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Original Article

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Airway Management for Initial PEG Insertion in the Pediatric Endoscopy Unit: A Retrospective Evaluation of 168 Patients

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ABSTRACT

Purpose: Percutaneous endoscopic gastrostomy (PEG) tube placements are commonly performed pediatric endoscopic procedures. Because of underlying disease, these patients are at increased risk for airway-related complications. This study compares patient characteristics and complications following initial PEG insertion with general endotracheal anesthesia (GETA) vs. anesthesia-directed deep sedation with a natural airway (ADDS).
Methods: All patients 6 months to 18 years undergoing initial PEG insertion within the endoscopy suite were considered for inclusion in this retrospective cohort study. Selection of GETA vs. ADDS was made by the anesthesia attending after discussion with the gastroenterologist.
Results: This study included 168 patients (GETA n=38, ADDS n=130). Cohorts had similar characteristics with respect to sex, race, and weight. Compared to ADDS, GETA patients were younger (1.5 years vs. 2.9 years, p=0.04), had higher rates of severe American Society of Anesthesiologists (ASA) disease severity scores (ASA 4–5) (21% vs. 3%, p<0.001), and higher rates of cardiac comorbidities (39.5% vs. 18.5%, p=0.02). Significant associations were not observed between GETA/ADDS status and airway support, 30-day readmission, fever, or pain medication in unadjusted or adjusted models. GETA patients had significantly increased length of stay (e^{β}=1.55, 95% confidence interval [CI]=1.11–2.18) after adjusting for ASA class, room time, anesthesia time, fever, and cardiac diagnosis. GETA patients also had increased room time (e^{β}=1.20, 95% CI=1.08–1.33) and anesthesia time (e^{β}=1.50, 95% CI=1.30–1.74) in adjusted models.
Conclusion: Study results indicate that younger and higher risk patients are more likely to undergo GETA. Children selected for GETA experienced longer room times, anesthesia times, and hospital length of stay.

Keywords: Pediatrics; Anesthesiology; Gastroenterology; Endoscopy

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INTRODUCTION

Percutaneous endoscopic gastrostomy (PEG) tube placement is one of the most commonly performed endoscopic procedures worldwide [1]. It is favored over both nasogastric intubation and parenteral nutrition for long-term supplementation because it is associated with comparatively lower rates of aspiration, mucosal ulceration, and infection [2,3]. PEG insertions require both endoscopy and sedation, and patients who require them are frequently malnourished with significant comorbidities such as gastroesophageal reflux disease, recurrent aspiration, cardiac disease, and dysphagia, placing them at increased risk for aspiration during the procedure [4-8]. Currently, published guidelines do not make recommendations that address airway management or endotracheal intubation in these patients [9-11].

As an initial step to generate evidence for future guidelines, we compared the demographics and incidence of complications between patients undergoing initial PEG insertion with general endotracheal anesthesia (GETA) and those undergoing initial PEG insertion with anesthesia-directed deep sedation (ADDS) without endotracheal intubation.

MATERIALS AND METHODS

Study design

This retrospective cohort study was approved by the Johns Hopkins All Children's Hospital (JHACH) Institutional Review Board (IRB00154055). Patients meeting inclusion criteria were identified by a retrospective chart review.

Patient selection

All patients aged 6.0 months to 18.0 years who underwent initial PEG insertion within the Special Procedures Unit at JHACH between January 2002 and January 2017 were considered for inclusion in this study. Patients were excluded if they had procedures involving PEG tube exchange or replacement, procedures performed in combination (e.g., tracheostomy and PEG insertion under the same anesthetic), or procedures that were abandoned.

Endoscopy procedure

All PEGs were placed by two experienced pediatric gastroenterology attending physicians in the Special Procedures Unit. One gastroenterologist acted as endoscopist and the other assisted with placing the PEG tube. PEG tubes used included a 14-French MIC (Kimberly-Clark Corporation, Irving, TX) and a 16-French CORFLO (CORPAK MedSystems, Buffalo Grove, IL, USA). All patients received cefazolin 25 mg/kg prophylactically every 8 hours for a total of three doses unless patient allergy dictated a substitution. The first dose was administered within 1 hour before surgical incision.

Administration of anesthesia

GETA or ADDS was administered by an anesthesiology attending or certified registered nurse anesthetist. Choice of GETA vs. ADDS as well as anesthetic agent was made by the anesthesiology attending after patient evaluation and discussion with the gastroenterologist.

All patients received standard American Society of Anesthesiologists (ASA) monitoring (pulse oximeter, noninvasive blood pressure, electrocardiogram, end-tidal CO_2, temperature) throughout the case as well as supplemental oxygenation via endotracheal tube, nasal canula,

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or simple facemask as needed to maintain an oxygenation greater than 92% on pulse oximeter. Maneuvers including jaw thrust, airway suctioning, and mask ventilation were also used as needed to maintain airway patency. However, these maneuvers are not included within the present study due to insufficient documentation within our electronic medical records system.

After PEG insertion was complete, patients were transported to the post-anesthesia care unit for recovery and were admitted to the inpatient hospital service for observation.

Study variables

Patient demographic information collected included age, sex, and race. Clinical variables included weight, ASA class, prematurity, and preoperative cardiac, genetic, neurologic, and oncologic disorders. Procedural variables included room time, procedure time, and anesthesia time. Postoperative clinical outcomes assessed included need for airway support within 30 days (invasive ventilation, noninvasive ventilation, or continuous positive airway pressure [CPAP]), 30-day all-cause readmission, fever greater than 100.4 degrees Fahrenheit within 24 hours, pain medication administered within 8 hours (fentanyl, morphine, hydromorphone), and postoperative length of stay.

Statistical analysis

Study variables were summarized as median and range for continuous variables and counts and percentages for categorical variables. Demographic and clinical differences between patients undergoing GETA and ADDS were compared by Kruskal-Wallis test for numerical variables and Fisher's exact test for categorical variables. Associations of GETA and ADDS status with postoperative outcomes and procedural factors were assessed by using unadjusted and adjusted logistic regression for categorical outcomes and linear regression for continuous outcomes. Covariates with $p<0.15$ in unadjusted analyses were included in adjusted models. Statistical significance was evaluated with 2-tailed tests at alpha=0.05. All analyses were carried out in SAS version 9.4 (SAS Institute, Cary, NC, USA).

RESULTS

This study included 168 patients, of which 38 underwent PEG insertion with GETA and 130 underwent PEG insertion with ADDS. Distribution of demographic and clinical characteristics overall and stratified by GETA/ADDS status are presented in **Table 1**. GETA and ADDS cohorts had similar characteristics with respect to sex (47% female vs. 49% female, $p=0.86$), race (79% Caucasian vs. 78% Caucasian, $p=1.00$), and weight (11.2 kg vs. 11.9 kg, $p=0.42$). Compared to patients who received ADDS, patients undergoing GETA were younger (1.5 years vs. 2.9 years, $p=0.04$), had higher rates of severe ASA physical status scores (ASA 4–5; 21% vs. 3%, $p<0.001$), and higher rates of cardiac comorbidities (39.5% vs. 18.5%, $p=0.02$).

Table 2 presents the distribution of postoperative outcomes and procedural variables overall and stratified by GETA/ADDS status. When compared with percentages in the ADDS cohort, the GETA cohort had higher percentages of patients who required postoperative airway support (7.9% vs. 2.3%), pain medication (92% vs. 88%), and 30-day readmission (18.4% vs. 14.6%), but it had a lower percentage of patients with postoperative fever (24% vs. 39%). Postoperative length of stay was longer in the GETA group (median=5.5 days, range=1–58 days) than in the ADDS group (median=2 days, range=0–140 days). Median room time and anesthesia time were also longer in the GETA group than in the ADDS group.

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Table 1. Demographic and clinical characteristics

Variable	Total (n=168)	GETA (n=38)	ADDS (n=130)	*p*-value*
Age at surger, (yr)	2.5 (0.6–17.7)	1.5 (0.6–14.9)	2.9 (0.6–17.7)	0.04
Sex				0.86
Male	82 (48.8)	18 (47.4)	64 (49.2)	
Female	86 (51.2)	20 (52.6)	66 (50.8)	
Race				1.00
Black	33 (19.6)	7 (18.4)	26 (20.0)	
White	131 (78.0)	30 (79.0)	101 (77.7)	
Other	4 (2.4)	1 (2.6)	3 (2.3)	
Weight (kg)	11.8 (2.3–68.0)	11.2 (3.5–34.5)	11.9 (2.3–68.0)	0.42
ASA physical status				<0.01
1–3	156 (92.9)	30 (78.9)	126 (96.9)	
4–5	12 (7.1)	8 (21.1)	4 (3.1)	
Cardiac diagnosis	39 (23.2)	15 (39.5)	24 (18.5)	0.02
Genetic diagnosis	59 (35.1)	14 (36.8)	45 (34.6)	0.85
Neurologic diagnosis	139 (82.7)	35 (92.1)	104 (80.0)	0.09
Oncologic diagnosis	5 (3.0)	2 (5.3)	3 (2.3)	0.32
Prematurity	1 (0.6)	1 (2.6)	0 (0.0)	0.23

Values are presented as median (range) or number (%).
GETA: general endotracheal anesthesia, ADDS: anesthesia-directed deep sedation.
*The nonparametric *p*-value is calculated by the Kruskal-Wallis test for numerical covariates and Fisher's exact test for categorical covariates. Bold font indicates statistical significance.

Table 2. Outcomes and procedural variables

Variable	Total (n=168)	GETA (n=38)	ADDS (n=130)	*p*-value*
Outcomes				
Airway support†	6 (3.6)	3 (7.9)	3 (2.3)	0.13
30-day readmission	26 (15.5)	7 (18.4)	19 (14.6)	0.61
Fever (24 hr postop)	60 (35.7)	9 (23.7)	51 (39.2)	0.09
Pain medication (8 hr postop)	149 (88.7)	35 (92.1)	114 (87.9)	0.57
Length of stay (d)	2 (0–140)	5.5 (1–58)	2 (0–140)	<0.01
Procedural variables (min)				
Room time	21 (12–73)	27 (16–49)	20 (12–73)	<0.01
Procedure time	6 (2–66)	6 (3–23)	6 (2–66)	0.24
Anesthesia time	27 (16–197)	39 (20–197)	27 (16–166)	<0.01

Values are presented as number (%) or median (range).
GETA: general endotracheal anesthesia, ADDS: anesthesia-directed deep sedation.
*The nonparametric *p*-value is calculated by the Kruskal-Wallis test for numerical covariates and Fisher's exact test for categorical covariates. Bold font indicates statistical significance. †Includes invasive ventilation, noninvasive ventilation, and continuous positive airway pressure within 30 days postoperatively.

Table 3 presents the unadjusted and adjusted association results for the postoperative outcomes. We found no statistically significant associations between GETA and ADDS cohorts regarding airway support, 30-day readmission, fever, and pain medication in unadjusted or adjusted models. GETA patients, however, had significantly longer length of stay than did ADDS patients (e^{β}=1.55, 95% CI=1.11–2.18, which represents an approximately 55% increase in the geometric mean) after adjusting for ASA class, room time, anesthesia time, fever, and cardiac diagnosis. GETA patients also had longer room time (e^{β}=1.20, 95% CI=1.08–1.33) and anesthesia time (e^{β}=1.50, 95% CI=1.30–1.74) in adjusted models (**Table 4**).

DISCUSSION

PEG is the preferred enteral feeding modality for patients with a functioning gastrointestinal system who require gastric decompression or long-term supplemental nutrition [1]. Though PEG insertions are generally regarded as safe and well-tolerated, known complications include aspiration, esophageal and gastric rupture, PEG tube migration, buried bumper syndrome,

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Table 3. Unadjusted and adjusted associations for clinical outcomes comparing GETA to ADDS

Outcomes	Unadjusted		Adjusted	
	Estimate (95% CI)	*p*-value	Estimate (95% CI)	*p*-value
Categorical*				
Airway support†	3.59 (0.77–16.76)	0.10	1.68 (0.34–8.24)§	0.52
30-day readmission	1.36 (0.53–3.49)	0.52	0.55 (0.15–1.94)‖	0.35
Fever	0.50 (0.22–1.13)	0.10	0.51 (0.22–1.24)¶	0.14
Pain medication	1.46 (0.43–4.99)	0.54	1.43 (0.42–4.89)**	0.57
Continuous‡				
Length of stay	2.35 (1.71–3.23)	<0.01	1.55 (1.11–2.18)††	0.01

GETA: general endotracheal anesthesia, ADDS: anesthesia-directed deep sedation, CI: confidence interval. *Categorical outcomes are given as odds ratio (95% CI) comparing GETA to ADDS group (reference). †Includes invasive ventilation, noninvasive ventilation, and continuous positive airway pressure within 30 days postoperatively. ‡Continuous outcomes are given as exponentiated coefficient (e^{β}) (95% CI) for GETA/ADDS status from linear regression model. §Adjusted for age, race, anesthesia time, and cardiac diagnosis. ‖Adjusted for sex, American Association of Anesthesiologists (ASA) physical status, anesthesia time, and genetic diagnosis. ¶Adjusted for age, room time, and genetic diagnosis. **Adjusted for age. ‡Continuous outcomes are given as exponentiated coefficient (e^{β}) (95% CI) for GETA/ADDS status from linear regression model. ††Adjusted for ASA class, room time, anesthesia time, fever, and cardiac diagnosis.

Table 4. Unadjusted and adjusted associations for procedural variables comparing GETA to ADDS

Procedural variables	Unadjusted		Adjusted	
	e^{β} (95% CI)*	*p*-value	e^{β} (95% CI)*	*p*-value
Room time	1.29 (1.15–1.44)	<0.01	1.20 (1.08–1.33)†	<0.01
Procedure time	1.11 (0.92–1.33)	0.27	1.07 (0.89–1.29)‡	0.49
Anesthesia time	1.53 (1.31–1.78)	<0.01	1.50 (1.30–1.74)§	<0.01

GETA: general endotracheal anesthesia, ADDS: anesthesia-directed deep sedation, CI: confidence interval. *Exponentiated coefficient (95% CI) for GETA/ADDS status from linear regression model. †Adjusted for sex, race, procedure time, and anesthesia time. ‡Adjusted for race, anesthesia time, and cardiac and neurologic diagnosis. §Adjusted for sex, race, procedure time, and genetic diagnosis.

localized cutaneous irritation, inflammation and infection, deep tissue infection, and sepsis [4-8]. Sedation for the procedure may be associated with additional risk. Therefore, careful evaluation and discussion are needed before proceeding with GETA or ADDS.

Endoscopy outside of the operating room and administration of deep sedation by non-anesthesiologists are increasingly common trends in PEG insertion and related endoscopic procedures [12-15]. Furthermore, airway management within the endoscopy suite is highly variable [16]. Unsurprisingly, complications secondary to airway management challenges are responsible for most cases of cardiopulmonary arrest as well as 30% of perioperative deaths during deep sedation in remote locations [16-18]. Most complications are due to failure to rescue an airway or inability to identify risk factors for aspiration or difficult airways [16]. Trained providers can prevent many airway-related complications with appropriate preoperative assessment and planning and by closely monitoring the patient intraoperatively to quickly identify inadequate oxygenation, ventilation, and airway management [19].

Given the prevalence and severity of airway-related compilations in the endoscopy suite, the choice between GETA and ADDS may have profound implications. However, clinical evidence surrounding the use of GETA and ADDS is currently lacking. Several studies have evaluated the use of ADDS in special populations such as the elderly and patients undergoing endoscopic retrograde cholangio-pancreatography (ERCP) [18,20]. A 2013 study conducted by Barnett et al. [21]. evaluated 393 adult patients undergoing ERCP with either GETA or ADDS in which the decision to intubate was made on a case-by-case basis by anesthesia staff. Study results indicated that most cases proceeded with ADDS without endotracheal intubation, but patients who underwent general anesthesia with endotracheal intubation had significantly higher average body mass indexes and ASA physical status scores when

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compared to non-intubated patients. A 2005 study of airway management during pediatric endoscopy (esophagogastroduodenoscopy, colonoscopy, or both) evaluated the frequency of airway maneuvers and patient complications after either GETA or ADDS [22]. The authors concluded that children undergoing ADDS were more likely than children undergoing GETA to experience complications secondary to respiratory status change, including desaturation <70% and laryngospasm. ADDS children also received "frequent and prolonged" active airway management with maneuvers such as jaw thrust. As in the report by Barnett et al. [21], surveyed anesthesiologists in this study cited extremes of age and body mass index as grounds for intubation, as well as history of reflux and recent vomiting.

Although these studies investigated airway management in the endoscopy unit, neither incorporated patients undergoing PEG insertion, which merits additional consideration. PEGs are typically provided to patients with severe comorbidities who are at increased risk for intra-procedural aspiration from coexisting dysphagia or gastroesophageal reflux disease, or who have a preoperative history of aspiration. To our knowledge, this is the first study to compare GETA to ADDS in children undergoing initial PEG insertion.

Results of our investigation indicate that the cohorts were similar in race and sex composition, but patients selected for GETA were more likely to be younger, have higher ASA physical status scores, and have preexisting cardiac comorbidities. Each of these findings suggests that the anesthesia care provider was more likely to use GETA over ADDS in patients who were considered higher risk for anesthesia-related complications.

GETA patients were also more likely to require postoperative airway interventions such as CPAP, bilevel positive airway pressure, or re-intubation and had longer postoperative lengths of stay. These findings may seem surprising in the context of a protected intraprocedural airway. However, it is likely that the higher clinical risk of patients within this cohort may contribute both to the anesthesia provider's selection of GETA over ADDS and to the patient's postoperative course. Intubated patients also experienced longer anesthesia times and room times, which may reflect the time needed to safely intubate and extubate the trachea. Duration of the PEG insertion procedure was similar in the two cohorts.

Interestingly, patients receiving ADDS experienced a higher rate of postoperative fever, which was defined as a body temperature exceeding 100.4° Fahrenheit within 24 hours of PEG insertion. This may be a surrogate finding for procedural complications including aspiration, atelectasis, or pneumonia. However, patients in this study were treated symptomatically, and it is difficult to definitively determine the underlying cause of the patient's fever. Confirmatory postoperative chest x-rays are not usually ordered to assess children, owing to concern for radiation exposure, and in the fast-paced environment of the endoscopy suite, charting of events such as aspiration may be incomplete or omitted.

Patients who received GETA were re-admitted to the hospital within 30 days of PEG insertion more frequently than were those who received ADDS. However, after adjusting for ASA physical status classification, genetic comorbidities, sex, and anesthesia time, significant differences were not observed. This finding highlights the importance of recognizing high-risk patients preoperatively and carefully selecting them for ADDS or GETA. Given the increasing prevalence of sedation and anesthesia outside of the operating room, additional investigation is warranted to ensure that this patient population continues to receive safe and high-quality healthcare.

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Some limitations should be considered when interpreting our data. Because this was a retrospective cohort study, patients were not randomly assigned to GETA or ADDS. Instead, the type of airway was determined on a case-by-case basis following a discussion between the gastroenterologist and anesthesiologist and results are therefore subject to variation by attending. Although we used multivariate modelling, unmeasured confounders and disease severity may explain the results. The difference in cohort size between the two groups may also be consider a weakness for measuring statistically significant associations. Finally, data from PEG insertions performed between January 2002 and January 2017 were included in this analysis and both surgical and anesthetic technique may have evolved over time.

In conclusion, to our knowledge, this is the first study to compare GETA to ADDS during initial PEG insertion. With 168 enrolled patients, this is also the largest known study to evaluate airway management in pediatric endoscopy. Our results indicate that younger and higher-risk patients are more likely to undergo endotracheal intubation. Despite having their airway secured with an endotracheal tube during the procedure, children selected for intubation continued to experience higher rates of postoperative airway interventions such as CPAP and longer hospital length of stay. These findings may, in part, reflect greater severity of underlying disease process, and future studies that control for disease severity are warranted.

Room time and anesthesia time, but not procedure time, were also slightly longer in the GETA cohort than in the ADDS cohort, a finding that may have important implications for cost. Reduced anesthesia exposure also has long-term patient safety considerations in pediatric patients. However, cost and effects related anesthesia exposure are not directly addressed by this study. Our results highlight the importance of careful patient evaluation before selecting GETA or ADDS for initial PEG insertion in children.

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REFERENCES

1. Rahnemai-Azar AA, Rahnemaiazar AA, Naghshizadian R, Kurtz A, Farkas DT. Percutaneous endoscopic gastrostomy: indications, technique, complications and management. World J Gastroenterol 2014;20:7739-51.
PUBMED | CROSSREF
2. Qureshi AZ, Jenkins RM, Thornhill TH. Percutaneous endoscopic gastrostomy versus nasogastric tube feeding during neurorehabilitation. Ifs, ands, or buts. Neurosciences (Riyadh) 2016;21:69-71.
PUBMED | CROSSREF
3. Seres DS, Valcarcel M, Guillaume A. Advantages of enteral nutrition over parenteral nutrition. Therap Adv Gastroenterol 2013;6:157-67.
PUBMED | CROSSREF
4. Peck J, Mills K, Dey A, Nguyen ATH, Amankwah EK, Wilsey A, et al. Comparison of tolerance and complication rates between early and delayed feeding after percutaneous endoscopic gastrostomy placement in children. J Pediatr Gastroenterol Nutr 2020;70:55-8.
PUBMED | CROSSREF

5. Khalaf RT, Green D, Amankwah EK, Peck J, Carr V, Goldenberg NA, et al. Percutaneous endoscopic gastrostomy tubes may be associated with preservation of lung function in patients with cystic fibrosis. Nutr Clin Pract 2019;34:290-6.
PUBMED | CROSSREF
6. Driver K, Schilling R, Goodwin A, Martinez D, Amankwah E, Shakeel F, et al. Safety and efficacy of bedside percutaneous endoscopic gastrostomy placement in the neonatal intensive care unit. J Pediatr Gastroenterol Nutr 2018;67:40-4.
PUBMED | CROSSREF
7. Mills K, Odiaga J, Karjoo S, McClenathan D, Wilsey M. Quality improvement initiative: the administration of early nutrition following percutaneous endoscopic gastrostomy tube placement in children. Gastroenterol Nurs 2020;43:E5-8.
PUBMED
8. Sochet AA, Grindy AK, Son S, Barrie EK, Hickok RL, Nakagawa TA, et al. Percutaneous endoscopic gastrostomy after cardiothoracic surgery in children less than 2 months old: an assessment of long-term malnutrition status and gastrostomy outcomes. Pediatr Crit Care Med 2020;21:50-8.
PUBMED | CROSSREF
9. Romano C, van Wynckel M, Hulst J, Broekaert I, Bronsky J, Dall'Oglio L, et al. European Society for Paediatric Gastroenterology, Hepatology and Nutrition guidelines for the evaluation and treatment of gastrointestinal and nutritional complications in children with neurological impairment. J Pediatr Gastroenterol Nutr 2017;65:242-64.
PUBMED | CROSSREF
10. Krishnan U, Mousa H, Dall'Oglio L, Homaira N, Rosen R, Faure C, et al. ESPGHAN-NASPGHAN Guidelines for the evaluation and treatment of gastrointestinal and nutritional complications in children with esophageal atresia-tracheoesophageal fistula. J Pediatr Gastroenterol Nutr 2016;63:550-70.
PUBMED | CROSSREF
11. Thomson M, Tringali A, Dumonceau JM, Tavares M, Tabbers MM, Furlano R, et al. Paediatric gastrointestinal endoscopy: European Society for Paediatric Gastroenterology Hepatology and Nutrition and European Society of Gastrointestinal Endoscopy Guidelines. J Pediatr Gastroenterol Nutr 2017;64:133-53.
PUBMED | CROSSREF
12. Moon SH. Sedation regimens for gastrointestinal endoscopy. Clin Endosc 2014;47:135-40.
PUBMED | CROSSREF
13. Yamaguchi D, Yamaguchi N, Takeuchi Y, Yukimoto T, Ikeda K, Matsumoto K, et al. Comparison of sedation between the endoscopy room and operation room during endoscopic submucosal dissection for neoplasms in the upper gastrointestinal tract. BMC Gastroenterol 2017;17:127.
PUBMED | CROSSREF
14. Lin OS, Weigel W. Nonoperating room anesthesia for gastrointestinal endoscopic procedures. Curr Opin Anaesthesiol 2018;31:486-91.
PUBMED | CROSSREF
15. Sharp CD, Tayler E, Ginsberg GG. Anesthesia for routine and advanced upper gastrointestinal endoscopic procedures. Anesthesiol Clin 2017;35:669-77.
PUBMED | CROSSREF
16. Goudra B, Singh PM. Airway management during upper GI endoscopic procedures: state of the art review. Dig Dis Sci 2017;62:45-53.
PUBMED | CROSSREF
17. Goudra B, Singh PM. ERCP: the unresolved question of endotracheal intubation. Dig Dis Sci 2014;59:513-9.
PUBMED | CROSSREF
18. Amornyotin S. Sedation-related complications in gastrointestinal endoscopy. World J Gastrointest Endosc 2013;5:527-33.
PUBMED | CROSSREF
19. Amornyotin S, Leelakusolvong S, Chalayonnawin W, Kongphlay S. Age-dependent safety analysis of propofol-based deep sedation for ERCP and EUS procedures at an endoscopy training center in a developing country. Clin Exp Gastroenterol 2012;5:123-8.
PUBMED | CROSSREF
20. Amornyotin S, Chalayonnavin W, Kongphlay S. Propofol-based sedation does not increase rate of complication during percutaneous endoscopic gastrostomy procedure. Gastroenterol Res Pract 2011;2011:134819.
PUBMED | CROSSREF

21. Barnett SR, Berzin T, Sanaka S, Pleskow D, Sawhney M, Chuttani R. Deep sedation without intubation for ERCP is appropriate in healthier, non-obese patients. Dig Dis Sci 2013;58:3287-92.
PUBMED | CROSSREF

22. Lightdale J, Zgleszewski S, Newburg A, Heard L, Fox V. Airway management during total intravenous sedation with propofol in a pediatric endoscopy unit. Gastrointest Endosc 2005;61:PAB307.
CROSSREF