- No play that requires coordination should be attempted for the next 12 hours (e.g. cycling, skating, swimming or climbing). The child should rest quietly at home.
- Supervise all playing and/or bathing for the next 12 hours. Do not leave the child alone at home.
- In case of vomiting, strange and unusual behaviour, or any other symptom or sign that does not seem normal for the child, seek immediate help or dial the provided telephone number.
- Give the medication as prescribed by the physician.

If the parent/caregiver does not understand and agree to the above, the child is not ready for discharge.

10.5 Follow up or patient satisfaction

Following up on the wellbeing of the child within the week postoperatively is advisable, to receive feedback on the overall experience both of the child and of the parent/caregiver. Feedback aids in refining and improving the practice of paediatric PSA.

Evaluating patient satisfaction in children involves a multidimensional approach that entails different aspects of clinical care, safety and the absence or tolerable presence of certain known side effects, and in some settings, the cost of the procedure and sedation.[25] Macario et al.[26] concluded that the avoidance of postoperative nausea and vomiting was more important to some patients than the prevention of postoperative pain. Regular audit of the practitioner's practice is recommended and patient satisfaction could be included in future projects in a way tailored to the specific population applicable.

11. Drugs used in procedural sedation and analgesia

There is no one ideal drug for PSA available yet; therefore, combinations of drugs are often used. Most of the drugs used do not have both analgesic and sedative properties.

The intravenous route is often used because of the predictable onset and offset of action.

However, the placing of an IV cannula in children may be cumbersome and other modalities should be considered.

Inhalation sedation with N_2O in oxygen is a longstanding and safe method to gain a child's cooperation and trust, especially in the dentist's office.

A useful technique in children is intranasal administration of sedation, especially when intravenous cannulation is challenging. It requires less cooperation and onset is faster than with oral sedation. The effect of drugs administered intranasally is more predictable due to direct absorption into the bloodstream and no first-pass metabolism. Sufficient cooperation can be

achieved within about 10 minutes, which allows for placement of the intravenous cannula. The intravenous route can then be used for the remainder of the sedation.

Oral sedation is an alternative for short, non-painful procedures. Owing to its unpredictability in terms of onset of action, effect and duration of action, it is seldom used as sole method for PSA. However, it is a useful route to administer premedication in order to obtain a child's cooperation for intravenous line placement. Some guidelines recommend that when only oral drugs are administered for sedation, intravenous cannulation is still mandatory.

Many of the maximum doses recommended here are lower than those quoted in the respective package inserts. This is because PSA frequently involves the administration of more than one type of drug. Drugs for PSA can act synergistically when used in combination and it is suggested that the doses be reduced accordingly and titrated to effect in divided doses. The sum of the incremental doses must not exceed the recommended maximum dose.

When administering drugs for PSA, the SP must remember that there is no fixed-dose, only a maximum dose. Drug dosages in children are usually calculated according to the child's weight. It is, therefore, important that the child's weight is documented on the sedation chart. If the child's weight is not available, the PAWPER tape can be used as a simple and reliable method of weight estimation in children and infants.

In general, the drugs selected for PSA should have a duration of action appropriate for the duration of the procedure. Sufficient time for peak brain effect (the target site) must be allowed, to prevent overdose of sedatives. Titration of administered drugs is deemed to be one of the single most important layers of safety. The SP must possess the relevant knowledge of the pharmacokinetics of each of the chosen sedatives used.

SASA recommends that GA induction agents (propofol, ketamine, etomidate, dexmedetomidine) and the short-acting opioids (fentanyl, alfentanil, sufentanil, remifentanil) should only be used by those formally trained in anaesthesia or intensive care medicine, or by experienced SPs with anaesthetic experience who are trained in specific advanced sedation techniques. SPs using these drugs in children must have *at least* a qualification in APLS.

In paediatric practice, the use of off-label and unlicensed drugs is common. Off-label drug use implies the use of licensed medicines outside the conditions of the license. Unlicensed drug use means using pharmaceutical products that have not been approved by any licensing authority of a specific country. Preparation of drugs by non-pharmacists occurs frequently and has resulted in the administration of medication "cocktails" in clinical practice. SPs are responsible for choosing the right drug and dose after careful consideration of expert opinion, scientific data on the drug(s), and what is published in medical literature.

11.1 Sedatives

11.1.1 Benzodiazepines

11.1.1.1 Midazolam

Midazolam is a short-acting, water-soluble benzodiazepine with sedative, anxiolytic, amnestic and anticonvulsant properties. It has no analgesic effect. Used in the recommended doses (Table III), the administration of midazolam should result in a conscious, compliant child. It can be administered via various routes; used alone, as an oral agent, or as an intravenous sedative technique.

When administered in combination with other depressant drugs (particularly opiates, with which midazolam has a super-additive effect), or used on its own in higher than recommended doses, midazolam is likely to result in the loss of upper airway muscle tone with obstruction. Respiratory and cardiac depression are also possible consequences. Children predisposed to upper airway obstruction are particularly at risk. Ataxia, dystonia and diplopia are other possible adverse effects associated with midazolam use.

The reported incidence of paradoxical agitation is quoted as high as 15% in paediatric patients.[27,28] The most common causative agent is the benzodiazepines and these reactions more commonly occur within 3–6 minutes after administration.[29] The reaction was originally described as "behavioural toxicity" and includes symptoms such as agitation, aggression, excitement and excessive movement, characterised by confusion and disinhibition, and also includes sympathetic activation resulting in hypertension and tachycardia. The patient can be at risk of injuries to themselves as well as the staff around them.

The proposed management includes BLS guidelines and reassurance. If the patient is very agitated, pharmacological management is advised to abort the reaction using a dosage of flumazenil (Table IV). Smaller dosages (e.g. 5 mcg/kg) has also been described.[30,31] The literature also describes the usage of an alternative agent, such as ketamine. Additional dosages of midazolam are not recommended and increase the risk of unintended deeper levels of sedation which is associated with a greater risk of respiratory depression.

The intranasal route of administration is useful, particularly in children who need special care. However, it may cause a burning sensation, and a bitter after taste which may last for several days. A single puff (10 mg/puff) of lignocaine spray prior to installation of intranasal midazolam may improve tolerability, as will the use of an atomisation device. Mucosal Atomization Device (MAD®, LMA North America, San Diego, CA) is available and makes nasal administration easier and more acceptable.

Rectal administration could be considered in young children, but absorption may be unpredictable. Rectal administration may also be preferred in children who refuse oral medication. Parental consent should always be sought prior to administering medication via the rectal route. A paediatric feeding tube can be used to administer midazolam rectally.

Intramuscular administration is painful and is not recommended.

Table III: Sole agent dosing schedule of midazolam

Route of administration	Dose	Recommended maximum dose	Time to peak effect	Duration of action
Oral	0.25–0.5 mg/kg	7.5 mg	10–30 minutes	60 minutes*
Sublingual	0.25–0.3 mg/kg	0.3 mg/kg	10–15 minutes	20–60 minutes*
Intravenous	0.025–0.1 mg/kg**	1 mg	3–5 minutes	20–60 minutes*
Rectal	0.5–0.75 mg/kg	1 mg/kg	10–20 minutes	60 minutes*
Intranasal	0.2–0.3 mg/kg	0.3 mg/kg	10–15 minutes	60–120 minutes*

When used in combination with other drugs, doses should be decreased and titrated to effect
* Dose-related
** Titrate to effect, repeat dose every five minutes until desired level of sedation achieved

The intravenous formulation can be given orally mixed with a small volume of juice, cold drink or paracetamol syrup to disguise the bitter taste. Once mixed, the shelf life is less than 24 hours. To improve palatability, tablets can be crushed between two spoons and mixed in the same way.

When given intravenously, most children should require no more than 1 mg and, in combination with other depressant drugs, ≤ 0.5 mg is recommended. Titration to effect remains the best option.

11.1.1.2 Flumazenil

Flumazenil is an imidazobenzodiazepine compound used clinically as a benzodiazepine antagonist. It reverses the sedative and respiratory depressant effects of midazolam by competitively antagonising GABA-receptors. Flumazenil should be readily available whenever midazolam is used (Table IV).

Flumazenil has a quick onset of action. The duration of action is approximately one hour and, if large doses of midazolam have been administered, re-sedation may occur at this point. In such cases, the child should be carefully monitored for at least two hours, with a view to repeat the flumazenil dose. In an emergency, if intravenous access is not available, the intravenous dose may be given intranasally.

In patients who are taking benzodiazepines for seizures or behavioural disturbances, or any other drugs that potentially lower the seizure threshold, administration of flumazenil may precipitate these symptoms.

Table IV: Dosing schedule of flumazenil

Dose	Titration interval*	Maximum dose	Duration of action
10 µg/kg over 30 seconds	2 minutes	1 mg/kg	1 hour

* Repeat dose until desired effect is achieved or maximum dose reached

11.1.2 Anaesthetic agents

11.1.2.1 Ketamine

Ketamine is a popular and safe drug for procedural sedation. Ketamine is an N-methyl-D-aspartate glutamate receptor antagonist (NMDA agonist) which reduces the presynaptic release of the excitatory neurotransmitter, glutamate. The multiple actions and cardiovascular stability of ketamine make it a very useful agent for painful procedures. Used in high doses, it induces a state of cortical dissociation with profound analgesia, sedation and amnesia. Ketamine is sometimes associated with non-purposeful movements, which may limit its use when total immobility is required (e.g. for CT or MRI scans). In this instance, ketamine can be combined with other intravenous drugs (e.g. propofol) to prevent non-purposeful movements.

Compared with other anaesthetic agents, there is relative preservation of airway reflexes and muscular tone.[32]

Prophylactic co-administration of an anti-sialagogue (atropine 0.02 mg/kg orally or intravenously, or glycopyrrolate 0.01 mg/kg intravenously) is recommended to diminish the production of tracheobronchial secretions and saliva. The production of secretions can be particularly problematic in the presence of a URTI and will predispose to laryngospasm. The need for suctioning of secretions is often necessary.

The emergence delirium associated with ketamine in adults is less common in children and of a much smaller magnitude. It correlates significantly with the degree of preprocedural agitation. The addition of midazolam does not reduce the incidence of mild to moderate emergence agitation but will deepen and prolong sedation, increasing the likelihood of apnoea.[33-35]

The sympathomimetic action of ketamine may result in a tachycardia and hypertension.

Previously contraindicated in the context of head and eye injuries owing to concerns about raised intracranial pressure, ketamine is now accepted as safe in these patients. Other reported reactions (ataxia, nystagmus, myoclonus, random limb movements and opisthotonus) are rarely clinically important.[33]

Ketamine, as a single agent, can be used at subhypnotic doses to achieve an analgesic effect.

Ketamine can be given via multiple routes (Table V), including intranasally, but accurate pharmacodynamic information for children is not available.

When used in combination with other sedative agents, and to decrease the likelihood of complications (respiratory depression and airway obstruction), the dose of ketamine should be reduced and titrated to effect, especially when administered intravenously.[34]

Table V: Dosing schedule of ketamine

Route of administration	Dose	Onset of action	Time to peak effect	Duration of action
Sedation				
Oral	6–10 mg/kg	> 5 minutes	30 minutes*	4–6 hours
Intravenous (bolus)	0.25–1 mg/kg**	< 1 minute	3–5 minutes	10–15 minutes
Intravenous (infusion)	0.5–1 mg/kg/hour***	< 1 minute	3–5 minutes	10–15 minutes
Intramuscular	2–4 mg/kg	2–5 minutes	20 minutes	30–120 minutes*
Rectal	4–6 mg/kg	> 5 minutes	30 minutes*	30–120 minutes*
Intranasal	5 mg/kg	5–10 minutes	20 minutes	20–120 minutes
Analgesia				
Oral	4–6 mg/kg	> 5 minutes	30 minutes*	4–6 hours
Intravenous (infusion)	0.15–0.3 mg/kg/hour	< 1 minute	3–5 minutes	15 minutes

*Dose-related
**Titrate to effect, repeating dose every three minutes until desired level of sedation achieved
***Infusion following bolus dose of 0.25–1 mg/kg

11.1.2.2 Propofol

Propofol, a water-soluble phenol, is a short-acting, intravenously administered sedative hypnotic that can be used in small boluses titrated to effect (Table VI), or as a continuous infusion.

Propofol is a controversial drug in the non-operating theatre environment. Its rapid onset and offset make it attractive for PSA. However, it has a narrow therapeutic index with a small margin of safety when compared with the other sedatives outlined in these guidelines (e.g. midazolam and ketamine). Deep sedation, airway obstruction and apnoea occur rapidly and unpredictably. Children are particularly sensitive to repeated boluses of propofol.

Propofol should only be administered by an experienced SP, preferably with anaesthetic training, who is skilled in the airway management of children, and in a facility that meets all the criteria laid out in these guidelines (Appendix 1 and 2). It should only be used for brief procedures, as repeated doses or infusions are more likely to be associated with adverse events.

The use of capnography is highly recommended when propofol is used for sedation, due to the relatively high incidence of respiratory depression and airway obstruction. Supplemental oxygenation may mask this adverse event if oxygen saturation alone is monitored.

In up to 90% of cases, propofol causes pain on injection. Combination with lignocaine (0.1 ml 2% lignocaine/ml of propofol) will reduce this. Another option is to leave the tourniquet in place for 1 minute and give 1–2 ml of 2% lignocaine as pretreatment, before removing the tourniquet.[36]

Prolonged infusions (> 18 hours at > 4 mg/kg/hour) have been associated with fatal metabolic acidosis.

Propofol has no analgesic properties and an appropriate analgesic agent should also be given if a painful procedure is planned. However, the combination of propofol and other sedatives/analgesics will give rise to an increased risk of adverse events.[34,37] Advanced paediatric PSA with a combination of drugs should only be used by experienced SPs, with the ability to recognise and rescue unintended effects. Even though the incidence is very rare, the highest rate of intubation following serious adverse events in paediatric PSA is seen with propofol use (in a recent meta-analysis from cases in the emergency department).[38]

Table VI: Single agent dosing schedule of propofol

Dose	Onset of action	Duration of action	Repeat dose	Titration interval
0.3–0.5 mg/kg	45–90 seconds	5–8 minutes	0.5 mg/kg	1 minute

11.1.2.3 Ketofol

Ketofol is a combination of ketamine and propofol. The synergism between ketamine and propofol means lower doses of each drug can be used in combination, potentially decreasing the likelihood of side effects.

Used alone, this combination is adequate for minor medical and dental procedures. More painful procedures will require either deeper levels of sedation or the addition of further agents such as local anaesthetic.

The recommended preparation of ketofol for paediatric use is 50 mg ketamine with 90 mg propofol diluted to 10 ml. This results in a concentration of 5 mg/ml ketamine and 9 mg/ml propofol and, of this solution, 0.05 ml/kg is recommended (Table VII).

Both agents can have side effects, and airway vigilance is essential as the incidence is not necessarily lower in patients sedated with ketofol, compared to propofol alone.[39]

Providers need to be careful with repeating boluses as this could result in a high accumulative dosage of ketamine, ultimately prolonging the recovery from the sedation.[40]

The mixture of ketofol in a single polypropylene syringe has been shown to be compatible, both chemically and physically, at room temperature resulting in a predictable and stable concentration.[41,42]

Table VII: Dosing schedule of ketofol, consisting of ketamine 5 mg/ml and propofol 9 mg/ml

Route of administration	Dose	Onset of action	Duration of action	Repeat dose	Titration interval
Intravenous	0.05 ml/kg*	30–90 seconds	5–10 minutes	0.05 ml/kg	1–5 minutes

*Ketamine 0.25 mg/kg and propofol 0.45 mg/kg

11.1.3 Alpha-agonists

Alpha-agonists are sedative analgesics with anxiolytic, but no amnestic, effects. When used in the recommended doses as single agents, these drugs have little to no respiratory depressant effects. Oral agents are particularly useful in combination with simple analgesics for painful procedures.

11.1.3.1 Clonidine

Clonidine can be administered via multiple routes but, for the purposes of procedural sedation, the oral route is recommended (Table VIII).

Table VIII: Sole oral agent dosing schedule of clonidine

Dose	Onset of action	Time to peak effect
1–5 µg/kg	20–40 minutes	60 minutes

11.1.3.2 Dexmedetomidine

Dexmedetomidine is a highly selective α_2-adrenergic receptor-agonist providing sedation, anxiolysis, analgesia and sympatholysis, without respiratory suppression. Dexmedetomidine is being used increasingly for sedation in children, but this use is off-label owing to its global lack of licence for this age group. Dexmedetomidine is only recommended for use by those highly experienced in paediatric sedation and with anaesthetic training. It should only be used in an in-hospital setting.

Dexmedetomidine does not appear to have any effect on the respiratory system with airway patency and ventilation maintained.

Patients sedated with dexmedetomidine are rousable when stimulated as sedation mimics endogenous sleep and the EEG resembles that of natural non-rapid eye movement sleep. Dexmedetomidine causes interference with thermoregulation and the patient is at risk of developing hypothermia.

Transient hypertension, hypotension, bradycardia and sinus arrest are possible adverse events that may occur with dexmedetomidine use, especially with rapid loading doses, comorbid cardiac disease, younger patients with enhanced vagal tone, or when administered with other medications that possess negative chronotropic effects. Caution should be exercised with the loading dose (i.e. initial loading dose administered in not less than 10 minutes). It should be used with caution in younger children and avoided in those with cardiac disease.

Dexmedetomidine can be administered by intravenous bolus and/or infusion as well as intranasally, in which case it is best administered undiluted using an atomising device. Intranasal administration has the advantage of bypassing first-pass metabolism.[43] Dexmedetomidine can be administered via the buccal route using similar dosing to the intranasal route. However, this route is less effective than the intranasal route (Table IX). Ketamine (1 mg/kg) can be added to dexmedetomidine for sedation of painful invasive procedures.

Table IX: Dosing schedule of dexmedetomidine

Route of administration	Dose	Onset of action	Time to peak effect	Duration of action
Intravenous (bolus)	0.5–1 µg/kg over 10 minutes	5–10 minutes	15–30 minutes	60–120 minutes
Then intravenous (infusion)	0.2–1 µg/kg/hour	N/A	N/A	N/A
Intranasal	1–4 µg/kg	15–30 minutes	N/A	55–100 minutes

11.1.4 Other sedative agents

11.1.4.1 Chloral hydrate and trichlophos

Chloral hydrate is one of the oldest sedative-hypnotic drugs available. Despite its long track-record of use in this country, it is not registered for use in humans with the Medicines Control Council (MCC) of South Africa, but can be acquired for use provided a Section 21 application is made to the MCC. It has no analgesic properties and should be used for non-painful procedures only. Trichlophos is structurally similar and can be used interchangeably with chloral hydrate. Chloral hydrate and trichlophos are only available in oral form.

In the recommended doses (Table X), chloral hydrate is considered safe even though it has a very long half-life. Respiratory depression with airway obstruction can occur in predisposed patients. Therefore, chloral hydrate should never be administered by untrained personnel unable to manage unwanted events.

Extra care should be taken in children with conditions predisposing them to upper airway obstruction, such as tonsillar hypertrophy.[37] This is more likely to occur when higher doses

(≥ 75 mg/kg) are used, or when chloral hydrate is combined with other depressant drugs. Combination of chloral hydrate with other agents is therefore not recommended.

Other adverse effects include gastric irritation, nausea and vomiting. These effects are lessened by administration with food or water. Chloral hydrate has been shown to be more effective when taken on a full stomach.

The sedative effects of chloral hydrate are unreliable over the age of three years. In toddlers and infants, its duration of action may be prolonged. The degree of sedation is dose dependent. Postprocedural monitoring must continue until the level of sedation, without stimulation, is clearly decreasing.

In premature infants, the duration of action will be significantly prolonged and respiratory depressant effects will be evident at lower doses. It is not recommended for use in this group of patients.

Chloral hydrate is contraindicated in patients with porphyria.

Table X: Dosing schedule of chloral hydrate

Dose	Maximum dose	Onset of action	Time to peak effect	Duration of action
25–100 mg/kg	2 g	15–30 minutes	30–60 minutes	6–8 hours

11.1.4.2 Trimeprazine

Trimeprazine (Vallergan®) is a long-acting phenothiazine derivative, which may be used on its own or in combination with other sedatives (e.g. droperidol). It is available in oral form and, due to erratic absorption, the onset time is variable (Table XI). Trimeprazine also poses unwanted anticholinergic side effects such as dry mouth, tachycardia and fever, but convulsions and coma are rarely seen. Instances of paradoxical excitation have been described.

The long duration of action of trimeprazine makes it unsuitable for the outpatient or ambulatory setting.

Table XI: Dosing schedule of trimeprazine

Dose	Onset of action	Duration of action
1–2 mg/kg	60–90 minutes	5–8 hours

11.1.4.3 Droperidol

Droperidol is a butyrophenone with sedative and antiemetic, but no anxiolytic, properties.

It should only be used in combination with other sedatives, such as trimeprazine, due to commonly experienced dysphoria and "locked-in" feeling when prescribed alone.

Droperidol increases QT interval in a dose-dependent fashion among susceptible individuals and high doses of the intravenous form (usually in the setting of psychosis) have been associated with cardiac arrest. The doses recommended for sedation (Table XII) fall well below this level and no specific cardiac monitoring is recommended.

Droperidol may be administered by oral or intravenous routes (Table XII). For the purposes of paediatric sedation, only the oral route is recommended in combination with trimeprazine.

However, due to its long duration of action, droperidol should not be considered for outpatient procedural sedation.

In patients with established postoperative nausea and vomiting, droperidol is a very effective antiemetic in low doses, with no associated sedation.

Table XII: Dosing schedule of droperidol

Route of administration	Dose	Duration of action
Sedation		
Oral	0.05–0.2 mg/kg	2–6 hours
Antiemetic		
Oral or intravenous	10–20 µg/kg	6 hours

11.2 Analgesics

11.2.1 Opioids

Opioids are analgesic drugs that can induce varying degrees of sedation and respiratory and cardiac depression, particularly when used in combination with other respiratory depressant drugs (e.g. midazolam). Opioids are not primarily sedative drugs and the sedative action is a side effect.

11.2.1.1 Tilidine

Tilidine (Valoron®) is an intermediate-acting opiate available in droplet form. One droplet contains 2.5 mg of the active ingredient. Tilidine is a sublingually administered opioid, with a side effect profile common to this group of drugs. It has a bitter taste and is best administered under the tongue or just inside the tooth margins. In bigger children, where the body weight is excessive for age, the dose of a "drop per year of age" may be used as a guide, and titration to effect is recommended (Table XIII).

Tilidine may not be used for analgesia during sedation per se, but it might have been given to the patient upon presentation to alleviate pain. Be mindful that it can lead to unintended deeper levels of sedation should the patient undergo PSA following its administration (e.g. a patient presenting to the emergency department for a fracture that requires sedation

for manipulation). Bhatt et al.[34] found an increased odds ratio of adverse events in a large prospective, multicentre cohort study where preprocedural opioid administration was used. This should not discourage the alleviation of preprocedural pain but alert the practitioner to be mindful of those agents already used.

Table XIII: Dosing schedule of tilidine

Dose	Time to peak effect	Duration of action
1 mg/kg*	45 minutes	4–6 hours

* Number of drops = body weight/2.5

11.2.1.2 Fentanyl and alfentanil

Fentanyl and alfentanil are potent, short-acting opioids with significant potential for respiratory and cardiac depression, particularly when used in combination with other respiratory depressant drugs (Table XIV and XV). Practitioners administering these drugs should be experienced SPs with airway management skills. Meticulous monitoring of respiratory and cardiovascular parameters throughout the procedure and recovery period is imperative. Naloxone should be at hand.

Fentanyl and alfentanil should not be used as sole analgesic agents, but rather to augment the effects of simple analgesics. When used in combination with other depressant drugs, such as midazolam, doses should be reduced and titrated to effect. Slow titration of small boluses will decrease, but not eliminate, the possibility of adverse events. When combining fentanyl with either propofol or ketamine, the risk for adverse events and interventions are increased.[34]

In patients at risk of upper airway obstruction, administration of fentanyl or alfentanil may precipitate this event.

Neonates may experience prolonged sedation and respiratory depression because of a slower metabolism and excretion, and extreme caution should be exercised in this age group.

SPs should also be vigilant in the postprocedure period when the stimulus of the procedure has passed, but the drug is still active and more likely to cause respiratory depression.

Table XIV: Sole agent dosing schedule of fentanyl

Route of administration	Dose	Onset of action	Time to peak effect	Maximum dose	Duration of action
Intranasal	1–2 µg/kg*	10 minutes	15 minutes	3 µg/kg	1–2 hours
Intravenous	0.25 µg/kg**	Immediate	3–8 minutes	2 µg/kg	30 minutes***

When used in combination with other drugs, doses should be decreased and titrated to effect
* Repeat doses of 0.5 µg/kg, after 10 minutes if analgesia is inadequate to a maximum of 3 µg/kg, titrated
** Titrate to effect, repeating dose every three minutes until desired level of analgesia is achieved or maximum dose reached
*** Dose-related

Alfentanil has a rapid onset and short duration of action, making it useful for short, painful procedures. It should be titrated until the desired level of analgesia is reached (Table XV). If the procedure is expected to take longer than two minutes, an infusion should be initiated. This should be terminated at the conclusion of the procedure.

Table XV: Sole agent dosing schedule of alfentanil

Intravenous bolus dose	Titration interval	Duration of action	Infusion dose
0.5–1 µg/kg	2 minutes	< 5 minutes	0.5–1 mcg/kg/min

11.2.1.3 Remifentanil

Remifentanil is currently not recommended for analgesia in children for PSA, especially outside of the hospital environment.

11.2.1.4 Naloxone

Naloxone is a specific opioid antagonist that will reverse the respiratory depressant as well as analgesic effects of opioids. It should be readily available whenever opioids are used (Table XVI). It should only be used in cases of severe respiratory depression or respiratory arrest, as reversal of the analgesic effects may cause a profound sympathetic response. As the duration of action is short, respiratory depression may recur, requiring additional doses. For this reason, monitoring should continue for at least two hours after administration of naloxone. Once a response to the intravenous dose has been achieved, the additional total effective dose could be administered intramuscularly. In an emergency, if intravenous access is not available, the initial doses may be given intramuscularly.

Table XVI: Dosing schedule of naloxone

Dose	Titration interval*	Maximum dose	Duration of action
1–2 µg/kg	2 minutes	1 mg/kg	45 minutes

* Repeat dose until desired effect achieved, or maximum dose reached

11.2.2 Nitrous oxide

N_2O is an anaesthetic agent with analgesic properties. It is available in pure form or premixed in a 1:1 ratio with oxygen, known as Entonox®.

In older children who can hold a mask, N_2O is very useful because of its rapid onset and offset of action and its excellent safety profile. The recommended administered concentration is 50% (Table XVII) and often used by the operator-SP in South Africa, especially in dentistry, as this concentration or less will produce minimal sedation.

If a higher concentration is administered, the sedation must be classified as an advanced sedation technique, with all the implications of monitoring the patient attached to this sedation technique. For painful procedures, analgesia must be supplemented with, for example, local analgesia. If other sedatives are used, respiratory depression must be anticipated.

N_2O is only recommended in ASA I and II patients. In those with myocardial disease, N_2O may cause a detectable degree of myocardial depression and, in patients with respiratory disease it may alter the response to hypoxia.

N_2O diffuses into air-filled cavities and should not be used in the following cases:

- chest injuries, with possible pneumothorax
- head injuries, with possible pneumocranium
- suspected bowel obstruction

Although N_2O is emetogenic, vomiting is rare and aspiration exceedingly so.

N_2O is best administered via a demand-valve system connected to a cylinder of Entonox®. The procedure should be fully explained to the child, who should be able to hold the mask with the demand valve without assistance. The sensitive demand valve is activated by the child's inspiration, with the rate of delivery of gas determined by the force of inspiration.

In those children unable to operate a demand valve, a breathing circuit with continuous flow from an anaesthetic machine may be used. Scavenging should be available for such cases. To avoid the delivery of a hypoxic mixture when delivering N_2O other than as Entonox®, in-circuit gas analysis should be employed. If concentrations above 50% have been administered, supplemental oxygen should be administered for several minutes after N_2O has been discontinued to counter the possibility of diffusion hypoxia.

The cylinders and valve must be checked and maintained regularly, according to manufacturer's guidelines with documented servicing. Injury can be prevented by safe storage of these devices.

Table XVII: Dosing schedule of nitrous oxide (N_2O)

Dose (concentration administered)	Onset of action	Time to peak effect
50%	30–60 seconds	3 minutes
70%	30–60 seconds	3–5 minutes*

*Deep sedation will result if the child does not hold the mask themselves

11.2.3 Methoxyflurane

Methoxyflurane is a potent inhalational fluorinated hydrocarbon. It has recently become available in South Africa after withdrawal in the 1970s due to concerns about postoperative acute kidney injury. It provides good analgesia in subanaesthetic doses, and offers great potential for the provision of analgesia and sedation in the prehospital emergency care setting.

It has been reintroduced in clinical practice for use in procedural sedation as a self-administered analgesic since it doesn't appear to be associated with nephrotoxicity when administered for short periods at these doses. Deeper levels of sedation may result when administered directly by the practitioner, which is often the case in younger patients. Self-titration with an inhaler for anticipatory analgesia is recommended.[44-46]

The use of methoxyflurane is controversial due to its possible negative effects on kidney function.

11.2.4 Simple analgesics

Simple analgesics are analgesic drugs that have no sedative effects.

Paracetamol and nonsteroidal anti-inflammatory drugs (NSAIDs) are extremely useful, but must be allowed time to take effect before a procedure is performed (Table XVIII). NSAIDs should be avoided in any child requiring fluid resuscitation, until good urine output is established. Additionally, also avoid if any other contraindications to NSAIDs are present.

Suppository formulations of these drugs do not consist of a uniform distribution of the active ingredient. As a result, they cannot be divided to administer smaller doses.

Always consider asking parental consent for analgesic (or any) suppository medication before administration as discussed under consent for procedures.

Table XVIII: Dosing schedule of simple analgesics

Drug	Route of administration	Dose	Time to peak effect
Paracetamol	Oral	20 mg/kg	100–120 minutes
	Rectal	40 mg/kg	60–240 minutes
	Intravenous*	15 mg/kg	50–60 minutes
Ibuprofen	Oral	10 mg/kg	120–240 minutes
Diclofenac	Rectal	1–1.5 mg/kg	30–45 minutes
Ketorolac	Intravenous	0.5 mg/kg	60–120 minutes

*A loading dose of 20 mg/kg can be given if it is the first intravenous dose the patient receives

11.2.5 Local anaesthetics

Local anaesthetics should be considered wherever possible, bearing in mind that additional sedation or anxiolysis might be necessary. These can be used topically or by infiltration.

EMLA® (Eutectic Mixture of Local Anaesthetics) requires at least an hour for full effect. It can be used on intact or broken skin and penetrates to a depth of 3–12 mm. EMLA® stickers are also available and with the help of the provided documentation or a phone call prior to the procedure, it can be applied by caregivers at home 60–90 minutes prior to the procedure.

Warming and alkalinising the solution of local anaesthetic may reduce the sting experienced on infiltration.

It must be noted that the local anaesthetics are membrane depressants and, if given in excessive doses, may depress the cardiovascular and respiratory systems. This is especially important in PSA for dentistry if a block does not take effect and further doses of local anaesthetic are given.

Note that toxicity is additive; if one drug is used in combination with another, the combined dose should not exceed the maximum safe dose of either drug (Table XIX).

Table XIX: Maximum safe doses of local anaesthetic drugs

Drug	Dose with adrenaline	Dose without adrenaline
Lignocaine	7 mg/kg	3 mg/kg
Bupivacaine	2.5 mg/kg	2.5 mg/kg

References

1. Practice guidelines for moderate procedural sedation and analgesia 2018. A report by the American Society of Anesthesiologists Task Force on Moderate Procedural Sedation and Analgesia, the American Association of Oral and Maxillofacial Surgeons, American College of Radiology, American Dental Association, American Society of Dentist Anesthesiologists, and Society of Interventional Radiology. Anesthesiology. 2018;128(3):437-79.
2. Roback MG, Green SM, Andolfatto G, Leroy PL, Mason KP. Tracking and reporting outcomes of procedural sedation (TROOPS): standardized quality improvement and research tools from the International Committee for the Advancement of Procedural Sedation. Br J Anaesth. 2018;120(1):164-72. https://doi.org/10.1016/j.bja.2017.08.004.
3. Mason KP, Green SM, Piacevoli Q, International Sedation Task Force. Adverse event reporting tool to standardize the reporting and tracking of adverse events during procedural sedation: a consensus document from the World SIVA International Sedation Task Force. Br J Anaesth. 2012;108(1):13-20. https://doi.org/10.1093/bja/aer407.
4. Green SM, Irwin MG, Mason KP, on behalf of the International Committee for the Advancement of Procedural Sedation. Procedural sedation: providing the missing definition. Anaesthesia. 2021;76(5):598-601. https://doi.org/10.1111/anae.15213.
5. American Society of Anesthesiologists. Continuum of depth of sedation: definition of general anesthesia and levels of sedation/analgesia. Approved by ASA House of Delegates on October 13, 1999 and last amended on October 23, 2019. Available from: https://www. asahq.org/standards-and-guidelines/continuum-of-depth-of-sedation-definition-of-general-anesthesia-and-levels-of-sedationanalgesia.
6. General Dental Council. Standards for the dental team [Internet]. London: GDC; 2013. Available from: https://standards.gdc-uk.org/Assets/pdf/Standards%20for%20the%20Dental%20Team.pdf.
7. Thomas, J. Parental refusal: legal and ethical considerations. South Afr J Anaesth Analg. 2015;21:34-36.
8. Reed MJ, Dunn MJ, McKeown DW. Can an airway assessment score predict difficulty at intubation in the emergency department? Emerg Med J. 2005;22:99-102. https://doi.org/10.1136/emj.2003.008771.
9. Mallampati SR, Gatt SP, Gugino LD, et al. A clinical sign to predict difficult tracheal intubation: a prospective study. Can Anaesth Soc J. 1985;32:429-34. https://doi.org/10.1007/BF03011357.
10. American Society of Anesthesiologists. ASA physical status classification system. Last amended 13 December 2020. Available from: https://www.asahq.org/standards-and-guidelines/asa-physical-status-classification-system.
11. Fehrenbach and Associates. ASA physical status classification system for dental patient care. 2020. Available from: http://www.dhed.net/ASA_Physical_Status_Classification_SYSTEM.html.
12. Green SM, Leroy PL, Roback MG, et al. An international multidisciplinary consensus statement on fasting before procedural sedation in adults and children on behalf of the International Committee for the Advancement of Procedural Sedation. Anaesthesia. 2020;75(3):374-385. https://doi.org/10.1111/anae.14892.
13. Academy of Medical Royal Colleges. Safe sedation practice for healthcare procedures. Standard and guidance. October 2013. Available from: https://www.aomrc.org.uk/wp-content/uploads/2016/05/Safe_Sedation_Practice_1213.pdf.
14. Askar H, Misch J, Chen Z, Chadha S, Wang H. Capnography monitoring in procedural intravenous sedation: a systematic review and meta-analysis. Clin Oral Investig. 2020;24(11)3761-70. https://doi.org/10.1007/s00784-020-03395-1.