

Prospective Study

Efficiency and patient experience with propofol vs conventional sedation: A prospective study

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Author contributions: Thornley P, Al Beshir M, Gregor J, Antoniou A and Khanna N contributed to study conception and design; Thornley P, Al Beshir M and Khanna N contributed to data acquisition, data analysis and interpretation, and writing of the article; Gregor J, Antoniou A and Khanna N contributed to editing, reviewing and final approval of the article.

Supported by Division of Gastroenterology at Western University (in part), Canada.

Institutional review board statement: The study was reviewed and approved by the Western University Institutional Review Board.

Informed consent statement: All study participants provided informed verbal and written consent prior to study enrolment.

Conflict-of-interest statement: There are no conflicts of interest to report.

Data sharing statement: No additional data are available.

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Received: October 2, 2015

Peer-review started: October 2, 2015

First decision: November 5, 2015

Revised: December 7, 2015

Accepted: December 19, 2015

Article in press: December 23, 2015

Published online: February 25, 2016

Abstract

AIM: To determine whether anaesthesiologist-administered sedation with propofol (AAP) or endoscopist-administered conscious sedation (EAC) with fentanyl/midazolam shortens colonoscopy duration/total room time.

METHODS: This is a prospective, non-randomized, comparative study that enrolled patients greater than 18 years of age undergoing colonoscopy in a single Canadian academic outpatient endoscopy unit over a three-month consecutive period. Colonoscopies in this unit are performed both with AAP and EAC. Patient demographics, procedure-related data and adverse events were documented. Additionally, the level of procedure difficulty, and whether a staff endoscopist, trainee with assistance, or independent trainee, performed the procedure were documented. A validated modified 4-question, 5-point Likert scale telephone survey was used to assess patient satisfaction with colonoscopy. The telephone patient satisfaction survey was conducted 24-72 h following the procedure.

RESULTS: Two hundred and thirty patients were

enrolled during the study period with 126 patients in the AAP group and 104 patients in the EAC group. Mean procedure time was 18.3 ± 10.1 min in the AAP group and 14.7 ± 7.1 min in the EAC group ($P = 0.002$). Mean total room time was 36.8 ± 13.7 with AAP and 30.1 ± 11 min with EAC ($P < 0.001$). Multivariate analysis revealed the use of AAP ($P = 0.002$), resident participation ($P < 0.001$), diagnostic interventions ($P = 0.033$), therapeutic interventions ($P < 0.001$), lower body mass index ($P = 0.008$) and American Society of Anaesthesiologist class ($P = 0.016$), to be predictors of longer total room time. Patient age and gender were not significant predictors. After excluding cases in which trainees were involved, there was no significant difference in procedure time between the two groups ($P = 0.941$), however total room time was still prolonged in the AAP group ($P = 0.019$). The amount of pain experienced was lower with AAP ($P = 0.02$), with a trend toward overall higher patient satisfaction ($P = 0.074$). There were 2 sedation-related adverse events, both in the AAP group involving a patient with aspiration requiring hospitalization and a patient with hypoxia managed with bronchodilators.

CONCLUSION: EAC results in reduced total room time compared to AAP. Resident participation doubles procedure time regardless of sedation type.

Key words: Patient satisfaction; Fentanyl; Colonoscopy; Midazolam; Propofol

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Core tip: There is little research examining sedation type in light of patient satisfaction and overall efficiency of colonoscopy. Our novel prospective study evaluated the total procedure room time and patient satisfaction in a high-volume endoscopy center, which performs colonoscopy using conventional sedation and propofol sedation. A statistically significant reduction in total room time with conventional sedation (midazolam/fentanyl) when compared to anaesthetist-administered propofol was demonstrated. Patients reported less procedure pain when receiving propofol sedation compared to conventional sedation. Special discussion emphasizes the need to further examine strategies to maximize endoscopy unit efficiency to respond to increasing patient demand, while maximizing patient satisfaction.

Thornley P, Al Beshir M, Gregor J, Antoniou A, Khanna N. Efficiency and patient experience with propofol vs conventional sedation: A prospective study. *World J Gastrointest Endosc* 2016; 8(4): 232-238 Available from: URL: <http://www.wjgnet.com/1948-5190/full/v8/i4/232.htm> DOI: <http://dx.doi.org/10.4253/wjge.v8.i4.232>

INTRODUCTION

Colorectal cancer is the leading cause of cancer related death among non-smokers in Canada and is the fourth leading cause of cancer death worldwide^[1]. Patients presenting with a high suspicion of colorectal cancer based on physical examination and imaging studies should receive a colonoscopy within two weeks of diagnostic suspicion^[2]. Furthermore, any patient referred for a screening colonoscopy should receive a colonoscopy within six months of referral^[2]. However, with an ever-increasing average population age, demand for colonoscopies is expected to increase by 5%-10% per annum over the coming decades^[3]. Presently, hospital endoscopy units are experiencing overwhelming demand for their service and as such it is imperative to examine methods to improve overall endoscopy unit efficiency^[4,5].

There has been growing interest in finding the ideal sedation for colonoscopy that is safe, easy to administer, provides adequate sedation and allows for rapid recovery. A combination of benzodiazepines and opiates (midazolam and fentanyl), the medications used most commonly by gastroenterologists for procedural sedation, provides adequate analgesia and sedation during colonoscopy^[6]. Propofol is an intravenously administered hypnotic drug used for induction and maintenance of general anaesthesia and is also used in procedural sedation. The perceived benefits of propofol sedation during colonoscopy include rapid post-procedure drug clearance, improved patient comfort and rapid recovery/discharge^[2]. Propofol administered by an anaesthesiologist has been extensively investigated and multiple randomized controlled trials have shown that using propofol sedation for colonoscopy in generally healthy individuals can lead to faster recovery and discharge times and increase patient satisfaction without an increase in side-effects^[7]. Furthermore, propofol sedation is preferred by some endoscopists for colonoscopy procedures compared to conventional sedation^[6].

The Canadian Association of Gastroenterology released a position statement on the use of propofol for sedation during endoscopic procedures indicating "propofol has advantages over standard agents used for conscious sedation"^[2]. The rate of cecal intubation (a marker of colonoscopy completion) is increased in procedures in which propofol-induced sedation has been used^[6]. However, the literature regarding the experience, overall efficacy and efficiency of using propofol in endoscopy units is limited.

The aim of this study was to determine whether anaesthesiologist-administered propofol sedation (AAP) results in a shorter duration of colonoscopy procedure time and total procedure room time in comparison to endoscopist-administered conventional sedation (EAC) with midazolam and fentanyl for colonoscopy. Secondary outcomes include a comparison of procedure times with

or without resident involvement, patient satisfaction and procedure related complications.

MATERIALS AND METHODS

Overview and patient selection

We performed a prospective, non-randomized, comparative study recruiting patients during a three-month (12 wk) consecutive period at a single high-volume Canadian academic outpatient endoscopy unit where both AAP and EAC are utilized. Bowel preparation protocols, colonoscopy indication, therapeutics performed and American Society of Anaesthesiologists (ASA) class are identical for patients receiving both AAP and EAC and patients do not select the type of sedation they receive. The Western University Ethics Review Board approved this study for patient recruitment. All patients 18 years of age and over undergoing colonoscopy either for symptomatic or screening purposes were approached for possible involvement in the study. Study enrolment involved an informed consenting process prior to the potential participant entering the procedure room. Verbal consent as well as written consent was obtained prior to enrolment in the study. Patients were provided a contact telephone number and electronic mail address of the study research assistant who was available to answer study questions and remove participants from the trial at their request at any point during the study period. A total of five patients declined participation in the study and no participants requested to be removed from the study after enrolment. Exclusion criteria included age less than 18 years, inability to read or write English and patients with major psychiatric or cognitive impairment. Six gastroenterologists participated in the study. All participating endoscopists in the study were experienced gastroenterologists with more than 200 colonoscopies performed per year.

Measurement tools and data collection

Following patient consent, a detailed list of parameters was documented for each patient during their colonoscopy. Patient demographics including age, sex, body mass index (BMI) and ASA class, and procedure related data including indication, pre-procedure time, procedure duration, the presence or absence of any intervention, procedure completion time and total procedure room time were all recorded. Additionally, the level of procedure difficulty, and whether a staff endoscopist, trainee with assistance, or independent trainee, performed the procedure were documented. The trainee included either a gastroenterology resident or second year general surgery resident. We also collected anaesthesia related data, including type of sedation used and total sedative dose/administration method.

A validated modified 4-question, 5-point Likert scale telephone survey was used to assess patient satisfaction with colonoscopy^[8]. Forty-eight hours post-procedure, enrolled patients were contacted regarding our post-

procedure patient satisfaction survey. If unable to reach the patient at this time, one additional follow-up call was made the following day (72 h post-procedure). To avoid recall biases and maximize group standardization, no participants were contacted prior to 48-h post-procedure, nor were participants contacted beyond the 72-h post-procedure time interval. Participant satisfaction data was combined according to the group represented by each participant (AAP or EAC). Patient satisfaction data was analyzed as a whole. Thus, stratification for difference between participants reached at the 48 h vs 72-h post-procedure time point was not performed.

Throughout the study, a research assistant (PT) was available to answer participants' questions. The study research assistant was not involved in any direct care of study participants and was responsible for collecting patient written consent, recording study measurable and contacting patients post-procedure for the patient satisfaction survey.

Statistical analysis

For the purposes of statistical analysis, statistical significance was understood to be achieved when *P*-value was less than 0.05. χ^2 analysis and unpaired *t*-test were used to compare differences between the two patient groups (AAP vs EAC). χ^2 analysis and Wilcoxon 2 sample test were used to analyze the patient satisfaction survey responses. Study endpoints were analyzed with unpaired *t*-tests, Fischer exact tests and analysis of covariance were adjusted for gender where appropriate. Height discrepancies were correlated to gender differences. This approach was justified by performing a logistic regression of height and gender as independent variables with respective group as an endpoint and it was noted that only gender was a significant variable, height was not. Multivariate analysis was utilized to normalize the collected data set. Adjustments were made for a non-normally distributed total room and total procedure time and between-group statistical tests are based on the log-transformed data. All database management and statistical analysis was conducted and reviewed by the department's staff biomedical statistician, Larry Stitt, from Western University Department of Epidemiology and Biostatistics.

RESULTS

A total of 230 patients were enrolled in our study. A total of 126 (55%) patients received AAP, while 104 (45%) patients received EAC. The cecum was intubated in all patients and confirmed by standard cecal landmarks and in most instances by intubation of the ileum and direct visualization of intestinal villi. Patient demographics are outlined in Table 1.

Mean procedure time (time measured from scope insertion to scope removal) was 18.3 ± 10.1 min in the AAP group and 14.7 ± 7.1 min in the EAC group (*P* = 0.002). Mean total procedure room time (time measured

Table 1 Participants' demographics for endoscopist-administered sedation and anaesthesiologist-administered sedation with propofol groups *n* (%)

	EAC (<i>n</i> = 104)	AAP (<i>n</i> = 126)	<i>P</i> -value
Male sex - frequency	60 (57.7)	46 (36.5)	0.001
Age	59.8 (11.6)	57.1 (13.3)	0.101
Weight	183.3 (49.1)	174.6 (46.5)	0.169
Height	67.6 (4.2)	66.3 (4.0)	0.016
BMI	28.0 (6.5)	27.7 (6.2)	0.750
Indication - symptomatic	33 (31.7)	55 (43.7)	0.064
Intervention			0.936
None	31 (29.8)	37 (29.4)	
Diagnostic	25 (24.0)	34 (27.0)	
Therapeutic	36 (34.6)	43 (34.1)	
Diagnostic and therapeutic	12 (11.5)	12 (9.5)	
ASA class			0.089
1	42 (40.4)	52 (41.3)	
2	54 (51.9)	53 (42.1)	
3	8 (7.7)	21 (16.7)	

EAC: Endoscopist-administered conscious sedation; AAP: Anaesthesiologist-administered sedation with propofol; BMI: Body mass index; ASA: American Society of Anaesthesiologists.

Table 2 Multivariate analysis of procedure measurables

	Coefficient	<i>P</i> -value
BMI	-0.008	0.008
ASA class	0.066	0.016
Intervention - diagnostic	0.084	0.033
Intervention - therapeutic	0.246	< 0.001
Propofol sedation (AAP)	0.091	0.002
Resident involved	0.391	< 0.001

AAP: Anaesthesiologist-administered sedation with propofol; BMI: Body mass index; ASA: American Society of Anaesthesiologists.

from the moment the patient entered the room until the moment the patient was wheeled to recovery) was 36.8 ± 13.7 min with AAP and 30.1 ± 11 min with EAC ($P < 0.001$). Trainee involvement was 51/126 (40%) in the AAP group and 15/104 (14%) in the EAC group ($P < 0.001$). Multivariate analysis revealed the use of AAP ($P = 0.002$), resident participation ($P < 0.001$), diagnostic interventions ($P = 0.033$), therapeutic interventions ($P < 0.001$), lower BMI ($P = 0.008$) and ASA class ($P = 0.016$), to be predictors of longer total procedure room time, as detailed in Table 2. There were two sedation related adverse events in the AAP group. One case involved a patient who aspirated during procedure, which subsequently required hospitalization. The second adverse event involved a post-procedure, recovery room incidence of hypoxia, which was resolved by bronchodilators.

Log transformation of procedure time and total procedure room time was performed to normalize data for height and gender. With removal of trainee presence, there was no significant difference in procedure time between the two groups ($P = 0.941$) (Table 3). However, the total procedure room time was still prolonged in the AAP group ($P = 0.019$) relative to the EAC group

Table 3 Procedure time and total procedure room time with removal of trainee presence (staff endoscopist data only) for endoscopist-administered sedation and anaesthesiologist-administered sedation with propofol groups

	EAC (<i>n</i> = 89)	AAP (<i>n</i> = 75)	<i>P</i> -value
Total procedure time			
Mean \pm SD	13.0 \pm 4.9 min	12.9 \pm 4.8 min	0.941
Total room time			
Mean \pm SD	28.1 \pm 9.3 min	31.1 \pm 10.1 min	0.019

EAC: Endoscopist-administered conscious sedation; AAP: Anaesthesiologist-administered sedation with propofol.

(Table 3). With respect to the post-procedure patient satisfaction surveys, 74/104 (71%) of participants from the EAC and 80/126 (64%) of participants from the AAP group completed the telephone survey (Table 4). There was a trend toward overall higher patient satisfaction with AAP 72/80 (90%) in comparison to EAC 59/74 (80%) ($P = 0.074$). However there were no differences between the two groups with regard to statement 2, "I would strongly recommend this procedure to friends who qualify for it" ["strongly agree": EAC 55/74 (74%) and AAP 61/80 (76%)] and statement 3, "I would be willing to repeat this examination in the future if necessary" ["strongly agree": EAC 64/74 (87%) and AAP 67/80 (84%)] ($P = 0.882$ and 0.667 respectively). When examining pain experienced during procedures and patient satisfaction, the amount of pain experienced was lower with AAP 78/80 (98%) than EAC 64/74 (87%) ($P = 0.02$).

When examining the effect of resident participation on the efficiency of colonoscopy, we found that the mean procedure time was 12.9 ± 4.8 min in the staff endoscopist alone group (SE) and 26 ± 10.2 min in the resident participation (RP) group ($P < 0.001$). Mean total room time was 29.5 ± 9.8 min in the SE group and 44.4 ± 13.7 in the RP group ($P < 0.001$) (Table 5). Using multivariate analysis, the use of AAP was still a predictor of longer total procedure room time ($P = 0.002$).

DISCUSSION

As endoscopy units continue to receive increasing pressures to maximize efficiency, mechanisms to reduce cost of colonoscopy, while increasing overall number of colonoscopies performed annually must be examined. Propofol vs conventional sedation in colonoscopy has been extensively investigated and compared in multiple previous studies^[9]. Common outcomes studied include procedure time, recovery time, discharge time, cecal intubation rate, patient satisfaction, endoscopist satisfaction, level of sedation, pain control and complications. There is little literature comparing AAP to EAC with regard to total procedure room time and overall endoscopy unit efficiency.

This investigation has demonstrated that at a single-centre high-volume endoscopy unit, and after

Table 4 Results of the telephone patient satisfaction survey for endoscopist-administered sedation and anaesthesiologist-administered sedation with propofol groups *n* (%)

	EAC (<i>n</i> = 104)	AAP (<i>n</i> = 126)	<i>P</i> -value
Response rate	74 (71)	80 (64)	0.219
Question 1: I was very satisfied with the care I received			0.074
Agree	15 (20)	8 (10)	
Strongly agree	59 (80)	72 (90)	
Question 2: I would strongly recommend this procedure to friends who qualify for it			0.882
Disagree	1 (1.4)	0 (0.0)	
Not sure	2 (2.7)	6 (7.5)	
Agree	16 (22)	13 (16)	
Strongly agree	55 (74)	61 (76)	
Question 3: I would be willing to repeat this examination again in the future if necessary			0.667
Disagree	0 (0.0)	1 (1.3)	
Not sure	2 (2.7)	0 (0.0)	
Agree	8 (11)	12 (15)	
Strongly agree	64 (87)	67 (84)	
Question 4: I did not experience too much pain/discomfort during the procedure			0.021
Strongly disagree	4 (5.4)	0 (0.0)	
Disagree	5 (6.8)	2 (2.5)	
Not sure	1 (1.4)	0 (0.0)	
Agree	7 (9.5)	6 (7.5)	
Strongly agree	57 (77)	72 (90)	

EAC: Endoscopist-administered conscious sedation; AAP: Anaesthesiologist-administered sedation with propofol.

Table 5 Study endpoints - comparing staff endoscopists only with cases involving resident participation

	Resident involved (<i>n</i> = 66)	Staff endoscopist only (<i>n</i> = 164)	<i>P</i> -value
Total procedure time			< 0.001
Mean ± SD	26.0 ± 10.2	12.9 ± 4.8	< 0.001
Total room time			< 0.001
Mean ± SD	44.4 ± 13.7	29.5 ± 9.8	< 0.001

removal of trainee presence, there was no difference in procedure time with AAP or EAC but there was a significant difference in total procedure room time. There was however a trend toward overall greater patient satisfaction with AAP sedation. This raises important questions requiring further elucidation of how best to maximize patient satisfaction and efficiency in delivery of colonoscopy to the masses.

A previously reported model indicated that practice efficiency gains from rapid recovery agents (*i.e.*, propofol) could offset higher operating costs^[10]. There are multiple steps in the flow of a patient through the endoscopy unit affecting efficiency. Our findings suggest that the time saved in the recovery room with the use of propofol may be offset by increased time within the procedure room, thus not improving overall unit efficiency. Our study between EAC and AAP with respect to total procedure room time demonstrates a difference of 3 min per colonoscopy on average. This has implications when cumulatively added over the course of a full endoscopy day, with the potential for 1 full additional colonoscopy performed per day with EAC compared to AAP sedation (assuming a standard eight hour endoscopy procedure day).

Previous concerns regarding the cost prohibitive

nature of AAP have been raised and addressed in the literature^[11]. The cost of anaesthesia consultation and anaesthesiologist reimbursement for colonoscopy may represent limiting factors in AAP use over EAC. In a questionnaire conducted in the United States addressing 451 gastroenterologist and 460 endoscopy nurses it was demonstrated that 53% of gastroenterologists and 70% of endoscopy nurses preferred AAP to EAC if they were to have screening colonoscopy. When they were asked how much extra they were willing to pay out of pocket to have AAP, 60% and 63% (respectively) were unwilling to pay more than \$200, significantly less than is currently charged to patients in the United States^[12]. The administration of propofol by non-anaesthesiologists has been endorsed by several gastroenterology societies and there is growing evidence to suggest that propofol can be safely administered by a trained gastroenterologist or registered nurse particularly in low-risk patients in a screening setting^[13,14]. However, this is controversial and likely would not suit all endoscopists or endoscopy units. Similarly, the impact of endoscopist-directed propofol sedation on unit efficiency is unknown.

Our study was too small to demonstrate significant differences in safety between AAP and EAC. Korman *et al*^[15] previously outlined some of the implications of propofol sedation for colonoscopy. One such implication indicated that endoscopists are more likely to apply more forces during colonoscope insertion and push through loops and angulated segments as a result of deep sedation^[15]. Whether this can be linked to significant adverse event is unknown. In a retrospective study by Adeyemo *et al*^[16] among patients having a therapeutic colonoscopy, propofol use was independently and significantly associated with an increased perforation

risk, with adjusted odds ratios of 1.32. Additionally, there are implications to trainees learning colonoscopy techniques on patients under propofol sedation given that patient feedback is greatly reduced and thus reduction techniques are different and potentially dangerous^[15]. The significant difference between trainees involved in AAP vs EAC cases in our study is cause for reflection and evaluation of the number of AAP and EAC cases to which our trainees are exposed.

Our study has shown a significant difference in the pain/discomfort experienced during colonoscopy favouring AAP when compared with EAC ($P = 0.021$). However, 86.5% of patients in the EAC group either "agreed" or "strongly agreed" with the telephone survey statement: "I did not experience too much pain/discomfort during the procedure" which correlate with the result of the recent meta-analysis that showed little to no difference in pain scores for patients receiving propofol vs conventional sedation^[7]. Patients were also equally likely to have the procedure repeated which is important for surveillance. One important limitation of the current investigation.

Consistent with previous studies, trainee involvement in colonoscopy (either EAC or AAP) doubles procedure time and significantly increased total procedure room time^[17]. Colonoscopy training is the corner stone of any accredited gastroenterology fellowship program and adequate training is essential to ensure all future endoscopists are competent in conducting colonoscopy independently and delivering the best standard of care to their patients. Given the fixed costs associated with endoscopy units, it will be important to consider the impact of resident training in academic centers if colonoscopy funding changes to a cost per case model. Standard guidelines on teaching techniques may also improve efficiency.

Its worth mentioning that some other factors that could potentially improve overall colonoscopy performance and patient experience - particularly for inexperienced endoscopists - such as cap-assisted colonoscopy, magnetic endoscopic imaging system and anti-spasmodic medication were not investigated in our study^[18,19].

In conclusion, the principal results of this study suggest that AAP sedation is associated with increased total procedure room time relative to EAC. However, no significant difference in procedure time between EAC and AAP groups was observed. Given that the difference in total room time is not manifested in a difference in procedure time itself, it is likely that the additional time comes from either pre-procedure consultation required by the anaesthesiology team or post-procedure management prior to transfer out of the room to the recovery area. Strategies to reduce the need for in-room anaesthesiologist assessment may help improve overall unit efficiency. Future investigations should include overall cost-effectiveness analysis for EAC vs AAP and

direct comparison between AAP and EAC in terms of safety and efficiency.

ACKNOWLEDGMENTS

We would like to thank Larry Stitt (Western University, Department of Epidemiology) for his help with statistical analysis.

COMMENTS

Background

Colorectal cancer is the leading cause of cancer-related death among non-smokers in Canada and the fourth leading cause of cancer-related death worldwide. As the gold standard procedure for treatment and diagnosis of conditions of the colon, colonoscopies are an important screening measure. Additionally, with increased emphasis on colon cancer screening programs among the aging population of many nations, the number of colonoscopies performed globally will continue to increase drastically in the near future.

Research frontiers

A main factor known to increase patient satisfaction and willingness to return for a repeat colonoscopy is the organization of the clinic and its efficiency (*i.e.*, reduced patient anxiety and increased patient satisfaction with colonoscopy is associated with a reduced wait time before procedure). The research hotspot is to pursue a novel measurement of colonoscopy unit efficiency (total procedure room time), which has direct implications for overall unit efficiency, with emphasis on assessing patient satisfaction with different sedation types for colonoscopy, a highly controversial topic in current colonoscopy literature.

Innovations and breakthroughs

Much emphasis in currently focuses on decreasing the length of the colonoscopy procedure as a means to increase unit efficiency. In this study, the authors analyze the differences in total procedure room time between two differing sedation types for colonoscopy. The results demonstrate that currently administration of propofol-based sedation is better tolerated by patients and efforts to improve efficiency must be pursued as this modality is currently significantly slower in terms of total procedure room time than conventional sedation techniques for colonoscopy, which carries implications for responding to the rising demand for colonoscopy globally.

Applications

The results of this study suggest that anaesthesiologist-administered sedation with propofol leads to increased patient satisfaction with colonoscopy. However, this sedation type was found to lead to a significantly increased total procedure room time, without a difference in procedure time, which has important implications for efficiency of colonoscopy units.

Terminology

Throughout this article, the following terms are used frequently: Anaesthesiologist-administered propofol sedation (AAP) and endoscopist-administered conscious sedation (EAC). AAP refers to anaesthesiologist-administered sedation with propofol, whereby deeper sedation occurs with propofol during the colonoscopy procedure under the guidance of a trained anaesthesiologist. EAC refers to endoscopist-administered conscious sedation, a conventional sedation type commonly used for colonoscopies throughout Canada, whereby sedation is administered by the endoscopist (a trained gastroenterologist in the case of this study) in the form of a combination of midazolam and fentanyl, titrated to maximize patient comfort and ensure procedural safety.

Peer-review

Available papers concerning total procedure room time for colonoscopy are highly limited. This study includes important results on a controversial issue about colonoscopy sedation procedures and contributes to the ongoing discussion on the mode and delivery of sedation for colonoscopy.

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P- Reviewer: Koc S, Mark-Christensen A

S- Editor: Ma YJ L- Editor: A E- Editor: Li D





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