Guideline Statement: Management of Procedure-related Pain in Children and Adolescents

Paediatrics & Child Health Division
The Royal Australasian College of Physicians

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Executive Summary

(See attachment)

1. Why do we need a policy on procedural pain management?

1.1 Background

Significant advances have been made in the field of pain management in recent years. The essential question is no longer whether children feel pain but how best to manage it.[1] However, despite the established efficacy of pain management techniques, multiple studies show that pain is poorly managed and that children, in particular, continue to suffer unnecessarily.[2]

In the last decade, several bodies (American Academy of Pediatrics[3] [4], American College of Emergency Physicians,[5] United States department of Health and Human Services[6], Royal College of Paediatrics and Child Health[7] [8]) have published guidelines for management of acute pain, including procedural pain.[6] In 2003, the Royal Australasian College of Physicians recognised the need for a local document to:

- Raise awareness that the treatment of pain is essential and should be a priority.
- Invite paediatricians and other child health professionals to reflect on their own attitudes, beliefs and practices.
- Make recommendations relevant to paediatric settings in Australia and New Zealand which can then be a resource for individuals and institutions developing protocols.
- Bridge the gap between research and clinical practice.

1.2 Barriers to best practice

The values and attitudes of society, family members and health care professionals, together with health care practices within an organisational system, all present obstacles to optimal pain control.[2] [9-11] Such barriers include:

- Numerous myths and misconceptions about pain ("children don't feel pain", or "children won't remember pain").
- Personal biases about pain (e.g. that it is character building, or treatment takes too long).
- The belief that treating pain may mask the underlying condition (e.g. in the Emergency Department) and hinder diagnosis.
- Inadequate knowledge and inadequate development of skills during training and in continuing education.
- Under-use of pain assessment tools.
- A lack of recognised standards for pain relief.
- A relative paucity of large drug studies in the paediatric pain literature compared to the adult literature.
- A failure to recognise the need for an interdisciplinary approach, and integrate evidence from other disciplines, such as psychology, into medical practice.
- Ongoing debate regarding the use of certain sedatives and analgesics by non-anaesthetists.[12]

1.3 The experience of pain

Factors that affect the pain sensation and response:

1. Innate characteristics:
   - Age.
   - Gender.
   - Temperament.
   - Cognitive level.

   Variable characteristics:
   - Affective state.
   - Physiological responses.
   - Previous pain experience.
   - Meaning and context of pain.

Medical procedures

This document focuses on the treatment of pain and distress associated with medical procedures. It recognises that some procedures, such as bone marrow aspirate and burns dressings tend to be more painful than others, but that common procedures, such as injections and venepuncture, also cause considerable distress.[13]

1.4 Pain physiology

Historically, it was thought that neonates did not require analgesia for painful procedures, as their immature nervous systems meant that they would neither experience, nor remember, painful stimuli in the same way as adults. Over the past decade however, a wealth of laboratory and clinical neonatal research have indicated that this is not the case.

The development of pain pathways begins early in foetal life, with reflex responses to somatic stimuli being present from around 8 weeks gestation. At 26 weeks gestation, a clear flexion withdrawal response to noxious stimuli can be elicited. Furthermore, coordinated facial movements in response to heel prick are seen in premature infants of 26-31 weeks gestational age.

Complex synaptic connections in the dorsal horn of the spinal cord, descending inhibitory pain pathways, and cortical connections do not develop until the early neonatal period. Therefore, responses to any sensory input, including pain, may be amplified in neonates compared to adults.

Neurobehavioral dysfunction and increased pain behaviour may be observed in infants who were exposed to painful procedures during the early neonatal period. Hence, the long-term effects of inadequately treated procedural pain should not be underestimated, and every effort should be made to provide the child with analgesic modalities (pharmacological and non-pharmacological) appropriate to the procedure being performed.[14 15]

1.5 Pain assessment

Evidence based guidelines on pain recognition and assessment has been published[7] but they do not specifically include procedural pain. Pain assessment generally includes history, examination, investigation and measurement of pain and distress using validated tools. The pain assessments undertaken should be documented in the child's history.[7]

With regard to procedural pain, the aim is to prevent pain and distress as much as possible and this is taken into account when planning the procedure (see section 5). In practice it is important to find out if a child's expectations of a procedure are realistic and, if not, correct them well before the procedure.

There are no controlled trials of whether measuring expected pain cues children in advance for pain. It is known that under-prediction of pain makes subsequent procedure-related pain worse than over-predicting.[16]

During a procedure it is important to watch for early warning signs of pain and distress and be prepared to change tack: assess, treat, reassess and modify treatment if necessary.

Measuring pain intensity is one part of pain assessment. There are different objective and subjective methods of measuring pain: physiological monitoring of bodily processes, rating scales, and observation measures (for both the child and parent/staff).[17]

Although physiological monitoring of bodily processes (e.g. heart rate, respiratory rate) for children doesn't provide information regarding the subjective experience of pain, it may be useful in children who are pre-verbal or non-verbal or sedated.

Behaviour observation measures how children respond physically to pain rather than measuring pain directly. It is invaluable for children who cannot rate their pain. Tools have been developed for use in neonates (see neonatal document) and children,[18] as well as tools for non-verbal and cognitively impaired children post-operatively and in the home.[19] [20] Common indicators used include facial expression, crying or vocalisation, body movement and physiological changes. Although the FLACC (Face, Legs, Activity, Cry, Consolation) scale is commonly used for children with cognitive impairment it has not been validated for procedures (see section 8).

Self-report tools vary depending on age. Commonly used self-report tools include:[21]

- Pieces of hurt (3 - 6 years)
- Faces scales (4+ years)
- Visual analogue scales (6+ years)
- Numerical scales (8+ years)

The Pieces of Hurt, also know as the Poker Chip Tool, were developed to allow children to rate their pain by using chips that are described as 'pieces of hurt'

(one white chip representing no pain, and four red ones representing pain). The more chips the child uses, the greater their hurt.

Faces scales show a series of faces that are graded in increasing intensity from no pain to worst pain possible. One scientifically validated and commonly used scale is Faces Pain Scales – Revised which can be downloaded free of charge, for all non-commercial clinical, research and teaching purposes, from www.painsourcebook.ca with instructions available in 24 different languages. Others include the Wong and Baker Faces scale and the Oucher scale.

Visual analogue scales (VAS) require the patient to make a mark somewhere along a 100 mm line to indicate the amount of pain that they experience, with "no pain" at one end of the scale and "the worst pain" at the other.

Numerical scales (e.g. 0 -10) use numbers to represent increasing degrees of pain. Children must understand number concepts and have sufficient abstract thinking ability to use this type of scale.

It is important to link scores to an action: a downward trend in response to treatment is more meaningful than a single score.

1.6 Anticipatory anxiety

Unlike other causes of acute pain, procedural pain involves a degree of anticipation that can compound a child's distress, especially if they have had a "bad" experience.[22] However, the predictive nature of procedural pain also provides an opportunity to minimise the child's distress, fear and pain by intervening before, as well as during and after the procedure. Children and adolescents need help to develop trusting relationships with child health professionals and gain some control over what happens to them (see a consumer's prospective – section 8).

1.7 Consequences of under-treating pain

Preventing pain is not only humane, it can also reduce the risk of subsequent morbidity.[13]

- The literature suggests that pain has long lasting effects in infants and therefore should be prevented.[23]
- As a result of inadequate pain management, children may feel helpless, anxious, irritable and depressed and their coping skills may be undermined. Children become sensitised to pain through changes in the nervous system, and once pain has been under treated, it becomes harder to treat, even with the same noxious stimulus.[24]
- Children who experience extreme procedural pain can develop post-traumatic stress disorder.[13]
- Up to 25% of adults experience significant fear of needles, hospital and dental care and have an avoidant attitude to health care.
- Of the 10% of adults with needle phobia (DSM criteria) most date their phobia from experiences in the first 10 years of life.[25-28]

1.8 Underlying philosophy

As health care providers, we have a clinical, moral and ethical obligation to minimise pain and suffering in children. There are a number of ways to achieve this with regard to procedures:

1. Adopt a child-centred approach (listening to the needs of the child and family) rather than procedure-focused "get-it-over-with" approach.[29]
2. Make the child and their family active participants and members of the team, rather than passive recipients.[29]
3. Use parents for positive assistance, not negative restraint.[30]
4. Ensure that all procedures undertaken are necessary i.e. the benefit outweighs any negative impact caused by the procedure.
5. Ensure that all procedures are carried out in order to maximise safety for the child.
6. Perform procedures in a child friendly environment, away from the bed.[31]
7. Use pain assessment routinely.[7]
8. Use the least invasive equipment where possible.
9. Ensure that the person performing the procedure has appropriate technical expertise, or is closely supervised by someone who does.[3]
10. Use appropriate combinations of non-pharmacological and pharmacological interventions to manage pain and anxiety.[32] Sedation alone does not provide pain relief.
11. Optimise waiting time: too little time increases distress but too much time increases anticipatory anxiety. Time required for preparation is age and child-specific.[3 29]
12. Ensure that the development of anticipatory anxiety is prevented as far as possible by maximising the intervention to alleviate pain and distress for the first procedure (e.g. general anaesthetic for bone marrow aspirate).[31]

1.9 An Integrated approach

There is increasing recognition that a combination of pharmacological and psychological techniques is more likely to solve the problems of procedural pain, anxiety and behavioural distress in children than either approach alone.[29 32-34] Thus, pharmacological treatments need to be routinely presented within a psychological context, with regard to the social context and the language used. Such psychological factors need to be optimised.

There has been little discussion in the literature about how to design and implement integrated approaches, but combining the best of both interventions will meet the following goals:[32]

- Decrease anxiety before procedures.
- Provide a sense of mastery of stressful situations.
- Encourage the active involvement of parents.
- Provide significant pain control for invasive medical procedures.
- Promote effective coping with subsequent procedures.

2. Definitions and abbreviations used

2.1 Definitions

- **Children** - Refers to children and young people up to the age of 18 years. However, many of the principles contained in this document may also be applicable to managing procedural pain in adults.
- **Anticipatory anxiety** - The anxiety preceding an event from previous medical experience, modelling (e.g. by peers or family members), information acquired (whether from health professionals, internet or others) and the child's own assumptions.
- **Analgesia** - Absence of pain in response to stimulation which would normally be painful.
- **Pain** - The International Association for the Study of Pain (IASP) has developed a standard definition of pain, noting that **pain** is always subjective: "An unpleasant sensory and emotional experience associated with actual or potential tissue damage or described in terms of such damage" (www.iasp-pain.org). Furthermore, Zempsky and Schechter emphasise that this experience occurs from an early age and define pain as "an inherent quality of life that appears early in development and serves as a signal for tissue damage". [1]
- **Sedation** – As sedation is a clinical continuum its definition remains an area of controversy amongst various professional groups.
    - The American Academy of Pediatrics has suggested the following definitions to describe the sedation continuum:
        1. **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; and (3) permits appropriate response by the patient to physical stimulation or verbal command, e.g. "open your eyes". [35 36]
        2. **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 reflexes, and includes the inability to maintain a patent airway independently and respond purposefully to physical stimulation or verbal command.[35 36]
        3. **General Anaesthesia** - A medically controlled state of unconsciousness accompanied by a loss of protective reflexes, including the inability to maintain a patent airway independently and respond purposefully to physical stimulation or verbal command.[35 36]
    - The American Society of Anesthesiologists offers the general term **Sedation/analgesia** which they define as "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. Note the patients whose only response is reflex withdrawal from a

painful stimulus are sedated to a greater degree than encompassed by sedation/analgesia."[37]

- The American College of Emergency Physicians use the term **Procedural sedation** which they define as "a technique of administering sedatives or dissociative agents with or without analgesics to induce a state that allows the patient to tolerate unpleasant procedures while maintaining cardiorespiratory function. *Procedural sedation and analgesia* (PSA) is intended to result in a depressed level of consciousness but one that allows the patient to maintain airway control independently and continuously. Specifically, the drugs, doses, and techniques used are not likely to produce a loss of protective airway reflexes."[5]

2.2 Abbreviations used

AC gel	Topical anaesthetic preparation containing adrenaline and cocaine
ALA	Topical anaesthetic preparation containing adrenaline, lignocaine and amethocaine (also called LET)
AnGel	Topical anaesthetic preparation containing 4% amethocaine
CNS	Central Nervous System
CT	Computerised Tomography
CVS	Cardiovascular System
ELA-Max	Topical anaesthetic preparation containing lignocaine
EMLA	Eutectic Mixture of Local Anaesthetics
LET	Topical anaesthetic preparation containing adrenaline (epinephrine), lignocaine (lidocaine) and amethocaine (tetracaine) (see also ALA)
MCU	Micturating cystourethrogram
MRI	Magnetic Resonance Imaging
PSA	Procedural Sedation & Analgesia
TAC	Topical anaesthetic preparation containing tetracaine, adrenaline and cocaine

3. Scope

This document is designed for use as a resource for health professionals who wish to better manage procedure-related pain and distress in their paediatric patients. The document covers the management of infants, children and adolescents who are at risk of acute pain and/or anxiety as a result of medical procedures outside the operating room. It is intended to provide a framework so that people can write their own clinical practice guidelines relevant to their local situation and resources. The document does not cover acute pain associated with illness, surgery, endoscopy, dentistry, or chronic pain. However radiological procedures are included.

Procedural pain in neonates has been included in a separate document. This topic has already been the subject of a Cochrane review[38] and a number of published guidelines,[4 39-41] which have been the foundation of the Working Party's document.

4. Methods

4.1 Review of literature

A MEDLINE search for articles published between January 1990 and March 2004 was performed using a combination of key words including; *pain, wounds and injuries, catheterisation, urinary catheterisation, phlebotomy, spinal puncture, bone marrow examination, suture, minor surgical procedures, burn, dressing, emergency treatment, diagnostic imaging, needle biopsy, electroencephalography, conscious sedation, nerve block, local anaesthetics, analgesia, and analgesics.* This search was limited to randomised control trials, reviews, guidelines, consensus statements and meta-analyses reported in English in paediatric populations. A further search was performed of the Cochrane Database of Systematic Reviews for suitable articles. A total of 900 articles were identified. Two members of the working group independently assessed articles for inclusion based on title and abstract information. If there was disagreement final inclusion was decided by consensus opinion. A total of 370 articles were then available to the working group to be included as appropriate in the guideline. A PSYCHINFO search for articles was performed using a combination of keywords including; *pain, pain perception, pain management, distress, coping behaviour, painful medical procedures, procedural pain behaviour therapy, cognitive therapy, biofeedback training, hypnotherapy and relaxation.* Further articles were included that were known to working party members but overlooked in the literature search.

A Cochrane review of psychological interventions for needle-related procedural pain and distress in children and adolescents is in progress.[42]

4.2 Levels of evidence

All recommendations in the guideline were graded according to the following criteria based on the NHMRC levels of evidence. Where it is not possible to assign a level of evidence, appropriate scientific reference is made.

I Evidence obtained from a systematic review of all relevant randomised controlled trials.

II Evidence obtained from at least one properly designed randomised controlled trial.

III-1 Evidence obtained from well-designed pseudo-randomised controlled trials (alternate allocation or some other method).

III-2 Evidence obtained from comparative studies with concurrent controls and allocation not randomised (cohort studies), case-control studies, or interrupted time series with a control group.

III-3 Evidence obtained from comparative studies with historical control, two or more single-arm studies, or interrupted time series without a parallel control group.

IV Evidence obtained from case series, either post-test or pre-test and post-test.

5. Pre-procedure preparation

Key questions for all paediatric procedures

1. What is the procedure required?
2. Is this procedure really necessary?
3. How urgent is the procedure?
4. What is the expected intensity and duration of pain or discomfort for this child?

Patient characteristics that influence choice of technique

- Age.
- Previous experience with this or other procedures.
- Expected intensity and duration of pain.
- Anxiety levels of the child and parents, and their ability to cope.
- Physical state.
- Special situations (see Section 8)
    - Neonates.
    - Children with communication or behaviour problems.
    - Children with physical disability.
    - Children who are undergoing or likely to undergo repeated procedures.

After patient evaluation a decision can then be made in partnership with the child/family/care-givers on the choice of technique.

Critical incident analysis of adverse sedation events in paediatrics has identified several factors as contributing to adverse events associated with procedural analgesia and sedation in children. These include inadequate medical evaluation; inadequate monitoring during or after the procedure; inadequate skills in problem recognition and delay in intervention; and lack of experience of the practitioner with younger children or with the significance of an underlying medical condition.[43] Thus, prior to embarking on any pain relieving intervention in children, adequate history, examination, any necessary investigations, preparation of equipment and careful monitoring will help ensure a trouble-free experience. Wherever possible, preparation of equipment for a procedure should not occur in the presence of the child. Avoid situations where children can hear or see procedures being performed on other children, unless the situation is controlled and being used to model a procedure.

5.1 Evaluation and preparation of the patient

5.1.1 Non-pharmacological techniques

See Appendix 9.1.

Preparation of adults present at procedure

- Anxiety of parents and staff may interfere with ability to perform procedures successfully, and contribute to a child's distress.

- Adults need to assess any unresolved tensions related to their pain experiences growing up, to avoid unconsciously projecting them onto the child.[44]
- Train adults to coach children effectively in the use of coping behaviours.[45]

Preparation of child

- Provide age and developmentally appropriate information about the procedure and any sensations to expect.[16 46-48]
- Provide opportunities to ask questions.
- Consider exposure to aspects of stressor; such as handling equipment, practising procedure e.g. on a doll.
- Give child choices (e.g. whether to sit or lie, which hand for venepuncture) but not absolute control such as when to start procedure.[49]
- Consider previous effective coping or ineffective coping and the child's expectations of the procedure.
- Consider training the child and adults in specific coping and coping promoting behaviours and when to use these behaviours.

Preparation of adolescents

- Adolescents tend to minimize or deny pain, especially in front of their peers. It is vital to have a private conversation with them about forthcoming procedures.
- Provide developmentally appropriate information about the procedure and any sensations to expect.
- Like children, adolescents may regress to younger ways of behaving under the stress of pain.
- Give adolescents the opportunity to have parents involved or not. Help them take ownership of the procedure by giving them developmentally appropriate choices. Help adolescents feel able to accept strategies and medication to make the procedure easier for them (e.g. EMLA, breathing techniques, a stress ball).

5.1.2 Pharmacological techniques

Pre-procedure evaluation includes a careful patient history and physical evaluation. These should pay particular attention to cardio-respiratory status, potential for airway compromise, and any specific contraindications to the proposed analgesic medications.

Relevant points on history may include prior medical illnesses, information about medication use, known allergies, results of relevant pathology or radiological investigations, previous experiences with procedural analgesia/sedation or general anaesthesia.

Examination should include the patient weight, baseline vital signs including oxygen saturation and an assessment of conscious level. The patient's airway should be evaluated to ensure his/her ability to maintain a patent airway. Conditions that might impair positive pressure ventilation or endotracheal

intubation should be determined e.g. short neck, small mandible, or large tongue.

Children with American Society of Anaesthesiology Physical-Status Classification (ASA Class) 1 or 2 are generally considered to be at low risk during procedural analgesia. In the absence of an alternative risk grading system designed specifically for children, the ASA Physical class system remains the standard.

ASA Physical class:

1. Normal healthy patient
2. Patient with mild systemic condition
3. Patient with a severe systemic condition that limits activity but is not incapacitating.
4. Patient with an incapacitating systemic condition that is a constant threat to life.
5. Moribund patient not expected to survive for 24 hours.

In the following circumstances, use of procedural analgesic agents may have high risks:

- Neonates
- Critically ill patients
- Children with airway abnormalities that may cause airway compromise (e.g. facial or neck abnormalities, micrognathia, obstructive sleep apnoea, laryngomalacia)
- Patients with central nervous system conditions or neuromuscular disorders that may cause hypoventilation
- Patients with chronic lung disease or significant cardiac disease
- Patients with significant renal or hepatic impairment
- Patients known to have an increased risk of pulmonary aspiration (e.g. severe cerebral palsy)
- Severe obesity
- Raised intracranial pressure

Though many of these factors are not absolute contraindications to many of the drugs used, their presence may prompt a change in drug used or dosage, a change in the level of patient monitoring used throughout the procedure and experience level of the physician administering the sedation or may lead to referral for general anaesthesia or deferral of the procedure.

Recommendation regarding patient evaluation
All children undergoing procedural analgesia/sedation should have a pre-procedure evaluation to identify risk factors that may alter the method of analgesia used.

5.1.2.1 Pre-procedure fasting

Guidelines by various anaesthetic bodies such as the American Society of Anaesthesiologists, recommend that children should not consume solids for 4-8 hours or clear liquids for 2-3 hours prior to undergoing sedation for an elective

procedure. There is little data to suggest that pre-procedure fasting results in a decreased incidence of adverse events related to procedural sedation and analgesia. For non-elective or emergency procedures, delaying the procedure to meet these fasting guidelines may in some circumstances actually compromise the patient's condition.

Vomiting is a common event related to procedural analgesia and sedation but aspiration occurs rarely during sedation or general anaesthesia. During general anaesthesia the risk of pulmonary aspiration may be up to 1/373 for emergency cases and 1/4544 for elective cases.[50] In contrast, several large studies of children undergoing procedural analgesia outside of the operating theatre[51-53] had no episodes of clinically evident aspiration. Thus, although vomiting with aspiration is of great concern during procedural analgesia, the risk is low and the benefit of delaying the procedure to allow gastric emptying seems minimal.

The risk of aspiration during vomiting is directly related to the degree to which airway protective reflexes are lost. This, in turn, is influenced by medication type, dose, rate of administration and co-administration of other medications. Use of antacids and gastric emptying agents may decrease the risk of aspiration injury but their use for this purpose is not well studied in the paediatric population.

Recommendation regarding pre-procedure fasting
For each patient the risks and benefits should be considered by weighing up the potential for vomiting and aspiration against the urgency of the procedure. Techniques allowing effective analgesia for the procedure coupled with the lightest level of sedation should be employed. All sedated children should be managed as if they have full stomachs, with vigilance and preparation for vomiting.

5.2 Informed consent

Although there is no evidence that the use of an informed consent form has any impact upon clinical outcome or patient/family satisfaction, it should be considered good medical practice to discuss the proposed intervention with the patient and their carers. This should include a discussion of the aims of the intervention, its benefits, expected effects, potential side effects, alternative interventions that may be available and the need for monitoring and observation during and after the procedure prior to safe discharge.

Providing the carer with written information about the particular technique is highly desirable. As the expected effects, potential adverse events and recovery times prior to discharge will vary greatly between different agents, consideration should be given to generating consent forms that reflect the individual features of the different agents to clearly identify that these issues have been discussed with the child's parent. Alternatively, information sheets could be generated for techniques commonly used in an area and documentation within the medical record can be made that agent–specific issues were discussed with the parents.

Mature minors (14-16 years) may be able to consent to their own procedures and treatment if they are judged by the provider to be cognitively able to understand the risks and benefits and complications. While the need for this would be a rare occurrence and we encourage adolescents to keep parents and support people involved, it may sometimes be relevant (eg homeless youth).

Explanation of the procedure to the child may decrease anxiety and increase the level of cooperation during the procedure. The explanation may best be performed immediately prior to the procedure and should be carried out using developmentally appropriate terms and language.

Recommendation regarding informed consent
Informed consent for procedural analgesia should be obtained and documented in the patient's medical record. Information given to patients and parents should include aims of the intervention, anticipated effects and potential adverse effects that may occur during and after the intervention.

5.3 Role of parent

Evidence is mixed as to whether parents' presence is helpful for a child during painful procedures. It appears to depend on what the parents actually do.[54 55] Children mainly want their parents there, and parents usually want to be there. It is up to health care professionals to encourage parents and the child to be part of the health care team, and give them specific instructions.[56 57] Successful pain management depends on the interactions of parents, child, staff and everyone monitoring the intervention.

Parents have the potential to play an important role in the preparation of children for medical procedures by providing information about what to expect, giving older children a chance to ask any questions and younger children opportunity to act out the procedure with a toy medical kit. Parents may also be helping themselves understand what to expect in the process. Siblings may be helpful to distract a child especially before and after a procedure. However, their use may not be appropriate in all procedures.[56 57]

The treatment team needs to be sensitive to the changing needs of older children and adolescents, for example they may no longer want their caregivers or parents with them. It is important they provide explanations, support and pain relief while respecting the young person's choice for increasing independence.

Adult behaviour (parent and health care worker) at procedures has been described in one review as "simply too important to ignore."[17] Adult behaviours likely to enhance a child coping during a procedure include:

- Non-procedural talk (e.g. birthday parties, pets, favourite activities etc.).
- Distraction methods (e.g. favourite music, toys, games, bubbles, clowns etc.).
- Breathing techniques.
- The adult prompting the child to use coping strategies.

Adult behaviours likely to interfere with a child's coping include:

- Making reassuring comments (e.g. “It’ll be all right”).
- Making empathic comments (e.g. “I know it’s hard”).
- Apologising (e.g. “I’m sorry you have to go through this”).
- Criticising (e.g. “You’re being a baby”).
- Bargaining with the child (e.g. “I’ll get you a play station if you let them do it”).
- Providing explanations during the procedure.
- Giving the child control over when to start the procedure (e.g. “Tell me when you’re ready”).
- Catastrophising and becoming agitated.

What reassurance, empathy and apologising have in common is that they focus the child’s attention on the threatening and painful aspects of the medical procedure or on their own negative reactions, which often makes the procedure more distressing. Researchers do not suggest that parents are told not to reassure their children, rather that adults (both parents and staff) engage in behaviours that promote child coping, and avoid actions or statements that promote distress.[17]

Studies have shown that parent training programmes lead to a significant reduction in stress for the child. It is also possible to train nurses to model coping promoting behaviour and parents can then take their cues from this during the procedure. This is more cost effective if resources are limited.[17]

Following the procedure, parents should continue to monitor the child to ensure minimal distress or pain as a result of the procedure.

5.3.1 Language for talking to children and adolescents about pain and procedures

Choice of words is very important.[58]

Special problems related to talking about pain, include:

- Lying or withholding information to “protect the child” or “to avoid upsetting the child” because the child doesn’t cope as well, and is less likely to trust in the future.
- Setting up negative suggestions because it limits the child’s ability to use coping mechanisms to reduce perceived pain.

For example, an honest alternative to saying “this is going to hurt” is “some children say the needle going in feels like pressure. Others say it hurts a bit. Some say it feels like a bee sting. Others say it feels like a kitten scratching or a baby chick pecking. I wonder how it will feel to you?” This approach maintains trust because rather than prescribing or denying pain, you are saying; “I don’t know how it will feel for you, there are a range of possibilities, how would you like it to feel?”

Adolescents respect directness and honesty.

6. Resources

The resources required for management of procedural pain in children are dependent on the procedure, the pain management technique used, and the child.

6.1 Environment

- Setting – treatment room, not the child's bed or bedroom.[31]
- Environment – comfortable, friendly, calm adults.

6.2 Personnel

With all techniques used, staff should have:

- An understanding of and experience in the technique used.
- The ability to monitor clinical effectiveness and possible deterioration.
- The ability to manage adverse advents.

Non-pharmacological techniques
Ideally all staff should have knowledge of simple effective coping strategies to use with children of any age and to model for parents. Staff should be able to offer support for parents. A willing adult is needed for distraction.

Staff experienced and trained in psychological techniques (e.g. a Play Therapist) should be available in areas such as Oncology, or the Emergency Department where ill or injured children are placed in an unfamiliar environment with unknown physicians, nurses and other staff.[31]

Analgesia without sedation
Staff should have an understanding of and experience in the medications used. Additional skills required include the recognition of anaphylaxis, management of a compromised airway and ability to perform effective CPR.

Procedural sedation
There is no clear evidence from the literature as to the number of staff necessary for safe procedural sedation. A number of international and local protocols recommend one medical staff member to monitor the airway and patients clinical status (the "sedationist") with an additional staff member performing the procedure. The sedationist requires knowledge and experience in use of the medications, and knowledge and experience in advanced airway management. As sedation is a continuum (ranging from mild anxiolysis to deep sedation) and an individual child's response to sedative medication may vary, the sedationist needs the skills required to deal with the child slipping into the next deeper level of sedation. In a number of situations an additional staff member may be needed to assist those undertaking the procedure and sedation.

Level of evidence – Consensus opinion.

6.3 Equipment

Non-pharmacological techniques

Equipment for distraction should be available in settings where management of procedure-related pain in children is to occur. This includes toys, interactive books, puppets, bubbles, and magic wand, electronic games that will quickly engage and sustain a child's attention. Music, either live or recorded, and videos are also useful for distraction. Consider the nature and degree of movement possible during the procedure when selecting an appropriate type of distraction method.

Analgesia without sedation

Medications used for sedation and analgesia rarely result in anaphylaxis, respiratory compromise and cardio-respiratory arrest. The risk of such adverse outcomes is dependent on the medication used, its dose and administration route, the age of the patient, and the patients underlying drug sensitivities and comorbidities. However, to effectively manage such outcomes, suction, oxygen, bag-valve-mask devices, adrenaline and intubation equipment should be readily available in the department in which the procedure occurs.

The use of opioids or benzodiazepines necessitates that their antagonists, naloxone and flumazenil respectively, are available.

Procedural sedation

Respiratory compromise[52 59] is a recognised risk associated with a number of medications used for procedure-sedation in children. When these medications are used, there should be access to the above equipment in the immediate environment i.e. the room in which the sedation and procedure are occurring.

Level of evidence - Consensus opinion.

6.4 Monitoring during procedure

Staff using both non-pharmacological and pharmacological techniques should have the experience to determine if the technique currently being used is effective in making the child comfortable. Ongoing assessment should be made of any technique used with regard to the child's coping, especially at height of procedure.

Non-pharmacological techniques

Staff using non-pharmacological techniques and/or medications should have the experience to determine if the technique currently being used is effective in managing the child's current perception of pain. Ongoing assessment should be made of any technique used with regard to the child's coping, especially at height of procedure. It may be necessary to switch techniques or add another, but empathic or reassuring statements such as "It'll be all right" tend to increase distress. Assessment of pain needs to continue right to the end of the procedure. It is possible that pain in the last moments of a procedure will determine how the child remembers the situation overall.[60]

Procedural sedation

Monitoring associated with sedation may include; assessment of level of pain and/or level of sedation, heart rate, respiration rate, blood pressure, ECG rhythm, pulse oximetry, and capnography (end tidal CO_2 monitoring).

Absence of evidence exists in the literature concerning the optimal frequency of such monitoring. In most cases documentation before, after and if possible during the procedure is recommended. The duration of monitoring will be determined by the pharmacological properties of the individual medication used.

There is absence of evidence in the literature concerning the benefit of ECG rhythm monitoring during procedural sedation.

Pulse oximetry has been used to define hypoxemia and adverse advents in a number of studies evaluating different sedative agents.[52] [59] In general pulse oximetry is recommended to reduce the risk of unrecognised hypoxemia. However, pulse oximetry is limited in its ability to detect early hypoventilation and hypercarbia. Furthermore, although there is evidence that transient desaturation occurs during procedural sedation there is sparse evidence as to its clinical significance.[61]

Small observational studies (n<100) have reported on end tidal carbon dioxide monitoring for procedural sedation. Some have reported no increase in effectiveness over pulse oximetry and observation[62] [63] while others show increased ability to detect early respiratory depression.[64] [65] End tidal carbon dioxide monitoring may have a role in the monitoring during procedural sedation particularly when the patients respiratory efforts are unable to be visualised.

Level of evidence – IV for pulse oximetry and end tidal carbon dioxide monitoring and consensus opinion, for remainder.

6.5 Documentation

All patients undergoing analgesia or sedation for a procedure should have their pre-procedure evaluation, consent, and monitoring of vital signs documented pre, post and if possible during the procedure.

Level of evidence - Consensus opinion.

6.6 Table of resources suggested for individual techniques

Technique	Personnel	Monitoring/Equipment
Distraction	Willing adult	Materials that quickly capture and sustain a child's attention
Deep breathing, muscle relaxation	Adult with some experience with the techniques	
Self regulation	Staff with formal training	Biofeedback equipment
Topical anaesthesia	1. Must be able to take a basic medical history including: Previous LA exposure and any adverse reactions. 2. Record dose of agent used, time of administration, and any evidence of allergic reaction in patient notes. 3. Obtain informed parental consent. 4. Inform the child of the intended topical anaesthetic technique.	
Local Infiltration	1. Must be able to take a basic medical history including: Previous LA exposure and any adverse reactions. 2. Obtain patient weight to determine correct LA dose. 3. Obtain informed parental consent. 4. Inform the child of the intended infiltration technique and what they will experience, including any discomfort caused by the technique. 5. Record details of technique on an appropriate chart. 6. Record any adverse events related to the technique. 7. Must be competent in CPR.	1. Use smallest gauge needle required to perform local infiltration. 2. Check correct drug dose and volume. 3. Use aseptic technique.
Peripheral Nerve Block	Follow guidelines as for local infiltration. Practitioners should be trained in the technique, and be familiar with the use of a nerve stimulator (if indicated) for the technique. A trained assistant should be available to monitor the patient whilst the practitioner is performing the block.	1. Use short-bevelled needles, or specific insulated needles for connection to a nerve stimulator. 2. Check correct drug dose and volume. 3. Use aseptic technique. 4. Check resuscitation equipment. This should include an oxygen supply, equipment for artificial ventilation, suction, a defibrillator, and cardiac resuscitation drugs. 5. Monitor vital signs, including HR, RR, pulse oximetry, conscious level and BP. 6. Stop technique if pain experienced on injection of local anaesthetic – this may indicate intraneural injection.
Bier's Block (Intravenous Regional Anaesthesia)	Follow guidelines as for local infiltration. Practitioners should be trained in the technique and be familiar with it's potential complications. Risk factors for methaemoglobinaemia should be sought in the medical history if	1. Check tourniquet function prior to commencement of the block. 2. Check correct drug dose and volume. 3. Use aseptic technique. 4. Check resuscitation equipment as above. 5. Monitor vital signs as above.

	prilocaine is used. A trained assistant should be available to monitor the patient whilst the practitioner is performing the block.	6. The second tourniquet should not be deflated until at least 20 minutes after injection of the local anaesthetic.
Nitrous oxide analgesia	The person administering the nitrous oxide should be separate from the person performing the procedure. Anaesthetist to be present if: - Age under 12 months - Airway problem - Pre medicated	1. Separate means of delivering 100% oxygen. 2. Check resuscitation equipment. This should include an oxygen supply, equipment for artificial ventilation, suction, a defibrillator, and cardiac resuscitation drugs. 3. Monitor vital signs, including HR, RR, pulse oximetry, conscious level and BP. 4. Scavenging of expired gases if continuous flow device used.
Ketamine	Practitioners should be trained in the technique, and be familiar with the expected effects, contraindications and potential adverse events. Practitioners should be skilled in advanced airway management. The person administering the sedation should be separate from the person performing the procedure.	1. Check resuscitation equipment. This should include an oxygen supply, equipment for artificial ventilation, suction, a defibrillator, and cardiac resuscitation drugs. 2. Monitor vital signs, including HR, RR, pulse oximetry, conscious level and BP.
Midazolam	Practitioners should be trained in the technique, and be familiar with the expected effects, contraindications and potential adverse events. Practitioners should be skilled in advanced airway management. The person administering the sedation should be separate from the person performing the procedure.	1. Check resuscitation equipment. This should include an oxygen supply, equipment for artificial ventilation, suction, a defibrillator, and cardiac resuscitation drugs. 2. Monitor vital signs, including HR, RR, pulse oximetry, conscious level and BP.

7. Procedures

7.1 Introduction

Evidence and suggested techniques have been provided in section 7.3 for the following list of procedures commonly undertaken in the paediatric population:

- Capillary sampling.
- Intramuscular injections e.g. immunisations.
- Suprapubic aspiration.
- Central venous port access.
- Venepuncture.
- Intravenous cannulation.
- Arterial puncture.
- Intra-arterial cannulation.
- Central venous line insertion.
- Nasogastric tube insertion.
- Orogastric tube insertion.
- Endotracheal intubation.
- Endotracheal suction.
- Chest tube insertion or removal.
- Urethral catheterisation or MCU
- Laceration repair.
- Fracture manipulation.
- Foreign body removal.
- Burns and other wound dressing.
- Lumbar puncture.
- Bone marrow aspiration.
- Joint aspiration and/or injection.
- Renal biopsy.
- Radiological imaging (MRI, CT)

7.2 The procedure process

Prior to any procedure being undertaken the clinician responsible for the procedure needs to adequately plan for the procedure process. This is not merely deciding which pharmacological agent to use but rather it involves consideration of the total procedure process, including non-pharmacological and pharmacological pain management techniques before, during and after the procedure and optimising the overall psychological context including language which is part of every good procedure.

Before	**During**	**After**
Non-Pharmacological - Assessment of child's previous experience - Assessment of child's expectations - Find out child's likes and interests - Enlist parent's help - Start distraction immediately prior to procedure	Non-Pharmacological - Distraction - Breathing techniques - Other coping promoting behaviour and techniques	Non-Pharmacological - Correct any misconceptions - Reinforce coping behaviour -Focus on positive - Instil sense of achievement
Pharmacological - Consent - Fasting - Pre-procedure assessment	Pharmacological - Appropriate technique used for procedure	Pharmacological - Post-procedure assessment - Ongoing analgesia
General - Personnel - Equipment	General - Monitoring – pain and safety - Documentation - Management of complications	General - Discharge advice - Preparation for next time, nearer the time.

7.3 Procedures

7.3.1 Capillary sampling

- Venepuncture is the preferred method of blood sampling when a significant volume of blood is required. It has been shown to be less painful in neonates[66 67] and less likely to require resampling.[66 67]
- Capillary sampling is often used when the volume of blood required is small, e.g. blood glucose estimations, acid-base determination and drug level monitoring. The squeezing of the tissue is the most painful part of the procedure, [67] and is not relieved by topical anaesthesia in neonates.[68 69]
- EMLA cream,[69-71] other topical anaesthetic agents[68] and paracetamol[72] do not relieve the pain of capillary sampling.

Suggested techniques:

- Administration of15-50% sucrose[38 73-83] is effective in neonates and may be effective up to 2 months of age.[76] Systematic reviews of the literature suggest doses in the order of 0.5–1.0mls of 24% sucrose in 0.25ml aliquots, commencing 2 minutes before the procedure.[38 73-83] Concomitant use of a pacifier may further reduce behavioural responses to painful stimuli.[38 73-83] *A pacifier should only be used in accordance with parental wishes and its one-off use is not intended to promote or encourage regular pacifier use in infants.*
- Swaddling and containment of infants.
- Distraction, relaxation or other coping skills in children.
- Use of an automated lancet whenever possible.[84]

7.3.2 Intramuscular injection, suprapubic aspiration, central venous port access

- It is always preferable to avoid the intramuscular route of administration when an alternative route exists e.g. oral or intravenous.

Suggested techniques:

- Pacifier with 15-50% sucrose [38 74] up to 2 months of age (see 7.3.1).
- Swaddling and containment of infants.
- Distraction, relaxation or other coping skills in children.
- Topical anaesthetic agents such as EMLA cream, AnGel, ALA and ELA-max (see glossary) applied at the recommended time before needling.[85-89]

7.3.3 Immunisation

- The majority of children are exposed to multiple intramuscular injections through regular vaccinations. The pain and distress experienced by children and their carers may contribute to community non-adherence with paediatric immunisation schedules.[90]
- Parental prediction and parental assessment of their child's usual response to painful stimuli is an accurate predictor of significant distress

during vaccination.[90] Health care providers of childhood immunisation should consider methods to reduce pain and distress in all children.

- The use of EMLA cream to relieve the pain of vaccination has not been shown to reduce the antibody response to childhood immunization.[91 92]

Amethocaine has been shown to reduce the pain of both the needle prick and vaccine infiltration in children with haemophilia receiving subcutaneous immunisation.[a] EMLA has been shown to reduce pain scores in infants receiving immunisation.[81]

Suggested techniques:

- Pacifier with 15-50% sucrose [38 74] up to 2 months of age (see 7.3.1).
- Swaddling and containment of infants.
- Distraction, relaxation or other coping skills in children.
- Topical anaesthetic agents such as EMLA cream or AnGel applied at the recommended time before needling.[85-89]
- Vapocoolant applied 15 seconds before vaccination.[93]

Balance should be sought between the desire to reduce the pain and distress of immunisation, and the practical implications of adopting such a strategy, so as not to create barriers to routine childhood immunisation.

7.3.4 Venepuncture, intravenous cannulation, arterial puncture, intra-arterial cannulation

- These are often the most feared painful procedure performed on children. As such, the need for the procedure should always be justified.

Suggested techniques:

- Pacifier with 15-50% sucrose[38 73-75 82 94-97] up to 2 months of age (see 7.3.1).
- Swaddling and containment of infants.
- Distraction, relaxation or other coping skills in children.
- Topical anaesthetic agents such as EMLA cream, AnGel, and ELA-max applied at the recommended time before needling.[70 82 98-113]
- Local anaesthetic agents such as subcutaneous lignocaine are not usually used in this setting due to the pain of the actual injection and the agent itself. If used, buffering of local anaesthetic agents with sodium bicarbonate reduces the pain of administration without compromising efficacy.[114 115]
- Nitrous oxide has been shown to safe[116 117] and effective[117 118] in reducing the pain and anxiety of venepuncture and cannulation. Its rapid onset and offset make it particularly attractive for these brief procedures. Safe administration requires adherence to the conscious sedation guidelines referred to elsewhere in this document (Appendix 9.3).

7.3.5 Central venous line insertion

- The more prolonged duration of this procedure, together with the greater need for a cooperative patient, increases the need for adequate analgesia and sedation in these children.
- Consider general anaesthesia for this painful procedure however, conscious sedation and analgesia may be used in older children and adolescents depending on the adequacy of their psychological coping skills, preparation level and patient/family choice.

Suggested techniques:

- Pacifier with 15-50% sucrose up to 2 months of age (see 7.3.1).
- Swaddling and containment of infants.
- Distraction, relaxation or other coping skills in children.
- Topical anaesthetic agents such as EMLA cream, AnGel, and ELA-max applied at the recommended time before needling (see above).
- Local anaesthetic agents such as subcutaneous lignocaine.[119] Buffering of local anaesthetic agents with sodium bicarbonate reduces the pain of administration without compromising efficacy.[114 115]
- Nitrous oxide has been shown to reduce the pain and anxiety of painful procedures.[117 118] Safe administration requires adherence to the conscious sedation guidelines referred to elsewhere in this document. (Appendix9.3)
- Consider sedation.
    - Midazalam may be given IV, IM, orally or intra-nasally.
        - Major side effect: Respiratory depression.
    - Ketamine. Produces dissociative anaesthesia, as such has an analgesic effect.
        - Dose: 1mg/kg slow IV.
- Consider opioid analgesia. The use of intravenous opioids such as morphine, pethidine and fentanyl, may provide analgesia but not necessarily, sedation.
        - The dose should be titrated carefully against response.
        - Opioids should preferably be given via the intravenous route.

7.3.6 Nasogastric or orogastric tube insertion

Suggested techniques:

- Use a pacifier with sucrose in neonates[38] (see 7.3.1).
- Use swaddling or containment in infants.[120 121]
- Distraction, relaxation or other coping skills in children.

7.3.7 Endotracheal intubation

- Historically preterm neonates have been intubated while awake on a semi-elective basis. Such techniques are associated with adverse physiological responses.[122 123] Various pharmacological techniques supported by current evidence are discussed in the neonatal document.
- The provision of pain relief should be a part of a semi-elective/elective intubation in older children.

7.3.8 Endotracheal suction

- Ketamine does not appear to be effective in infants.[124]

Suggested techniques:

- Use a pacifier with sucrose in neonates prior to intubation.[38]
- Use swaddling or containment in infants.[120 121]
- Consider continuous intravenous infusion[125] or intermittent infusion[126] of opioids in infants.
- Consider use of intermittent infusion of morphine in older children.

7.3.9 Chest tube insertion or removal

- Intravenous midazolam does not appear to be effective in neonates.[127]

Suggested techniques:

- Use a pacifier with sucrose in neonates.[38]
- Consider slow intravenous opioid infusion (morphine) in neonates.[128 129]
- Consider subcutaneous infiltration of lignocaine[106 129]. Buffering of lignocaine with sodium bicarbonate reduces pain of administration without altering efficacy.[115]
- Consider use of short acting anaesthetic agents in neonates[128 129] or short general anaesthetic in older children.
- Consider use of distraction, relaxation or other coping skills in children.
- Use EMLA or intermittent bolus of morphine prior to chest tube removal.[130]

7.3.10 Urethral catheterisation or MCU

Suggested techniques:

- Consider use of a pacifier with sucrose in neonates.[38]
- Consider use of swaddling or containment in infants.[120 121]
- Use Lignocaine lubricant in older children.[131]
- Consider use of distraction, relaxation or other coping skills in children.
- Consider use of nitrous oxide (see Appendix 9.3).

7.3.11 Laceration repair

Suggested techniques:

- Consider use of distraction, relaxation or other coping skills in children.
- Cyanoacrylate tissue adhesives (skins glues) are the method of choice for repair of simple lacerations in children[132] as they are easy to use, offer rapid and painless application and provide similar cosmetic outcomes to suturing.
- When sutures are required topical agents should be used in preference to injected Lignocaine.
- The mixture of Lignocaine, Adrenaline and Tetracaine (ALA or LET) should be used in preference to cocaine containing topical anaesthetics (such as TAC and AC Gel) because of equivalent efficacy and better safety profile[133 134].

- If topical anaesthetic agents are not available or if supplementation of anaesthesia is required with infiltrated Lignocaine, pain of infiltration can be reduced by:
    - Buffering the Lignocaine with Sodium Bicarbonate.[115]
    - Warming the solution to body temperature.
    - Using the smallest needle available.
    - Injecting through wound margins rather than intact skin.
    - Injecting as slowly as practical.
- In young or anxious children sedation may be required to assist motion control and thereby facilitate suturing.
- Inhaled Nitrous Oxide is effective in providing analgesia and anxiolysis to facilitate suturing in children[135 136].
- For more complicated lacerations, intravenous Ketamine and Midazolam can provide excellent conditions for laceration repair providing a high degree of motion control[137].
- Oral or intranasal Midazolam may be used to facilitate laceration repair in children but the reported efficacy is significantly lower than the above stated techniques[137 138].

7.3.12 Fracture manipulation

- The manipulation of a displaced or angulated fracture in a child elicits a highly painful stimulus and thus powerful analgesia is required. In many settings, having a manipulation performed under general anaesthetic in the operating theatre may best provide this.
- In centres where personnel have expertise in the specialised procedural sedation/analgesia (PSA) techniques required, fracture manipulation maybe performed outside of the operating room.

Suggested techniques:

- Intravenous Ketamine has a well-documented safety and efficacy profile for PSA in children.
- The combination of Ketamine and Midazolam provides more effective analgesia than Fentanyl/Midazolam for emergency orthopaedic procedures in children and has fewer respiratory side effects[139].
- The combination of intravenous Propofol/Fentanyl offers a similar level of analgesia to Ketamine/Midazolam[140] but the much higher incidence of airway complications means that this combination is not recommended in children at this time.[141]
- In older children (in whom cooperation can be assured) in settings where specialised equipment is available and staff are experienced with the technique) intravenous regional anaesthesia (Bier's Block) may be used as an alternative[142].
- Inhaled Nitrous Oxide may be suitable in children with minimally displaced fractures requiring only minor manipulation[143].
- The use of non-pharmacological techniques of PSA during paediatric orthopaedic procedures has not been described but it should be recognised that such techniques can significantly enhance the PSA without worsening the risk of side effects.

7.3.13 Foreign body removal

- Little has been written on the use of procedural analgesia for removal of foreign bodies in children.

Suggested techniques:

- Non-pharmacological techniques should be employed to enhance the child's cooperation.
- Topical anaesthetic application by spray[144-146] or direct application[147]
- Intranasal midazolam may facilitate foreign body removal in children[137]

7.3.14 Burns and other wound dressing

- Children with burns and other traumatic wounds often require repeated painful procedures related to dressings changes. Inadequate pain control is associated with escalation of pain and anxiety with subsequent procedures.

Suggested techniques:

- Initial pain management for burns may best be managed with a continuous intravenous opioid infusion or intermittent opioid dosing with additional opioid or benzodiazepine doses prior to dressings. Some children may benefit from patient controlled analgesia (PCA) as a means of delivering opioid infusion
- Oral opioids (e.g. Codeine) or combinations of Codeine and Paracetamol are useful [148].
- Depending on the child's level of anxiety, oral Midazolam may be a useful adjunct.
- Inhaled nitrous oxide is a useful alternative for managing pain and anxiety related to burns dressings.
- Oral sustained release morphine preparations may provide baseline analgesia.
- Extensive debridement should be performed under general anaesthesia.
- Distraction, relaxation or other coping skills (non-pharmacological techniques are particularly effective in children undergoing repeated painful procedures).

7.3.15 Lumbar puncture

- The more prolonged duration of this procedure, together with the greater need for a cooperative patient, increases the need for adequate analgesia and consideration of conscious sedation in these children.

Suggested techniques:

- Use a pacifier with sucrose in neonates.
- Use swaddling or containment in infants.
- Distraction, relaxation or other coping skills in children.
- Topical anaesthetic agents such as EMLA cream, AnGel, and ELA-max applied at the recommended time before needling.[149-151]

- Consider using injectable local anaesthetic agents such as subcutaneous lignocaine; however the pain of the actual injection and the agent itself may be as bad as or worse than the actual procedure. Buffering of lignocaine with sodium bicarbonate reduces pain of administration without altering efficacy.[115]
- Nitrous oxide has been shown to safe[116] and effective[117 152] in reducing the pain and anxiety of lumbar puncture. Its rapid onset and offset make it particularly attractive for this relatively brief procedure. Its safe administration requires adherence to the conscious sedation guidelines referred to elsewhere in this document.
- Consider sedation.
    - Midazolam. May be given IV, IM, orally or nasally.[153 154]
- Consider general anaesthesia particularly for children who will need repeated procedures.

7.3.16 Bone marrow aspiration

- The more prolonged duration of this procedure, together with the greater need for a cooperative patient, increases the need for adequate analgesia and sedation in these children.
- Consider general anaesthesia for this painful procedure however, conscious sedation and analgesia may be used in older children and adolescents depending on the adequacy of their psychological coping skills, preparation level and patient/family choice.

Suggested techniques:

- Consider general anaesthesia.
- Distraction, relaxation or other coping skills in children.
- Topical anaesthetic agents such as EMLA cream, AnGel, and ELA-max applied at the recommended time before needling.
- Consider subcutaneous infiltration of lignocaine;[129] buffering of lignocaine with sodium bicarbonate reduces pain of administration without altering efficacy.[115]
- Nitrous oxide has been shown to safe[116] and effective[117 152] in reducing the pain and anxiety of bone marrow aspiration. Its rapid onset and offset make it particularly attractive for this relatively brief procedure. Its safe administration requires adherence to the conscious sedation guidelines referred to elsewhere in this document.
- Consider use of short acting anaesthetic agents in neonates[128 129] or short general anaesthetic in older children.
- Consider sedation.
    - Midazolam. May be given IV, IM, orally or nasally.[153 154]
- Ketamine. Produces dissociative anaesthesia, as such has an analgesic effect.[154]
- Consider opioid analgesia. The use of intravenous opioids such as morphine, pethidine and fentanyl, may provide analgesia but not necessarily, sedation. The dose should be titrated carefully against response. Opioids should preferably be given via the intravenous route.

7.3.17 Joint aspiration and/or injection

- For children under 10 -12 years use conscious sedation or general anaesthesia. Conscious sedation and analgesia may be necessary in adolescents depending on the adequacy of their psychological coping skills, preparation level and patient/family choice.

Suggested techniques:

- Consider general anaesthesia for children <12 years old.
- Distraction, relaxation or other coping skills in children.
- Topical anaesthetic agents such as EMLA cream, AnGel, and ELA-max applied at the recommended time before needling.
- Local anaesthetic agents such as subcutaneous lignocaine are not usually used in this setting due to the pain of the actual injection and the agent itself.
- Nitrous oxide has been shown to safe[116] and effective[155] in reducing the pain and anxiety of joint injections. Its rapid onset and offset make it particularly attractive for these relatively brief procedures. Its safe administration requires adherence to the conscious sedation guidelines referred to elsewhere in this document.
- Consider sedation.
    - Midazolam. May be given IV, IM, orally or nasally.[153 154]
    - Ketamine. Produces dissociative anaesthesia and as such has an analgesic effect.[154]

7.3.18 Renal biopsy

- General anaesthesia for children under 12 years is strongly recommended. Conscious sedation and systemic analgesia may be used in adolescents depending on the adequacy of their psychological coping skills, preparation level and patient/family choice.

Suggested techniques:

- Consider general anaesthesia for children <12 years old and for most adolescents.
- Topical anaesthetic agents such as EMLA cream, AnGel, and ELA-max applied at the recommended time before needling.
- Consider subcutaneous infiltration of lignocaine;[129] buffering of lignocaine with sodium bicarbonate reduces pain of administration without altering efficacy.[115]
- Nitrous oxide has been shown to safe and effective in reducing the pain and anxiety of invasive procedures. Its rapid onset and offset make it particularly attractive for these relatively brief procedures. Its safe administration requires adherence to the conscious sedation guidelines referred to elsewhere in this document.
- Consider sedation.
    - Midazolam. May be given IV, IM, orally or nasally.[153 154]
    - Ketamine. Produces dissociative anaesthesia, as such has an analgesic effect.[154]

- Consider opioid analgesia. The use of intravenous opioids such as morphine, pethidine and fentanyl, may provide analgesia but not necessarily, sedation. The dose should be titrated carefully against response. Opioids should preferably be given via the intravenous route.

7.3.19 CT scan

- Children may need to lie completely still for up to a minute. The whole process lasts about 15 minutes. In addition, some children may need to hold their breath on demand or have intravenous contrast.

Suggested techniques:

- Infants less than 3 months miss a feed and then are fed just before the scan. (Insert intravenous cannula if required before feed).
- Use swaddling or containment in infants.[120 121]
- Prepare children and parent/caregiver with procedural and sensory information.
- Consider play therapy.
- Distraction during procedure: e.g. audiotapes, or video if available.
- Consider sedation or general anaesthetic for:
    - Infants > 3 months old and toddlers (chloral hydrate 50mg/kg po).
    - Older children if they are not comfortable with equipment.
    - Children with pre-existing behaviour problems.
    - Certain respiratory and cardiac procedures due to excessive breath holding requirements.
    - Children unable to lie still.

7.3.20 MRI scans

- Children need to lie completely still for several minutes at a time in a noisy confined space. The whole process lasts between 25 and 90 minutes. In addition, some children may need to hold their breath on demand or have intravenous contrast.

Suggested techniques:

- Infants less than 3 months miss a feed and then are fed just before the scan. (Insert intravenous cannula if required before feed).
- Use swaddling or containment in infants.[120 121]
- Prepare children and parent/caregiver with procedural and sensory information.
- In children consider play therapy using a model of an MRI[156] or an MRI simulator.[157]
- Distraction during procedure e.g. audiotapes, or video if available.
- Consider sedation or general anaesthetic for:
    - Infants > 3 months old and toddlers (chloral hydrate 50mg/kg po).
    - Older children if they are not comfortable with equipment (e.g. claustrophobic).
    - Children with pre-existing behaviour problems.
    - Certain respiratory and cardiac procedures due to excessive breath holding requirements.

- Children unable to lie still.
- Note special monitoring requirements when using MRI scanners.[158]

7.4 Levels of evidence

Level I

- Buffering of local anaesthetics with sodium bicarbonate reduces pain of injection, without altering efficacy.[115]
- Sucrose is safe and effective for reducing procedural pain from single painful events in neonates.[38 73-75]
- EMLA and distraction are effective for paediatric vaccination.[90]
- EMLA is not effective in reducing pain associated with heal lancing in neonates.[69 70]
- Venepuncture is less painful than heel lancing for blood sampling in neonates.[66 67]
- Midazolam maybe associated with increased adverse advents in neonates.[127]
- Cyanoacrylate tissue adhesives (skins glues) are the method of choice for repair of simple lacerations in children.[132]

Level II

- Sucrose is effective for heel lancing in infants.[76-81]
- Sucrose is effective for venepuncture in neonates.[94 95]
- ELA-Max is as effective as EMLA for intravenous insertion in children.[98 99]
- EMLA does not adversely affect the antibody response to vaccination in infants from birth to six months of age.[91 92]
- AMET and AMLI are as effective as EMLA for intravenous insertion in children.[100]
- Amethocaine gel is effective for neonates undergoing skin puncturing procedural pain.[101]
- The use of EMLA with sucrose did not result in further analgesic efficacy than sucrose alone in neonates undergoing skin puncture.[82]
- Continuous flow nitrous oxide is more effective than oral midazolam in children for laceration repair.[136]
- Ametop provides effective pain relief during venepuncture in neonates.[68]
- EMLA is effective for vaccination in infants.[87 88 92]
- Ametop is more effective than EMLA for intravenous cannulation in children.[103]
- Ametop is as effective as EMLA for venepuncture in children.[104]
- Ametop is as effective as EMLA for Port-a-cath access in children.[86]
- Parental application is as effective as clinician application of EMLA for intravenous catheter insertion in children.[105]
- Single study to suggest buffered lignocaine does not change pain scores.[114]
- Human milk is not as effective as sucrose for heel lancing in neonates.[159]
- EMLA is effective for venepuncture in neonates.[106]
- Vapocoolant is as effective as EMLA in reducing immunization pain in school-aged children.[93]

- EMLA was more effective than tetracaine cream for venepuncture in children.[160]
- EMLA is effective for venepuncture in children.[107-109]
- EMLA or intradermal lignocaine in combination with nitrous oxide are more effective than nitrous oxide alone in venepuncture in older children and adolescents.[118]
- Refrigent topical anaesthetic spray is as effective as placebo topical spray for immunization in children.[161]
- Nitrous oxide is more effective than EMLA for intravenous cannulation in children.[162]
- EMLA is effective for Port-a-cath access in children.[89]
- EMLA patch is as effective as EMLA cream applied with Tegaderm for venepuncture in children.[111]
- Paracetamol is ineffective for heel lancing neonates[72]
- Lignocaine lubricant is effective for urinary catheterisation.[131]
- Ketamine is not effective in neonates for endotracheal tube suctioning.[124]
- EMLA or morphine is effective prior to chest tube removal.[130]
- The topical mixture of Lignocaine, Adrenaline and Tetracaine (ALA or LET) has a better safety profile and equivalent efficacy to cocaine containing topical anaesthetics (such as TAC and AC Gel).[133 134]
- Inhaled Nitrous Oxide is effective in providing analgesia and anxiolysis to facilitate suturing in children.[135 136]
- Intravenous Ketamine/Midazolam are effective in providing a high degree of motion control for laceration repair.[137]
- Oral or intranasal Midazolam is not as effective as intravenous Ketamine/ Midazolam for laceration repair.[137 138]
- Ketamine/Midazolam is more effective than Fentanyl/Midazolam for emergency orthopaedic procedures in children.[139]
- Ketamine and Midazolam is more effective than Meperidine and Midazolam in children undergoing painful procedures.[154]
- Midazolam is more effective as a premedication than Fentanyl in children undergoing painful procedures.[153]
- Intravenous regional anaesthesia (Bier's Block) is effective in older children for fracture manipulation.[142]
- Inhaled Nitrous Oxide is effective children for fracture manipulation of minimally displaced fractures.[143]
- EMLA is not effective for children undergoing intra-articular joint injection.[163]
- Lignocaine is effective for lumbar punctures in children.[149]
- Oral Fentanyl provides effective analgesia for lumbar punctures and bone marrow aspirates in children. However a significant number of children experience nausea and vomiting.[164]

Level III-1

- Tactile and vocal stimulation is effective for heel lancing in neonates.[84]
- An automated lancet is more effective for heel lancing in neonates.[84]
- Intravenous Propofol/Fentanyl is effective as Ketamine/Midazolam,[140] however the much higher incidence of airway complications means that this combination is not recommended in children.[141]

Level III-2

- Premixed 50% nitrous oxide and oxygen is safe for procedural sedation in children.[116]
- Nitrous oxide is effective for painful procedures in children.[117]

Level III-3

- Oral ketamine is effective for painful procedures in children.[165]
- EMLA is effective for one off lumbar punctures in children, but not repeated lumbar puntures.[166]

Level IV

- Nitrous oxide is effective analgesia for intra-articular injection in children.[155]
- General anesthesia is more effective than EMLA or oral Midazolam/EMLA for lumbar puncture or bone marrow aspirate in children.[167]

8. Special situations

8.1 Neonates

See separate neonatal guideline statement.

8.2 Children with communication or behaviour problems

The ideal goals of procedural intervention are the same for all children:

- Facilitation of a successful procedure.
- Minimising procedural pain and distress.
- No need for aggressive physical restraint.
- No fear of subsequent procedures.

There are several identifiable groups and children may belong to more than one:

1. Children with impaired cognition and inability to communicate are at risk for recurring inadequate pain control.

- Children with disability are reported to experience more pain and of different aetiologies than children without.[168 169]
- Pain assessment can be difficult. Parents' or primary care-givers' interpretation of behaviours is helpful. Children may use gestures etc to communicate that are not standardized.[170]
- Pain assessment tools are currently being validated for procedure-related pain in this group. Validation of the NCCPC-R (non-communicating children's pain checklist – revised) for pain in the home setting included use for pain that was short and sudden, similar to procedures.[20 171]
- They may be more distressed about procedures, which will exacerbate any pain.
- Maintain typical means of comfort and mobility.

Recommendation: *Essential to explore their means of communication. Err on side of over-treating. Use an approach which integrates non pharmacological and pharmacological techniques. Beware of co-morbidities that may contraindicate conscious sedation by the non-anaesthetist.*

2. Children with physical disability and preserved cognition e.g. severe burns, cerebral palsy.

- Method of pain assessment and treatment will depend on ability to communicate.
- Take particularly care to include their input by whatever means of communication. Maintain typical means of communication e.g. computer or communication board. Beware of compounding feelings of helplessness, (e.g. by ignoring their input) which will exacerbate any pain.
- Maintain typical means of comfort and mobility.
- Offer self-regulation techniques early on to improve sense of mastery and control.

Recommendation: *Establish communication first. Use an approach which integrates non pharmacological and pharmacological techniques.*

3. Children with behavioural problems related to pre-existing disorder (non-compliance, inattention, hyperactivity, aggression, destruction, psychosis etc).

   Recommendation: *Low threshold for pharmacological interventions*.

4. Children with behaviour problems related to procedures (conditioned anxiety, emotional withdrawal, attempts to avoid or escape treatment, and in some cases severe tantrums or aggression).

   Recommendations: *Systematic desensitisation, cognitive-behavioural therapy and coping strategies to reduce conditioned response. Consider pharmacological techniques if the need for procedure(s) arises during therapy.*
   .

8.3 Repeated procedures

Children with chronic or other serious illness have regular and often frequent procedures. Even noninvasive procedures can appear frightening and threatening to the child. It is the child's appraisal of the impending event which influences the emotional response and pain experience. In addition, children who undergo repeated painful procedures have increased vulnerability to developing conditioned anxiety and behavioural distress. This is related to having negative experiences rather than the accumulative number of procedures.[172]

Contrary to the myth, most do not get used to having them without psychological and/or pharmacological intervention. They may become stoically resigned and cooperative, but remain highly anxious.[173] There is little prospective data on experienced children's long term adjustment to repeated procedures, but it would appear that less than 25% of children learn to cope effectively themselves.[34] In the toddler and preschool age group increased distress is observed.[49] Furthermore, children's anxiety during procedures is a significant predictor for post-traumatic stress developing in mothers of children with cancer.[174]

Children who have already experienced a procedure are more likely to benefit from interventions that teach specific skills for coping, of which distraction may be the critical component.[173] These skills need to be taught as soon as the need for recurrent procedures becomes known, and children and parents experiencing continued distress need to be promptly referred to a pain team or psychologist. There is currently little information to help predict which child-parent dyad will have greatest difficulty coping with repeated painful procedures.

Ideally all young children with chronic illness requiring repeated procedures would be offered play therapy early on to:

- Provide a model for coping with procedures.
- Facilitate the child's attempts at mastery.
- Encourage expression and verbalisation of emotions.
- Animal toys and puppets may be ideal as children can safely identify with them.

Older children and adolescents also need developmentally and age appropriate information and strategies to cope with repeated procedures and they usually respect an honest, direct response to their questions and queries. Over time it may become relevant for older adolescents to take ownership of their chronic condition, including pain management. This transition of care should be encouraged and incorporated into the overall treatment plan. Peer support groups have been shown to be of benefit to adolescents, to help share the load of their experiences although there is no particular evidence with regard to procedural pain.

8.4 A consumer's perspective

The following section represents the views of a consumer, who is the mother of a 4 year old girl who has had repeated painful procedures throughout her life.

"Emily was born with a rare skin condition known as Congenital Melanocytic Nevi which presented as a series of mole birthmarks to about 60% of her body, the largest being on the back, neck and chest. When we first saw Emily we knew that her condition would guarantee her an extraordinary life with many challenges.

For cosmetic reasons and to reduce the likelihood of the abnormal pigmentation becoming malignant, we made the decision to begin plastic surgery to remove the nevi early in life. The options in Emily's case were dermabrasion, skin grafting and excisions where possible. She has had 12 operations in total so far.

Following surgery of dermabrasion, bandages are kept on for the first 5 to 7 days. The first bandage change was carried out in the burns & plastic ward (treatment unit) where Emily would also be bathed. Emily was given paracetamol and nitrous oxide gas to get her through the procedure. This procedure was very distressing for both of us, as many bandages were difficult to remove due to sticking.

The most traumatic time was the first couple of bandage changes. We found that the contact of family members and familiar faces played a big role in helping Emily get through the procedure. During bandage changes Emily would be distracted by her older sister Sarah singing or playing games with her. Medical staff blowing bubbles and playing her favourite music, showing her toys etc, all for distraction. Having the same nurse do the changes helped Emily as she built a trust with her. If she would see a new face you could see the fear in her. As a result, we always tried to have the same team carry out the procedure.

Emily and I would visit the hospital twice a week for further bandage changes until such time as I was comfortable to do the changes at home. The home bandage changes certainly lowered the stress levels for us both. Following all surgery, we worked very closely with the physiotherapists on a scar management program which involves Emily wearing pressure suits and silicone dressings to soften the scar tissue and blend it back into the skin. Emily had little or no anxiety about any part of this procedure.

Between operations we would often visit the hospital staff and other children in order for Emily to maintain that trust and keep her familiar with the hospital environment.

Before surgery, every procedure would be explained, including what we could expect post op and the type of drugs that would be used on Emily during the medical procedures. This was a good opportunity for us to ask any questions.

Emily's treatment became part of our every day life and that is exactly how we treat her condition. We made a point to keep things as normal as possible as we also had to consider our other daughter, Sarah, who was aged 3 when Emily was born We made a point of always including Sarah where possible in any of Emily's treatment. We are sure that, in her own way, Sarah was and is of great support to Emily. We found that distraction during bandage procedures helped Emily, such as family members playing her favourite music, games etc. We worked in partnership with the medical team and helped each other help Emily. We would monitor effective use of pain management; we knew what worked well for Emily and what didn't. During any procedure the most important thing was for us to remain very calm, and not show negative emotion. We smiled a lot. If we were calm, Emily was calm.

We always ensured that after any procedure we always talked about what had been done and let Emily know that everything was OK. We found this to be very important. We always rewarded Emily, telling her how brave she was by giving her lollies, soft toys, colouring books, chocolate etc. At home we found that she was always very eager to show and tell family and friends all about her hospitalization; we always encouraged her to talk about it if she wanted to.

At the age of 4 Emily has shown some long term effects of fear. On various occasions, while visiting other children in hospital, Emily has shown a dislike for certain smells and she will refer back to her time in hospital followed by comments such as "Lets go home now, I don't like hospitals". Recently in a local swimming pool she would not get changed in the first aid room because there was a first aid bed covered with a white sheet and she refused to sit on it, in fear that it was a hospital bed and she insisted on putting a towel on the floor rather than changing on the bed.

On another occasion Emily felt very nauseous when she smelt the aroma from a fairy floss machine. The smell, we believe, reminded her of the sweet smell of the gas prior to going off to sleep. However, if I was to show Emily photographs

taken 12 months ago of her in hospital during a treatment, she does not have any recollection of it.

We feel that Emily has been very lucky, because she is a very strong little girl, very resilient and a great healer. At times I think that it is the parents who are in more pain than their children!"

9. Appendices

9.1 Non pharmacological techniques for procedural pain management

- Psychological interventions are directed at the brain where pain is processed, or the interface between the child and the environment.
- They alter the perception, meaning and affect associated with the pain, and/or modification of pain behaviour or pain expression.
- They facilitate competent coping and enhance self esteem.

Psychological factors greatly influence the experience of pain in either positive or negative ways. All health care professionals should know how to prevent the pain-anxiety spiral,[34] and to use psychological techniques consciously to improve the management of procedure related pain, whether or not medications are being used.

Unlike medical interventions, psychological techniques can be used in the anticipatory phase as well as before, during or after a painful medical procedure. However particular types of coping behaviours are more appropriate at particular phases of the procedure.

No interventions are effective at all times for all children.[175]

9.1.1 Physical and environmental comfort strategies

- Positioning of the child for their own comfort and not for restraint (e.g. sitting up and being hugged by parent).[30]
- Touch, massage, heat, cold.[3 176]

9.1.2 Distraction

Description:

Refocuses attention away from negative focus onto something more positive which can be:

- External, such as a toy or bubbles.
- Internal, such as imagery.
- A combination, such as music or story telling.[177]

Comments:

- Distraction may involve breathing which is also relaxing.
- Distraction needs to be age related and tailored to the individual child.
- Techniques which have been successfully used in studies:
    - Music.
    - Counting objects in the room.
    - Blowing on a party toy.
    - Non-medical conversation.
    - Toys and puppets.
    - Books.
    - Bubbles.

- Videotaped cartoons, movies, video games and electronic “smart” toys.[49]

- Distraction is recommended for all age groups immediately before and during procedure.
- The technique needs to be employed **before** a child is distressed to be effective.
- Little training is required.

9.1.3 Cognitive behavioural strategies

Common elements:[178 179]

- Awareness of relationship between thoughts, feelings and behaviour.
- Involves an active partnership between child, family and trained staff.
- Use of a distraction technique.
- Coping self-statements.
- Success is improved by practice (modelling, mental rehearsal, role-playing).

9.1.3.1 Cognitive therapy

Description:
Modifying thoughts and images that are negative and maladaptive, using imagery and cognitive restructuring.

Comments:

- Especially useful in children who have conditioned anxiety to prepare them for procedures in combination with other techniques.

9.1.3.2 Progressive muscle relaxation and deep breathing

Description:
Progressive muscle relaxation and deep breathing (diaphragmatic breathing to decrease tension and increase comfort) have been studied as part of other therapies.

Comments:

- Young children respond to the suggestion that they “go like a wet noodle” and do tummy breathing (they can put their hand on their abdomen to check it’s moving in and out) and blow out their worries or their scared feelings.
- Older children respond to progressively relaxing muscle groups “breathing in comfort breathing out tension” until the whole body is relaxed.
- Older teenagers may be invited to tense muscles first, then let go. This is not usually necessary in younger children.
- This is an effective technique during a procedure,[17] especially if prompted by an adult.

9.1.4 Self regulation

Hypnotherapy, self hypnosis and biofeedback teach children to regulate their own pain.

9.1.4.1 Hypnosis

Description:
Hypnosis is a normal state of highly focused attention with a relative diminution of peripheral awareness. It is like being caught up in a good movie, or absorbed in a book. In this state it is possible to enhance control, especially over unwanted sensations, such as pain, which can be placed at the periphery of awareness, altered or even eliminated.[180]

Comments:

- Data supports effectiveness[181] including a randomized controlled trial showing the effectiveness of hypnosis in children with cancer having repeated lumbar puncture.[182] In this study when patients made the shift from therapist to self hypnosis, the benefit was not sustained. However, follow up has shown that when children are given the chance to use their self hypnosis without interruption by adults, the effect is beneficial (Liossi - personal communication).
- Hypnosis may be more applicable for frequent and regularly scheduled procedures.[175] However, its use in the emergency department has been described.[183]
- Hypnosis and biofeedback (see following section) require a motivated child and a trained adult to coach them. Both may take a number of sessions, but some children have avoided the need for general anaesthetic/sedation for bone marrow aspirate and lumbar puncture using hypnosis.[181]

9.1.4.2 Biofeedback

Description:
The use of electronic or electro-mechanical equipment to measure and feed back information about physiological functions which allow the user to gain control and see concrete evidence for mind body connections (how a change in thinking causes a change in the body responses). This causes a shift from a mainly external locus of control to an internal locus of control.

Comments:

- Biofeedback can provide training for a painful procedure.[184]
- Biofeedback is a useful but not essential adjunct to self hypnosis.

9.1.5 Reinforcement of coping behaviour

Comments:
After a procedure allow the child time to recover, focus the child's attention on successful coping and instil a sense of achievement.[49]

- While emphasising positive aspects, distressing experiences should be discussed afterwards.[22]
- Reframing of children's memories of their previous experience with a procedure may reduce anticipatory distress.[185]
- Reinforcement of coping behaviour is an essential part of preparing a child for the next procedure, regardless of whether pharmacological techniques have been employed in addition to non-pharmacological.

9.2 Guidelines for the use of local anaesthesia in children

The use of local anaesthetic enables many procedures to be performed on children that would otherwise be unacceptably painful. Local anaesthetic may be applied topically to the skin or mucous membranes, or it may be injected into a specific area supplied by a peripheral nerve to produce more widespread analgesia. Regional analgesia is produced when local anaesthetic is injected centrally around the spinal cord, spinal nerve roots, or more peripherally to block a nerve plexus. Guidelines relating to major regional analgesia, apart from intravenous regional blockade, will not be provided in this document, as these procedures should be performed only by trained anaesthetists. The following guidelines apply to all other situations where local anaesthetic agents are used.

9.2.1 Recommended maximum doses of amide local anaesthetics

Table I shows the recommended maximum doses of the commonly used amide local anaesthetic agents that may be used safely in children. Nonetheless, inadvertent intravascular injection of even a small fraction of these doses may result in systemic toxicity. It is therefore essential that an aspiration test be performed prior to the injection of any agent. Following this procedure, a test dose of 1-2mls should be administered to eliminate the possibility of accidental intravascular injection. Should this occur, continuous ECG monitoring will reveal ST segment elevation, and an increase in the height of the T waves, within 20 seconds of the injection.[186]

Table I: Maximal recommended doses of amide local anaesthetics

Drug	Maximal recommended dose (mg/kg)	With epinephrine 1:200000 (mg/kg)
Lignocaine	5	7
Bupivacaine	2	3
Ropivacaine	2.5	4
Levobupivacaine	2.5	4
Prilocaine	5[a]	7

[a]Dosage should be limited to 3-4 mg/kg in infants and young children.

Adrenaline containing solutions should never be administered to an area supplied by an end artery (i.e. digits, penis, nose), due to the risk of tissue ischaemia and necrosis.

Recommended dosage guidelines for the topical anaesthetic EMLA are shown below in Table II.

Table II: Recommended maximum doses of EMLA in neonates, infants, and children

Age	Maximum dose (g)	Maximum skin area (cm^2)
0-3 months	1	10
3-12 months	2	20
1-5 years	10	100
6-11 years	20	200

9.2.2 Choice of local anaesthetic agent

The choice of local anaesthetic depends on the site of administration, the desired onset of action, and the duration of anaesthesia required.

Lignocaine and prilocaine are intermediate acting agents, with durations of action of 60-90 minutes and 60-120 minutes, respectively. Their action can be prolonged by the addition of adrenaline. Other agents have a longer duration of action of approximately 2-3 hours, which is not altered by the addition of adrenaline.

The potential for toxicity associated with the use of bupivacaine has led to the development of the isomerically pure agents ropivacaine and levobupivacaine, which are associated with less CNS and CVS toxicity. Both agents are pure L-isomers, as opposed to bupivacaine which is a racemic mixture of L- and D-bupivacaine, the D-form being the more toxic of the two stereo-isomers. Fortunately, severe toxicity and death is a rare occurrence considering the widespread use of bupivacaine in clinical practice. Therefore, in the majority of patients replacement of bupivacaine with ropivacaine or levobupivacaine is probably not warranted.

Clinical circumstances where replacement should be considered, due to an increased risk of bupivacaine toxicity, are:

1. Neonatal analgesia
2. Prolonged local anaesthetic administration (i.e. continuous infusion)
3. Impaired liver function
4. Techniques requiring a large volume of local anaesthetic

9.2.3 Local anaesthetic toxicity

All local anaesthetic agents have a narrow therapeutic index.

Local anaesthetic toxicity may be divided into local and systemic toxicity.

Local toxicity may occur with topical ester-linked local anaesthetic agents (e.g. 4% Amethocaine gel) in the form of allergic dermatitis, as these agents are metabolised to paraaminobenzoic acid, a known allergen that is also found in many suntan lotions.

Systemic toxicity is dependent on the total dose of drug administered, the degree of protein binding, the speed of absorption into the circulation, and the

site of administration. The greater the vascularity of the injection site, the more rapid the uptake of agent into the circulation.

Systemic toxicity may result in:

1. CNS toxicity.
2. CVS toxicity.
3. Methaemoglobinaemia.
4. Allergic reactions.

The manifestations of CNS and CVS toxicity are shown below in Table III. The degree of observed toxicity mirrors the rise in plasma drug concentration.

Inadvertent intravascular injection may lead to immediate CVS collapse without preceding CNS toxicity.

Table III: Symptoms and signs of CNS and CVS toxicity

CNS	Circumoral numbness Light-headedness Dizziness Auditory and visual disturbances Restlessness Muscular twitching Seizures Coma Respiratory arrest
CVS	Arrhythmias Hypotension Cardiac arrest

Neonates and infants less than 6-9 months have a relatively increased risk of systemic toxicity due to reduced protein binding and hepatic clearance of local anaesthetic agents.

Methaemoglobinaemia occurs following administration of large doses of prilocaine exceeding 600mg in adults. Prilocaine is contraindicated in infants less than 6 to 9 months of age.

The use of EMLA cream is usually safe in neonates and infants who do not have coexisting diseases that may predispose to methaemoglobinaemia, such as:

1. Haemoglobinopathies.
2. Glucose-6-phosphate dehydrogenase deficiency.
3. Exposure to aniline dyes and oxidants (sulfonamides, nitrates, nitrites, antimalarial agents).

However, the recommended doses of EMLA (See Table II, Section 10.1.1) should not be exceeded.

9.2.4 Local anaesthetic techniques

9.2.4.1 Topical anaesthesia

Description:
Direct application of a local anaesthetic agent to the site of action, commonly the skin, conjunctiva, mucous membranes and open wounds.

Comments:
- Systemic uptake of the agent is rarely a problem and these techniques are generally considered 'low risk'.
- Topicalisation of the upper airway, because of its effects on vital protective airway reflexes, should be considered a higher risk procedure.

Contraindications:
- Allergy to local anaesthetic.

9.2.4.2 Local infiltration anaesthesia

Description:
Infiltration of a local anaesthetic agent into subcutaneous tissues to produce anaesthesia at, or immediately adjacent to, the area infiltrated.

Comments:
- The needle used for infiltration should be as small a gauge as possible (25-27G), to minimise the pain produced by needle puncture.
- Topical anaesthesia should always be applied prior to needle insertion whenever possible.
- Rapid uptake of the agent into the local circulation, and inadvertent intravascular injection, increases the likelihood of this technique causing adverse systemic effects.

Contraindications:
- Allergy to local anaesthetic.
- Infection at the site of infiltration.

9.2.4.3 Peripheral nerve block

Description:
Infiltration of a local anaesthetic agent around a peripheral nerve with the intention of producing anaesthesia in the part of the body innervated by that nerve.

Comments:
- Uptake of the agent by the local circulation, and inadvertent intravascular injection, increases the likelihood of this technique causing adverse systemic effects.
- Traumatic nerve damage poses a further significant, albeit rare, potential risk with this technique.

Contraindications:

- Allergy to local anaesthetic.
- Infection at the site of injection.
- Bleeding disorders.
- Patients on anticoagulant therapy.
- Patients with degenerative neurological diseases.
- Patients at risk of developing a compartment syndrome.

9.2.4.4 Intravenous regional analgesia (Bier's block)

Description:
The perfusion of an isolated part of the circulation (normally the distal part of a limb) with local anaesthetic to produce anaesthesia in those tissues supported by that vascular bed.

Comments:
Intentional injection of local anaesthetic into the circulation poses a significant potential risk for systemic toxicity in the event of accidental tourniquet deflation.

Contraindications:

- Allergy to local anaesthetic.
- Open wounds.
- Unstable fractures.
- Limb ischaemia.
- Sickle cell disease.
- Epilepsy.
- Cardiac dysrythmias.

9.2.5 Further references

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9.3 Nitrous oxide analgesia

9.3.1 Nitrous oxide (N_2O)

Nitrous Oxide is an anaesthetic gas with significant analgesic and some amnesic and anxiolytic properties. It has a rapid and predictable onset and offset of action and can safely be titrated to produce a state of "conscious sedation".

9.3.2 Delivery system

Nitrous oxide may be administered via demand valve units requiring the generation of up to 5.0cm H_2O of negative pressure[187]or via a continuous flow device. The latter is more suitable for use in children under 5 years of age. The demand valve units usually delivers a fixed N_2O/O_2 mix of 50% nitrous oxide with oxygen (Entonox), with the continuous flow device able to deliver a variable concentration of up to 70% nitrous oxide with oxygen. Continuous flow devices require the continuous presence of a qualified person to monitor for signs of over sedation. Both systems require a circuit that enables scavenging of exhaled gases to minimise environmental exposure.[188]

9.3.3 Indications

- Intravenous cannulation / Venepuncture
- Lumbar puncture
- Intra arterial cannulation / Arterial puncture
- Urinary catheterisation
- Bone marrow aspiration
- Dressing/wound changes (burns)
- Injection of local anaesthetic
- Intramuscular or intra articular injection
- Removal of drains (excluding intercostal catheter)

Possible indications:

- Nasogastric tube insertion
- Bronchoscopy / Gastroscopy
- Renal /Liver/Muscle biopsy
- Reduction of simple limb fractures
- Foreign body removal

9.3.4 Contraindications

- Closed head injury / raised ICP.
- Respiratory distress.
- Pneumothorax.
- Bowel obstruction.

- Intoxicated / drug overdose.
- Depressed conscious state (AVPU)
- Pulmonary hypertension.

Relative contraindications:
- Age under 12 months*
- Airway problem*
- Pre medicated*

*Requires an anaesthetist to be present.

9.3.5 Pre-requisites for safe administration

1. Parental consent for sedation and procedure.
2. Fasted for min 2hrs if N_2O > 50% prescribed.
3. N_2O prescribed on medication chart indicating % concentration to be administered.
4. No contra indications are present.
5. Person administering N_2O and observing child is allocated to this task only.
6. Inability to provide N_2O without O_2.
7. Appropriate resuscitation equipment present (section 6.5).
8. Presence of anaesthetist if child premedicated / sedated (benzodiazipines, opiates, choral hydrate).

9.3.6 Safe delivery of N_2O

1. Provide 100% oxygen for 2-3 minutes before and after the procedure.
2. Maintain verbal contact with child at all times.
3. Monitor HR, RR, O_2 saturation, Conscious state
4. Provide 100% oxygen for 2-3 minutes after procedure to avoid diffusion hypoxia.[189]
5. Provide 100% O_2 if child experiences adverse effects (see below), desaturates or becomes deeply sedated.

**Sedation Score:*
1. Awake
2. Easily roused
3. Hard to rouse
4. Unrousable

***Deep Sedation*[187]*:*
- Inability to respond to voice
- Likely loss of protective airway reflexes

9.3.7 Adverse effects of N2O analgesia

Major: [116]
1. Over sedation / airway obstruction
2. Diffusion Hypoxia
3. Rapid expansion of air filled spaces

4. Bone Marrow suppression with chronic use

Minor: [116]

1. Nausea / Vomiting
2. Euphoria
3. Tingling / dizziness

Incidence of major adverse events: [116]

Age	0-1yr	2.3%
	1-4yrs	0.2%
	5-10yrs	0.3%
	11-18yrs	0.4%
	Over all	0.3%

Incidence of minor adverse events: [116]

Over all 5.0%

9.3.8 Folinic acid prophylaxis guidelines

Oxidation of vitamin B_{12} by N_2O causes inactivation of methionine synthetase and possible megaloblastic erythropoiesis. This is dose related and may be worsened in patients with:

- pre-existing vitamin B_{12} or folate deficiency
- pre-existing bone marrow suppression
- severe sepsis
- extensive tissue damage

Chronic inhalation may result in neurological effects, including subacute degeneration of the spinal cord.[189]

Accordingly, a number of centres in Australia and New Zealand recommend protocols to minimise Vitamin B_{12} oxidation. Two such protocols are as follows:

1. Patients requiring daily or second daily N_2O for longer than 2 weeks should receive folinic acid 15mg orally daily.
2. Patients requiring N_2O three times a week or more for a period of two weeks or more should receive folate 250mcg/kg daily (max 10mg) and Vitamin B_{12} 5mg orally daily.

9.3.9 Further references

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9.4 Midazolam

Description:
Short-acting sedative/anxiolytic (no analgesic properties).

Comments:
- Flumazenil is reversal agent.

Contraindications:
- Hypersensitivity to benzodiazepines.

Dose:
IV 0.05-0.15 mg/kg. (max. dose 5mg) - titrated in small aliquots to effect.
PO 0.5 mg/kg. (max dose 15mg)
PR 0.25-0.5 mg/kg. (max dose 10mg)
IN 0.2-0.5 mg/kg. (max dose 10mg)

Adverse events:
- Respiratory depression (especially in combination with narcotics).
- Paradoxical reactions (agitation, dysphoria).
- Nasal irritation with IN route.

9.5 Ketamine

Description:
Powerful analgesic and deep sedation agent.

Comments:
- Should only be used in facilities with personnel competent in airway management.
- Should be injected slowly (over at least 1 minute) and titrated in small increments to effect.

Contraindications:

- Age < 6 months.
- Increased intracranial or intraocular pressure.
- Hypertension.
- Thyroid disease.
- Porphyria.
- Acute asthma attack or URTI (increased risk of laryngospasm).

N.B. Ketamine may be helpful as an adjunct to general anaesthesia in severe life-threatening asthma due to its bronchodilator effect.

Dose:
IV 0.5-1.5 mg/kg
PO 5-10 mg/kg

Adverse events:

- Increase in intracranial or intraocular pressure.
- Laryngospasm (rare if no contraindications and with slow injection).
- Emergence agitation (rare in children <10 years).
- Excessive salivation and tears.
- Hypertonicity (fasciculations, twitching, myoclonus).
- Transient erythematous rash and red eyes.
- Nystagmus.

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