the lowest tertile of anesthesiologist use, and 36% of low-volume community hospitals were in the highest tertile.

Only institution type and physician specialty were significantly associated with receipt of anesthesiologist-assisted colonoscopy in the hierarchical analysis (table 4). The odds of receiving anesthesiologist-associated colonoscopy were five times higher (odds ratio: 4.9; 95% confidence interval 4.4–5.5) if the patient had the colonoscopy in a low-volume community hospital compared to a high-

volume community hospital. The odds of receiving anesthesiologist-associated colonoscopy were 1.7 times higher (95% confidence interval 1.1–2.6) if the colonoscopy was performed by a surgeon.

Discussion

In this population-based analysis, we found that the proportion of anesthesiologist-assisted colonoscopies in Ontario more than doubled over the study period, from 8% in 1993 to 19% in 2005. These figures are similar to those reported from a survey of American endoscopists in 2004, in which 28% of respondents were regularly

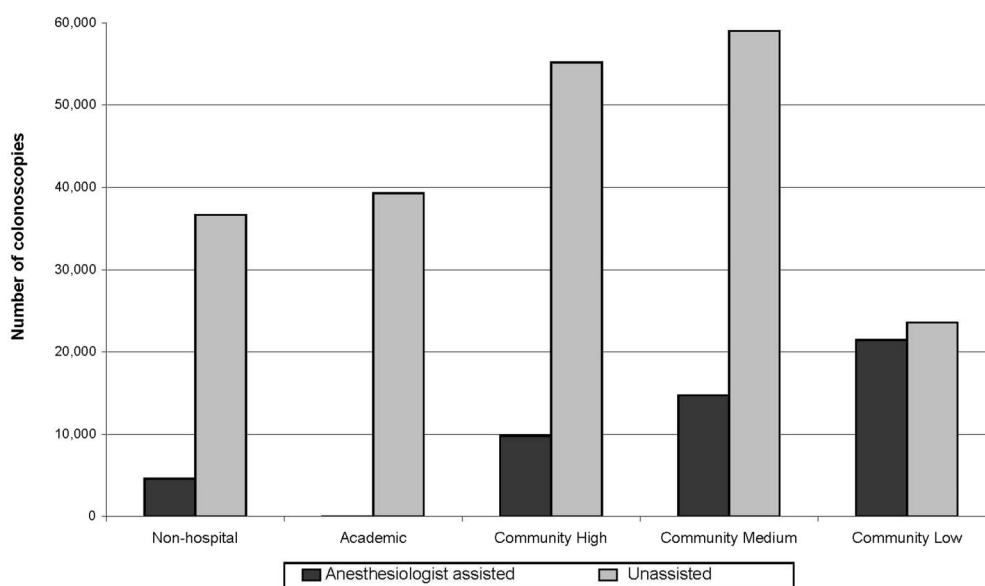


Fig. 2. The number of anesthesiologist-assisted and -unassisted outpatient colonoscopies in adults by institution type in 2005 in Ontario. Institution types include nonhospital facility, academic hospital, low-volume community hospital (fewer than 10,000 acute weighted cases [AWC]/yr), medium-volume community hospital (10,000–25,000 AWC/yr), and high-volume community hospital (more than 25,000 AWC/yr).

Table 4. Results from Two-level Hierarchical Model (Patients within Physician) of Patient, Physician, and Institutional Factors Associated with Anesthesiologist-assisted Outpatient Colonoscopy in Ontario Adults, 2005

	OR (95% CI)	P Value
Physician speciality		
Surgery	1.7 (1.1–2.6)	0.03
Internal medicine	1.2 (0.5–2.6)	NS
Other practitioners	0.7 (0.3–1.5)	NS
Gastroenterology	1	NA
Setting		
Non-hospital	0.3 (0.3–0.4)	< 0.0001
High-volume community hospital	0.2 (0.18–0.23)	< 0.0001
Medium-volume community hospital	0.3 (0.3–0.4)	< 0.0001
Low-volume community hospital	1	NA

Patient age, sex, comorbidity, median neighborhood income, and physician colonoscopy volume were not significant. Academic hospitals were excluded from this analysis.

NA = not applicable; NS = not significant.

assisted by either an anesthesiologist or a certified registered nurse anesthetist, although there appeared to be wide regional variation in reported practice.¹ We found that institution type/volume was most strongly associated with anesthesiologist assistance at colonoscopy. A similar population-based analysis would be less feasible in the United States where there are multiple payors and their policies are an important driver of receipt of anesthesiologist-assisted colonoscopy.⁸

Our results suggest that in an unregulated setting, anesthesiologist assistance with colonoscopy is principally driven by institution factors. Not only was institution type the strongest predictor of anesthesiologist-assistance but 85% of hospitals clustered at either the upper or lower end of the range of anesthesiologist use. This “all or none” pattern of utilization may reflect institutional policy or “culture” with respect to this practice. For example, in smaller hospitals where often there is no dedicated endoscopy unit, colonoscopy is often performed in the operating room, where access to anesthesiologists is greater and personnel are accustomed to performing procedures with the assistance of an anesthesiologist. Colonoscopy is also more often performed by surgeons in these facilities (data not shown). Furthermore, in smaller hospitals, this practice might also be tied to anesthesiologist retention as the additional income from providing assistance for colonoscopies may be necessary to support a fulltime position. By contrast, in academic hospitals that provide quaternary care, the demands of complex surgical cases may preclude routine anesthesiologist assistance for outpatient colonoscopy.

Regardless of the cause, the finding of such wide variation in practice between hospitals may be of concern. In other contexts, variation in healthcare utilization by region or hospital has been linked to underlying quality issues; for example, others have shown that greater healthcare utilization in the treatment of condi-

tions such as hip fracture or myocardial infarction leads to greater cost without improvement in patient satisfaction^{17,18} or outcomes.¹⁹

Our findings suggest that neither patient risk nor administration of propofol to improve endoscopy unit efficiency, two reasons often cited in the literature for anesthesiologist involvement,^{3–5} are important determinants of anesthesiologist assistance with colonoscopy. Specifically, we found that patient comorbidity was not associated with this practice, likely indicating that provision of this service is not tied to perceived patient risk. Furthermore, if endoscopy unit efficiency was an important consideration in the uptake of anesthesiologist-assisted colonoscopy, higher rates of anesthesiologist assistance in higher volume rather than in lower volume facilities (as we found) might be expected.

Our study has some potential limitations. As medications cannot be determined from the Ontario administrative data, we cannot be sure that the presence of an anesthesiologist at colonoscopy indicates that propofol was used for the procedure. However, given the paucity of nonanesthesiologists trained in propofol administration in Ontario, our findings likely reflect the increasing use of propofol for colonoscopy sedation. A second issue was the failure of the three-level hierarchical model to converge. It is difficult to be absolutely certain of the reasons for this failure of convergence; however, we found that in 85% of hospitals, the proportion of colonoscopies assisted by an anesthesiologist was either very low or very high. This means that in these centers, there was little between physician variability in the use of anesthesia. We hypothesize that the similarity of physician behavior within the majority of centers likely led to difficulties in estimating the three-level multilevel model, as the physician effect could not be separated from the hospital effect in most instances.

There are important cost implications to the use of anesthesiologist-assisted colonoscopy. In United States, the mean charge allowed by Medicare was \$106 in 2003, but when the procedure is covered by commercial insurers, reimbursement increases to an average of \$400.⁸ By using published estimates that 14.2 million colonoscopies are performed annually in the United States,²⁰ the reported median Medicare costs (\$106) and applying the 19% population-based rate of anesthesiologist-assisted colonoscopy that we observed, a very conservative estimate of the incremental physician-related cost of anesthesiologist-assisted colonoscopy in the United States is \$286 million per year. If the reported commercial insurance rate is used (\$400), our estimate would rise to just over \$1 billion dollars per year.

There is a lack of consensus about the criteria, if any, that should be used to regulate the use of anesthesiologist assistance with colonoscopy. To date, American payors who do regulate this practice restrict it to either high-risk patients or to those whose procedure-related

discomfort cannot be managed with conventional sedation. Our study suggests that institutional factors should also be considered if formal regulation of anesthesiologist assistance with colonoscopy is contemplated. For example, the effects on anesthesiologist retention in small hospitals may need to be weighed, whereas in nonhospital facilities, such as ambulatory endoscopy centers, an onsite anesthesiologist may confer additional benefits, such as expertise with emergency resuscitation.

In summary, in a healthcare setting in which anesthesiologist-assisted colonoscopy is unregulated, we have found that this practice is increasing and that it is most strongly associated with institution type. Although anesthesiologist assistance with colonoscopy is costly, regulation of this practice may have important downstream effects. If regulation is being considered, further evaluation of patient and institution factors is warranted to ensure that anesthesiologists' services are allocated in a manner that is most beneficial to patients and to the healthcare system rather than simply being left to the discretion of the payor.

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