A Proposed Mechanism to Assess Knowledge of Pediatric Hospitalists to Identify and Manage Rare Events During Procedural Sedation

abstract

OBJECTIVE: The goal of this study was to assess the knowledge of pediatric hospitalists (PHs) in identifying and managing rare events during procedural sedation (PS) with ketamine and nitrous oxide (N₂O).

METHODS: A Web-based survey with multiple choice questions and case scenarios was used to determine the knowledge of PHs in identifying infrequent contraindications and managing laryngospasm, a rare life-threatening complication during PS. The survey was sent to all PHs at St Louis Children’s Hospital.

RESULTS: Forty percent of experienced PHs (>50 sedation procedures performed) and 5% of inexperienced PHs (<50 sedation procedures performed) identified all 4 ketamine contraindications. Twenty-one percent of experienced PHs and 4% of inexperienced PHs identified all 6 N₂O contraindications. Ninety-five percent of PHs identified presence of laryngospasm in a case scenario. As the patient in the case scenario progressed from partial to complete laryngospasm, 84% and 82% of PHs chose either the preferred or acceptable strategy to manage the patient. With further deterioration in the patient’s status in the scenario, 66% and 71% of PHs chose either the preferred or acceptable strategy to manage the patient. The preferred strategy at each step is one that attempted the least invasive maneuver to manage the patient. There was no significant difference between experienced and inexperienced PHs in the management of laryngospasm.

CONCLUSIONS: Knowledge gaps exist among PHs regarding contraindications for ketamine and N₂O that are infrequently encountered in patients and for the management of laryngospasm, a rare adverse event with ketamine. Ongoing teaching tools are necessary to assess and maintain the knowledge of sedation providers regarding rare events during PS that can improve their proficiency.

Pediatric hospitalists (PHs) across the nation provide sedation for various painful procedures and for radiologic imaging of children.¹⁻³ There is no national standard for training and credentialing of PHs for procedural sedation (PS). The Joint Commission requires ongoing professional practice evaluation (OPPE) of competencies for physicians in all areas of patient care.⁴ Measuring outcomes is the primary means of OPPE for physicians. However, outcomes alone may not be an appropriate measure of the competencies of PH sedation providers because PHs often do not have sufficient sedation volumes to encounter infrequent contraindications and rare complications during PS. Assessing the medical knowledge of
sedation providers to recognize infrequent contraindications and manage rare complications may be a means to assist in the OPPE of sedation providers. The hospitalist sedation program at St Louis Children’s Hospital consists of 50 PHs who provide PS at multiple settings in the hospital by using a variety of agents based on their training. All PHs provide sedation in the emergency department, and a core group of PHs in the division provides sedation in specialized sedation units. The sedation volumes of PHs are variable, ranging from 10 to 25 to 100 to 150 per year depending on if they are part of the core group of sedation providers. Thus, using outcomes alone as a measure of procedural competency may not be appropriate because many of the contraindications to sedation agents are infrequently encountered, and life-threatening complications such as laryngospasm are rare during PS.

In an effort to measure the medical knowledge of PH sedation providers, we developed a self-assessment teaching tool for the 2 most commonly used PS agents, ketamine and nitrous oxide (N₂O). Our goal was to identify knowledge gaps in PH sedation providers regarding rare complications and infrequent contraindications for PS and to develop strategies to address those gaps, thus improving the medical knowledge of PH sedation providers and the quality of a PH sedation program.

METHODS
A Web-based anonymous survey was developed by using a combination of multiple choice questions and case-based scenarios to determine the medical knowledge of PHs regarding the pharmacologic properties of ketamine and N₂O as well as contraindications to these 2 agents. A case scenario of a patient progressing from partial to complete laryngospasm was used to determine the knowledge of PHs regarding the management of laryngospasm. The questions in the scenario queried the ability of the PH to identify laryngospasm, proceed through the scenario, and make appropriate choices at each step. In the case scenario, the clinical presentation of partial laryngospasm is accompanied by stridor, which then progresses to complete laryngospasm presenting with total airway obstruction, an inability to ventilate, and a lack of chest movement with bag-mask-valve ventilation. The preferred answer to each question is based on our institutional consensus for management at that step of the scenario. This consensus does not necessarily represent the only acceptable treatment strategy for laryngospasm; thus, acceptable answers include responses reflecting effective management at a particular step. Initial steps in our algorithm for the management of laryngospasm consist of: (1) airway maneuvers to optimize airway patency that includes firm pressure applied over the “laryngospasm notch” accompanied by a vigorous forward pull of the mandible (jaw thrust) and neck extension; and (2) effective mask seal accompanied by application of 100% oxygen and continuous positive airway pressure, with or without ventilation. If these maneuvers are ineffective in relieving sustained glottis closure, the next step in our algorithm is administration of intravenous low-dose succinylcholine (0.5 mg/kg) to terminate the laryngospasm and facilitate assisted or controlled positive pressure ventilation.

The primary goal is to rapidly achieve effective bag-valve-mask ventilation and improve oxygenation, without tracheal intubation. Finally, if oxygen saturation continues to deteriorate, definitive management is to administer an intubating dose of succinylcholine (2 mg/kg) and perform direct laryngoscopy with tracheal intubation to secure the airway, optimize pulmonary ventilation, and treat hemodynamic collapse or bradycardia with atropine, if indicated. The case scenario was constructed so that respondents exit the case scenario as soon as they choose the option of intubating the patient, and they are then taken to the next question in the survey.

The survey was sent to all 49 PHs in our program. A χ² test and Fisher’s exact tests were used to determine if there was a significant difference between experienced and inexperienced PHs in the identification of contraindications and management of laryngospasm.

Institutional review board approval was obtained for the survey.

RESULTS
Sedation Experience of the Group
PHs were stratified into experienced versus inexperienced with respect to ketamine and N₂O, using a threshold of 50 procedures performed with each sedation agent. Fifty percent of PHs were experienced with ketamine, and 35% were experienced with N₂O. Thirty-five percent of respondents had performed sedation for ≥5 years. All of the PHs identified the sedative properties of ketamine, and 88% correctly identified the sedative properties of N₂O. A smaller percentage correctly identified their analgesic properties (ketamine: 88%; N₂O: 55%).
Identifying Contraindications

We queried PHs regarding 2 absolute contraindications for ketamine (schizophrenia and age <3 months) and 2 relative contraindications (increased intracranial pressure and elevated intraocular pressure), as per the clinical guidelines of Green et al (Table 1). As a group, experienced PHs showed greater awareness of most of the contraindications compared with inexperienced PHs. Nevertheless, only 40% of experienced PHs correctly identified all 4 contraindications (compared with 5% for the inexperienced group).

We queried PHs on 6 contraindications for N₂O sedation (Table 2). Although experienced PHs showed higher percentages of identification of each contraindication compared with inexperienced PHs, overall only 21% of experienced PHs identified all 6 contraindications (compared with 4% for inexperienced PHs).

Managing Complications

Ninety-five percent of PHs identified the presence of laryngospasm in the case scenario (Fig 1). As the patient progressed from partial to complete laryngospasm (steps 1 and 2), 84% and 82% of PHs chose either the preferred or acceptable answers to manage the patient. With further deterioration in the patient’s status (steps 3 and 4), 66% and 71% of PHs chose either the preferred or acceptable answers to manage the patient. The preferred answers at steps 1, 2, and 3 reflected a management strategy that attempted the least invasive maneuver to manage the patient at each step. There was no significant difference between experienced and inexperienced PHs in the management. There was a lack of awareness of the airway maneuver to manage laryngospasm, as shown by only 11% (n = 4) of PHs choosing that as a first step in the management of complete laryngospasm. Of those 11%, 3 of the 4 were experienced PHs.

DISCUSSION

The medical knowledge of sedation providers can affect their sedation proficiency. Because serious complications and major contraindications are encountered infrequently, it is important that OPPE measures the medical knowledge of PHs for dealing with such events. The results of our survey of PH sedation providers suggest that sedation training needs to be ongoing to maintain that knowledge base. Although PHs with greater experience in sedation (>50 procedures performed with a given agent) evidenced greater knowledge about contraindications to ketamine and N₂O compared with inexperienced PHs (<50 procedures performed), <50% correctly identified all the contraindications, suggesting that continued training is helpful to all PHs for maintaining their knowledge base. Laryngospasm is a rare but potentially life-threatening complication, with an incidence of 0.3% in an analysis of 8282 ketamine sedations by Green et al. It is important that PS providers
understand how to manage laryngospasm with less invasive maneuvers, such as continuous positive airway pressure for partial laryngospasm or airway patency maneuvers for complete laryngospasm, before attempting more invasive procedures, such as administration of succinylcholine to relax the vocal cord and intubation to secure the airway. There was also a knowledge gap regarding the appropriate dose of succinylcholine for intubation; 40% of PHs chose a lower dose than is recommended in a case scenario. Dosing information is available in the crash cart. Given that no intubations had been performed with ketamine sedations in the 5 years before the survey was conducted, it is likely that familiarity with the dosing of rescue medications (succinylcholine, atropine) had waned, emphasizing again the need for ongoing training to maintain high levels of proficiency.16

Our study is limited by the small numbers of PHs that were surveyed (n = 49) and the fact that all were from a single institution (St Louis Children's Hospital).

Several studies report the safety of PS by nonanesthesiologists (including PHs) by measuring the nature and incidence of adverse events.1–3 The rate of adverse outcomes during sedation is a measure of the OPPE of sedation providers. However, to the best of our knowledge, there are no studies measuring the medical knowledge of sedation providers for rare events, which can also affect their professional competency. Our sedation self-assessment survey is a useful tool to measure the medical knowledge of PH sedation providers in identifying infrequent contraindications and managing rare complications during PS. In conjunction with additional measures such as case-based simulation scenarios in the simulation center, this self-assessment tool can be useful for maintaining sedation knowledge of PH sedation providers, which in turn can improve their proficiency.

REFERENCES


2. Cravero JP, Beach ML, Blike GT, Gallagher SM, Hertzog JH; Pediatric Sedation Research Consortium. The incidence and nature of adverse events during pediatric sedation/anaesthesia with propofol for procedures outside the operating room.

![FIGURE 1 Laryngospasm case scenario. BMV, bag-mask-ventilation; CPAP, continuous positive airway pressure; HR, heart rate; OAW, oral airway. N for each question, number of PH who answered that question. N for each answer, number of PH who selected the answer in the box.](image-url)


