Sedation in children requiring MRI in a regional hospital: a retrospective study

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Abstract

Background: Many children undergo stressful procedures as part of their medical treatment. One of which is the Magnetic Resonance Imaging (MRI). MRI scans require patients to be still for prolonged periods. For children, a MRI scan can be confronting and scary. In our hospital we use sedation to minimise distress for the child and also optimise the quality of the MRI scan.

Objectives/aims: The purpose of this study was to assess the quality, success and safety of the hospital Paediatric sedation Clinical Practical Guidelines (CPG) in managing children who required sedation for MRI scans.

Method: A retrospective study of sedation episodes were analysed at the Ballarat Health Services over the period of Sep 2015 to Oct 2017. Data was collected from patients between the ages of 1 day to 18 years of age. Demographic data, fasting status, non-pharmacological techniques, drugs used, adverse effects, indication and type of MRI were studied. Success and failure rate of sedation were calculated. A primary outcome was defined as completion of a quality MRI scan. A failed outcome was the MRI requiring rebooking. Adherence to local sedation protocol was checked.

Results: Of the total 80 episodes identified, MRI scans were requested for the following body area (74% Brain, 6% Spine, 10% Brain and spine, 1% Brain and orbit, 9% musculoskeletal). Chloral hydrate (oral), midazolam (oral, intranasal, buccal, and intravenous) and ketamine (intravenous) were the drugs used. The success rate was 89%. Eight for MRI Brain, one for MRI spine had unsuccessful sedation. Of these, 2 occurred when the protocol was followed, 7 episodes had variations in the protocol. Distraction, verbal reassurance and sleep deprivation were also used.

Adverse events occurred on 30% of occasions. In 4% of occasions these were classed as severe eg desaturations, dizzy spells.

Implications/outcomes for planned research project: The availability of guidelines and facilities to provide sedation for children in rural/regional hospitals minimises travel, risks of GA and the waiting time. The sedation CPG safely manages children for this painless sedation and changes have been recommended to the CPG to address adverse events and better streamline choice of sedation for the different age groups.

Final thoughts: Similar initiatives may be useful in other regional/rural hospitals to help enhance the patient experience and minimise travel.

Introduction

Procedural sedation and analgesia is a common clinical practice that alleviates pain, anxiety, and suffering for patients during medical procedures. Effective sedation enhances the performance of these procedures, with improvements in the patient and medical provider experience. Procedural sedation involves administering sedative or dissociative agents with or without the concomitant delivery of analgesic agents (2)

Purpose of the study

- To assess the success/failure rate of sedation in children requiring MRI since the creation of the clinical practice guideline (CPG) in 2015
- To find if there is any correlation between type of MRI (Brain, spine etc.) with or without IV contrast and sedation requirements
- To assess if babies <4 months required more than 'feeding and wrapping'
- To assess the compliance with the clinical practice guidelines/sedation protocol

Definitions

Procedural sedation should be viewed as a treatment strategy for the administration of sedative or analgesic medications to intentionally suppress a patient's level of consciousness. The intended sedation depth should vary in accordance with the specific needs of the patient and procedure. Sedation depths of "mild," "moderate," and "deep" levels of altered consciousness are frequently cited in the medical literature (2)

The university Michigan sedation score (3)

The following score was used to assess the depth of sedation.

0 Awake and alert

1 Minimally sedated; may appear tired/sleepy, responds to verbal conversation and or sound

2 Moderately sedated; somnolent/sleeping; easily roused with light tactile stimulation or simple verbal command - also known as conscious sedation.

3 Deep sedation; deep sleep, rousable only with deep or significant physical stimulation

4 Unrousable

Methodology

Children between age 1 day to 18 years who required MRI with or without sedation in a regional hospital were studied retrospectively between Sep 2015- Oct 2017. List was collected from the ward book and the clinical coding department.

As per our hospital sedation protocol, babies up to the 3-4 months should be fed and wrapped as the first choice. We used oral chloral hydrate, oral/buccal/intranasal/intravenous (IV) midazolam and IV ketamine. All patients were assessed for adequate fasting prior to use of sedating drugs.

We applied the '2-4-6' fasting rule for elective procedures using moderate sedation.

- 2 hours for clear fluids
- 4 hours for breast milk
- 6 hours for solids and formula milk
- For an emergency procedure where a child is not fasted, the anaesthetic department was called as the airway needed to be secured prior to procedure.

Sedation episodes were considered successful when the MRI got completed with good quality films and the episodes which required rebooking of the MRI were considered to be the failed episodes.

Assessment

History

Before sedation, a history was taken to document any previous sedation events/complications, baseline status and to determine if the patient had any specific risk factors that warranted additional consultation before sedation.

Basic medical data was collected:

- age and weight
- vital signs
- medications
- allergies
- physical abnormalities

Risk factors requiring consultant input were assessed.

Clinical assessment

- Fasting status as mentioned above was confirmed.
- A physical examination, including a focused evaluation of the airway (tonsillar hypertrophy, abnormal anatomy [e.g. mandibular hypoplasia]) was done to determine if there is an increased risk of airway obstruction.

Monitoring during/after the procedure

Continuous pulse oximetry, heart rate and respiratory rate monitoring occurred throughout the procedure.

Equipment

An easily accessible emergency cart or kit containing equipment to provide the necessary age- and size-appropriate drugs and equipment to resuscitate a non-breathing and unconscious child was

made available. The contents of the kit allowed for the provision of continuous life support while the patient was being transported within the hospital. All equipment and drugs were checked and maintained on a scheduled basis. The patient with a sedation score of 2 or more was accompanied by 'a competent clinician' and nurse. A competent clinician is defined as a staff member who has the knowledge, skills and training to:

- Observe and interpret the patient's level of sedation and vital signs.
- Maintain airway patency and adequate ventilation.
- Understand the pharmacology of the sedation agent, potential complications/risks and appropriate use of antagonist agent.

All paediatric patients sedated in children's ward being transported to radiology had an 'airway kit' accompanying them which had,

1. Appropriately sized Bag/valve mask with oxygen and suction checked and available.
2. Appropriately sized guedel airway
3. Paediatric yankauer sucker attachment
4. Continuous pulse oximeter monitoring
5. Mobile phone/ward phone

Documentation

- 'Time Out': Confirmed correct patient ID before administering sedation
- Doctor documented sedation drugs on medication chart
- Paediatric Sedation Record MR/005.02 completed prior to sedation being given
- Doctors/Nurses administered sedation and documented time of administration
- For children in MRI with sedation, nurse documented HR, RR and oxygen sats every 5 minutes during procedure on age appropriate VICTOR chart

Discharge criteria

- Normal vital signs
- Return to pre-sedation level of conscious state: Alert and oriented for development age
- Nausea/vomiting adequately managed
- Discharge instructions given to parent or guardian

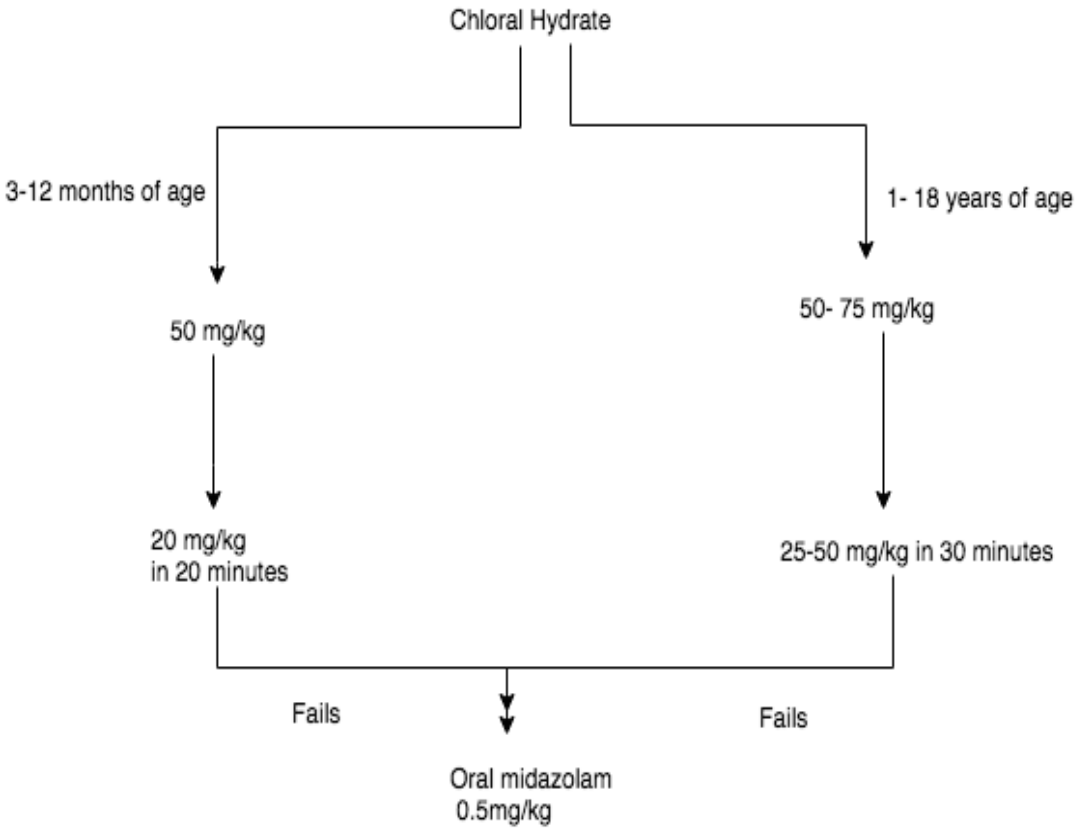
Data analysis

There were total of 80 sedation episodes. Of the MRI taken, there was about 59 (74%) of Brain MRI, 8 (10%) of Brain and spine MRI, 7 (9%) of musculoskeletal - knee, wrist, elbow, hip, pelvis, right thigh and leg MRI. Spine MRI constituted about 6% (5) and there was only one Brain and orbit MRI. Of these, about 30% (24) of MRI required IV contrast.

Our hospital sedation clinical practice guideline (CPG)

Our sedation protocol recommended to use oral Chloral hydrate at a dose of 50 mg/kg with a top up dose of 20 mg/kg in interval of 20 minutes if needed, for children between 3-12 months of age. 50-75 mg/kg of chloral hydrate with a top up dose of 25-50 mg/kg in 30 minutes' interval for children between 1-18 years of age. For children who did not get sedated with chloral hydrate, the recommended second line medication was oral midazolam at a dose of 0.5 mg/kg. The same is depicted below in the flow chart 1.

Flowchart 1 showing the hospital protocol

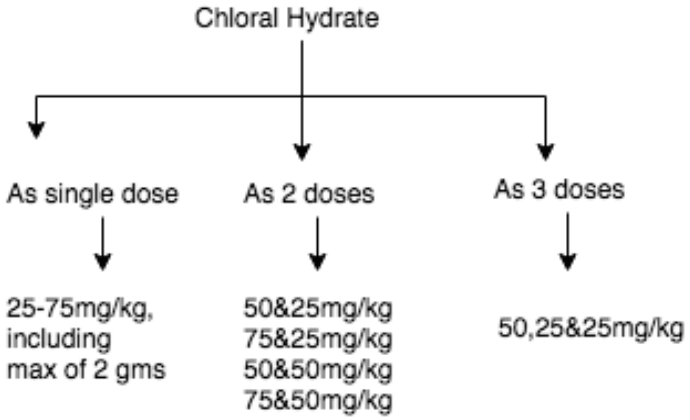


Medication and number of doses used in practice for sedation

Chloral hydrate

The study showed that we used a single dose of Chloral hydrate most of the time. Chloral hydrate was used at a dose of 25-75 mg/kg as a once only dose to a maximum of 2 grams, as 2 doses at a dose of 50-75 mg/kg as the initial dose followed by 25-50 mg/kg as the top up dose or with 2 top up doses of 25 mg/kg each after the initial dose. See flowchart 2.

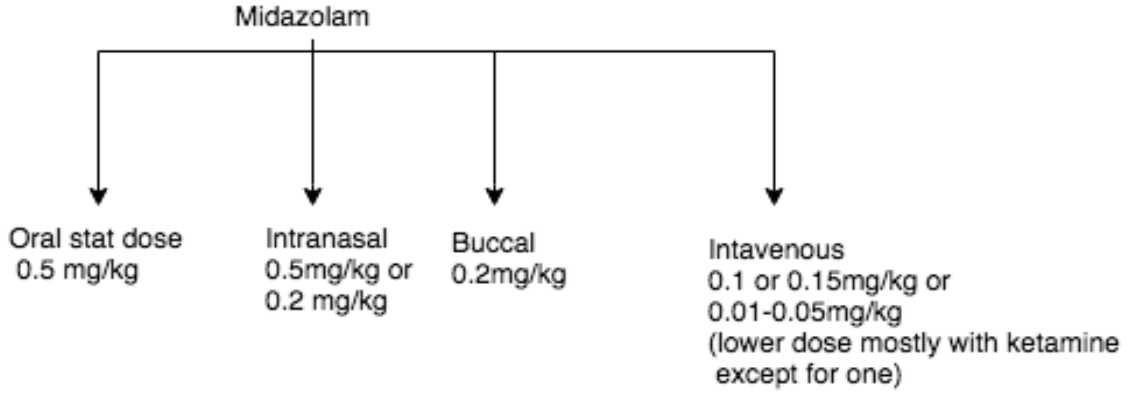
Flowchart 2 Chloral hydrate, dosage and number of doses used in practice



Midazolam

Oral, intranasal, buccal and intravenous routes were used for administration of midazolam. 0.5 mg/kg was used for the oral and 0.2-0.5 mg/kg was used for the intranasal and buccal routes. For the intravenous administration, doses ranging from 0.001- 0.005 mg/kg to 0.1- 0.15 mg/kg were used. See flowchart 3.

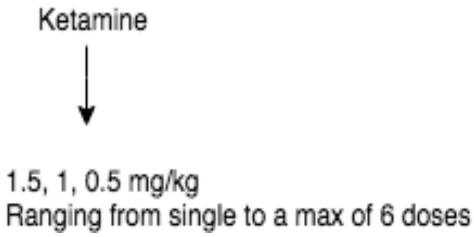
Flowchart 3 Midazolam, doses and routes used



Ketamine

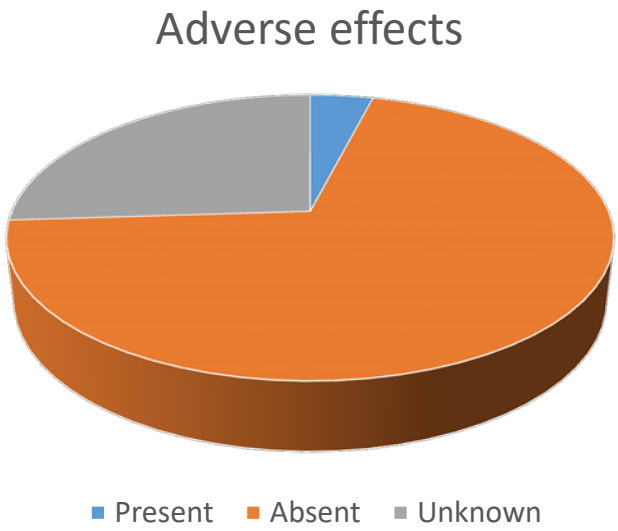
Ketamine was used intravenously at a dose ranging from 0.5 mg/kg to 1.5 mg/kg to a maximum of 6 doses. See Flowchart 4.

Flowchart 4 **Ketamine, doses used**



Adverse effects

Picture 1 **Adverse effects**



There were adverse effects like desaturations requiring supplemental oxygen, vomiting, and brief dizzy spell but none of them required met calls or resuscitation.

Success/failure rate

Of the 80 episodes, 71 (89%) had successful MRI and 9 (11%) had failed MRI. Of the 9 failed ones, 8 (89%)- were MRI Brain, 1/9 (11%) was failed MRI spine.

Table 1 **Sedation requirements in different age group**

Age	Chloral Hydrate (CH) as the initial drug	Consultant's choice of choosing a different agent as the initial drug	Success with only CH (not requiring further medication)
<1year	26/28 (93%)	2/28 (7%)	24/26 (92%)
1-5 years	26/28 (93%)	2/28 (7%)	21/26 (81%)
5-10 years	20/20 (100%)	0/28 (0%)	12/20 (60%)
>10 years	2/4 (50%)	2/4 (50%)	2/2 (100%)

As mentioned above in table1, Chloral Hydrate was used as the initial drug in 26/28 (93%) in children <1-year-old. Of the 26 children, 24 of them did not require further medication to sedate them and chloral hydrate resulted in successful sedation 92% of the time in children who were <1-year-old.

In the next group of children aged between 1 to 5 years of age, chloral hydrate was used as the initial drug in 26 children of the total 28 (93%), Of the 26 children, 21(81%) did not require other medications to get sedated. In the third group of children, aged between 5-10 years of age, chloral hydrate was used as the initial drug 100% of the time, 20/20 and of the 20 children, only 12 (60%) of them did not require further medications for sedation that was required for a successful MRI.

Of the total four children aged >10 years of age in our study, two of them had chloral hydrate as the initial drug (50%), they both (100%) did not require further medication to complete the MRI.

From the above Table 1, it was noted that chloral hydrate had more success rate with younger children than older children with the exception of >10 years old where other non-medical factors had much influence in the success of the MRI.

Table 2 Comparison of requirement of medications other than chloral hydrate

	Only MIDAZOLAM GROUP (IV, oral & IN)	**Only KETAMINE GROUP (IV)**	**Both Midazolam and Ketamine group**
Total	10/80 (13%)	2/80 (3%)	7/80 (9%)
MRI	7 (70%) MRI Brain, 2 (20%) B&S, 1 (10%) spine 8 no contrast, 2 contrast	All-Brain, without iv contrast	5 (71%) MRI brain, 2 (29%) B&S, 4 (57%) contrast
Successful	6/10 (60%)	½ (50%)	5/7 (71%)
Failed	4/10 (40%)	½ (50%)	2/7 (29%)

Comparison of other medication requirement including intravenous drugs

Of the total 80 episodes, we have used midazolam, ketamine other than chloral hydrate 19 times (23%), see Table 2. Of the total 80, midazolam (intravenous, oral and intranasal routes) was used 10 times (13%), ketamine intravenous was used twice of the 80 (3%). On seven occasions, we have used both ketamine and midazolam (9%). On comparing the occasions where midazolam and ketamine were used, a similarity was noted, among the 19 episodes. The similarity was that, all of those sedation episodes requiring medications like midazolam/ketamine were for MRI brain, brain and spine or spine. On further discussion with our radiographers, we noted that MRI spine required prolonged sedation as its time consuming and MRI brain required relatively deeper sedation for the child to stay still and not to move the head, for good quality films.

Table 3 Unsuccessful episodes (9/80 (11%)

Age	Medication in mg/kg	Protocol followed?	Reason	Repeat MRI/Rebooking
3 years	CH 71 + 25, midazolam oral 0.5	Yes	Poor oral compliance, No IVC (intravenous cannula)	Rebooked
1 year	CH 75 + 25 midazolam oral 0.5	Yes	Failed cannulation attempts	Successful with Ketamine 1 + 1 + 0.5 + 0.5 + 0.5 + 0.25
6 years	CH 70 + IV midazolam 0.1 + 0.1 + Ketamine 1 + 0.5 + 0.5	No	Not sedated, moving	Rebooked
6 years	CH 73 & 20 + IV midazolam 0.01 + ketamine 1	No	Unsettled, restless and moving	Rebooked
7 years & 6 years	CH 75	No	No IVC, MRI staff unable to reschedule	Rebooked
3 years	CH 50 + 15	No	No IVC	Partially successful with Ketamine 1, 0.5, 0.5→referred to RCH
14 years	Midazolam 0.2 IN	No	Consultant choice to go for IN midazolam, Not sedated, moving, rescheduled/no IV cannula	Midazolam 1mg iv max dose + Ketamine iv 1 + 0.5
3 months	Midazolam oral 0.5	No	Fed & wrapped, dummy offered→ unsettled/no IV Cannula	CH 25 + 6 doses of 0.1 iv midazolam

The above Table 3 shows, of the total 80, (11%) 9 sedation episodes failed to give a successful outcome and it was noted that most of the time, 6 out of the 9, absence of intravenous cannula was one of the reason why further medications could not be used to sedate. MRI booking for the day was full that they could not reschedule or wait for cannulation to be done when the initial sedation failed and hence the failed MRI had to be rebooked on another day.

Of the 9, on three occasions chloral hydrate was used as a single drug, not in adequate dosage and further medication (oral midazolam) was not used. On two other occasions, Chloral hydrate followed by oral midazolam were used but could not achieve the required sedation both the times. One of them had poor oral compliance and spat out most of the oral medications. Oral and intranasal midazolam were used as the initial medication on two other episodes of sedation and the children were not sedated adequately and the MRI was rebooked.

Chloral hydrate followed by intravenous medications (iv midazolam, iv ketamine) were used during two of the sedation episodes at different doses but failed to sedate on both the occasions.

Of the 9 failed, variation in protocol was noticed seven times and the protocol was followed twice.

Successful episodes 71/80 (89%)

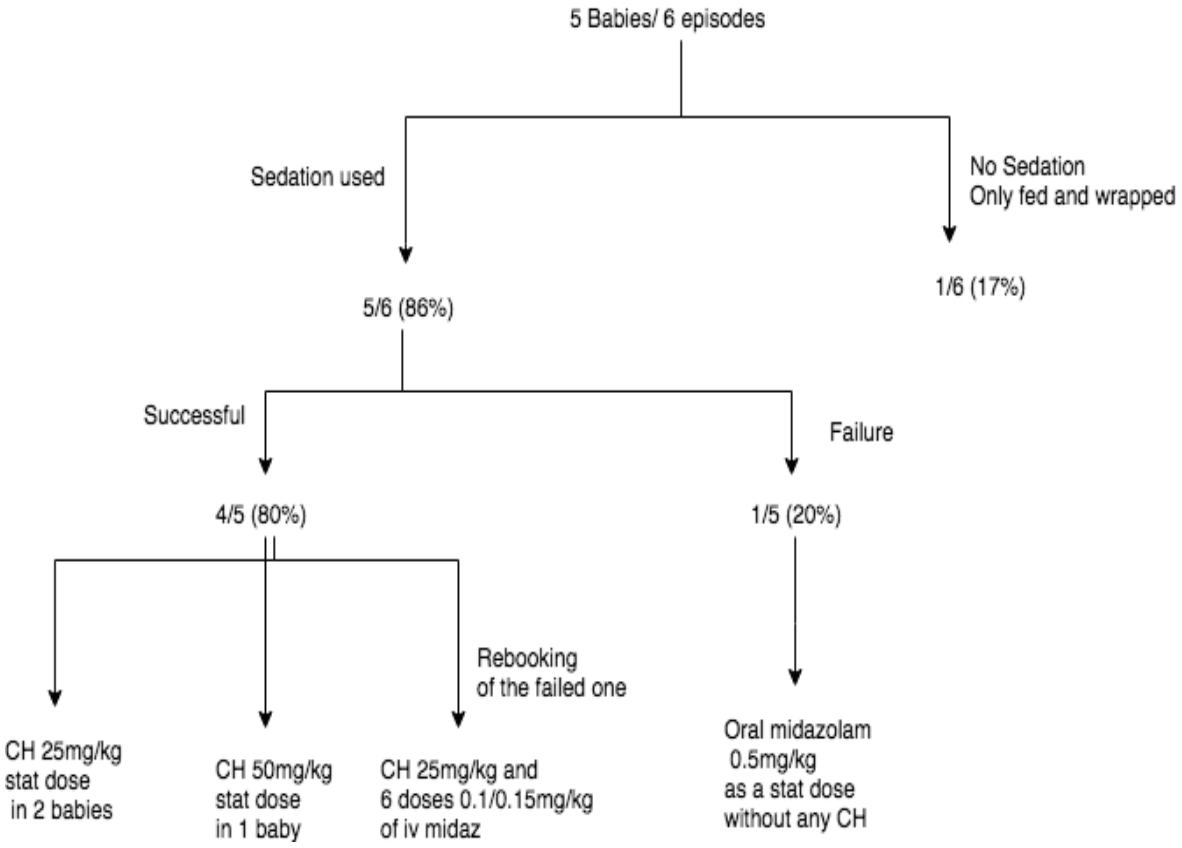
Of the total 80 episodes, 71 (89%) had successful outcome. Of the 71, chloral hydrate was used as the single agent in 59 episodes which constitutes about 83%. Other drugs were used on 12 occasions (17%) of the total 71 successful episodes.

Protocol variations

The sedation episodes in 12 of the successful 71 (17%) had variations in the hospital sedation protocol. In 6 children, we have used chloral hydrate followed by IV midazolam in 2 different doses 0.01-0.05mg/kg or 0.1mg/kg followed by Ketamine usage in two. In the other 4, chloral hydrate was used followed by intranasal/buccal midazolam. On 2 occasions, intranasal midazolam/IV ketamine was used as the initial drug without any Chloral Hydrate.

Babies: less than 4 months of age

Flowchart 5 Sedation in babies<3 months old



There were six MRI done in five babies who were <3 months of age, see flowchart 5. Of the six MRI done, one did not require any sedation and was only fed and wrapped. Sedation was used in the remaining five (86%). Of these five, four were successful (80%) and 1 failed (20%). Among the four successful ones, chloral hydrate was used as the only drug for three and the other one required chloral hydrate followed by multiple doses of intravenous midazolam.

Oral midazolam was used as the initial and the only drug in the baby 1/5 (20%) who failed sedation. It was noted that babies required more than feeding and wrapping and most of them were successful with chloral hydrate.

Conclusion

- Sedation when used cautiously works most of the time with minimal adverse effects
- 89% 8/9 of failed ones were MRI Brain, 11% 1/9 was MRI spine as they required prolonged and relatively deeper sedation
- Absence of intravenous cannula /failed attempts of cannula was significantly affecting the failure rates.
- Babies often required more than feeding and wrapping.
- Chloral Hydrate worked better in younger children than older children when used alone.
- Only MRI Brain, spine, Brain and spine required intravenous sedation.

Outcome

- The procedural sedation clinical practice guideline (CPG) is in the process of getting updated to reflect clinical practice, flowchart 6 and 7 shown in the next page.

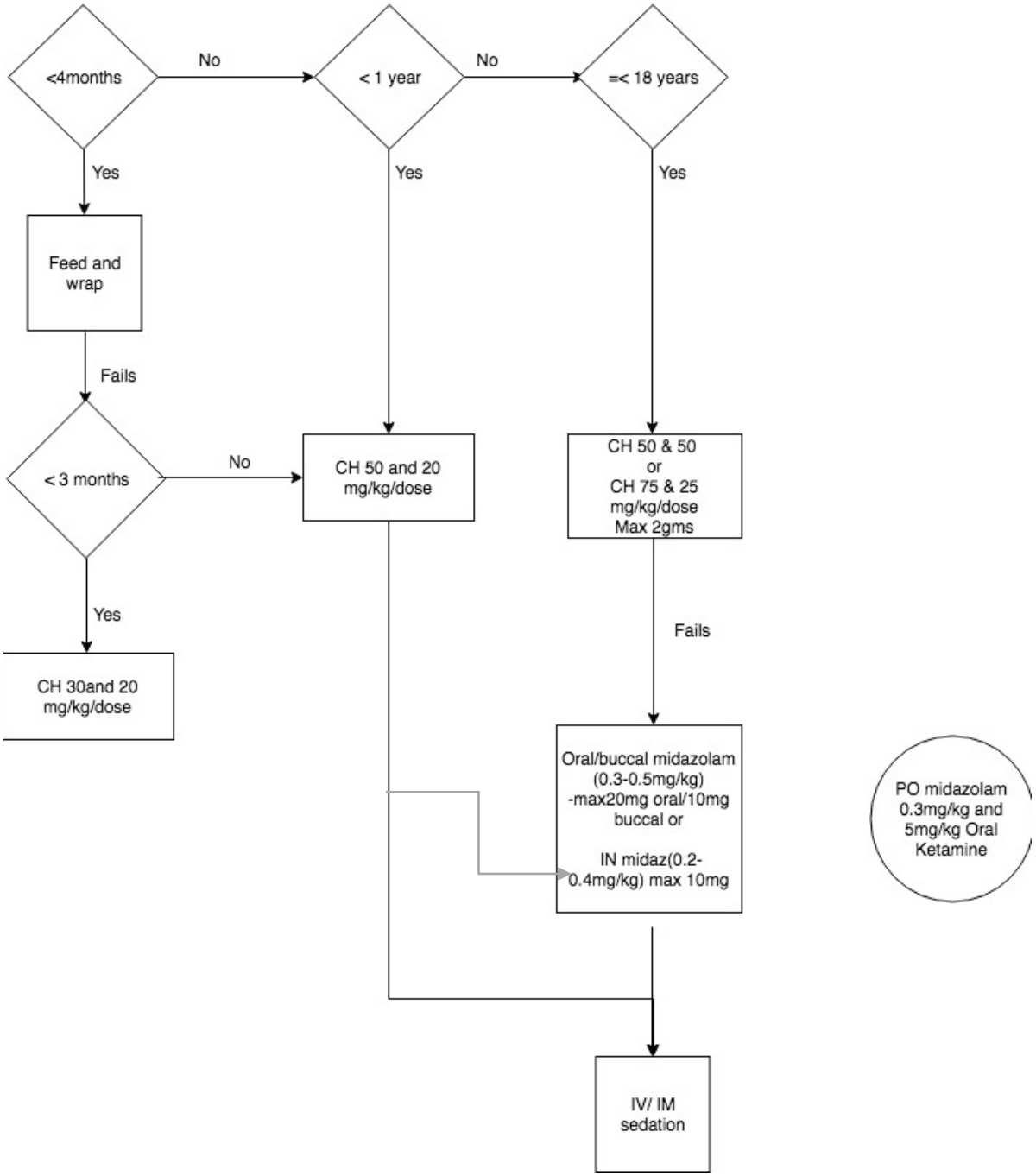
Implications

The availability of guidelines and facilities to provide sedation for children in rural/regional hospitals minimises travel, risks of General Anesthesia and the waiting time. The sedation CPG safely manages children for this painless sedation and changes have been recommended to the CPG to address adverse events and better streamline choice of sedation for the different age groups.

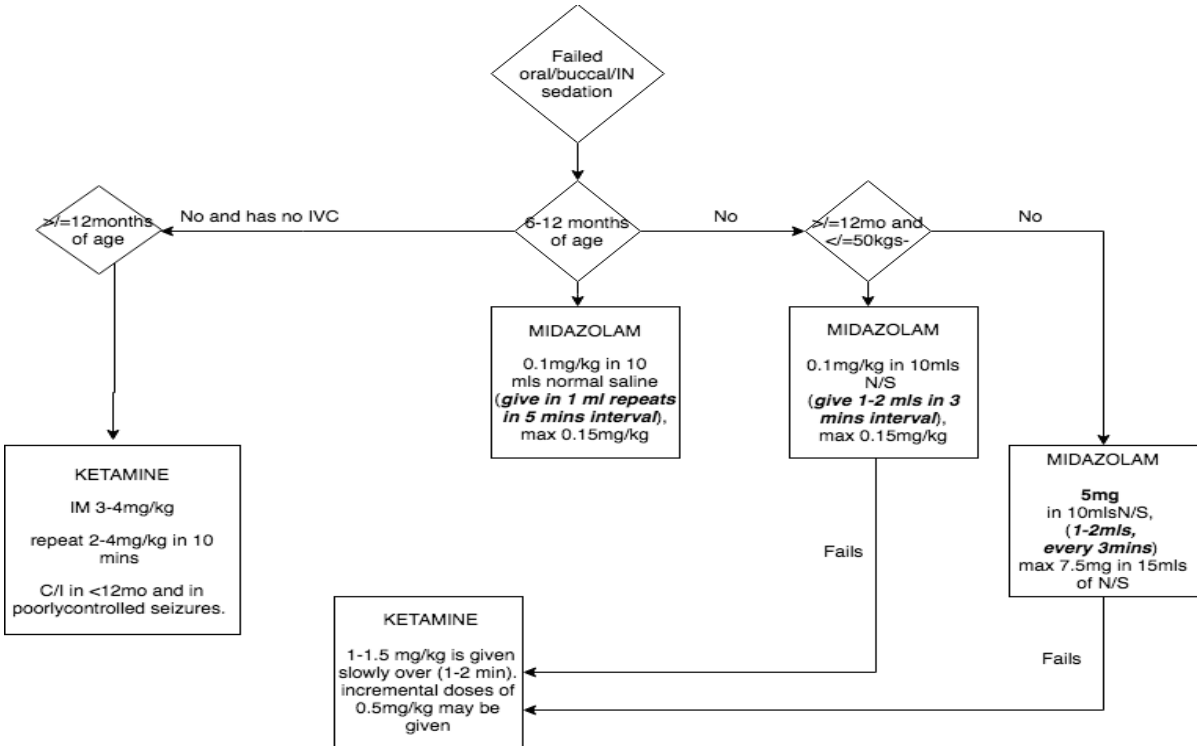
Final thoughts/recommendation

Similar initiatives may be useful in other regional/rural hospitals to help enhance the patient experience and minimise travel.

Flowchart 6 **Suggested idea to update the CPG based on clinical practice at our hospital and the RCH sedation guideline (1)**



Flowchart 7 Intravenous/intramuscular sedation if enteral route fails



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Presenter

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