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Sedation with Ketamine for Paediatric Procedures in the Emergency Department – A Review of 500 Cases

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ABSTRACT

Ketamine has been used to "consciously" sedate patients for a variety of paediatric procedures in our department since 1998. This is a retrospective review of the first 500 paediatric patients given ketamine for conscious sedation. Ketamine was given, either intramuscularly (3-4 mg/kg) or intravenously (1-2 mg/kg) together with atropine (0.02 mg/kg), with or without intravenous midazolam (0.05 mg/kg). The main indications for giving ketamine were for laceration repair, especially those of the lip, tongue and buccal mucosa (54.4%); manipulation and reduction of upper limb fractures (25.8%); incision and drainage of abscesses (12%), removal of foreign bodies (6.4%) and a potpourri of other conditions. Seventy-five point six percent of our patients were less than six years old and the male to female ratio was 1.9 : 1. Ninety-six percent of our patients were discharged home well and only one child (0.2%) was admitted for observation possibly as a consequence of ketamine. We find ketamine to be a relatively effective drug for use for conscious sedation in children.

Keywords: Ketamine, Conscious Sedation, Paediatric Procedures

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INTRODUCTION

Ketamine, together with atropine, has been increasingly used in recent years as an effective form of conscious sedation in children in an ambulatory or emergency room setting and its use has been found to be safe and useful for a variety of clinical indications.

Our department is the only local emergency room catering to children aged 16 years and below. Since September 1998, we have been using a combination of ketamine and atropine with or without midazolam either intramuscularly or intravenously to "consciously" sedate children who need to undergo various painful procedures in our department.

Table 1. Indications and contraindications for ketamine use in KK Children's Emergency Department.

Indications
• Short, painful procedures especially those requiring immobilisation. e.g. complex facial lacerations, reduction of fractures, and foreign body removal.
• Examination judged likely to produce excessive emotional disturbance.
Contraindications
• Age less than six months (use with caution for those six to 12 months old)
• History of airway instability, tracheal surgery or tracheal stenosis
• Procedures involving stimulation of posterior pharynx
• Active pulmonary infection or disease (including URTI)
• Full meal within three hours of procedure
• Cardiovascular disease including angina, heart failure or hypertension
• Head injury associated with loss of consciousness, altered mental state or emesis
• Central nervous system masses, abnormalities or hydrocephalus
• Poorly controlled seizure disorder
• Glaucoma or acute globe injury
• Psychosis Porphyria, thyroid disorder or on thyroid medicines

Through its use, we were able to carry out the various procedures effectively and discharge these patients home with or without follow-up, thereby avoiding an admission and/or general anaesthesia for the child.

MATERIALS AND METHOD

Table I gives the indications and contraindications for ketamine use in our department. These guidelines follow those of Green's group in Loma Linda[1]. All children undergoing conscious sedation in our department are closely monitored and their vital signs charted by our nurses on a conscious sedation chart and subsequently reviewed by our doctors to determine fitness for discharge. Table II lists the parameters that are monitored while Table III lists the criteria for discharge of patients from our department after conscious sedation. We retrospectively reviewed the first 500 cases in our department who had been given ketamine for conscious sedation. The period under review was from September 1998 to October

Table II. Conscious sedation monitoring chart.

Monitoring of parameters during conscious sedation
Airway : Norm (N) Maintained with ease (ME) Maintained with difficulty (MD) Not maintained (NM)
Colour : Norm (N) Mottled (M) Cyanosed (C)
Resp : Norm (N) Mild Resp Distress (MD) Severe distress (SD)
Blood Pressure
Heart Rate
Oxygen Saturation

NB: Till End of PROCEDURE = Parameters every 5 mins
Till End of OBSERVATION = Parameters every 15 mins

Table III. Criteria for discharge/discharge instructions.

General discharge criteria/instructions following conscious sedation:

- Normal Vital Signs
- Recognises, interacts with or is consolable by parent/caregiver
- Verbalise appropriately
- Motor function appropriate for age
- Able to swallow liquids
- Responsible parent/caregiver present

Table IV. Sex distribution (n = 500).

Sex	No of Cases	% of total (n = 500)
Male	330	66%
Female	170	34%

2000. Data were extracted from these records, and subsequently matched with our in-house computer records. Where necessary, the patients' actual case notes were traced and reviewed.

The ages of our patients were rounded to the nearest whole year. We looked at the various types of clinical procedures requiring conscious sedation and also the final outcome of these patients. The records of those admitted were reviewed to determine if these admissions were as a consequence of conscious sedation or otherwise.

Unfortunately, as this was a retrospective review, we could not fully record or interpret the range of side-effects encountered in this series.

RESULTS

Sex Distribution

The male to female ratio was 1.9 to 1 (Table III).

Table V. Age distribution (n = 500).

Age (in complete years)	No. of Cases	% of Total (n = 500)
1*	39	7.8%
2	93	18.6%
3	82	16.4%
4	63	12.6%
5	50	10.0%
6	51	10.2%
7	41	8.2%
8	29	5.8%
9	12	2.4%
10	10	2.0%
11	8	1.6%
12	9	1.8%
13	7	1.4%
14	1	0.2%
15	4	0.8%
16	1	0.2%

* NB :Youngest child = 10 months old

Age Distribution

More than three-quarters (75.6%) of our cohort were aged six years or younger (Table IV). Our youngest patient was 10 months old.

Doses of ketamine used and concomitant use of midazolam

The doses of ketamine given was between 3 mg/kg to 4 mg/kg intramuscularly (IM) or 1 mg/kg to 2 mg/kg intravenously (IV). All our patients were given atropine concurrently (0.02 mg/kg). Additional doses of ketamine were administered when clinically indicated. The cumulative dose of ketamine given was within the range for IV or IM as described above. Midazolam was also used together with ketamine in some instances with the aim of reducing the emergence phenenomen. One hundred and fifty-one cases (30.2%) were given midazolam together with ketamine and atropine. Eight of the patients (1.6%) had a topping up of their initial ketamine doses.

Types of Procedure

Table V summaries the types of procedures that underwent conscious sedation with ketamine in our cohort. Repair of complex lacerations constituted the largest group (54.4%) and this included repair of lip, tongue, buccal mucosa, other facial and digital lacerations, and nail bed injuries. The next big group was manipulation and reduction of upper limb fractures and dislocations (25.5%).

Table VI. Types of procedure (n = 500).

Types of Procedure	n = 500	Percentage of cohort (%)
Laceration Repair:	272	54.4%
Scalp lacerations	(67)	(13.4%)
Lip lacerations	(71)	(14.2%)
Tongue lacerations	(12)	(2.4%)
Other facial lacerations	(19)	(3.8%)
Digital lacerations/crush injuries	(95)	(19.0%)
Other lacerations	(8)	(1.6%)
Manipulation/Reduction:	129	25.8%
Upper limb fractures	(123)	(24.6%)
Dislocations	(6)	(1.2%)
Removal of Foreign Bodies:	32	6.4%
Nose	(17)	(3.4%)
Ear	(8)	(1.6%)
Other	(7)	(1.4%)
Incision and Drainage of Abscess:	60	12.0%
Eye	(27)	(5.4%)
Others	(33)	(6.6%)
Others:	7	1.4%
Zipper stuck in penis	(3)	(0.6%)
Stuck ear rings	(3)	(0.6%)
Removal of stitches over chin	(1)	(0.2%)

Table VII. Outcome of conscious sedation (n = 500).

Disposition	Number	% (n = 500)
Discharged	210	42%
Outpatient follow-up	270	54%
Admitted because of conscious sedation	1	0.2%
Other Admissions	18	3.6 %
Failure of manipulation and reduction	(11)	(2.2 %)
Other clinical Indications	(7)	(1.4 %)
Absconded	1	0.2 %

Side-Effects

As this was a retrospective series, we could not fully ascertain the spectrum of side-effects encountered in our cohort, particularly the incidence of emesis or transient desaturations. Other common side effects encountered were myoclonic jerks as well as generalised flushing. No one needed to be intubated. Recovery time could not be properly ascertained due to insufficient data recorded. One child had significant tonic-clonic jerks after ketamine was administered (see the last paragraph of "Discussion").

We also could not properly ascertain the degree of analgesia provided by ketamine due to the retrospective nature of the study.

Outcome

We managed to send 96% of our patients home following conscious sedation (Table VI). All were discharged by three hours post-procedure. Eighteen patients (3.6%) were admitted either because of the failure of the procedures or because of their clinical condition (e.g. laceration with head injury requiring 24-hour observation). Only one child (0.2 %) was admitted possibly as a result of the ketamine given to her (see "Discussion").

DISCUSSION

What is "Conscious Sedation"?

The term "conscious sedation" has been considered by many to be an oxymoron and a myth[2]. Frequently, in the context of painful paediatric procedures, "unconscious sedation" is required to achieve an adequate level of sedation and analgesia. The definition of various states of sedation are shown in Table VIII[3-10].

The goals of procedural sedation are[7]:

- to guard the patient's safety and welfare
- to minimise physical discomfort or pain
- to minimise the negative psychologic responses to treatment by providing analgesia, and to maximise the potential for amnesia
- to control behaviour
- to return the patient to a state in which safe discharge is possible.

What is Ketamine?

Ketamine has been in use since 1970[11-14]. It is an effective and safe drug for use as conscious sedation in children and it has been increasingly used in the paediatric outpatient setting[15] over these last few years.

Besides being a dissociative anaesthetic[12-14], ketamine has analgesic properties and acts non-competitively at the N-methy-D-aspartate (NMDA) receptor as well as reducing the presynaptic release of glutamate and antagonising the muscuranic and nicotinic acetylcholine receptors. Ketamine is best described as a "Dissociative Sedation". This is defined as "a trancelike cataleptic state characterised by profound analgesia and amnesia, with retention of protective airway reflexes, spontaneous respiration and cardiopulmonary stability[16]."

Use of Ketamine in children

There have been various reports of the relative safety of ketamine for conscious sedation in children[17-24] with largest paediatric series to date (n = 1022) from Steven Green's group[17-19] in Loma Linda.

Ketamine can either be given intramuscularly (IM) or intravenously (IV). The optimal dose for IM ketamine is not known. Green et al found that intramuscular ketamine doses of 4 to 5 mg/kg produced adequate sedation in 93% to 100% of their patients[25]. We have been using an IM dose of 3 mg/kg to 4 mg/kg and an IV dose is 1 mg/kg to 2 mg/kg.

Table VIII. Definition of sedation states.

Lighter ←	level of sedation →		Deeper
AAP 1991/2	**Conscious sedation:** A medically controlled state of depressed consciousness that 1) allows protective reflexes to be maintained 2) retains the patient's ability to maintain a patent airway independently and continuously 3) permits appropriate response by the patient to physical stimulation or verbal command (e.g. "open your eyes")	**Deep sedation:** A medically controlled state of depressed consciousness or unconsciousness from which the patient is not easily aroused. It may be accompanied by a partial or complete loss of protective airway reflexes and includes the inability to maintain a patent airway independently and respond to purposefully to physical stimulation or verbal command.	**General anaesthesia:** A medically controlled state of unconsciousness accompanied by a loss of protective reflexes including the inability to maintain a patent airway.
ACEP 1994	**Sedation:** Controlled lessening of a patient's awareness of the environment and/or pain perception while maintaining stable vital signs, an independent airway, and adequate spontaneous respirations.	**Deep sedation:** Profound depression of awareness to any stimuli. This state is frequently accompanied by a loss of protective reflexes and requires active attention to appropriate airway and ventilatory management and blood pressure control.	**General anaesthesia:** Complete loss of awareness of the environment accompanied by loss of protective reflexes.
ASA 1996	**Sedation/analgesia:** A state that allows patients to tolerate unpleasant procedures while maintaining adequate cardiorespiratory function and the ability to respond purposefully to verbal command and/or tactile stimulation.	**Deep sedation:** Patients whose only response is reflex withdrawal to painful stimuli are likely to be deeply sedated, approaching a state of general anaesthesia, and should be treated accordingly.	**General anaesthesia:** undefined.

NB:
AAP : American Academy of Pediatrics
ACEP: American College of Emergency Physicians
ASA : American Society of Anesthesiologists.

Both have been found to be equally effective, with the IM route having a slower onset of action (within three to five minutes) and the IV route having a quicker onset but shorter duration of sedation due to its rapid redistribution. A reasonable practice would be to use the IM route for longer and more complex procedures because of its sustained sedative effects and to use the IV route for quick "in-and-out" procedures. When using the IV route, ketamine should be given gradually.

Side-Effects of Ketamine

The side effects of ketamine are generally mild and self-limiting. Transient oxygen desaturations might occur and these are managed with brief courses of oxygen. Some patients also develop transient flushing over the face and torso. In children, secretions induced by ketamine can sometimes cause significant pooling and obstruction of the airway[17,18,26]. For this reason ketamine is used concurrently with atropine.

Emesis is also a common side-effect occurring with increasing age (12.1% in those aged five years and above compared to 3.5% in those younger than five years old)[26].

The so-called emergence reactions or recovery agitation with ketamine[26-29] occurs more often in older children (more than 10 years old) and adults rather than in younger children. The behavioural side effects of ketamine may be due to its actions at the nicotinic receptors. In recent reviews, this phenomenon was found to be minimal in young children. It is possible that the incidence in younger children is lower because younger children might not be able to verbalise or describe effects such as bad dreams. The practice of adding midazolam to the ketamine/atropine combination to minmise the emergence phenemenon has been questioned[27,29]. Some studies suggest that there is a higher incidence of emergence reactions occurring with midazolam together with a higher risk of respiratory depression. Sherwin et al[27] concluded that concurrent administration of IV midazolam with IV ketamine did not diminish agitation and had no measurable effect. Wathern et al[29] concluded that addition of IV midazolam in those 10 years or older was associated with more agitation (5.7% versus 35.7%) and that midazolam did not alter the incidence of emergence phenomenon.

Only Green at al's series seem to indicate the reverse[28]. They found that recovery agitation was inversely associated with increasing age but questioned whether this was because the pre-procedural level of agitation, possibly being higher in their series,

could have resulted in the younger children being more prone to recovery agitation. Though we did initially routinely use midazolam with ketamine, we have now abandoned this practice.

Ketamine can give rise to myoclonic jerks or involuntary movements[17,18,26]. The myoclonic jerks can be very gross but is self-limiting. However, seizures associated with ketamine have not been previously reported. We are still uncertain whether the gross jerks noted in the seven-year-old girl represented myoclonic jerks/involuntary movements or an actual seizure event. This patient had previously been well and ketamine was given for manipulation and reduction of a upper limb fracture following a fall. There had not been an associated head injury and while in the ward for a day, this child remained well.

CONCLUSION

In this study, we have shown that ketamine is an effective drug and suitable for use in children requiring conscious sedation for a variety of painful procedures. The side-effects encountered was minimal, though we could not better quantify this in this retrospective review due to the lack of data recorded. Ninety-six percent of our children could be safely discharged home following ketamine administration and only one patient (0.2%) had to admitted due to the possible side-effects of ketamine. She too was discharged well after a night's observation. We have since embarked on a more detailed audit of all cases of conscious sedation undertaken in our department prospectively. This will allow us to better define all the side-effects that might result from the use of ketamine as well as better determine the recovery time from conscious sedation for our patients.

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