

Pediatric Emergence Delirium with Ketamine: A Current and Comprehensive Literature Review

AUTHORS: HT Nguyen, MCJ Tran, A Patel

AFFILIATION: University of Medicine and Dentistry of New Jersey, NJ

INTRODUCTION: Ketamine is a commonly used anesthetic agent both inside and outside of the operating theatre. ER physicians, orthopedists and other medical staff alike have used it for minor surgical procedures in the pediatric population, whereas anesthesiologists have used it for premedication and anxiolysis in children. As a phencyclidine, ketamine offers the advantage of amnestic anesthesia with potent analgesia. This unique property in addition to the relative maintenance of upper airway reflex patency, to the relative high dose requirement for apnea threshold, and to the relative bronchodilation effects has led to the widespread use. However, one of the main factors limiting its usage has been the adverse psychological effect in the postanesthetic recovery period where patients can experience hallucinations and emergence delirium. This is a literature review of ketamine-induced pediatric emergence delirium (ED) and how it affects perioperative management.

METHOD: A literature search from 1959 to present was conducted regarding ketamine-induced pediatric emergence delirium. Twenty relevant sources were identified and reviewed.

RESULTS: The incidence ranges from 3%⁴ to 100%⁶, where clinically relevant range is 5-30% in the adult population²⁰. This prevalence is less in the pediatric population²⁰. The risk factors for developing ED include age >15 years, larger doses >2mg/kg IV, rapid administration, female gender, personality disorders or frequent dreaming. Within the age <15 group, children who have higher ASA classification and who are less than 5 years old have a higher incidence of ED⁸.

DISCUSSION: Phencyclidine was first used clinically by Greifenstein in 1959, but was abandoned due to an unacceptably high rate of postoperative delirium. It was not until 1970 when ketamine emerged as a popular choice in this class of intravenous anesthetics. Ketamine was chosen from among 200 different phencyclidine derivatives because of its relatively low incidence of emergence delirium compared to the original formulation. Emergence delirium can be associated with auditory, visual, and confusional illusions which can progress to delirium. Interestingly, repeated doses of ketamine reduce the incidence of ED. Emergence delirium is characterized by vivid dreams and hallucinations that can complicate postoperative management and patient satisfaction. It usually occurs within the first hour of emergence and disappears within several hours, but has been described to occur even up to 24 hours after the administration of ketamine. There is a spectrum of ED severity presentation. Vivid dreams, illusions, and extracorporeal experiences (sense of floating outside one's body) can be associated with fear, excitement, euphoria and confusion. The mechanism is believed to be secondary to ketamine depressing the inferior colliculus and medial geniculate nucleus. These are auditory and visual relay nuclei. The result is a misinterpretation of auditory and visual stimuli. Additionally, losing skin and musculoskeletal sensations lead to impaired gravity perception, causing the extracorporeal experiences. Ketamine-induced ED is most effectively prevented with

benzodiazepines. Midazolam is more effective than diazepam. Diazepam at 0.1mg/kg intravenous and dexmedetomidine at 2.5microgram/kg intramuscularly reduces ED^{7, 14}. Thiopental and inhaled anesthetic can further decrease the incidence. In contrast, inclusion of atropine or droperidol as a premedication can increase the prevalence. Awakening in quiet areas or playing music during anesthesia has not been proven to attenuate emergence delirium. Ketamine has been shown to be effective as an adjuvant analgesic in neuraxial anesthesia and in a multimodal approach to acute postoperative pain control. The incidence of delirium in these situations was insignificant compared to the control groups. Small doses of ketamine intraoperatively during knee surgery improve postoperative pain. Caudal ropivacaine and ketamine assist in pediatric postoperative analgesia. Ketamine in an epidural mixture of morphine, bupivacaine, and epinephrine have additive analgesic effects. . It can be concluded that despite the concern for ketamine-induced pediatric emergence delirium, there are situations where incorporating ketamine into the anesthetic management improve patient outcome. Furthermore, it has been shown that these benefits may outweigh the negligible incidence of ketamine-induced pediatric ED, especially when adding other preventive pharmacotherapy.

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