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ORIGINAL ARTICLE

Anesthesia Assistance in Screening Colonoscopy and Adenoma Detection Rate Among Trainees

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Abstract

Background and Aims The use of anesthesia assistance (AA) for screening colonoscopy has been increasing substantially over the past decade, raising concerns about procedure safety and cost without demonstrating a proven improvement in overall quality indicators such as adenoma detection rate (ADR). The effect of AA on ADR has not been extensively studied among trainees learning colonoscopy. We aimed to determine whether type of sedation used during screening colonoscopy affects trainee ADR.

Methods Using the electronic endoscopy databases of two hospitals in our medical center, we identified colonoscopies performed by 15 trainees from 2014 through 2018, including all screening examinations in which the cecum was reached. Multivariable logistic regression was used to determine factors associated with adenoma detection.

Results We identified 1420 unique patients who underwent screening colonoscopy by a trainee meeting the inclusion criteria. Of these, 459 (32.3%) were performed with AA. Overall trainee ADR was 39.6%, with ADR increasing from 35.0% in year one of training to 42.8% in year three ($p=0.047$). ADR for cases with AA was 37.9%, while ADR for conscious sedation cases was 32.0% ($p=0.374$). Despite this 5.9% absolute difference, the use of AA was not associated with finding an adenoma on multivariable analysis when controlling for patient age, sex, smoking status, body mass index, trainee year of training, mean withdrawal time, supervising attending ADR, and bowel preparation quality (OR 0.85; 95% CI 0.67–1.09).

Conclusions Despite providing the ability to more consistently sedate patients, the use of AA did not affect trainee ADR. These results on trainee ADR and sedation type suggest that the overall lack of association between AA use and ADR is applicable to the trainee setting.

Keywords Colonoscopy · Sedation · Propofol · Trainee · Adenoma density under the curve

Introduction

In the USA, there has been a well-documented shift in the last decade in the method of sedation being used for patients undergoing screening colonoscopy, with many gastroenterologists now using anesthesia assistance (AA) with propofol to achieve deep sedation, as opposed to conscious sedation (CS) with narcotics and/or benzodiazepines [1–3]. A 2016 study found that while 34.4% of colonoscopies nationwide were performed with AA, the Northeast had the highest regional use of AA during colonoscopy at 53% [4]. This widespread practice has been associated with increased cost [2, 3, 5] as well as a possible increase in overall adverse event rate [4, 6, 7], without being shown to consistently increase overall colonoscopy quality indicators like adenoma detection rate (ADR)

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[8–12] and cecal intubation rate [9, 10, 13]. However, the use of propofol sedation for outpatient colonoscopy has been associated with higher patient satisfaction ratings, shorter recovery times, and shorter discharge and patient turnaround times compared to the use of CS [12].

While multiple studies have shown an increase in ADR as gastroenterology training year increases and as the number of procedures trainees perform increases [14, 15], it is not yet clear if the type of sedation used during outpatient colonoscopy affects trainee ADR. One study of trainee colonoscopy quality indicators demonstrated that procedure times decreased as trainees progressed through training, including procedures where adenomas were resected, and that CS procedures involving trainees tend to involve higher doses of narcotics and benzodiazepines when compared to attending-only procedures [16]. It is possible that AA use may provide trainees with the ability to more comfortably sedate outpatients for the additional procedure time required to increase their ADR. We aimed to determine whether the use of sedation for outpatient colonoscopy is associated with gastroenterology trainee ADR.

Methods

Study Population and Data Source

We used the electronic endoscopy databases of two hospitals in our academic medical center to identify all patients who underwent average-risk screening colonoscopy with a trainee and attending supervisor during the time period spanning July 1, 2014, through June 30, 2018. We included only the index colonoscopies for each patient and only examinations where the cecum was reached. All colonoscopes used were equipped with high definition and consistent across all endoscopists. Information regarding the use of water immersion technique versus carbon dioxide or air insufflation was not available. From the electronic medical record, we recorded patient age, sex, smoking status, and body mass index (BMI). Manual chart review of the colonoscopy procedure report was used to determine trainee fellowship year, bowel preparation quality, and supervising attending. The quality of the bowel preparation was determined by the endoscopist using the Aronchick bowel preparation scale [17] and recorded in the colonoscopy report. Bowel preparation was considered optimal if the physician rated the preparation as adequate, good, or excellent. Bowel preparation was considered suboptimal if the physician recorded that the preparation was fair, poor, or inadequate in any location of the colon. Mean trainee withdrawal time was calculated based on screening procedures where no intervention was performed (negative-result screening colonoscopies).

Training Setting and Ascertainment of Anesthesia Use

At our institution located in the Northeast region of the USA, gastroenterology trainees perform outpatient colonoscopy cases under attending supervision using both AA and CS. During year one of training, the majority of endoscopic learning takes place on inpatients requiring diagnostic procedures. Trainees perform 100–150 colonoscopies during year one of training, about 20–40 of which are screening procedures considered eligible for inclusion in ADR calculation. During years two and three of training, trainees perform about 200 colonoscopies each year, the majority of which are outpatient procedures. These outpatient procedures are performed under the supervision of five gastroenterology hospitalist attendings, who give both intra-procedural feedback and quarterly aggregate procedural feedback on procedural skills to each trainee. While supervising attendings receive annual report cards on their colonoscopy quality performance indicators including ADR and mean withdrawal time, trainees do not receive such report cards but rather receive frequent feedback focused on procedural technique and readiness for independent practice. Trainees perform one to four colonoscopies per day in a procedure block that is shared among the gastroenterology fellows.

American Society of Anesthesiologists (ASA) status is documented in all procedures. The majority of outpatients undergoing screening colonoscopy are ASA class I or II. Though patients with higher ASA scores are more likely to require AA, no specific guidelines determine which patients will undergo screening colonoscopy with AA as opposed to CS. Rather, trainee or attending physicians determine whether a patient will undergo screening colonoscopy with AA or CS based on a combination of additional factors including patient age, sex, and medical comorbidities such as obesity and history of respiratory problems as well as physician preference and scheduling/availability. An outpatient colonoscopy case was considered to be an AA case based on manual review of the procedure report stating that an anesthesiologist was present administering propofol-based monitored anesthesia care.

Primary Outcome and Statistical Analysis

The primary outcome was the prevalence of at least one adenoma on screening colonoscopy. Analysis of the text of pathology reports was used to determine whether adenomatous polyps were detected and the number of adenomatous polyps detected on colonoscopies performed by a trainee with an attending supervisor during the defined

study period. No distinction was made between adenomas detected by the trainee alone versus adenomas detected by the supervising attending during the trainee case. As such, trainee ADR (the percentage of cases where at least one adenoma was detected) may include adenomas detected by the trainee alone, the supervising attending alone, or by the trainee and supervising attending together.

The distributions of those undergoing colonoscopy by a trainee and supervising attending were calculated by patient age, sex, smoking status (ever or never use), BMI, anesthesia type (AA vs. CS), trainee year of fellowship, mean trainee withdrawal time, bowel preparation quality (optimal vs. suboptimal), and supervising attending ADR. ADR for supervising attendings was defined by the proportion of average-risk screening colonoscopies without a trainee present where at least one adenomatous polyp was found. The supervising attending ADR for cases without a trainee present over the time period of the study (2014 through 2018) was used for analysis. Univariable analysis using Chi-square tests and Cochran–Armitage trend tests for categorical values and ordinal categories, respectively, were used to compare trainee colonoscopies where adenomas were detected to those colonoscopies where an adenoma was not detected. We used a multivariable logistic regression model with all covariables, including type of sedation used, to identify factors independently associated with the detection of ≥ 1 adenoma. Results are reported with odds ratios (ORs) and 95% confidence intervals (CIs). Finally, we performed multivariate Poisson regression to determine whether there was an association between type of sedation used and the number of adenomas detected per colonoscopy, with results reported as rate ratios and 95% CIs. All analyses were performed with SAS version 9.4 (Cary, NC). This study was approved by the Institutional Review Board of Columbia University.

Results

We identified 1420 unique patients who underwent average-risk screening colonoscopy in which the cecum was reached by 15 different trainees during the defined time period. Of these, 459 patients (32.3%) underwent colonoscopy with AA. The age group that underwent the most colonoscopies in the cohort were those ages 50–59, who represented 46.4% of the total cohort. 830 patients (58.5%) were female, and the great majority (90.5%) had optimal bowel preparations. The remainder of the baseline characteristics of the subjects and colonoscopies, including the number of colonoscopies performed at each level of training, are displayed in Table 1.

Overall trainee ADR was 39.6%. Trainee ADR increased from 35.0% in the first year of training to 42.8% in the third year of training ($p = 0.0467$). Trainee ADR was 32.0% during cases in which CS was used as compared to 37.9% in cases with AA. This absolute difference in ADR of 5.9% favoring AA did not reach statistical significance on univariable analysis ($p = 0.3741$). Similarly, ADR was not significantly higher in cases with AA on univariable analysis when cases were divided by year of training (see Table 2). There

Table 1 Baseline characteristics of fellow screening colonoscopies eligible for ADR calculation from 2014 to 2018 ($n = 1420$)

	Subjects
Age (mean, SD)	60.6 ± 8.1
Age distribution (*n*, %)	
50–59	659 (46.4)
60–69	531 (37.4)
70–79	212 (14.9)
≥ 80	18 (1.3)
Sex (*n*, %)	
Female	830 (58.5)
Male	590 (41.6)
Smoking status	
Ever	265 (18.7)
Never	882 (62.1)
Unknown	273 (19.2)
BMI	
< 18	6 (0.4)
18–24.9	248 (17.5)
25–29.9	471 (33.2)
30–34.9	280 (19.7)
≥ 35	166 (11.7)
Unknown	249 (17.5)
Anesthesia type (*n*, %)	
Conscious sedation	961 (67.7)
AA	459 (32.3)
Year of Training (*n*, %)	
1	220 (15.5)
2	761 (53.6)
3	439 (30.9)
Trainee mean withdrawal time in minutes (*n*, %)	
13–15	835 (58.8)
16–18	463 (32.6)
19–21	122 (8.6)
Bowel preparation (*n*, %)	
Optimal	1285 (90.5)
Suboptimal	135 (9.5)
Supervising attending ADR[a] (*n*, %)	
< 20%	31 (2.2)
20–29%	499 (35.1)
30–39%	473 (33.3)
≥ 40%	417 (29.4)
Overall trainee ADR (%)	39.6

AA anesthesia assistance, *ADR* adenoma detection rate

[a]Total ADR excluding trainee procedures

Table 2 Univariable analysis of trainee colonoscopies with adenomas detected

	Subjects (*n*, %)	*p* value
Total colonoscopies with adenomas detected	562 (39.6)	
Sex		< 0.0001
Men	272 (46.1)	
Women	290 (34.9)	
Age		0.0012
50–59	238 (36.1)	
60–69	207 (39.0)	
70–79	107 (50.5)	
≥ 80	10 (55.6)	
Smoking status		0.8385
Ever	109 (41.1)	
Never	347 (39.3)	
Unknown	106 (38.8)	
BMI		0.7997
< 18	1 (16.7)	
18–24.9	95 (38.3)	
25–29.9	182 (38.6)	
30–34.9	112 (40.0)	
≥ 35	70 (42.2)	
Unknown	102 (41.0)	
Year of training		0.0467
1	77 (35.0)	
2	297 (39.0)	
3	188 (42.8)	
Trainee mean withdrawal time in minutes		0.9288
13–15	331 (39.6)	
16–18	181 (39.1)	
19–21	50 (41.0)	
Supervising attending ADR[a]		0.0003
< 20%	5 (16.1)	
20–29%	172 (34.5)	
30–39%	212 (44.8)	
≥ 40%	173 (41.5)	
Bowel preparation		0.0537
Optimal	519 (40.4)	
Suboptimal	43 (31.9)	
Anesthesia type		0.3741
Conscious sedation	388 (32.0)	
AA	174 (37.9)	
AA by year		
Fellowship year 1	45 (36.6)	0.5788
Fellowship year 2	74 (36.1)	0.3144
Fellowship year 3	55 (42.0)	0.8166

AA anesthesia assistance, *ADR* adenoma detection rate

[a]Total ADR excluding trainee procedures

was a significant association between supervising attending ADR and trainee ADR ($p = 0.0003$).

In our multivariable model including all covariables (Table 3), trainee colonoscopy with AA was not associated with ADR (OR 0.85; 95% CI 0.67, 1.09). Patient factors associated with trainee adenoma detection included male sex (OR 1.72; 95% CI 1.37, 2.16), older patient age (OR for age group 70–79 compared to 50–59: 1.84; 95% CI 1.34, 2.54; OR for age group ≥ 80 compared to 50–59: 2.88; 95% CI 1.08, 7.70), and optimal bowel preparation (OR 1.58; 95% CI 1.07, 2.34). Supervising attending ADR was also associated with trainee adenoma detection (OR for supervising attending ADR 30–39% compared to < 20%: 4.27; 95% CI 1.59, 11.44; OR for ADR ≥ 40% compared to < 20%: 3.71; 95% CI 1.38, 10.00). Trainee year of fellowship and trainee mean withdrawal time were not associated with adenoma detection on multivariable analysis.

Among cases in which adenomas were detected, the number of adenomas detected per colonoscopy can be found in Table 4. The majority of cases (56.9%) had only one adenoma detected. As displayed in Table 5, adenoma density was not associated with type of sedation used for colonoscopy when analyzed using multivariate Poisson regression and adjusting for all other covariables (RR 1.01, 95% CI 0.89, 1.16).

Discussion

In this single-center study of trainee colonoscopies, we found that the type of sedation used during screening colonoscopy does not affect trainee ADR. While the observed absolute difference of 5.9% in trainee ADR in our study favored those cases performed with AA, this difference was not significant on univariable analysis. Furthermore, when accounting for patient age, patient sex, year of training, trainee mean withdrawal time, supervising attending ADR, and bowel preparation quality, the type of sedation used during screening colonoscopy was still not associated with trainee ADR. As such, while an absolute difference in ADR of even 1.0% is clinically meaningful to colorectal cancer outcomes [18], the observed difference in our study is likely secondary to confounding factors, such as patient age and medical comorbidities, that are likely to be associated with both the prevalence of colorectal adenomas and AA use. Type of sedation used for colonoscopy similarly was not associated with the density of adenomas detected on colonoscopy by trainees.

To our knowledge, this is the largest study to date specifically evaluating if AA using propofol sedation may result in an increase in ADR among trainees learning colonoscopy. Our findings of a lack of association between trainee ADR and type of sedation used for screening colonoscopy are

Table 3 Multivariable analysis of factors independently associated with trainee ADR (adjusted for patient age, patient sex, patient smoking status, patient BMI, trainee year of fellowship, mean trainee withdrawal time, supervising attending ADR, and bowel preparation quality)

	Odds ratio for ADR (95% CI)	*p* value
Conscious sedation	1.0	
AA	0.85 (0.67, 1.09)	0.2004
Age		
50–59	1.0	
60–69	1.22 (0.95, 1.55)	0.1145
70–79	1.84 (1.34, 2.54)	0.0002
≥ 80	2.88 (1.08, 7.70)	0.0348
Sex		
Male	1.72 (1.37, 2.16)	< 0.0001
Female	1.0	
Smoking status		
Ever	1.08 (0.81, 1.44)	0.6122
Never	1.0	
Unknown	0.90 (0.63, 1.27)	0.5327
BMI		
< 18	0.34 (0.04, 3.00)	0.3309
18–24.9	1.0	
25–29.9	0.97 (0.70, 1.34)	0.8320
30–34.9	1.12 (0.78, 1.60)	0.5444
≥ 35	1.40 (0.92, 2.12)	0.1163
Unknown	1.07 (0.68, 1.66)	0.7751
Year of training		
1	1.0	
2	1.13 (0.81, 1.58)	0.4699
3	1.29 (0.90, 1.85)	0.1627
Trainee mean withdrawal time in minutes		
13–15	1.0	
16–18	0.93 (0.73, 1.18)	0.5510
19–21	1.11 (0.75, 1.66)	0.6018
Supervising Attending ADR[a]		
< 20%	1.0	
20–29%	2.63 (0.98, 7.07)	0.0560
30–39%	4.27 (1.59, 11.44)	0.0039
≥ 40%	3.71 (1.38, 10.00)	0.0096
Bowel preparation		
Optimal	1.58 (1.07, 2.34)	0.0214
Suboptimal	1.0	

AA anesthesia assistance, *ADR* adenoma detection rate, *BMI* body mass index

[a]Total ADR excluding trainee procedures

consistent with prior studies that have shown this lack of association among the general population of endoscopists [8–12]. In a large study of Medicare beneficiaries undergoing colonoscopy in 2003, Dominitz et al. [8] similarly found that while AA was associated with a higher rate of polyp detection in unadjusted analyses, there was no significant association on adjusted analyses. While Wang et al. [19] found the use of AA to be significantly associated with the finding of advanced neoplasia compared to CS in a large population of patients in the Clinical Outcomes Research Initiative (CORI) database in 2010, the absolute difference in advanced neoplasia between the groups of 1% was not considered to be clinically meaningful. Nakashbendi et al. [9] analyzed 699 inpatients who underwent screening colonoscopy at a single academic center between 2012 and 2013 and found no association between ADR and AA use. While this study differentiated between attendings and trainees and similarly found no effect of AA use on trainee ADR, it included only 429 colonoscopies performed by trainees. Our study of 1420 colonoscopies uniquely analyzed the ADR of

Table 4 Adenoma density in cases where at least one adenoma was detected ($n=562$)

Adenoma density (number of adenomas found on colonoscopy)	Conscious sedation (*n*, %)	AA (*n*, %)	Total (*n*, %)
1	228 (58.8)	92 (52.9)	320 (56.9)
2	73 (18.8)	39 (22.4)	112 (19.9)
3	40 (10.3)	19 (10.9)	59 (10.5)
4	21 (5.4)	8 (4.6)	29 (5.2)
5	14 (3.6)	8 (4.6)	22 (3.9)
6	7 (1.8)	3 (1.7)	10 (1.8)
7	2 (0.5)	1 (0.6)	3 (0.5)
8	1 (0.3)	1 (0.6)	2 (0.4)
9	1 (0.3)	2 (1.1)	3 (0.5)
10–15	1 (0.3)	0 (0.0)	1 (0.2)
16–20	0 (0.0)	1 (0.6)	1 (0.2)

15 trainees over the three-year fellowship period and failed to show an association between AA use and ADR.

Higher physician ADR is associated with a significantly decreased risk of interval colorectal cancer, advanced-stage interval cancer, and fatal interval cancer [18, 20]. Our finding of an overall collective trainee ADR of 39.6% (46.1% in male patients, 34.9% in female patients) exceeds that of the current published individual performance targets of an ADR of ≥ 25% in a mixed male/female population (≥ 30% for men and ≥ 20% for women) [21] and is consistent with prior studies showing high trainee adenoma and polyp detection rates [14–16]. Many studies on fellow involvement and ADR have shown a higher ADR in colonoscopies involving trainees as compared to attending-only procedures [14, 15, 22], which has been attributed to having both "two pairs of eyes" present during the procedure and also the extra care taken in teaching and achieving optimal colonoscopy technique when a trainee is present. Our study additionally found that higher supervising attending ADR (calculated from cases not involving trainees) was associated with higher trainee ADR. This trend has been previously observed in the same data source and setting as our present study [23]. This earlier study also showed that increased supervisor withdrawal time was associated with longer trainee withdrawal time. While withdrawal time data for individual colonoscopies were not analyzed in this data set (only mean trainee withdrawal time during negative-result colonoscopies was analyzed), it may be that supervising attendings with longer withdrawal times and higher ADRs encourage trainees to take more care and time in detecting adenomas as compared to supervising attendings who typically conduct colonoscopies with shorter withdrawal times.

While it is well established that longer mean withdrawal time increases ADR during screening colonoscopy [24], we did not find an association between mean trainee withdrawal time and trainee ADR. Trainee mean withdrawal times in negative-result screening colonoscopies in our study were not substantially different from each other and were uniformly

Table 5 Multivariate analysis of factors independently associated with adenoma rate, i.e., number of adenomas per colonoscopy or adenoma density under the curve (adjusted for patient age, patient sex, patient smoking status, patient BMI, trainee year of fellowship, mean trainee withdrawal time, supervising attending ADR, and bowel preparation quality)

	Rate ratio for adenoma (95% CI)	*p* value
Conscious sedation	1.0	
AA	1.01 (0.89–1.16)	0.8414
Age		
50–59	1.0	
60–69	1.33 (1.16–1.52)	< 0.0001
70–79	1.76 (1.50–2.06)	< 0.0001
≥ 80	1.20 (0.69–2.08)	0.5292
Sex		
Male	1.54 (1.36–1.74)	< 0.0001
Female	1.0	
Smoking status		
Ever	1.09 (0.94–1.27)	0.2601
Never	1.0	
Unknown	0.92 (0.76–1.12)	0.4033
BMI		
< 18	0.23 (0.03–1.62)	0.1389
18–24.9	1.0	
25–29.9	1.01 (0.85–1.20)	0.9216
30–34.9	0.96 (0.78–1.17)	0.6708
≥ 35	1.40 (1.12–1.74)	0.0028
Unknown	1.06 (0.83–1.34)	0.6428
Year of training		
1	1.0	
2	1.01 (0.84–1.21)	0.9458
3	1.28 (1.05–1.55)	0.0133
Trainee mean withdrawal time in minutes		
13–15	1.0	
16–18	1.08 (0.95–1.22)	0.2615
19–21	1.05 (0.84–1.31)	0.6697
Supervising attending ADR[a]		
< 20%	1.0	
20–29%	1.47 (0.82–2.63)	0.1954
30–39%	2.17 (1.22–3.86)	0.0087
≥ 40%	2.22 (1.24–3.96)	0.0071
Bowel preparation		
Optimal	1.17 (0.94–1.44)	0.1529
Suboptimal	1.0	

AA anesthesia assistance, *ADR* adenoma detection rate, *BMI* body mass index

[a]Total ADR excluding trainee procedures

above the recommended 6 minutes or greater [21], which likely accounts for this observed lack of association.

We recognize several limitations of our study, including its retrospective design, which does not allow us to determine the degree of fellow involvement in each colonoscopy. As such, the supervising attending may have been more involved in the colonoscope withdrawal and adenoma detection in some trainee procedures as compared to others, and it is not known for trainee cases if adenomas were detected by the trainee alone, the supervising attending alone, or by the trainee and supervising attending together. Our study was performed at a single academic center, and findings may not be generalizable to the general population of gastroenterology trainees. This limitation is likely mitigated by the inclusion of only screening colonoscopies in our study, thus excluding surveillance colonoscopies and colonoscopies done for diagnostic purposes. Finally, as the use of water immersion versus gas insufflation technique for each case could not be determined, this distinction was not included as a variable in the analysis.

In summary, we found that AA use for average-risk screening colonoscopy does not improve trainee ADR when compared to CS use. Our study helps to confirm that despite providing the ability to more comfortably sedate patients, the practice of AA use for screening colonoscopy does not necessarily contribute to colonoscopy quality among cases involving trainees. This finding should add to all of the considerations that endoscopists must weigh when choosing the method of sedation for patients undergoing screening colonoscopy.

Author's contribution AK, AP, JK, XFK, RGC, BL, and SK were involved in study concept and design. AK, AP, JK, and BL contributed to acquisition of data. AK and BL were involved in analysis and interpretation of data. AK, BL, and SK drafted the manuscript. AK, AP, JK, XFK, RGC, BL, and SK were involved in critical revision of the manuscript for important intellectual content. AK and BL were involved in statistical analysis. SK and BL contributed to study supervision. All authors approve the final manuscript submitted and they approve the authorship list.

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Compliance with Ethical Standards

Conflict of interest All authors declare that they have no conflict of interest and nothing to declare.

Ethical approval This analysis was approved by the Institutional Review Board of Columbia University.

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