Journal of Anesthesia & Clinical Research

ISSN: 2155-6148

Amornyotin. J Anesthe Clinic Res 2011, S12
DOI: 10.4172/2155-6148.S12-001

Review Article Open Access

Pediatric Sedation and Analgesia in a Developing Country

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Abstract

The management of acute pain and anxiety in children undergoing diagnostic and therapeutic procedures has developed substantially in the past two decades. An increase in the numbers of investigations and non-surgical interventions in children has created an enormous demand for sedation services. Procedural sedation and analgesia for children is now widely practiced by a various group of the specialists. The goal of procedural sedation is the safe and effective control of pain, anxiety and motion as well as to provide an appropriate degree of memory loss or decreased awareness. Short acting, rapid onset drugs with little adverse effects and improved safety profiles are replacing outdated regimens. This article is to discuss the decision making process used to determine appropriate drug selection, dosing and sedation endpoint. It also reviews the current status of sedation and analgesia for pediatric procedures in a developing country.

Keywords: Sedation; Analgesia; Pediatric; Developing country

Introduction

Pediatric sedation and analgesia has evolved over the past two decades. The growing number of pediatric procedures requiring sedation and analgesia are recognized even in developing countries. The optimum levels of sedation depend on patients' physical status and the type of procedure. They also should be targeted. The ability to provide safe and effective sedation and analgesia is an important skill for physicians involved in pediatric patients. Children are more prone to anxiety in the acute setting. Procedural sedation and analgesia is the use of sedative, analgesic and dissociate drugs to provide anxiolysis, analgesia, sedation and motor control during painful and unpleasant procedures.

Pediatric procedural sedation and analgesia (PPSA) is ubiquitous in any hospital that cares for children and depending on the institution and country. The idea of how PPSA should be defined varies widely from physician to physician. In developing countries, there have limited anesthesiologists, the majority of PPSA inside or outside the operating room is done by anesthetic nurses. Additionally, they only use basic monitors including noninvasive blood pressure, heart rate, pulse oxymeter and/or electrocardiogram. Unfortunately, the developing countries have no their practice guidelines. The guidelines established by the American Academy of Pediatrics (AAP) [1], the American Society of Anesthesiologists (ASA) [2] and the Joint Commission on Accreditation of Healthcare Organizations [3] serve as the standard for institutional policy development in the area of PPSA.

The guideline defines terms throughout and in particular:

Minimal sedation: a drug-induced state which patients respond normally to verbal commands.

Moderate sedation (conscious sedation): a drug-induced depression of consciousness which patients respond purposefully to verbal commands. Spontaneous ventilation is adequate. Cardiovascular function is usually maintained.

Deep sedation: a drug-induced depression of consciousness which patients can not be easily aroused but respond purposefully after repeated verbal or painful stimulation. Spontaneous ventilation may be inadequate. Cardiovascular function is usually maintained.

General anesthesia: a drug-induced loss of consciousness which patients are not arousable, even by painful stimulation. Patients often require assistance in maintaining a patent airway. Cardiovascular function may be impaired.

This article provides an overview of our current knowledge regarding the role of anesthesiologists in determining the field of PPSA, and the current status of PPSA in Thailand. It also briefly discusses current controversies generated in this multi-disciplinary area of clinical practice. This review is divided into three parts: 1. the pre-PPSA assessment period, 2. the intra-PPSA management period, and 3. the post-PPSA period.

Pre-PPSA assessment period

All patients scheduled to receive PPSA should have an up-to-date history and relevant physical examination. The preprocedural pediatric assessment should include all of the items listed in the adult preprocedural evaluation, including NPO status as well as the patient's weight (in kg), age, and gestational age. A physical examination should focus primarily on the upper airway, lungs, cardiovascular system, and baseline neurological status. To aid in assessment risk, the ASA has developed a classification system for patients, which categorizes individuals on a general health basis. Several studies have documented the fact that sedation risk in children rises with increasing ASA physical status [1,4,5]. ASA physical status 1 and 2 are considered low risk patient populations. ASA physical status 3 and 4 are high risk patient populations. The specific high risk patient populations in which anesthesia consultation may be warranted including known respiratory or hemodynamic instability, obstructive sleep apnea, high risk airway management, ASA physical status ≥4, infants born <37 weeks and <60 weeks post conception, history of sedation related adverse events, and patients with neuromuscular disease affecting respiratory or brain stem function.

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Received November 28, 2011; **Accepted** December 14, 2011; **Published** December 18, 2011

Citation: Amornyotin S (2011) Pediatric Sedation and Analgesia in a Developing Country. J Anesthe Clinic Res S12:001. doi:10.4172/2155-6148.S12-001

In this pre-assessment period, there are no differences in a routine practice between the developed countries and the developing countries. However, the majority of PPSA practices in the developing countries like Thailand were sedated by anesthesiologists and/or anesthetic personnel [6-8]. Consequently, the majority of PPSA is commonly done in the operating room.

Intra-PSA management period

Any time sedative and analgesic medications are to be given to a pediatric patient, a clearly worded informed consent should be obtained. This consent should include a listing of the possible consequences of adverse drug reactions, allergic reactions and airway difficulties. Prior to undertaking PPSA, there are some key pieces of equipment that must be in place. These equipments that should be in place before starting a sedation are suction, oxygen, airway, pharmacy, monitors, and extra equipment such as defibrillator (SOAPME) [1].

Intraoperatively, the standard monitors that are recommended in the adult patient are the same as in the pediatric patients. There should be included continuous monitoring of heart rate and oxygen saturation, and intermittent recording of respiratory rate and noninvasive blood pressure. Partial obstruction and apnea can be detected by the physician when the precordial stethoscope is applied to the trachea or upper chest wall. Additionally, capnography detects increasing levels of carbon dioxide before desaturation occurs and can detect early inadequately ventilation [9]. However, the cost of capnometer is relatively high. The developing countries have none or few capnometers, though this monitor is not routinely used.

A sedative drug can only be considered safe after experience in hundreds or thousands of cases. Good protocols are important for the safety and success of the PPSA. Depending on the procedure, PPSA can involve monotherapy or combination therapy. Each regimen and administration of PPSA must be carefully personalized for each patient. The regimen depends on patient's physical status and co-morbidities as well as the preference of an anesthesiologist and the facility of the hospital. When administered, the drugs should be given as an appropriate initial dose with subsequent doses until titrated to effect. Consequently, they should be given as a titrated infusion technique. However, the most important factor is the judgement of the physician [1,2,4,5,10,11].

Common drug-receptor systems used for PPSA by anesthesiologists and anesthetic personnel in Thailand include the following:

1. Opioid receptors: fentanyl, morphine, meperidine (pethidine)
2. Gamma-aminobytyric acid (GABA) receptors: propofol
3. Benzodiazepine receptors: midazolam
4. N-methyl-D-aspartate (NMDA) receptors: ketamine

Fentanyl

Fentanyl is a potent synthetic opioid with no intrinsic anxiolytic or amnestic properties. It has a rapid onset, short duration of action, lack of direct of myocardial depressant effects, and absence of histamine release. Because of its potency, hemodynamic stability, and brief duration of action in small doses, fentanyl is an attractive analgesic for short painful procedures, making it an excellent choice for PPSA especially for ambulatory cases. Intravenous (IV) fentanyl can be easily and rapidly titrated for painful procedures [12,13]. The combination of fentanyl and midazolam is a popular PPSA regimen, with a safety profile when both drugs are carefully titrated [12-14]. Initial IV dose is 1.0 mcg/kg and may repeat every 3 minutes, but the maximum recommended dose is 50 mcg/dose. In Thailand, physicians including anesthetic personnel are usually used this drug for painful PPSA. Low dose of fentanyl in combination with low dose of midazolam and/or propofol may be used for PPSA.

Morphine

Morphine is a natural opioid and has a long duration of action. It is useful for painful or long duration procedures. Morphine is a good choice for PPSA owing to its desirable effects of being able to produce analgesia, euphoria and sedation. Generally, the elimination half-life is longer and clearance is decreased in newborns compared with older children and adults. It is not commonly used for short or ambulatory procedures. Side effects associated with morphine include nausea, dry mouth, felling of warmth, heaviness of extremities, hypotension, and pruritus. Initial IV dose is 0.05-0.15 mg/kg and may repeat every 5 minutes, but the maximum recommended dose is 3 mg/dose.

Meperidine (pethidine)

Meperidine is a synthetic opioid and has grown out of favor in past years. It has 0.10 the potency of morphine and is metabolized in the liver by hydrolysis and N-demethylation. The metabolites of meperidine are toxic to the central nervous system at high doses and in patients with renal impairment. Fatal reactions have also occurred in patients taking monoamine oxidase inhibitors or in patients with hyperthyroidism [15]. Meperidine 0.5-1.0 mg/kg IV combined with midazolam 0.05-0.1 mg/kg IV provides effective sedation for gastrointestinal endoscopy. However, meperidine is not recommended for PPSA in the emergency department [16,17].

Propofol

Propofol is a phenol derivative with sedative, hypnotic and anesthetic properties. Its clinical effects are dose dependent. Propofol has antiemetic, anxiolytic, hypnotic, amnestic and anesthetic properties. However, it does not have analgesic effects. Propofol can be given to children in the settings of gastroenterology [7,8,18,19], emergency department [19,20], and critical care series [21] with good efficacy, rapid recovery, and apparent safety. The most serious adverse effect of propofol is potent respiratory depression and apnea can occur suddenly. The respiratory depression rates vary extensively by the study [22]. Propofol can also produce hypotension, although this effect is typically transient and of little clinical importance in healthy patients [22]. Propofol is well known to be painful upon injection, the addition of lidocaine has been shown to decrease the incidence of pain during injection [20].

Propofol can be administered by various techniques such as IV bolus, continuous infusion, target controlled infusion, patient-controlled sedation, computer-assisted propofol administration. In Thailand, propofol can be used only by anesthesiologists and anesthetic personnel. Initial intravenous bolus dose of propofol is 1.0 mg/kg and is followed by 0.5 mg/kg, and the repeated dose is needed. In my experience, I usually use the initial bolus dose of propofol and follow by the continuous IV technique. The continuous IV infusion of propofol dose is 100-150 mcg/kg/min.

Midazolam

Midazolam is the drug most commonly used for sedation in children during procedures [12,14,15]. It is a shorting, water soluble benzodiazepine with anxiolytic, amnestic, sedative, muscle relaxant, and anticonvulsant properties. In Thailand, midazolam is commonly

used for PPSA. The author usually uses low dose midazolam in combination with other sedative agents. Midazolam is approved for many routes, including intravenous, oral and nasal and is most useful for PPSA. Initial intravenous dose of midazolam is 0.025-0.1 mg/kg and may repeat another dose, but the maximum recommended dose is 0.4-0.6 mg/kg. However, the maximum total dose is 6 mg for children 6 months to 5 years of age and 10 mg for children 6 years of age and older.

Ketamine

Ketamine is a phencyclidine derivative with dissociative sedative, analgesic and amnestic properties [23]. It is one of the most sedative-analgesic agents and results in a number of desired clinical effects that are dose dependent [24]. Typically, spontaneous respiration and airway reflexes are maintained although may not be totally normal. Neuropsychiatric effects of ketamine include visual hallucinations that may be accompanied by emergence phenomena and agitation. Ketamine generally causes an increase in heart rate, blood pressure, cardiac output, intracranial pressure, and intraocular pressure. Ketamine can induce salivation, and cholinergics have traditionally been coadministered. The single most severe adverse effect with ketamine sedation is laryngospasm.

Ketamine is clinically effective by a number of different routes. IV doses of 0.25 to 0.5 mg/kg can produce intense analgesia for 10 to 15 minutes, although the elimination half-life is 2 to 3 hours. A dose of 1-1.5 mg/kg IV may be needed for more painful procedures, and may repeat dose every 10 minutes as needed. In Thailand, anesthetic and non-anesthetic physicians usually use ketamine for PPSA. The author commonly uses low dose ketamine in combination with low dose midazolam, opioid drug, and/or low dose of propofol [6-8]. This combination technique produces stable hemodynamic effects, and can reduce the sedation-related adverse effects.

Reversal Agents

Naloxone

Naloxone is a pure mu-opioid antagonist with a high affinity for the receptor. It can reverse the unwanted respiratory depression induced by opioids, like morphine and fentanyl [25]. Naloxone does not, however, reverse the rigid chest wall phenomenon associated with fentanyl. A single dose of naloxone is 0.1 mg/kg up to 2 mg. Because of its rapid removal from the brain, naloxone has a short duration of action and one dose typically only lasts for 30-45 min; it may be repeated if deemed necessary, continued monitoring of the patient is mandatory.

Flumazenil

Flumazenil is a benzodiazepine antagonist and can safely reverse the sedative and respiratory effects caused by benzodiazepines [25]. It is a highly specific benzodiazepine receptor antagonist with little intrinsic effect. Flumazenil is a competitive antagonist at the receptor site; therefore, its effects are reversible. It is not recommended for routine use. The half-life of flumazenil is shorter than that of benzodiazepines and therefore requires repeated administration of the antagonist until the sedatives have worn off [9].

Post-PPSA period (Recovery and discharge)

The recovery area should be equipped with oxygen, suction, equipment for bag mask ventilation and for tracheal intubation. Monitoring equipment including non-invasive blood pressure, pulse oximetry, electrocardiography, and ventilation monitoring should be available as well. Patients should be discharged only when they have met specific criteria.

The criteria for discharge should include:

1. Stable vital signs
2. Return to the level of consciousness that is similar to the baseline for that patient
3. Pain under control
4. Adequate muscle strength to maintain a patent airway
5. Nausea and/or vomiting should be controlled

At the time of discharge, the status of the child should be documented. Specific instructions should be given to the child's family instructing them what to do if the child should appear sedated or have any other medical problems.

In the developed countries, most of PPSA procedures can be safely done with ambulatory setting. However, the majority of PPSA procedures in developing countries like Thailand are done with inpatient setting

Conclusion

In the setting of developing country, PPSA can be safely and effectively performed with a multi-drug IV regimen utilizing anesthetic personnel with appropriate basic monitoring. However, comprehensive pre-procedure evaluation and proper patient selection and preparation as well as availability of skilled professionals for sedation administration are key components to provision of quality patient care. Additionally, the physician must always be prepared to rescue patients who move to a deeper level of sedation.

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This article was originally published in a special issue, **Pediatric Anesthesia** handled by Editor(s). Dr. Fabrizio Racca, SS Antonio Biagio e Cesare Arrigo Hospital, Italy