Prolonged sedation and airway complications after administration of an inadvertent ketamine overdose in emergency department
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The use of ketamine for pediatric sedation in the Emergency Department for painful procedures has become increasingly popular. Ketamine is a safe and effective sedative for diagnostic or therapeutic procedures in the Emergency Department. Sedation with this dissociative agent produces a rapid onset action, potent analgesia, adequate sedation, amnesia and minimal side effects. We report a case of prolonged sedation and airway complications after administration of an inadvertent intramuscular ketamine overdose in a healthy child. European Journal of Emergency Medicine 2008, 15:92–94 © 2008 Wolters Kluwer Health | Lippincott Williams & Wilkins.

Keywords: airway complications, emergency department, ketamine, sedation, overdose

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Case report
A 3-year-old child was presented to the Emergency Department (ED) in our hospital, after cement that his father was preparing at home entered his eye. The patient was a healthy child, without medical problems. His weight was 15.8 kg. Physical examination was normal, except for pain and right ocular tumefaction and it was impossible to open it. The ophthalmologist’s evaluation was unsuccessful because of pain and child agitation. We decided to sedate the child with intramuscular ketamine to make exploration easy.

The parents were informed about procedural sedation, its risks and benefits, and informed written consent was collected.

The patient was placed on continuous pulse oximetry and a cardiac monitor. Before the procedure started the patient’s vital signs were: blood pressure 130/70 mmHg, pulse rate 161 beats/min, ventilation rate 34 breaths/min and oxygen saturation 96%. Data about allergies, prior illnesses and antecedents of problems related with sedative drugs were recorded. No contraindication existed for ketamine administration.

The nurse was told to administer 45 mg (3 mg/kg) intramuscular ketamine (Ketolar 50 mg/ml, vial 10 ml, for intramuscular or intravenous administration; Pfizer, Dublin, Ireland). Ketamine was injected without accidents and his effect began quickly, in 2 min. No coadministered medications were injected.

During the procedure, the patient was continuously monitored with pulse oximetry and his vital signs were registered every 5 min. The duration of ocular exploration was 10 min.

One hour and 15 min after ketamine administration, the child presented an episode of airway misalignment and oxygen saturation decreased to 82%. The child required manual airway-opening maneuvers and oxygen by a nonrebreathing mask; his oxygen saturation returned to 100%. During the next 2 h, he experienced four more similar events. He returned to the normal state with repositioning of the airway and supplemental oxygen in a few seconds. None of these episodes required bag-mask ventilation or pressure positive ventilation.

The patient did not return to pretreatment levels of verbalization, awareness and normal neuromuscular activity until 20 h after ketamine administration. Until recovery was well established, cardiac monitoring, pulse oximetry and medical staff supervision were continuous. No more events were detected. Thirty-six hours after ketamine administration, he was discharged.

In this case, when the child presented several episodes of airway misalignment and when he did not wake at the expected time, we suspected a dosing error. We spoke with the responsible nurse, checked the preparation and administered dose. The ketamine vial available in our ED is Ketolar 50 mg/ml (vial 10 ml). The nurse assumed that the vial contained total mg, so she administered 9 ml
Ketamine is unique among the agents used for procedural sedation and analgesia in that it produces a ‘dissociative state’. Ketamine exerts its effect by ‘disconnecting’ the limbic and thalamocortical systems. This ‘dissociative state’ is characterized by potent analgesia, sedation and amnesia whereas cardiovascular stability is maintained and spontaneous breathing and protective airway reflexes are preserved [1,2]. It is a drug extensively used in the ED for a variety of brief painful or emotionally disturbing procedures such as repair of injuries, reduction of fractures, foreign-body removal, genitourinary procedures, eye procedures, etc. [3]. Several studies have shown successful use of ketamine in well-structured sedation programs with trained personnel [4–11].

Ketamine can cause adverse effects, such as emergence phenomena (hallucinations, delirium), excessive salivation, clonus, hypertonicity, nausea, vomiting, transient diplopia, nystagmus, rash, elevation of intracranial and intraocular pressures and cardiovascular stimulation (tachycardia and hypertension). Airway complications are rare [12]. Some authors have tried to identify predictors of airway complications. They analyzed five potential predictor variables: age, sex, American Society of Anesthesiologists’ risk classifications, quantity of first ketamine dose and number of ketamine doses administered. Children with and without complications were compared. No study variables had significant univariate associations with airway complications [13].

Few publications have reported cases of airway complications after administration of intramuscular ketamine. Green et al., in a series of 1022 children who were given intramuscular ketamine (4 mg/kg), describe 14 cases (1.4%) with airway complications (airway misalignment, laryngospasm, apnea and respiratory depression). Seven cases demonstrated airway misalignment and, in five of these cases, transient oxygen desaturation was noted. In all these cases, repositioning airway was necessary. None required assisted ventilation [3].

Nine cases of inadvertent ketamine overdose previously have been reported in the literature. Overdoses were 5, 10 or 100 times the intended dose. In five children, the dosing error was not discovered until late in the sedation course, when the child was not waking at the expected time. Prolonged sedation was reported in all patients (3–24 h). Four children experienced brief respiratory complications (two after intramuscular administration). In all of these reports, respiratory depression occurred at the time of peak concentrations of drug, 1–2 min after intravenous administration and 4–6 min after intramuscular injection. Data suggest that ketamine-associated respiratory complications are a direct result of unusually high central nervous system concentrations [14]. Airway misalignment, however, may occur at any time during dissociative sedation [1]. For this reason, the pulse oximetry monitoring must be continuous.

When ketamine is administered by the intramuscular route the dissociative state begins in approximately 5 min and persists for 15–30 min. Resolution of the dissociative state occurs when the drug is distributed from the central nervous system to the peripheral tissue. Prolonged sedation would be expected with higher doses, in that the redistribution phase would be prolonged [14]. In our case, the patient was not waking at the expected time, showing prolonged sedation 20 h after drug administration. For this, we thought about the possibility that he had been administered an inadvertent ketamine overdose.

The control of pain and anxiety in the ED is an important facet of emergency medicine practice. Ketamine is one of the sedative drugs most used for painful procedures in the ED. The lack of regular use of this drug can produce errors in its preparation, as occurred in the described case. To minimize confusion, Green et al., recommend that only one of the three available ketamine formulations should be stocked in the ED. EDs that mainly use the intramuscular route should stock only the 100-mg/ml concentration, to minimize volume injection. To use by intravenous route exclusively, one might consider stocking only the diluted 10-mg/ml and administer it with a tuberculin syringe to maintain dose accuracy and spread the injection over at least 1 min. The 50-mg/ml concentration can be stocked in EDs that use both routes [14].

In our institution, when we use a sedative drug, the physician generally tells the nurse the quantity in milligrams of the drug she must administer. The nurse, depending on the drug formulations stocked in the ED, must calculate the dose to administer in milliliters. It is generally at this point when the mistake occurs. To avoid this error in the future, we have produced medication cards. These cards contain the quantity of milliliters that must be administered according to the weight, maximum drug dosage, contraindications and possible adverse effects.
effects. Nurses and physicians receive specific training for use of these cards.

The popularity of ketamine has grown and therefore, to avoid future complications, it is necessary that physicians and nurses, who are involved in the care of sedated children, are specifically trained in use of pediatrics sedative drugs, advanced airway maintenance and resuscitation. Therefore, continued training in this area is necessary in the ED.

References