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Sedation Strategies for Procedures Outside the Operating Room

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With the rapid development of diagnostic and therapeutic procedures performed outside the operating room (OR), the need for appropriate sedation care has emerged in importance to ensure the safety and comfort of patients and clinicians. The preparation and administration of sedatives and sedation care outside the OR require careful attention, proper monitoring systems, and clinically useful sedation guidelines. This literature review addresses proper monitoring and selection of sedatives for diagnostic and interventional procedures outside the OR. As the depth of sedation increases, respiratory depression and cardiovascular suppression become serious, necessitating careful surveillance using appropriate monitoring equipment.

Key Words: Sedation, procedure, monitoring, capnography, dexmedetomidine, remifentanil

INTRODUCTION

With the rapid development of diagnostic and therapeutic procedures performed outside the operating room (OR), patient needs for sedation or monitored anesthesia care have been increasing. Sedation relaxes anxiety, discomfort, and pain during a procedure. This makes the patient comfortable and allows children or uncooperative adults to undergo procedures without body movement.[1] In an analysis of 63000 diagnostic or therapeutic procedures performed under sedation or monitored anesthesia care, 41% of sedations was performed by non-anesthesiologists.[2] The most common procedures performed under non-anesthesia sedation are gastrointestinal endoscopy (64%) and cardiovascular procedures (30.5%).[2]

The depth of sedation depends on the type and purpose of the procedure, and possible complications are closely associated with the depth of sedation. According to a report by the Pediatric Sedation Research Consortium in 2009, pulmonary complications, such as apnea, aspiration, or desaturation, occurred 235 times per 10000 sedation/anesthesia administrations outside the OR.[3] Many non-anesthesiologists practice anesthesia and sedation in their field, and while some of them are anxious when performing these, others perform these without any awareness of the dangers. Moreover, despite the recommendation of a standard anesthesia setup, including an anesthesia machine, standard monitoring, anesthesia cart, and suction apparatus at the endoscopy location, great variations are observed in the arrangement of equipment in each clinical field.[1,4,5]

This review serves as a general guide focusing on sedation procedures outside the OR and describes pre-procedure patient evaluation, intra-procedure monitoring, and administration strategies for sedatives and analgesics that are needed to provide safe and satisfactory sedation outside the OR.

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PRE-PROCEDURE EVALUATION AND PREPARATION

Clinicians should be aware of the following: 1) reviewing previous medical records and interviewing the patients or caregiver for knowing underlying medical conditions (e.g., abnormalities of major organ systems, allergies); 2) previous experience or adverse events with sedation and anesthesia, sensitivity to sedatives or analgesics, and pain tolerance; and 3) current medical history and exposure to psychotropic drug.[1] A

physical examination, including patient demographics (weight and height), vital signs (blood pressure, heart rate, respiratory rate, temperature, and oxygen saturation), evaluation of the airway (mouth opening, short neck, neck mobility, facial anomaly, neck mass, and tracheal deviation), state of the teeth (protruding, damaged, or shaken teeth), and lung and heart sounds (mummer, irregular beats, and abnormal breathing sound), should be performed before starting sedation.[1,6]

According to the American Society of Anesthesiologists (ASA) pre-procedure fasting guidelines, the minimal fasting time is 2 h for clear liquids, 4 h for breast milk, 6 h for infant formula, 6 h for nonhuman milk, 6 h for a light meal, and 8 h or more for fried foods, fatty foods, or meat for gastric emptying.[1] However, in a previous analysis of 400 patients who underwent propofol sedation, although 70% of the enrolled patients had a shorter fasting time than recommended, no differences in respiratory events regardless of the fasting status were observed.[7] In addition, other researchers reported no significant differences in aspiration or emesis according to fasting times in the emergency department.[8,9] Fasting time is determined by the required level of sedation, type and site of procedures, and necessity of airway manipulation.[1,9] Recently, drinking clear liquids (water, apple juice, orange juice without pulp, etc.) until 2–3 h prior to anesthesia has been allowed because avoiding hypoglycemia improves patient comfort.[10] Fasting time, which is applied flexibly, is based on the premise that immediate treatment should be possible when a problem occurs, and it is generally recommended to fast for 6 h for light meals before sedation.

Pre-procedure laboratory testing is guided by underlying medical conditions and the predictable affected result of sedation.[1,6] Sedatives or analgesics can cause cardiopulmonary compromise, and hence, emergency equipment and drugs should be prepared (Table 1).[1]

PATIENT MONITORING

An analysis of the ASA Closed Claims database demonstrated that respiratory depression caused by an overdose of sedatives or opioids was responsible for 21% of monitored anesthesia care-related claims, and about half of these claims were judged as preventable with better monitoring with vigilance and an alarm system.[11]

Table 1. Emergency Preparedness during Sedation

Preparation	Examples
Intravenous assessment	Fluid, catheter, needle and syringe, alcohol swab, tourniquets, etc.
Airway management	Basic: oxygen, suction, face mask and bag, and oral or nasal airway Advanced: supraglottic airway device and endotracheal intubation set
Pharmacologic antagonists	Flumazenil, naloxone, etc.
Emergency medications	Resuscitation medications and defibrillator

Respiratory monitoring

Respiratory depression is the most frequent adverse event during sedation,[12] and hence, pulse oximetry is widely applied for detecting hypoxia or a desaturation event.[13] However, pulse oximetry tends to delay the detection of respiratory suppression. A previous study reported that pulse oximetry can detect only 38% of apnea or hypoventilation events during colonoscopy with sedation, whereas capnography is more reliable than pulse oximetry for early detection of hypoventilation.[14] A clinical study concluded that monitoring respiratory activity by using capnography improved patient safety related to respiratory adverse events during sedation with a combination of benzodiazepines and opioids for endoscopic retrograde cholangiopancreatography (ERCP) and endoscopic ultrasonography (EUS).[15] Capnographic monitoring of respiratory activity during sedation can lead to rapid interventions, such as patient stimulation, withholding medication and/or oxygen supplementation, thus reducing the frequency of hypoxemia, severe hypoxemia, and apnea.[15]

The ASA guidelines recommend monitoring of pulse oximetry with appropriate alarms and exhaled carbon dioxide via capnography and continuous observation of qualitative clinical signs.[1]

Hemodynamic monitoring

For hemodynamic monitoring, the Standards of Practice Committee of the American Society for Gastrointestinal Endoscopy recommended the monitoring of blood pressure and heart rate during sedation.[16] In addition, other organizations of anesthesiologists have suggested that procedural sedation should require hemodynamic monitoring for the assessment of blood pressure, heart rate, and electrocardiography.[11,17-20] Unless monitoring interferes with procedures, such as magnetic resonance imaging, it is recommended to check blood pressure before sedation, and then continuously monitor blood pressure (e.g., at 5 min intervals), heart rate, and electrocardiography during moderate sedation, especially in patients with significant cardiovascular disease or dysrhythmias.[1]

Monitoring the depth of sedation

Sedation levels can be evaluated by the clinician. Evaluating the depth of sedation is very important because the greater the depth of sedation, the greater the impact on cardiopulmonary function.

The depth of sedation is classified as follows: minimal sedation (anxiolysis), normal response to verbal commands and unaffected cardiopulmonary function; moderate sedation/analgesia (conscious sedation), purposeful response to verbal commands and intact airway and cardiopulmonary functions; deep sedation/analgesia, response to painful stimulation and requirement of assistance for proper ventilation and airway

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patency; and general anesthesia.[1,21] Clinicians sometimes prefer the digitalized form because it is more convenient than clinical observations.

The bispectral index (BIS) monitor (BIS vista monitor revision 3.0; Aspect Medical Systems, Norwood, MA, USA) is the most widely used monitoring instrument and is based on the interpretation of electroencephalograms (Fig. 1). It can be applied simply by attaching a single patch on the forehead to the temporal region of the head. BIS presents values between 90 and 100 for 'awaken,' between 70 and 90 for 'light to moderate sedation,' between 60 and 70 for 'superficial anesthesia,' and between 45 and 60 for 'general anesthesia.' Previous clinical studies did not provide satisfactory results for applying the BIS for short procedural sedation.[22-24] In a previous clinical study, the Spearman correlation between the BIS and the observer's assessment of alertness/sedation was 0.59 [95% confidence interval (CI), 0.44–0.74] and that between the BIS and the continuum of depth of sedation was 0.53 (95% CI, 0.36–0.70).[22] The correlations were not strong enough, and no clinical relevance was observed in the sedation complications regardless of the BIS.[22] Moreover, in a comparative study between the BIS and conventional clinical assessment during short procedures, no significant differences were observed in propofol dosage, oxygen desaturation, and requirement of hemodynamic and respiratory support between groups of patients undergoing bronchoscopy under propofol sedation.[23] Furthermore, no clinical benefit regarding awareness was observed during the procedures between the study groups.[23] In contrast, during long procedures that required moderate sedation, BIS monitoring provided some clinical benefits.[25,26] In a comparison between the BIS and invisible groups during deep sedation for ERCP, BIS monitoring led to a reduction in the required propofol dose.[25] Another study on ERCP also reported an improvement in recovery time, but did not report a reduction in cardiopulmonary complications.[26]

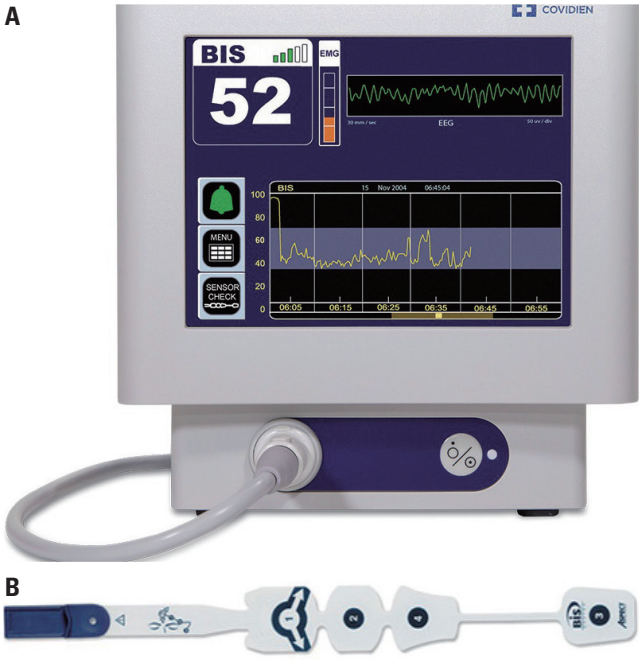

Fig. 1. BIS monitor and a sensor. The BIS is a processed electroencephalogram monitor that measures the hypnotic effects of anesthetics and sedatives. The BIS monitor (A) reports a single number from 0 to 100 that represents an integrated measure of cerebral electrical activity. A sensor (B) is placed usually placed at the forehead. BIS, bispectral index.

Designated individual for patient monitoring

ASA guidelines emphasize the presence of a designated individual other than the practitioner or procedural team to monitor the patient throughout the procedure. The designated individual should be trained to recognize apnea and airway obstruction and to check the level of sedation and vital signs.[1]

SEDATIVES AND ANALGESICS

For procedures outside the OR, the use of inhalation agents is limited, and hence, most institutes prefer the use of intravenous agents. The dosage and side effects of individual sedative or analgesic agents commonly used are listed in Table 2.[27-35]

Midazolam

Midazolam is the most frequently used benzodiazepine because of the rapid onset of and short duration for procedural sedation. It provides proper anxiolysis and antegrade amnesia.[29,32] It enables respiratory depression and obtuse responses to carbon dioxide retention via central respiratory depression.[36] In particular, rapid intravenous administration might increase respiratory depression.[32,36] The dose requirements decrease with increasing age, which results in prolonged and profound drug responses in older adults.[32] Because it is a central nervous system depressant, geriatric patients and those with severe illness and compromised cardiopulmonary reserves have to be closely monitored.[32] Because midazolam has no analgesic effect, it is often used in combination with opioids, such as fentanyl; however, the combined use thereof can increase the risk of respiratory depression and severe hypotension.[32]

The administration of midazolam sometimes induces paradoxical reactions (disinhibitory reactions), including uncontrolled aggressiveness, agitation, or hallucinations. Paradoxical reactions are manifested within 5 min of intravenous midazolam administration and are preceded by transient sedation before sudden agitation.[37] The paradoxical reactions are related to genetic factors, alcohol abuse, or psychological disturbance, and are assumed to be due to the loss of cortical resistance caused by the inhibitory reaction of midazolam and reduced serotonin control.[38] Flumazenil, an antidote to benzodiazepines, and haloperidol are helpful to attenuate paradoxical reactions after midazolam administration.[38-40]

Table 2. Summary of Sedation Drugs Commonly Used

Drug	Intravenous dosage	Analgesic effect	Onset	Duration	Side effects
Midazolam	Bolus for deep sedation: 0.1–0.4 mg/kg Bolus for moderate sedation: 0.01–0.1 mg/kg	-	1–5 min	<2 h	Paradoxical excitement (occasionally), hypotension, bradypnea
Propofol	Bolus for deep sedation: 1–2.5 mg/kg Infusion for moderate sedation: 25–100 μg/kg/min	-	<1 min	5–10 min	Hypotension, bradypnea/apnea
Dexmedetomidine	Bolus for deep sedation: 1 μg/kg over 10 min Infusion for moderate sedation: 0.2–0.7 μg/kg/h	++	10–15 min	~30 min	Biphasic hemodynamic effect: bolus administration has been associated with hypertension
Remifentanil	Infusion for moderate sedation: 0.05–2 μg/kg/min	+++	<1 min	5–10 min	Hypotension, bradypnea/apnea, bradycardia
Etomidate	Bolus for deep sedation: 0.2–0.5 mg/kg	-	<1 min	3–5 min	Adrenocortical dysfunction, especially in continuous IV administration
Ketamine	Bolus for deep sedation: 0.5–2 mg/kg Bolus for moderate sedation: 0.2–0.8 mg/kg Infusion for moderate sedation: 10–20 μg/kg/min	++	<1 min	12–25 min	Dissociative hallucination, increased ICP and IOP, tachycardia, and hypertension

ICP, intracranial pressure; IOP, intraocular pressure; IV, intravenous.
Moderate sedation (conscious sedation): purposeful response to verbal commands and intact airway and cardiopulmonary functions; deep sedation: response to painful stimulation and requirement of assistance for proper ventilation and airway patency.

Propofol

Propofol is a white-colored formula with benefits of rapid onset of anesthesia and a short recovery time. It provides smoother recovery than do other intravenous sedatives, and enables quicker recovery of psychomotor performance and lower incidence of postoperative nausea and vomiting than do other regimens.[41] Because propofol has no analgesic effect, it can be combined with opioids. Owing to its fast onset and recovery profiles, it is also used for sedation in pediatric patients undergoing MRI.[42,43] When combined with ketamine, it has lower side effects.[44] The authors prefer to co-administer propofol (a bolus of 1 mg/kg) and ketamine (a bolus of 0.5–1 mg/kg) for shorter sedation (<20 min) in children. This is because ketamine can compensate for the cardiovascular and respiratory depressive effects caused by propofol due to its sympathomimetic effects and can reduce propofol-injection pain.

Propofol sedation has been shown to cause euphoria in over 40% of patients undergoing gastroenteroscopy[45] and is associated with a risk of drug addiction or abuse. Since propofol addiction was first reported in 1992, many people have become aware of the danger of addiction: the biggest event was the death of popstar Michael Jackson in 2009 due to propofol misuse. Propofol was designated as a controlled substance in Korea in February, 2011 (the first in the world), as there is a potential risk of abuse and propofol abusers are increasing. Because injection pain is the most frequent side effect of propofol, the concomitant use of lidocaine is recommended.[46,47] Propofol induces respiratory depression and exerts a greater effect on cardiovascular depression with profound hypotension than do other intravenous agents.[48,49] Rapid injection of the sedative formula, old age, and poor physical status results in the debilitation of patients, especially those vulnerable to catastrophic cardiorespiratory effects.[48,49] Because propofol is a lipid-based formula, rapid bacterial contamination might easily develop and induce life-threatening sepsis,[48-50] and hence, sterile and aseptic handling is important. Although very rare, propofol infusion syndrome, which involves severe metabolic acidosis, renal failure, rhabdomyolysis, and cardiac failure, may develop in cases of single administration of propofol.[51]

Dexmedetomidine

Dexmedetomidine is a selective α_2-receptor agonist and provides anxiolytic, sedative, and analgesic effects.[52,53] Dexmedetomidine reduces norepinephrine release and inhibits sympathetic outflow in the central nervous system; therefore, it can cause profound bradycardia, especially in young patients with a high vagal tone.[52,54] If transient hypertension occurs during the infusion of loading dose, a reduction of infusion rate should be considered.[52] Meanwhile, hypotension may also occur, especially in geriatric patients or patients with diabetes mellitus or chronic hypertension.[52,53]

A feature of dexmedetomidine is that it has analgesic properties in addition to its role as a hypnotic, while being opioid sparing; thus, it is not associated with significant respiratory depression. Dexmedetomidine is most often used in the intensive care unit for light to moderate sedation. An earlier study suggested that using dexmedetomidine for sedation in mechanically ventilated adults may reduce the time to extubation and intensive care unit stay.[55] It should not be administered over 24 h,[52] because it induces potential withdrawal responses, such as agitation and an abrupt increase in blood pressure.

Patients on dexmedetomidine can be cooperative, which are beneficial in some procedures, such as blepharoplasty. Previous clinical studies demonstrated that dexmedetomidine provides less respiratory depression with better analgesic efficacy and deeper sedation level than does midazolam for double-balloon enteroscopy[56] and ablation for atrial fibrillation.[57] It can be used in combination with other sedatives, like

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propofol, opioids, and benzodiazepines, to enhance sedation and to help maintain hemodynamic stability by decreasing the requirement for other sedatives.[58,59] Because dexmedetomidine has a late onset of 10–15 min, combined administration of small doses of midazolam (1.5–2 mg) for rapid hypnosis or fentanyl (25–50 μg) for rapid analgesia when starting sedation with infusion of dexmedetomidine at a rate of 0.5±0.3 μg/kg/min is generally favored. Dexmedetomidine is also used for procedural sedation in children.[60] However, it should be noted that the use of dexmedetomidine for procedural sedation in pediatric patients has not been well evaluated and its use is not currently approved in children in any country.

Opioids

Some clinicians prefer to use additional opioids with hypnotics. An addition of opioids effectively reduces the hypnotic requirements and controls procedure-induced discomfort. However, it should be noted that respiratory depression and hemodynamic suppression might be possible even when low doses of sedatives are used with opioids; therefore, special attention should be paid.

Intravenous fentanyl has an onset of 5 min and a duration of 30–60 min. A previous study demonstrated that the combined use of fentanyl could reduce propofol requirements for procedural sedation without any delay in recovery time for patients undergoing elective EUS.[61]

Remifentanil, an ultra-short-acting opioid is preferred for use in combination with sedatives because of its rapid recovery. Remifentanil has been reportedly used as a component of conscious sedation in patients undergoing painful medical procedures.[62] Remifentanil infusion at a rate of 0.5±0.3 μg/kg/min provided sufficient analgesia, but was accompanied by a high incidence of respiratory depression at subtherapeutic levels.[62] Because of its significant respiratory depression, careful monitoring of capnography during remifentanil infusion is recommended.

Morphine and meperidine might induce bronchospasm related with histamine release. Rapid administration of opioids, especially fentanyl, alfentanil, sufentanil, and remifentanil, might induce chest wall rigidity, which can disturb proper ventilation.[28]

Etomidate

Etomidate has unique characteristics, including an easy dosing profile, limited suppression of ventilation, lack of histamine liberation, and protection from myocardial and cerebral ischemia.[63] It is frequently used for procedural sedation[64] and as an induction agent for rapid sequence intubation[63] in the emergency department. In addition, etomidate is a good induction agent for hemodynamically unstable patients.[65] Etomidate is also used in patients with traumatic brain injury, because it is one of the only anesthetic agents able to decrease intracranial pressure and maintain a normal arterial pressure.

Despite its numerous cardiovascular and respiratory advantages, etomidate has a notable side effect of adrenocortical suppression. It is possible even in single administration, and sometimes, exogenous glucocorticoid supply is required during the postoperative period.[66] Moreover, etomidate has disadvantages, such as pain at the injection site, myoclonus, and frequent nausea, which have led to its decreased usage as an anesthetic, and it not being recommend for elective sedation.[27,67]

Ketamine

Unlike most sedatives, including midazolam and propofol, that potentiate the inhibitory action of γ-aminobutyric acid, ketamine is an antagonist of N-methyl-D-aspartate receptor.[27] The unique characteristic of ketamine is dissociative anesthesia, which is a status in which the patients appear conscious with eye opening but have catatonia that prevent them from responding to external stimuli.[27] Ketamine induces psychomimetic effects, such as hallucinations or dysphoria.[27] Unlike other sedatives, ketamine has a central sympathomimetic effect and can transiently increase blood pressure and heart rate.[68] However, when catecholamines are depleted, ketamine exhibits negative cardiovascular responses.[27,69] Ketamine preserves the airway reflex and respiratory drive, but increases oral secretion, which might increase the incidence of laryngospasms.[68] Because of the above-mentioned characteristics of ketamine, even sub-anesthetic ketamine administration is contraindicated in cases of high-risk coronary disease, uncontrolled hypertension, increased intracranial pressure, increased intraocular pressure, psychosis, and hepatic dysfunction.[70]

SPECIAL CONSIDERATIONS FOR INDIVIDUAL PROCEDURES

Gastrointestinal procedures

Endoscopic therapeutic procedures, such as hemostasis, biopsy, stent dilation, endoscopic mucosal dissection, and endoscopic submucosal dissection, are potentially stimulating and often require sedation/analgesia.[71] A clinical study demonstrated that, during endoscopic submucosal dissection, a continuous infusion of propofol and remifentanil by an anesthesiologist might increase the satisfaction of the endoscopist and reduce patient movement than does the administration of an intermittent bolus of midazolam/propofol by an endoscopist; however, the patient satisfaction scores were significantly higher in the intermittent bolus of midazolam/propofol group.[72] This result was likely because of the amnestic property of midazolam. Amnesia may have affected the patient's satisfaction levels, and it is considered one of the goals of sedation for endoscopy.[73] Although the patient may appear perfectly relaxed and cooperative during the procedure, the fact that the patient can recall the events later may have been a cause of dissatisfaction with the entire procedure. The addition of a small dose

of midazolam to the regimen of continuous propofol and remifentanil infusion may be helpful in overcoming this problem. A retrospective review of sedation for endoscopic submucosal dissection also reported that complete resection rates were significantly higher and that procedure times were significantly shorter with continuous infusion of propofol with opioid by an anesthesiologist than with intermittent propofol/midazolam injection by an endoscopist.[74] However, aspiration pneumonia was more frequent in patients receiving continuous propofol and opioid infusion than in those receiving the intermittent injection.[74] A combined administration of propofol and opioid may have difficulties for non-anesthesiologists to adequately titrate the dosages of these drugs, because these co-administration enhances their side effects of respiratory depression, hypotension, and bradycardia.

ERCP is more complex than other endoscopic procedures. It often requires precise intervention and complete immobilization without gagging or squirming to ensure the safety and success of the procedure. Moreover, many patients who require ERCP are vulnerable. In a recent clinical study of conscious sedation for ERCP, the combined use of dexmedetomidine (a loading dose of 1 μg/kg over 10 min) resulted in significantly better patient satisfaction scores and lower desaturation rates than did the combined use of midazolam (0.05 mg/kg) during remifentanil infusion (a loading dose of 1 μg/kg and an infusion rate of 0.05–0.2 μg/kg/min).[75] In addition, dexmedetomidine has been reported to be safe and to decrease the total dose of other hypnotics in very old patients undergoing ERCP.[76]

Sedation for MRI or CT

For ensuring patient satisfaction and acquiring good-quality MRI and CT images, immobilization of the patient is important during these imaging procedures. However, staying alone for long periods in a dark, noisy environment is not easy for children and adults with claustrophobia. In a review focused on sedation for pediatric MRI, dexmedetomidine was found to have a greater sedative effect than did chloral hydrate, pentobarbital, and midazolam; in addition, preterm or small children should preferably be given general anesthesia for the safety and success of the diagnostic test.[77] A randomized controlled study compared pharmacodynamic responses to a combination of dexmedetomidine (a loading dose of 1 μg/kg and an infusion rate of 0.5 μg/kg/h) and midazolam (0.1 mg/kg) vs. propofol (250–300 μg/kg/min) in children anesthetized using sevoflurane for MRI, and demonstrated that dexmedetomidine-midazolam provided adequate anesthesia, although it had a more prolonged recovery time than did propofol.[78] Neurodevelopmental disorders might change the sedative requirements.[79] In an animal study, autistic rats showed increased requirements of propofol and dexmedetomidine than did the control rats.[79]

Neurologic interventions

A recent matched-cohort study comparing conscious sedation and general anesthesia for patients undergoing flow diverter placement for aneurysms demonstrated that conscious sedation could be successfully applied for short and simple neurologic procedures.[80] When selecting sedatives for neurologic procedures, ketamine should be avoided because of its characteristics of increasing intracranial pressure[81] and inducing psychomimetic activity,[82] which may affect the validity of the neurologic examination.

Cardiologic procedures

Cardiologic procedures that require sedation include cardioversion, ablation, transesophageal echocardiography, device implantation, and percutaneous transcatheter valve procedures. Propofol administration by nursing staff might be appropriate for some cardiologic procedures that require moderate sedation. However, proper training is essential for using capnography to detect respiratory depression, and using a target-controlled infusion pump is recommended for propofol administration.[83] A study comparing dexmedetomidine (a loading dose of 1 μg/kg over 10 min and a maintenance infusion rate of 0.2 μg/kg/h) and thiamylal (a bolus of 1.25 mg/kg and the same bolus dose every 15 min) for sedation during ablation of atrial fibrillation showed that both sleep-disordered breathing events and the number of body movements were significantly lower in the dexmedetomidine group than in the thiamylal group.[84] Therefore, they suggested that dexmedetomidine was a safe and proper sedative for cardiologic procedural sedation.[84]

CONCLUSION

The need for sedation and anesthesia outside the OR is increasing because of the increased use of diagnostic tools and procedural treatment methods. It is important to understand the characteristics and side effects of sedatives and analgesics when selecting them, because the degree or depth of sedation required to improve the patient's stability and to ensure the success of the procedure may vary. Clinicians should remember that as the depth of sedation increases, the risks of respiratory depression and cardiovascular suppression become serious, and hence, precautions should be taken using appropriate surveillance systems.

AUTHOR CONTRIBUTIONS

Wrote the first draft of the manuscript: Youn Yi Jo. Approved the final version: Youn Yi Jo and Hyun Jeong Kwak. Each author has participated sufficiently in the work to take public responsibility for appropriate portions of the content.

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