Methods for reducing procedural pain in children and young people

Key points
1. There is no definitive clinical practice guideline – and so some uncertainty – about which methods to choose to manage acute procedural pain in children.
2. Tested pharmacological methods include topical local anaesthetics, vapocoolant sprays and nitrous oxide.
3. Tested non-pharmacological methods include cooling vibration analgesia, hypnosis, distraction and virtual reality games.
4. A combination of physical, psychological and pharmacological methods is recommended to reduce procedural pain in children.

As part of the national immunisation programme, children in the UK are routinely exposed to up to 17 potentially painful intramuscular injections between the ages of eight weeks and 14 years (Bit.ly/NHSImmunisations2016). However, health professionals’ strategies to manage the associated pain and distress has been deemed suboptimal (Taddio et al, 2009). Similarly, investigations and procedures are a source of acute pain for children in hospital (Howard et al, 2012), but less than a third of painful procedures are accompanied by an identified pain-relieving intervention (Stevens et al, 2011).

Despite a plethora of research into acute paediatric procedural pain management, there are no definitive clinical practice guidelines, and there is some uncertainty about which strategies are most likely to be effective in different clinical situations (Lee et al, 2014). In the guidelines that do exist (Box 1), the emphasis is on combining different methods – for example, analgesia and anxiety reduction (Howard et al, 2012). This has been described as a ‘3P’ – pharmacological, physical and psychological – approach, whereby pain relief may be achieved by combining methods selected by nurses based on their assessment of the child (Taddio et al, 2010).

Pharmacological methods
Topical local anaesthetics
Topical local anaesthetics prevent the transmission of pain by blocking sodium channels in the nerves (Howard et al, 2012). Similarly, investigations and procedures are a source of acute pain for children in hospital (Howard et al, 2012), but less than a third of painful procedures are accompanied by an identified pain-relieving intervention (Stevens et al, 2011).

Although parental reports indicate that topical local anaesthetics have no effect on procedure-related fear (Hedén et al, 2016), on heel lance pain in neonates (Tutag Lehr and Taddio, 2007), tetracaine 4% gel and lidocaine 2.5% plus prilocaine 2.5% cream have been shown to be effective in managing procedural pain associated with venepuncture or cannulation (Table 1).

Although parental reports indicate that topical local anaesthetics have no effect on procedure-related fear (Hedén et al, 2016), on heel lance pain in neonates (Tutag Lehr and Taddio, 2007), tetracaine 4% gel and lidocaine 2.5% plus prilocaine 2.5% cream have been shown to be effective in managing pain associated with venepuncture or cannulation in children aged between three months and 15 years – the former providing better pain relief than the latter (Lander et al, 2006). Lidocaine 4% cream is as effective as lidocaine 2.5% plus

SnowWorld is a virtual reality game that distracts children so they feel less pain

Author Rebecca Saul is a clinical nurse specialist at the pain control service, Great Ormond Street Hospital for Children Foundation Trust, London.

Abstract Children and adolescents commonly undergo potentially painful procedures – starting with immunisation – but strategies aimed at preventing or reducing procedural pain are often lacking. This article describes the pharmacological and non-pharmacological methods found to be effective in managing procedural pain in children and young people, explores the physiological mechanisms underpinning their pain-relieving effects, and sums up the evidence regarding their use. This is the final part in a three-part series on managing paediatric pain.

prilocaine 2.5% cream for cannulation in children aged 3-18 years (Koh et al, 2004) and for venepuncture in those aged 5-17 years (Eichenfield et al, 2002).

**Vapocoolant sprays**

Vapocoolant sprays, such as ethyl chloride, reduce pain associated with needle insertion by lowering the temperature of the skin, thereby reducing activation of nervesensitising chemicals and the physiological processes triggered by tissue damage (Lane and Latham, 2009). Ethyl chloride should be applied to clean, dry skin at a distance of 20cm and for no longer than 10 seconds (less if skin blanching occurs). Repeated application on the same area of skin should be avoided, and venepuncture should be carried out within 45 seconds (Davies and Molloy, 2006).

Although the efficacy of vapocoolant sprays in reducing venepuncture-related pain is not clear (Hogan et al, 2014; Howard et al, 2012), there is evidence of moderate quality to support their efficacy in reducing pain associated with intravenous cannulation in children aged 3-18 years. Cooling does not make cannulation more difficult, although it can cause mild discomfort on application (Griffith et al, 2016).

**Nitrous oxide**

A self-administered, inhaled gas mixture of 50% nitrous oxide and 50% oxygen (Entonox) may be used to reduce pain during minor procedures lasting less than 15 minutes (Pedersen et al, 2013). Entonox has a rapid onset and offset (1-5 minutes) (Pasarón et al, 2015) but the patient must be:

- Able to independently use a hand-held device and inhale the gas;
- Must be closely monitored for side-effects by a trained health professional (Macqueen et al, 2012).

Entonox should be avoided in conditions in which the expansion of trapped air may be dangerous, such as pneumothorax, abdominal distension, myringoplasty, head injury or long-term lung conditions (BOC Healthcare, 2011). Its prolonged use (continuously for more than 24 hours, or more frequently than every four days) can cause the inactivation of vitamin B12; this can, in rare cases, lead to megaloblastic anaemia or neurological toxic effects such as myelopathy (BOC Healthcare, 2011; Wijsesekera et al 2009; Medicines and Healthcare products Regulatory Agency and Commission on Human Medicines, 2008).

Entonox has been found to be effective in preventing pain in children undergoing:

- Percutaneous renal biopsies (Pietrement et al, 2001);
- Urethral or rectal catheterisation for urodynamic investigations (Emedo et al, 2014);
- Joint injections for juvenile idiopathic arthritis (Cleary et al, 2002).

However, more research is required to clarify its efficacy in reducing pain during

### Table 1. Topical local anaesthetics for use in children before venepuncture or cannulation

<table>
<thead>
<tr>
<th>Generic name (brand name)</th>
<th>4% tetracaine gel (Ametop)</th>
<th>Lidocaine 2.5% + prilocaine 2.5% cream (EMLA)</th>
<th>Lidocaine 4% cream (LMX 4)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age range</strong></td>
<td>Neoponates (&gt;28 weeks’ gestation) to 18-year-olds</td>
<td>Neoponates (&gt;37 weeks’ gestation) to 18-year-olds</td>
<td>Children aged &gt;1 month to 18 years</td>
</tr>
<tr>
<td><strong>Application</strong> time before venepuncture**</td>
<td>30 minutes</td>
<td>1 hour</td>
<td>30 minutes</td>
</tr>
<tr>
<td><strong>Application</strong> time before cannulation**</td>
<td>45 minutes</td>
<td>1 hour</td>
<td>30 minutes</td>
</tr>
</tbody>
</table>
| **Maximum application time** | Remove after 1 hour | Children aged >3 months: 2-3 hours (to reach maximum effect) | ● Children aged 1-3 months: 1 hour  
● Children aged 3-12 months: 4 hours  
● Children aged ≥12 months: 5 hours |
| **Duration of effect**     | 4-6 hours | 1-2 hours | 2 hours |
| **Side-effects**           | ● Erythema  
● Pruritus  
● Blistering | ● Skin blanching  
● Vasoconstriction  
● Redness  
● Oedema | ● Skin blanching |
| **Effect on ease, or success, of procedure** | Superior to EMLA for ease of cannulation  
Vasoconstrictive properties do not affect success of procedure | Prilocaine may affect the oxygen-carrying capacity of red blood cells, so methaemoglobin levels should be monitored in children aged <3 months | ● To prevent systemic accumulation of lidocaine, LMX4 should not be reapplied within 12 hours  
● May affect the adherence of dressings applied to keep cannula in place |

*See local drug formularies for dosages and additional prescribing information. Under an occlusive dressing.

Non-pharmacological methods

Cooling vibration analgesia

Cooling vibration analgesia (CVA) combines cold and high-intensity vibrations as counter stimuli to the pain of needle-related procedures (Schreiber et al, 2016). A commonly described device for administering CVA to children is Buzzy; a reusable, battery-powered vibration-producing device to which an ice pack is attached (Moadad et al, 2016). CVA activates cold and vibration receptors, which, in turn, activate inhibitory interneurons in the spinal cord, thereby reducing pain signals transmitted via peripheral nociceptive pathways (Baba et al, 2010).

The CVA device is applied 3-10cm from the area where venepuncture or cannulation is to be performed (Kearl et al, 2015; Inal and Kelleci, 2012). Some devices have an integrated tourniquet; alternatively, the device can be held manually or attached with a velcro strap (Moadad et al, 2016). CVA is started 30-60 seconds before the procedure and applied throughout (Kearl et al, 2015; Inal and Kelleci, 2012). It should not be used over areas of broken skin or nerve damage (Inal and Kelleci, 2012), and should be used with caution in children with conditions involving sensitivity to cold, such as sickle cell disease or Raynaud’s disease (Schreiber et al, 2016).

Studies have shown CVA to be effective in reducing pain and anxiety in children:

- Aged 4-18 years undergoing venepuncture (Inal and Kelleci, 2012);
- Aged 4-12 years undergoing IV cannulation (Moadad et al, 2016);
- Aged 4-17 years with cognitive impairment undergoing needle procedures (Schreiber et al, 2016).

Hypnosis

Hypnosis has the potential to significantly reduce self-reported pain and distress during needle-related procedures (Birnie et al, 2014; Uman et al, 2013). It is at least as effective as distraction techniques, and is useful in reducing discomfort, during procedures such as:

- Venepuncture;
- Bone-marrow-aspirate;
- Lumbar puncture;
- Bladder catheterisation (Accardi and Milling, 2009).

When used in combination with pharmacological agents, hypnosis may be more effective than distraction during lumbar puncture and bone marrow aspiration (Landier and Tse, 2010); when combined with topical local anaesthetic, it reduces anxiety and pain in children aged 6-16 years undergoing venepuncture (Liossi et al, 2009).

Distraction

Neurocognitive pathways that are directed towards pain perception can be disrupted when attention is drawn towards an engaging task (Sil et al, 2014). Common distraction techniques employed to this effect include:

- Watching cartoons;
- Playing with a toy;
- Listening to music (Uman et al, 2013).

Distraction techniques significantly reduce children’s self-report of pain and distress during needle-related procedures (Birnie et al, 2014) and routine immunisations (Chambers et al, 2009). Table 2 features an overview of techniques used to distract children during immunisations, and whether they were found to affect pain and distress. More evidence is required on the efficacy of each technique and its effectiveness at different developmental stages (Uman et al, 2013).

Active distractions such as game playing or problem solving may compete more effectively with attention directed towards pain than passive distractions such as watching television (Birnie et al, 2014). However, the distress of the procedure may interfere with younger children’s ability to engage with an active distraction; passive distraction (such as watching an age-appropriate DVD) may be more effective in reducing distress in children aged 1-7 years undergoing procedures such as venepuncture (MacLaren and Cohen, 2005).

Interactive electronic programmes

Virtual reality involves a computer-generated, three-dimensional environment that stimulates the auditory and visual senses. It can be immersive (where a helmet is worn) or non-immersive (no helmet), but it is unclear which is more effective in reducing pain (Koller and Goldman, 2012).

The immersive VR programme SnowWorld uses images simulating movement through an icy environment alongside aural distraction (music and sound effects) and an interactive game (shooting snowballs at penguins and snowmen). It has been found to be effective in reducing pain in children with burn injuries undergoing wound debridement (Hoffman et al, 2008) or painful physiotherapy (Schmitt et al, 2011).

Non-immersive, electronic hand-held devices such as Ditto offer patient preparation programmes and distraction games for children aged 3-12 years undergoing painful procedures. These have been associated with reduced self-report of pain.
during burns dressings (Brown et al, 2012), but their use for needle-related procedures requires further investigation (Malloy and Milling, 2010).

Conclusion

Painful procedures conducted in children and young people should always be accompanied by a strategy aimed at preventing or reducing pain and distress. This can often be achieved by combining pharmacological and non-pharmacological strategies. A number of methods are available to health professionals, all with some level of evidence supporting their use in the clinical setting.

References


For more on this topic go online...

Selecting a needle size for childhood vaccinations

Bit.ly/NTNeedleSize