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Procedural Sedation in Infants, Children, and Adolescents

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Introduction

Hello and welcome to this PedsCases podcast on Procedural Sedation. Our names are Summer Hudson and Katie Gourlay, and we are second year medical students at the University of Alberta. This podcast was developed by PedsCases and the Canadian Pediatric Society and will discuss the CPS Position Statement “Recommendations for Procedural Sedation in Infants, Children, and Adolescents”¹. This podcast was created in collaboration with the lead author of the statement, Dr. Kristina Krmpotic, a pediatric intensivist at IWK Health in Halifax, Nova Scotia, Canada.

In this PedsCases podcast we will explore approaches to procedural sedation in infants, children, and adolescents undergoing common diagnostic and therapeutic procedures requiring sedation and analgesia outside the operating room by non-anesthesiologists / non-intensivist clinicians. For the purposes of this podcast and the position statement, the term “Procedural Sedation” refers to the administration of pharmacologic agents for the purpose of sedation, allowing the patient to tolerate unpleasant procedures while maintaining cardiorespiratory function². For a detailed review of the management of distress and pain in children, please review the PedsCases podcast created by Drs. Anastasia Zello, Evelyn Trottier, and Samina Ali.

Mirroring the CPS guideline, this podcast will focus on the prevention of sedation-related adverse events through appropriate patient assessment and selection, advance preparation for emergency situations, and thorough monitoring during and following the administration of pharmacologic sedation until patients have returned to baseline.

Learning Objectives

By the end of this podcast, listeners should be equipped to:

1. List the indications and goals for procedural sedation;
2. Outline training and skills requirements for clinicians performing procedural sedation services in the pediatric population;
3. Discuss the selection, classification, and pre-evaluation process for children requiring procedural sedation;
4. Describe potential complications of procedural sedation in children; and

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5. Highlight the key elements of emergency preparedness for adverse events during and following sedation.

Clinical Case #1 - Diagnostic Imaging/Distressed Child

To learn about the indications and goals for procedural sedation, let's start with a clinical case. You are the attending physician in the emergency department when Abdul, a 6-year-old boy presents with a 4-hour history of worsening headache and one episode of vomiting after sustaining a fall on his head from 3 feet. On exam, he is irritable and is in obvious discomfort. You determine that a CT-head is indicated. Is procedural sedation indicated to obtain this image?

Goals for Procedural Sedation

There are many reasons a child may require procedural sedation. The main goal of procedural sedation, as outlined by the CPS guideline, is to “minimize distress, physical discomfort, and pain while maintaining airway reflexes, adequate oxygenation and ventilation, and cardiopulmonary stability, reflected by limited deviation from baseline vital signs.” These goals fit our aims for Abdul - we want to keep him comfortable and still during the CT scan, so we can obtain a high-quality image.

Skills & Training

Now that we've identified the goal of procedural sedation, let's talk about moving forward with procedural sedation.

First, it is essential to be aware of the necessary skills and training a clinician requires to perform safe and effective procedural sedation.

Non-anesthesiologist clinicians can perform procedural sedation safely, in both tertiary care and community hospitals, with individual physician competency determining the success of the procedure. The CPS guideline states that the clinician administering sedation must be prepared to manage emergencies including but not limited to: airway obstruction, laryngospasm, aspiration, apnea, hypoxia, hypoventilation, bradycardia, arrhythmias, hypotension, cardiac arrest, seizures, allergic reactions and paradoxical reactions. The clinician should be prepared to manage the patient at any depth of sedation. Importantly, clinicians must ensure that an expert in pediatric resuscitation is immediately available throughout the duration of the sedation.

Specific credentialing requirements vary significantly between institutions. Therefore, clinicians should refer to their institutional requirements to ensure they are well-equipped to administer procedural sedation.

Clinical Case #2 - Lumbar Puncture

Now let's discuss the selection, classification, and pre-evaluation process for children requiring procedural sedation. To do so, we'll look at the case of 8-year-old Naia admitted to the Pediatric Ward of a community hospital for suspected meningitis. She requires a lumbar puncture. What additional information is needed to determine if procedural sedation can be administered safely by a non-anesthesiologist clinician?

Selection & Evaluation

In evaluating a child for procedural sedation, always conduct a thorough history. As outlined by the American Society of Anaesthesiologists (ASA for short), key elements to identify on history include:

- Demographic data (including name, age, and weight);
- Recent or current symptoms of acute illness (like upper respiratory tract infection) or active chronic conditions (like a recent asthma exacerbation);
- Past medical history (including acute and chronic medical conditions, previous sedations and anaesthetics, and a thorough review of systems);
- Allergies;
- Medications;
- Family history of anesthetic complications;
- Social history; and
- Fasting status.

As a note, if the child is not currently fasting, the clinician should provide recommendations prior to the procedure, consistent with institutional guidelines and practices. Current guidelines ASA recommend a fasting period of at least 1 hour for clear liquids, 4 hours for human milk, and 6 hours for formulas and solid foods.

In addition to a detailed history, a focused physical exam is another critical component of the pre-evaluation for sedation. This should include baseline vital signs, cardiopulmonary exam, and airway assessment to identify barriers to intubation.

Classification

The history and physical exam in combination will allow you to classify the patient by the ASA Physical Status Classification System. This system scores children on a scale of 1 to 5 based on the severity of their symptoms. ASA I status is assigned to healthy children with no underlying conditions. ASA II status is assigned to children with only mild systemic disease (such as well-controlled diabetes or asthma). ASA III status applies to those children with severe systemic disease, such as asthma accompanied by active wheeze or complicated diabetes. ASA IV is assigned to those children with severe systemic disease that is a constant threat to life (e.g. sepsis or severe bronchopulmonary dysplasia). Lastly, ASA V status is assigned to children who are not expected to survive past 24 hours with or without the procedure in question, such as those with severe traumatic brain injury or severe septic shock.

Only those children with a classification of ASA I or ASA II are considered “appropriate” for procedural sedation by a non-anaesthesiologist clinician. Children who are ASA III or above warrant further evaluation by the anaesthesia team and may not qualify for sedation by the general clinician, as these children are at increased risk for cardiorespiratory complications.

Other children may also be at increased risk of complications and should be referred to anaesthesia for consultation prior to administering procedural sedation. This includes children with a potentially difficult airway, as indicated by previous difficulties or phenotypic features, such as craniofacial abnormalities or obesity, as well as children with pulmonary hypertension, or existing respiratory disease. It also includes children with obesity or obstructive sleep apnea. Preterm infants should also receive consultation, as this group is susceptible to post-anaesthetic apneas until age 60 weeks post conceptual age. It is important to note that all infants less than 6 months of age also have an increased risk of adverse events.

Naia’s chart shows that she weighs 24.6kg, which is at the 50th percentile for her age. Her father shares that she has a past medical history of well-controlled type 1 diabetes mellitus, and she has never been sedated or anesthetized before. She has no allergies and her only medication is insulin. Dad states that there is no family history of adverse reactions to sedation or anaesthesia. Naia has not eaten in the last 6 hours. Based on this information, you determine that Naia meets criteria for ASA Physical Status Level II, and is an appropriate candidate for procedural sedation without further consult from anaesthesia.

How will you prepare to ensure the procedure goes smoothly?

Complications

Overall, pediatric considerations for sedation will be different than those for adults. Because children are more likely to demonstrate spontaneous behaviors and movements, they can require deeper sedation levels. It is not uncommon for children to have varied responses to medications and progress to a deeper level of sedation than intended. As a result, clinicians administering procedural sedation must be prepared to manage children at any level of sedation.

Children also consume more oxygen than adults, so hypoxia can develop much more quickly during periods of respiratory depression. Respiratory depression is a serious concern in patients undergoing sedation, and must be recognized quickly so that immediate interventions can be performed.

Anatomical differences in the pediatric airway include a larger tongue or narrower airway, which may make airway management more difficult. Other patients at risk for difficult airway management include obese patients and patients with a historically difficult airway.

Emergency Preparedness

Having reviewed the potential complications of procedural sedation, what can clinicians and institutions do to remain vigilant in the prevention of adverse events?

Most adverse events can be prevented through proper patient selection, preparation, monitoring, and emergency management. The first key step in emergency preparedness is proper selection and classification of patients for procedural sedation, as previously discussed.

Next, prior to beginning sedation, clinicians must ensure availability of appropriate personnel, monitoring equipment, emergency equipment, and rescue medications.

What constitutes appropriate personnel? The CPS guideline states that at least two health care practitioners should be present during administration of procedural sedation. At least one clinician skilled in procedural sedation, advanced airway management, and resuscitation must be present at all times. If the clinician administering the sedation is also performing the procedure, the second, highly qualified assistant, such as another physician or a nurse with advanced resuscitation skills, can be delegated the responsibility for continuous patient monitoring and administration of medications. Adequate monitoring includes continuous pulse oximetry, intermittent blood pressure monitoring every 5 minutes, continuous 3-lead electrocardiography, and end-tidal carbon dioxide monitoring when available. The latter is specifically important for procedures requiring moderate to deep procedural sedation. Pulse oximetry is insufficient because normal saturations may be maintained long after the onset of inadequate ventilation. Intermittent auscultation should also be performed to assess airflow and mitigate risk of respiratory failure through early recognition of hypoventilation or airway obstruction.

Finally, let's talk about the final important component of our emergency preparedness strategy: emergency equipment and rescue medications.

Before administering procedural sedation, the clinician responsible should ensure availability of age- and size-appropriate emergency equipment, and immediate access to rescue medications including resuscitation drugs and reversal agents. These include Atropine, Epinephrine, Flumazenil, Naloxone, and Succinylcholine. We encourage you to read the CPS guideline for dosing recommendations.

A handy mnemonic for the checklist of emergency equipment is SOAPME:

- The S stands for suction catheters and apparatus.
- O stands for oxygen supply and delivery equipment, which includes flow meters, tubing, and nasal prongs.
- A stands for airway equipment - including face masks for various face sizes, both nasopharyngeal and oropharyngeal airways, laryngoscope handles and blades, endotracheal tubes, and stylets.

- The P stands for positive-pressure delivery system - for example, a bag-valve-mask apparatus.
- The M stands for monitors - like the O2 saturation monitors and ECG leads we discussed before.
- Lastly, the E stands for emergency cart - containing all necessary resuscitation equipment including alternate airways, tools for achieving vascular access, and associated medications.

Naia is being monitored by yourself, a clinician well-acquainted with procedural sedation, and a pediatric nurse with several years experience. You have prepared all of the emergency drugs and equipment you may require. You have calculated and plan to administer weight appropriate doses of medications you are familiar with and are ready to proceed with the lumbar puncture.

Medications

It is important to note that specific medications for procedural sedation are numerous and distinct. Medication choices vary widely based on patient characteristics, procedure type and duration, as well as institutional availability and practitioner familiarity. and are thus beyond the scope of this podcast. Clinicians administering procedural sedation should have a comprehensive understanding of agent onset, mechanism of action, and adverse effects for all medications they are administering.

Documentation, Monitoring and Recovery

Once emergency measures are in place and sedation agents are chosen and the team is ready to proceed, one team member should be assigned the task of monitoring and documenting throughout the procedure. Real-time vital signs should be recorded every 5 minutes throughout the sedation and every 15 minutes during recovery, until the patient has returned to baseline. Medications used, side effects experienced, and use of any emergency intervention previously mentioned, should also be documented. The efficacy of sedation used can be recorded using a formal scoring system. In addition to documentation of the pre-sedation evaluation and informed consent, discharge instructions should also be specified and recorded.

Importantly, if any reversal agent is given, the patient should be monitored for signs of cardiorespiratory depression. Most agents that reverse sedation have a shorter half-life than their counterpart sedatives. Therefore, all patients must be monitored until baseline vitals have been re-established, and overnight hospitalization for observation should be strongly considered for those patients requiring emergency intervention during sedation.

Conclusion

Let's review some take-home points to summarize:

1. The main goals of procedural sedation are to maximize patient comfort and safety, while minimizing movement and anxiety to ensure procedural success.

2. When considering a child for procedural sedation, you should perform a detailed history and physical exam. Consider the factors that place a child at increased risk for procedural sedation and their ASA classification, in determining whether procedural sedation can be administered safely by a non-anesthesiologist.
3. Emergency preparedness is imperative for the procedural sedation of any child. The clinician must ensure the appropriate personnel, monitoring equipment, and rescue medications are immediately available prior to commencing any procedural sedation in case the child deteriorates and resuscitation is required.

Thank you for joining us on this episode of PedsCases and stay tuned for more interesting and educational content!

References

1. Krmpotic K, Rieder MJ, Rosen D. Canadian Pediatric Society, Acute Care Committee, Drug Therapy and Hazardous Substances Committee, Hospital Pediatrics Section, Community Pediatrics Section, Pediatric Emergency Medicine Section. Recommendations for procedural sedation in infants, children, and adolescents. **Month**, 2021.
2. <https://www.cmaj.ca/content/192/40/E1162>