Nurse-Administered Propofol Sedation: Feasibility and Safety in Bronchoscopy

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Key Words

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Abstract

Background: Propofol is a fast-acting intravenous sedative that has advantages as a procedural sedative over traditional regimens. It has been shown to have a similar safety profile to traditional sedating medications in the setting of gastroenterologic endoscopy. Nurse-administered propofol sedation is given by a specially-trained nurse, without anesthesiologist involvement. **Objectives:** We have used nurse-administered propofol sedation in our bronchoscopy suite for several years. In this report, we summarize our experience with nurse-administered propofol sedation, and demonstrate it to be feasible and safe for bronchoscopic procedures. **Methods:** Procedure reports and nursing notes for 588 bronchoscopic procedures performed between July 2006 and June 2008 were retrospectively reviewed. Patient demographics, procedure type and indication, procedure time, medication doses, and adverse events were noted and analyzed. **Results:** Nurse-administered propofol sedation was used in 498/588 (85%) procedures. Patients utilizing nurse-administered propofol sedation had an average age of 53 years (range 18–86) with an average weight of 80 kg. 56% of the patients were male, and 57% of the procedures were performed on outpatients. Average procedure dura-

tion was 25 min (range 3–123). The average propofol dose was 3.13 mg/kg (range 0.12–20 mg/kg). Adverse events attributable to sedation were noted in 33 (6.6%) procedures. Of the 14 (2.8%) major adverse events (death, need for intubation, ICU stay, or hospitalization), only 6 (1.2%) were potentially attributable to the sedation regimen. There were 2 deaths, neither of which was related to sedation. **Conclusions:** Nurse-administered propofol sedation is a feasible and safe sedation method for bronchoscopic procedures.

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Introduction

Several studies have demonstrated increased patient satisfaction with flexible bronchoscopy when sedating medications are used to facilitate patient comfort [1–3]. The British Thoracic Society has recommended that: ‘Sedation should be offered to patients where there is no contraindication’ [4]. Traditionally, benzodiazepines and narcotics, or some combination thereof, have been used to achieve moderate sedation [5, 6]. However, the use of these medications can be complicated by prolonged sedation, respiratory compromise, and the need for antagonist use, which may have undesirable side effects in and of themselves. In addition, there is a potential for drug interactions, especially with the use of benzodiazepines.

Propofol is a short-acting intravenous sedative/hypnotic agent that has a rapid onset of action. Published literature regarding its use in bronchoscopy is limited. In 1993, it was shown to have similar efficacy to midazolam, with more rapid recovery [7]. Recently it has been the focus of multiple studies as a sedative agent for gastrointestinal endoscopic procedures, and has been found to be safe and effective [8–10]. The advantages of faster onset of action and recovery times have also been demonstrated, and it had a more favorable patient satisfaction profile than traditional sedation techniques [11, 12].

Nurse-administered propofol sedation (NAPS) is the administration of propofol by non-anesthesia personnel, with the goal of moderate sedation. This technique has been studied widely in gastrointestinal endoscopy, and has been shown to be safe and effective in multiple settings [8, 13–15].

The use of NAPS for flexible fiberoptic bronchoscopy has not yet been reported. Based on ample positive experience with NAPS in our gastroenterology unit [8, 13–15], NAPS has been utilized extensively in our bronchoscopy suite since 2004. It is the purpose of this study to retrospectively describe the utility and safety of NAPS for bronchoscopic procedures at our institution.

Methods

This study was approved by the institutional review board at Indiana University Purdue University Indianapolis/Clarian Health Partners. All patients signed informed consent for the procedures. Patients who underwent any procedures in our bronchoscopy suite from July 2006 to June 2008 were identified and their charts were retrospectively reviewed. This specific time period was chosen because in July 2006, computerized procedure reports began to be utilized exclusively at our institution; this allowed for consistent and dependable data collection. Procedure reports, nursing sedation flow sheets and nursing notes were reviewed, and the following data were collected: patient age, sex, weight, procedure indication, procedure performed, procedure duration (time from scope insertion to scope removal), inpatient versus outpatient status, propofol dose, dose of any other sedatives used, route of insertion of bronchoscope, adverse events, and rescue procedures required. Physicians performing the procedure classified the patient as either low (ASA I–II), medium (ASA III), or high risk (ASA IV–V) for the procedure based upon disease and co-morbidities. Adverse events were defined as the peri-procedural cardiorespiratory complications recorded by the sedation nurse per protocol. These include hypoxia (oxygen saturation <90%), use of supplemental oxygen by nasal cannula in excess of 4 l/min, need for positive pressure ventilation, endotracheal intubation, and hypotension (systolic blood pressure <90 mm Hg).

Adverse events were classified as major or minor, depending upon interventions required. Major complications were those that resulted in death, unplanned endotracheal intubation (even

if temporary) or post-procedure extubation failure, admission to the hospital, or upgraded admission status (i.e. transfer from a ward bed to an ICU or intermediate care bed). Patients who were electively intubated prior to a procedure were not counted as an adverse event, unless they were unable to be extubated. Those patients who were intubated out of necessity during the procedure were counted as adverse events. Adverse events were further categorized as either related or unrelated to procedural sedation. Any adverse events that could have been secondary to propofol were classified as such, as determined by adverse reactions in the package insert and previously published data.

NAPS Protocol

The use of NAPS for endoscopic procedures was approved by the sedation committee at our institution, which included anesthesiology input. Propofol was administered by nurses who had completed a propofol administration training protocol, which required the nurse to be trained in Advanced Cardiac Life Support and sedation techniques. The training protocol included watching a video regarding propofol administration, didactic reading, and successful completion of a written examination regarding moderate sedation. This protocol educated the nurse on the pharmacokinetics of propofol, and bedside evaluation of depth of sedation and timing of drug administration. The nurse was then proctored while administering propofol for at least 15 cases by an experienced NAPS nurse, until proficiency with administration was demonstrated.

Our institutional NAPS protocol dictates the following procedures. Oxygen is administered via nasal cannula at a rate of 4 l/min. The NAPS nurse is responsible only for propofol administration and patient monitoring. Sedation is initiated with a small dose of midazolam (1–2 mg intravenously) and fentanyl (25–50 µg intravenously). Propofol is then given as a 20–40-mg intravenous bolus, followed by 10–20 mg intravenously every minute to maintain adequate sedation. The NAPS nurse is responsible for the timing and dose of propofol administration, and works closely with the procedural physician to titrate the level of sedation depending on the procedures performed and the length of the procedure. The procedural physician is able to help guide the procedural nurse in regards to the level of sedation; however, most experienced NAPS nurses have demonstrated significant proficiency at titrating the level of sedation, and the role of the bronchoscopist in this regard is generally quite limited. The decision to use NAPS for a particular procedure is based upon the discretion of the attending physician and the availability of a NAPS-qualified nurse at the time of the procedure. Additional dosing with midazolam or fentanyl or other sedating medications is at the discretion of the attending physician.

Results

Patient Data

588 bronchoscopic procedures that took place from July 2006–June 2008 in our bronchoscopy suite were reviewed (procedures performed outside of the bronchoscopy suite were excluded). 498 (85%) utilized NAPS for sedation. The data analyzed and presented are for these

Table 1. Indication for procedure

Indication	n (%)
Pulmonary infiltrates	112 (22)
Lung mass	73 (15)
Research	63 (13)
Lymphadenopathy	53 (11)
Pneumonia	49 (10)
Cancer	36 (7)
Hemoptysis	35 (7)
Atelectasis	17 (3)
Cough	11 (2)
Tracheomalacia/stenosis	9 (2)
Interstitial lung disease	8 (2)
Bronchiectasis	7 (1)
Surveillance	7 (1)
Broncholith	5 (1)
Tracheoesophageal fistula	5 (1)
Cavitary lesion	3 (<1)
Tracheal papillomatosis	3 (<1)
Foreign body	2 (<1)

498 procedures unless otherwise noted. Average patient age was 53 years (range 18–86), and average weight was 80 kg (range 41–173). 56% of patients were male, and 57% of procedures were performed on an outpatient basis. 84% of patients were ASA class I or II, 16% were class III, and <1% were class IV or V. Research bronchoscopies, which were performed on HIV-positive patients and healthy volunteers, comprised 13% of NAPS patients. Primary procedure indications were varied, and are noted in table 1.

Procedure Data

The procedures performed are outlined in table 2. Most patients (65%) underwent a single procedure, and 35% of patients underwent 2–4 procedures during a single bronchoscopy. Route of bronchoscope insertion was usually oral or nasal (91%), although some patients were electively intubated prior to the procedure for anticipated difficult procedures or for safety concerns (8%). The average procedural duration was 25 min. Procedures performed under elective intubation were generally done so to secure the airway in the event of bleeding (such as during endobronchial tumor biopsy), and the elective nature of the intubation was noted in the procedure note.

Propofol dosing is also listed in table 2. Average propofol dose was 242 mg. Adjusted for weight, the average dose was 3.13 mg/kg. Because of the variation in the amount of time of each procedure, and accepting that

Table 2. Procedure data

	n (%)
Procedure	
Bronchoalveolar lavage	269 (54)
Transbronchial forceps biopsy	86 (17)
Inspection only	68 (14)
Transbronchial needle aspiration	65 (13)
Endobronchial ultrasound	60 (12)
Endobronchial forceps/needle biopsy	27 (5)
Argon plasma coagulation	22 (4)
Cryo-ablation	22 (4)
Secretion removal	15 (3)
Autofluorescence	11 (2)
Intrabronchial valve removal	4 (<1)
Brachytherapy	3 (<1)
Foreign body removal	3 (<1)
Brush	3 (<1)
Photodynamic therapy	1 (<1)
Number of procedures per sedation	
1	323 (65)
2	157 (32)
3	16 (3)
4	2 (<1)
Route	
Oral	298 (60)
Nasal	155 (31)
Intubation	39 (8)
Tracheostomy	3 (<1)
Tracheal stoma	3 (<1)
Average procedure time (range)	25 min (3–123)
Propofol dose, average (range)	
Total dose	242 mg (10–1,320)
Dose/weight	3.1 mg/kg (0.1–20)
Dose/weight/procedure time	0.15 mg/kg/min (0.01–1.21)

longer procedures would require larger doses of propofol, we calculated the average dose per kg/min of the procedure; the average was 0.15 mg/kg/min. Average doses of midazolam and fentanyl were 1.9 mg and 61 µg, respectively. Other sedating medications used at attending physician discretion included promethazine in 11 patients (2.2%), diphenhydramine in 1 patient (<1%) and meperidine in 1 patient (<1%).

Adverse Events

Adverse events occurred in 11.8% of all NAPS procedures, with major adverse events occurring in 2.8%. Major adverse events included pulmonary hemorrhage (1.2%), hypoxia/respiratory failure (0.8%), bronchospasm (0.2%), airway obstruction by tumor (0.2%), stridor (0.2%) and pneumothorax (0.2%). The details of these adverse

Table 3. Adverse events data – NAPS procedures (498 procedures in total)

	n (%)	Due to sedation, n (%)	Outcome/required interventions
Total adverse events	59 (11.8)	32 (6.4)	
Minor	45 (9)	26 (5.2)	
Hypoxemia	19 (3.8)	19 (3.8)	
Hemorrhage	15 (3.0)	0	
Hypotension	5 (1)	5 (1)	
Vomiting	2 (0.4)	0	
Wheezing	1 (0.2)	1 (0.2)	
Epistaxis	1 (0.2)	0	
Combativeness	1 (0.2)	0	
Cough	1 (0.2)	1 (0.2)	
Major	14 (2.8)	6 (1.2)	
Hemorrhage	6 (1.2)	0	1 death; 4 required intubation and ICU admission; 1 required admission for observation
Airway obstruction by tumor	1 (0.2)	0	death
Pneumothorax	1 (0.2)	0	chest tube, admission
Bronchospasm	1 (0.2)	1 (0.2)	admission
Hypoxia/respiratory failure	4 (0.8)	4 (0.8)	2 required intubation/ICU admission; 1 required periprocedural intubation, extubated post-procedure; 1 required admission for observation
Stridor	1 (0.2)	1 (0.2)	admission for observation

events are described in table 3. Of the major adverse events, 6 (1.2% of all patients) were classified as likely related to sedation. These were bronchospasm, hypoxia/respiratory failure and stridor. Major adverse events included deaths, neither of which was related to procedural sedation. One resulted from massive pulmonary hemorrhage, and the other was due to tumor obstructing the trachea secondary to manipulation.

Minor adverse events included transient hypoxemia responding to an increase in FiO₂ (4.0%), minor bleeding (2.8%), transient hypotension responding to intravenous fluid boluses (1.0%), vomiting (0.4%), wheezing (0.2%), epistaxis (0.2%), combativeness (0.2%) and coughing (0.2%). Of these, hypotension, transient hypoxemia, wheezing, and cough were classified as possibly being related to propofol (5.4%).

As a rough historical control, adverse event data was also analyzed for those procedures for which NAPS was not utilized. These data are presented in table 4 and include 90 procedures. The overall adverse event rate was 10.0%. Major adverse events for these procedures occurred in 2.2% of procedures. Of the major adverse events among those receiving traditional sedation, both (2.2%) were respiratory failure requiring unplanned endotracheal intubation and were classified as being due to sedation.

Discussion

Propofol has been used for induction of anesthesia and sedation since the early 1980s, and has been shown to be safe and effective. Cardiac and respiratory adverse events are commonly reported, and most are minor and self-limiting. As reported by the Lexi-Comp drug manual, common adverse reactions include hypotension (17%), local injection site discomfort (18%) and apnea (12–24%) [16]. In our series, the incidence of these adverse reactions was significantly lower. Local injection site discomfort may have been ameliorated by our use of small doses of fentanyl and midazolam prior to administration of propofol. Our initial bolus dose was generally less than 0.5 mg/kg, which is significantly less than that commonly used for anesthesia induction (which is usually a 2-mg/kg bolus). This may have accounted for the reduced incidence of apnea and hypotension seen in our cohort.

The use of propofol as sedation for bronchoscopic procedures has been demonstrated to be safe and effective for the experienced bronchoscopist. Early studies demonstrated propofol to provide comparable safety and efficacy profiles to midazolam for bronchoscopic sedation, with propofol demonstrating significantly improved recovery times [7, 17]. More recently, the administration of propofol versus midazolam utilizing electroencephalo-

Table 4. Adverse events for non-NAPS procedures (90 procedures in total)

	n (%)	Due to sedation, n (%)	Outcome/required interventions
Total adverse events	9 (10)	5 (5.6)	
Minor	7 (7.7)	3 (3.3)	
Hypoxemia	3 (3.3)	3 (3.3)	
Hemorrhage	3 (3.3)	0	
Hypertension	1 (1.1)	0	
Major	2 (2.2)	2 (2.2)	
Hypoxemia/respiratory failure	2 (2.2)	2 (2.2)	1 required intubation/ICU admission; 1 required periprocedural intubation, was extubated post-procedure

graphic bispectral index monitoring was evaluated [18]. This study demonstrated once again the similar safety profile of propofol to midazolam and its improved recovery times, and also showed improved patient satisfaction scores for the propofol group. Another recent comparative trial demonstrated propofol to have the same incidence and severity of oxygen desaturation and procedural complications as a combination of hydrocodone and midazolam [19]. These studies highlight propofol's safety profile for bronchoscopy; none, however, utilized a nurse administered protocol.

The use of nurse administered propofol sedation was first reported in the gastroenterology literature in 2002 [8]. Since that time, the interest in the use of NAPS for endoscopic procedures has grown significantly. A Pubmed search for 'nurse-administered propofol sedation' before 2002 yielded zero results; since that time, this search yields 25 papers. However, there is very little literature regarding the use of propofol for bronchoscopic procedures. In fact, in a 2007 review of sedation for bronchoscopy, it was noted that: 'There is less experience with this drug in the outpatient setting' [20]. Currently, no literature exists regarding the use of NAPS for bronchoscopy.

The reported incidence of complications with flexible bronchoscopy is varied, and very little data regarding adverse events from procedural sedation exists. In 1978, Dreisin et al. [21] reported an 11% total complication rate, with 5% major complications in 205 prospectively studied flexible bronchoscopies. Sedation data was not rigorously reported in this study. Also in 1978, Pereira et al. [22] prospectively reported major adverse events in 1.7% of bronchoscopic procedures. However, it was not noted what type of sedation, if any, was used in this patient population. In 1995, a retrospective study by Pue and Pacht [23], which utilized midazolam for sedation, demonstrat-

ed major adverse events in 0.5% of flexible bronchoscopies. More recently, a retrospective review of over 23,000 flexible bronchoscopies at a single institution in China demonstrated a severe complication rate of 0.64% [24]. However, these procedures were performed under local anesthesia only; no sedation was utilized.

The literature regarding adverse events related to NAPS use with GI endoscopy is extensive. In 2002, Rex et al. [8] published a series of 2,000 consecutive endoscopic cases that had utilized NAPS. They demonstrated no hypotensive episodes and only 5 cases of desaturation below 85%. In 2003, Walker et al. [13] demonstrated respiratory compromise in 7/9,152 cases; none required intubation.

Our noted incidence of major adverse events in those receiving NAPS was 2.8%, which is comparable to the rates of complication in the bronchoscopic studies noted above. Additionally, during the study time period, there were 90 procedures that utilized traditional sedation, which consisted of an intravenous benzodiazepine/narcotic combination. These procedures had an overall adverse event rate of 10%, with a major adverse event rate of 2.2% (table 4). While the retrospective nature of this comparison and the low number of non-NAPS procedures preclude a rigorous comparative statistical analysis, NAPS does not appear to be associated with an increased number of adverse events.

Our institution has an active interventional pulmonology service, and these procedures have been noted to have a higher incidence of complications [25]. In our cohort, 4 of the 14 major adverse events were directly related to interventional bronchoscopic procedures (3 were argon plasma coagulation/cryotherapy procedures, 1 was removal of an intra-bronchial valve), and 3 of these 4 were major adverse events that were classified as being due to

sedation. In addition, as the only tertiary referral center in the state of Indiana, our institution serves a large number of patients with advanced oncologic and hematologic disease, as well as a large population of pre- and post-solid organ and bone marrow transplantation patients. These patients are known to have a higher incidence of complications with bronchoscopy [26]. The incidence of adverse events, both major and minor, was acceptable and comparable to previously published studies, as noted above.

NAPS has become the preferred mode of sedation for the physicians performing bronchoscopy at our institution. Overall, propofol has been used in 85% of procedures since July 2006. However, between January and June 2008, NAPS was utilized for 98% of bronchoscopic procedures.

There has been significant controversy regarding the use of NAPS for GI endoscopy. Multiple articles have been published demonstrating safety in the use of NAPS without direct anesthesiologist involvement [8, 13]. However, because of the narrow therapeutic window of propofol, its propensity to cause apnea, and the lack of a reversal agent, the American Society of Anesthesiologists states that: 'Practitioners administering these drugs should be qualified to rescue patients from any level of sedation, including general anesthesia' [27]. This language is consistent with the package insert. We would argue that this controversy has less merit for bronchoscopy, as the largest risk with inadvertent general anesthesia is management of the airway, including bag-mask ventilation and endotracheal intubation. For most pulmonary practitioners, these skills are part of their everyday practice [28]. It is notable that in the USA some state nursing boards prohibit nurses from administering propofol as a result of safety concerns. While we believe that our experience, coupled with cited published literature, should alter such restrictions, practitioners should note both local statutes and hospital policy before undertaking NAPS in their institutions.

Recently, a water-soluble pro-drug formulation of propofol, fospropofol, was evaluated in a phase III study for use in bronchoscopy [29]. Fospropofol is converted to propofol by tissue alkaline phosphatase, and the rise in plasma levels is more predictable and significantly slower than that of propofol. This trial evaluated fospropofol administered at 2 or 6.5 mg/kg for safety and efficacy. Major adverse events occurred in 13.9% of procedures, with 4.0% attributed to fospropofol. This adverse event profile is comparable to our study (2.8% major events, with 1.2% due to NAPS). Our study adds to the growing evidence that propofol or its derivatives may be safely used by non-anesthesia personnel in the bronchoscopy suite.

Given the pharmacodynamic advantage over propofol, fospropofol's manufacturer submitted for US Food and Drug Administration approval a package insert that did not require anesthesia involvement in fospropofol's delivery. The FDA, however, approved fospropofol only for use by qualified anesthesia personnel. This approval limits use of fospropofol by non-anesthesia personnel to off-label use, which is similar to that of propofol. We would propose that NAPS has a similar safety and efficacy profile as compared to fospropofol. Whether the theoretical benefits of fospropofol over propofol translate into a clinical difference in a head-to-head comparison has not been studied. However, propofol has been widely used in hospitals and intensive care units for some time, and most practitioners have more experience with this drug than with fospropofol, potentially making propofol a more practical option for many physicians. Regardless, these studies underline the feasibility and safety of propofol and its prodrug when used by adequately trained non-anesthesia personnel under the supervision of a critical care specialist.

This retrospective review has certain limitations. First, the patients were not randomized, and the decision to utilize NAPS was at the discretion of the treating physician or the availability of a NAPS-trained nurse. Additionally, detailed data regarding co-morbid conditions were unable to be reliably obtained with our retrospective study design. Any future prospective trial should include this data in order to fully characterize the patient population. In our NAPS protocol, the attending physician could use additional midazolam and fentanyl at their discretion. While the amounts of midazolam and fentanyl were small, they may have confounded the effect of NAPS. The retrospective design relies on accurate reporting of complications by physicians performing procedures; the possibility of underreporting adverse events exists. Our study only evaluated immediate complications of procedures as recorded in the procedure notes. Later adverse events (such as pneumothorax) may have been missed; it is unlikely, however, that these adverse events would have been due to procedural sedation.

This study leaves several questions unanswered. Firstly, while propofol has been shown to decrease recovery time in bronchoscopy as compared to traditional sedation techniques [7, 18], NAPS as a delivery regimen has not been studied with regards to recovery time. Two studies have addressed this question in regards to GI endoscopy; in both, NAPS was shown to decrease recovery time and improve patient satisfaction when compared to traditional sedation regimens [11, 12]. In addition, no studies have

directly evaluated cost-effectiveness for the use of propofol with bronchoscopy. While one study has implied that NAPS is more cost-effective than traditional sedation for GI endoscopy [11], the volume of bronchoscopy in most centers is less than that of endoscopy. This may negate any cost benefit derived from the use of NAPS. Our study did not address patient satisfaction. While one recent study has demonstrated propofol to have a better global patient

satisfaction profile to midazolam [18], this result should be corroborated in any future prospective NAPS trials.

In conclusion, this paper demonstrates that NAPS for bronchoscopic procedures is feasible, effective and safe. Further prospective studies are warranted to evaluate the relative safety, efficacy, cost-effectiveness and patient satisfaction profile of NAPS versus traditional sedation regimens.

References

- Putinati S, Ballerin L, Corbetta L, Trevisani L, Potena A: Patient satisfaction with conscious sedation for bronchoscopy. *Chest* 1999;115:1437–1440.
- Chhajed PN, Wallner J, Stolz D, Baty F, Strobel W, Brutsche MH, Tamm M: Sedative drug requirements during flexible bronchoscopy. *Respiration* 2005;72:617–621.
- Maltais F, Laberge F, Laviolette M: A randomized, double-blind, placebo-controlled study of lorazepam as premedication for bronchoscopy. *Chest* 1996;109:1195–1198.
- British thoracic society guidelines on diagnostic flexible bronchoscopy. *Thorax* 2001; 56(suppl 1):i1–i21.
- Pickles J, Jeffrey M, Datta A, Jeffrey AA: Is preparation for bronchoscopy optimal? *Eur Respir J* 2003;22:203–206.
- Prakash UB, Offord KP, Stubbs SE: Bronchoscopy in North America: the ACCP survey. *Chest* 1991;100:1668–1675.
- Clarkson K, Power CK, O'Connell F, Pathmakanthan S, Burke CM: A comparative evaluation of propofol and midazolam as sedative agents in fiberoptic bronchoscopy. *Chest* 1993;104:1029–1031.
- Rex DK, Overley C, Kinser K, Coates M, Lee A, Goodwine BW, Strahl E, Lemler S, Sipe B, Rahmani E, Helper D: Safety of propofol administered by registered nurses with gastroenterologist supervision in 2000 endoscopic cases. *Am J Gastroenterol* 2002;97:1159–1163.
- Bhardwaj G, Conlon S, Bowles J, Baralt J: Use of midazolam and propofol during colonoscopy: 7 years of experience. *Am J Gastroenterol* 2002;97:495–497.
- Heuss LT, Schnieper P, Drewe J, Pflimlin E, Beglinger C: Safety of propofol for conscious sedation during endoscopic procedures in high-risk patients: a prospective, controlled study. *Am J Gastroenterol* 2003;98:1751–1757.
- Sipe BW, Rex DK, Latinovich D, Overley C, Kinser K, Bratcher L, Kareken D: Propofol versus midazolam/meperidine for outpatient colonoscopy: Administration by nurses supervised by endoscopists. *Gastrointest Endosc* 2002;55:815–825.
- Koshy G, Nair S, Norkus EP, Hertan HI, Pitchumoni CS: Propofol versus midazolam and meperidine for conscious sedation in GI endoscopy. *Am J Gastroenterol* 2000;95: 1476–1479.
- Walker JA, McIntyre RD, Schleinitz PF, Jacobson KN, Haulk AA, Adesman P, Tolleson S, Parent R, Donnelly R, Rex DK: Nurse-administered propofol sedation without anesthesia specialists in 9,152 endoscopic cases in an ambulatory surgery center. *Am J Gastroenterol* 2003;98:1744–1750.
- Weston BR, Chadlawada V, Chalasani N, Kwo P, Overley CA, Symms M, Strahl E, Rex DK: Nurse-administered propofol versus midazolam and meperidine for upper endoscopy in cirrhotic patients. *Am J Gastroenterol* 2003;98:2440–2447.
- Fatima H, DeWitt J, LeBlanc J, Sherman S, McGreevy K, Imperiale TF: Nurse-administered propofol sedation for upper endoscopic ultrasonography. *Am J Gastroenterol* 2008;103:1649–1656.
- Lexi-Comp Inc., American Pharmaceutical Association: Drug Information Handbook. Hudson/Washington, D.C., Lexi-Comp/American Pharmaceutical Association, 2007.
- Crawford M, Pollock J, Anderson K, Glavin RJ, MacIntyre D, Vernon D: Comparison of midazolam with propofol for sedation in outpatient bronchoscopy. *Br J Anaesth* 1993; 70:419–422.
- Clark G, Licker M, Younessian AB, Soccal PM, Frey JG, Rochat T, Diaper J, Bridevaux PO, Tschopp JM: Titrated sedation with propofol or midazolam for flexible bronchoscopy: a randomized trial. *Eur Respir J* 2009, Epub ahead of print.
- Stolz D, Kurer G, Meyer A, Chhajed PN, Pflimlin E, Strobel W, Tamm M: Propofol versus combined sedation in flexible bronchoscopy – a randomized, non-inferiority trial. *Eur Respir J* 2009;34:1024–1030.
- Vincent B, Silvestri G: An update on sedation and analgesia during flexible bronchoscopy. *J Bronchol* 2007;14:173–180.
- Dreisin RB, Albert RK, Talley PA, Kryger MH, Scoggins CH, Zwillich CW: Flexible fiberoptic bronchoscopy in the teaching hospital: yield and complications. *Chest* 1978; 74:144–149.
- Pereira W Jr, Kovnat DM, Snider GL: A prospective cooperative study of complications following flexible fiberoptic bronchoscopy. *Chest* 1978;73:813–816.
- Pue CA, Pacht ER: Complications of fiberoptic bronchoscopy at a university hospital. *Chest* 1995;107:430–432.
- Jin F, Mu D, Chu D, Fu E, Xie Y, Liu T: Severe complications of bronchoscopy. *Respiration* 2008;76:429–433.
- Chhajed PN, Malouf MA, Tamm M, Spratt P, Glanville AR: Interventional bronchoscopy for the management of airway complications following lung transplantation. *Chest* 2001; 120:1894–1899.
- White P, Bonacum JT, Miller CB: Utility of fiberoptic bronchoscopy in bone marrow transplant patients. *Bone Marrow Transplant* 1997;20:681–687.
- Practice guidelines for sedation and analgesia by non-anesthesiologists. *Anesthesiology* 2002;96:1004–1017.
- Tape TG, Blank LL, Wigton RS: Procedural skills of practicing pulmonologists: a national survey of 1,000 members of the American College of Physicians. *Am J Respir Crit Care Med* 1995;151:282–287.
- Silvestri GA, Vincent BD, Wahidi MM, Robinette E, Hansbrough JR, Downie GH: A phase 3, randomized, double-blind study to assess the efficacy and safety of fospropofol disodium injection for moderate sedation in patients undergoing flexible bronchoscopy. *Chest* 2009;135:41–47.