



Procedural pain management in children of all ages

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Abstract. *To summarise the story, procedural pain management does not only have humane aspect in paediatric population, but it also prevents numerous complications, child's negative attitude in following contacts with medical staff, percentage of chronic pain suffering patients, as well as cost of the treatment itself. Good pain assessment contributes to the prevention and/or early recognition of pain as well as the effective management of pain. When managing procedural pain in infants, older children and adolescents, not only proven analgesic strategies are important, but also suitable preparatory measures that contribute to reduction in anticipatory and procedural anxiety. Families, play therapists, nursing staff, and other team members should be included.*

Key words: *procedural pain, children, treatment, pain management*

Good pain assessment contributes to the prevention and/or early recognition of pain as well as the effective management of pain (1, 2). Acute pain measurement tools exist. Tools differ depending on three broad groups of factors: child-related, user-related, and structural. Various factors should be taken into consideration when making choices about which acute pain measurement tool to use. For example, the age, cognitive level, language, ethnic/cultural background of the child, the setting for which they are to be used, and the tool's psychometric properties (e.g. validity and reliability) in that context (3, 4). There are three fundamental approaches when assessing pain in children. First one is self-report, which refers to measuring expressed experience of pain. Second is observational/behavioural, which relies on measuring behavioural distress associated with pain or measuring the perceived experience of pain by parent or carer report. Third one is physiological, which primarily measures physiological arousal consequent to pain.

The most psychometrically sound and deducible self-report tools, based on age/developmental level and type of pain, have been recommended for use in clinical trials (5). When talking about procedural pain they include: Wong and Baker FACES Pain Scale (6), intended for 3–18 year olds; Faces Pain Scale-Revised (7), intended for 4–12 year olds; Visual analogue and numerical rating scales intended for 8 years plus; Pieces of Hurt Tool (8), intended for 3–8 year olds and MSPCT (The Multiple Size Poker Chip Tool) (9), intended for 4–6 year olds.

When it comes down to observational/behavioural measures, what everyone must have in their mind is that pain and pain-related distress cannot be easily separated either conceptually or at a practical level. For example, crying and screaming can be indicators of fear or pain. While talking about premature infants and neonates not all neonatal pain assessment tools have been rigorously tested for construct validity, feasibility, and clinical utility (10). However, the fol-

lowing tools are broadly used for neonatal pain assessment. Acute procedural pain measures include: PIPP (Premature Infant Pain Profile) (11); CRIES (12) and NFCS (Neonatal Facial Coding Scale) (13). On the basis of the highest evidence of validity, reliability, and clinical utility and use within practice settings, the following behavioural tools can be recommended for children and young people without cognitive impairment: FLACC (Face, Legs, Arms, Cry, and Consolability) (14), intended for 1–18 year olds and CHEOPS (Children's Hospital of Eastern Ontario Pain Scale (15), intended for 1–18 year olds. While there is less substantive evidence of reliability, validity, clinical utility, and widespread use within practice settings, the following tools are suitable for use with children and young people with cognitive impairment: NCCPC-R (Non-Communicating Children's Pain Checklist (16), intended for 3–18 year olds and PPP (The Paediatric Pain Profile) (17), intended for 1–18 year olds.

Heart rate variability, skin conductance, and changes in salivary cortisol are physiological parameters that can be indirect indicators of pain presence (18). Blood pressure, heart rate, and respiratory rate have been shown less reliable as pain indicators in newborns, infants, and younger children after major surgery (19). More recently, the magnitude of evoked cortical activity has been suggested as a possible indicator of pain, but it has limited clinical utility and as all other physiological measures it should be used in conjunction with other tools/measures to determine the presence and intensity of pain.

Routine painful diagnostic and therapeutic procedures can cause great distress for children and their families. It is important that they should be achieved with as little pain as possible. If we are talking about children who have chronic illness, in which these procedures often need to be repeated, this can generate very high levels of anxiety and distress if their previous experience has been poor. Procedural pain management should include both pharmacological and non-pharmacological strategies whenever possible.

Interest in the use of non-pharmacological pain management strategies in acute pain is increasingly growing. Tactile stimulation has been shown to be effective for needle related procedural pain in neonates (20, 21). There is growing evidence which support the use of psychological interventions for a variety of acute pain indications that include a wide variety of physiological, behavioural, and cognitive techniques aimed at reducing pain and pain-related distress through the modulation of thoughts, behaviours, and sensory information. Some of them that are most strongly supported are guided imagery, distraction, and hypnosis (22).

The following general principles apply to the management of all procedures at any age. Children of all ages are capable of feeling pain and require analgesia for painful procedures. Developmental difference in the response to pain and analgesic efficacy should be taken into account when planning analgesia. What you should consider is whether the planned procedure is necessary, and how the information it will provide might influence care. Avoid multiple procedures if possible. Plan the timing of procedure to minimise the frequency of a painful procedure. Consider weather sedation

or even general anaesthesia are likely to be required for a safe and satisfactory outcome and would modification of the procedure reduce pain. For example, venipuncture is less painful than heel lance. Environment should also be suitable, ideally quiet, calm place with toys and distractions. Provide personnel who possess the necessary skills, and experienced help when necessary. Allow sufficient time for analgesic drugs and other analgesic measures to be effective. Formulate a clean plan of action should the procedure fail or pain become unmanageable using the techniques selected.

When it comes down to procedural pain management in the neonates, in this age-group is particularly difficult and what can complicate the interpretation of evidence is the low sensitivity of many pain measurement tools. Clinically, neonates appear to be sensitive to the adverse effects of many drugs, including analgesics, but reductions in the response to pain have been observed following nontraditional analgesia such as sucrose and physical and environmental measures, which are currently not known to have potentially harmful effects. Breast-feeding should be encouraged during the procedure, if feasible (23, 24). Non-pharmacological measures including non-nutritive sucking, 'kangaroo care', swaddling/facilitated tucking, tactile stimulation, and heel massage can be used for brief procedures (25, 26, 27).

Sucrose solutions reduce many physiological behavioural indicators of stress and pain in neonates (28, 29). Sucrose effects are most likely related to the sweet taste of the solution with very low volumes (0.05–2 ml) in concentrations of 12–24 % being effective within 2 min of administration. Upper volume limits per procedure have been suggested according to the gestational age in weeks: 27–31 (0.5 ml maximum), 32–36 (1.0 ml maximum), > 37 (2.0 ml maximum). The effectiveness of sucrose appears to decrease with age and at present it's use as a primary analgesic should be limited to the neonatal period until further information is available. When talking about sucrose side effects and toxicity, coughing, choking, gagging, and transient oxygen desaturations have been reported. The solution should be applied carefully to the tongue one drop at a time. There is some evidence that adverse effects of sucrose, including a temporary increase in 'Neurobiologic Risk' score, is more frequent in very premature infants, especially those < 27 and 28–31 weeks gestational age.

When talking about blood sampling in neonates, where an indwelling arterial catheter is not available, venipuncture (VP) or heel prick blood sampling (HPBS) is used. Blood sampling, especially in those neonates admitted in ICUs who are likely to require frequent blood sampling, has been identified in many studies as a significant cause of pain and morbidity. VP is the preferred option to HPBS whenever practical as it appears to be less painful (30, 31). A large number of studies speak in favour of that sucrose before VP or HPBS reduces the behavioural pain scores measured by a range of validated assessments (30, 32, 33, 34). Topical local anaesthesia (LA) can reduce the pain of VP, but is not effective for HPBS (35, 36). HPBS pain can be reduced with procedure modification such as using an automated spring-loaded device, avoiding squeezing the heel, and using

a wider area of the plantar surface of the heel (37). Relieving the pain of HPBS has been challenging with pharmacological methods. However, non-pharmacological methods including breast-feeding, non-nutritive sucking, kangaroo care, and pre-massage of the heel before and during HPBS have consistently demonstrated reduced behavioural pain scores and physiological markers (25, 26). Morphine with topical LA tetracaine was more effective than LA alone for central venous line placement in ventilated neonates (35). In addition, low-dose remifentanyl combined with sucrose reduced the pain of insertion of central venous catheters (38).

Preterm infants 'at risk' of retinopathy of prematurity (ROP) should have regular ocular examination. A combined analgesic approach which includes LA, a pacifier, swaddling, and the addition of a sweet solution prior to the screen is likely to be most effective for ROP screening examination pain (39). Laser treatment should be with general anaesthesia if timely treatment is needed (40).

Sampling of cerebrospinal fluid is often considered as a minor procedure in infants, but what we should all have in our mind is that it is associated with pain that can be reduced by suitable analgesia (41). Topical local anaesthesia is effective in reducing lumbar puncture pain (41, 42). Indirect evidence suggests that subcutaneous infiltration of LA would also be effective, but it has not been 'consistently' shown to be superior to placebo in the neonate, in contrast to positive effects in older children and adults (43).

Urine sampling is important method of detecting urinary tract infection in neonates. Direct catheterization of the urethra or bladder by the percutaneous suprapubic route is often preferred because some types of urine collection bags have a high rate of contamination, and 'clean catch' specimens can be difficult or time-consuming to collect. Pain responses were observed in neonates and infants having either urethral or suprapubic catheterization with local anaesthesia (44). Transurethral catheterization with local anaesthetic gel is preferred as it is less painful than suprapubic catheterization with topical local anaesthesia (44). Sucrose analgesia immediately before bladder catheterization in neonates and infants up to 3 months old was not effective at neutralizing pain responses. However, a reduction in response was observed in the subgroup of those < 30 days old (45).

Nasogastric tube (NGT) insertion is a painful and distressing procedure frequently neglected when it comes down to pain-relieving strategies (46). Neonates who have not fully established enteral feeding or who have not developed a coordinated suck will require NGT feeds. Some of the studies indicated that sucrose (0.5 ml of 24 %) given 2 min before NGT insertion reduces the behavioural pain score and physiological responses in a small number of stable preterm infants (47).

The management of immunization and intramuscular injection includes swaddling, breast-feeding of pacifier, and sucrose which should be considered in neonates and infants undergoing vaccination (48, 49). When talking about older children, psychological strategies such as distraction should be used (50, 51). Consider additional pro-

cedure modifications such as vaccine formulation, order of vaccines (least painful first), needle size, depth of injection (25 mm 25 gauge needle), or the use of vapocoolant spray (52, 53). Children typically fear needle-related pain. The use of either nonpharmacological or pharmacological pain reduction strategies may reduce subsequent negative recall (54). There is good evidence that non-pharmacological methods, particularly distraction, can reduce immunization pain (50, 54). Topical local anaesthesia (EMLA, AMETOP) is clearly capable of reducing components of vaccination pain in both infants and older children, but the efficacy and the balance of effectiveness against cost are difficult to determine from the studies presently available (55). Lidocaine local anaesthesia added to asparaginase or benzyl penicillin injection reduced the pain response in two studies, but this approach requires further investigation (56, 57).

When managing procedural pain in infants, older children and adolescents, not only proven analgesic strategies are important, but also suitable preparatory measures that contribute to reduction in anticipatory and procedural anxiety. Families, play therapists, nursing staff, and other team members should be included.

When it comes down to blood sampling and intravenous cannulation in children, topical local anaesthesia as well as psychological strategies to reduce pain and anxiety should be used (58, 59, 60). Two of the topical LA, EMLA and AMETOP (amethocaine), have been shown as one of the best solutions in the management of venous cannulation (58, 59, 60). Recent evidence suggests that AMETOP has an advantage over EMLA for cannulation (61, 62). AMETOP has a faster onset of action. Newer preparations such as liposomal encapsulated LA or newer LA delivery systems may offer advantages in some situations. Buffered injected LA, for example, lidocaine + bicarbonate 10:1, administered with a fine 30-g needle subcutaneously prior to cannulation is faster in onset and may be as acceptable and effective as topical preparations (60, 63, 64). Nitrous oxide (50–70 %) inhalation has been used in children older than 6 years who can self-administer during venipuncture in some circumstances. 50 % nitrous oxide and EMLA have been shown to be equally effective for venipuncture with further improvements in pain reduction using a combination of the two (58, 65). The efficacy of vapocoolant topical spray has not been clearly established. Vapocoolant spray was not effective in reducing pain in one study of intravenous cannulation but did show a modest reduction in pain in a later study (66, 67).

Lumbar puncture (LP) is necessary in acutely ill children in whom meningitis is suspected. Other children require 'elective' or 'planned' LP. This may be for diagnostic reasons, such as evaluation of possible raised intracranial pressure, or for intrathecal treatments such as chemotherapy. In the case of LP, most commonly, local anaesthesia (either topical or infiltration) is combined with sedative agents, such as midazolam, or behavioural techniques, such as distraction or other cognitive-behavioural interventions (50, 68). 50 % nitrous oxide/oxygen could be offered to children willing and able to cooperate (69). Ketamine analgesia/sedation or general anaesthesia (GA) is sometimes used in emergency departments

and oncology units with appropriate facilities (70). It appears that older children, especially those who may only need to undergo this procedure once, may tolerate it with adequate behavioural techniques and LA, whereas children requiring multiple LPs should be offered sedation or GA (71).

When talking about chest drain (tube) insertion and removal in both, neonates and older children, there is little published evidence looking at analgesic options. Inhalation agents such as nitrous oxide or isoflurane may be helpful in these procedures, but further study is needed (72). Nitrous oxide is contraindicated in the presence of pneumothorax. Multimodal therapy, including IV morphine, nitrous oxide, topical LA infiltration, and NSAID, is likely to be superior to a single agent, but such combinations, although in clinical use, have not been studied.

Urine specimens are usually obtained by 'clean catch' or midstream specimen (MSU). Suprapubic aspirate (SPA) may be used for obtaining urine from young infants, however sampling by urethral catheterization seems to be less painful (44). Bladder catheterization may be required in children who developed urinary retention, particularly those receiving epidural analgesia postoperatively, as well as for radiological or other investigation of the renal tract, for example, micturating cystourethrogram (MCUG) also known as voiding cystourethrogram (VCUG). Very ill patients in ICU may also require catheterization to monitor urine output. Bladder catheterization, such as MCUG or VCUG, has been shown to cause significant pain and distress, which can be reduced by psychological preparation and behavioral pain management techniques such as distraction or hypnosis (73). Local anaesthetics incorporated into lubricant gels are frequently used in adults to reduce the pain and discomfort of catheterization, but this has not been well studied in children. Pretreatment of the urethra with lidocaine 10 min before catheterization reduces pain in a group of children with a mean age of 7.7 years (74). However, in younger children with mean age 2 years, application of lidocaine gel to the 'genital mucosa' for only 2–3 min before the procedure and its subsequent use as a lubricant did not decrease pain (75). Techniques combining adequate preparation, local anaesthesia, and behavioural interventions are likely to be more effective (76).

Infants who are unwell and unable to feed, particularly those with respiratory problems, may need to be 'tube fed' for a sort period. Older children may also be fed via NGS, for example, in patients with cystic fibrosis who sometimes require supplementary feeding on multiple occasions. NGT is often maintained in the postoperative period and may need to be re-inserted if it becomes displaced. In conclusion, it is very important to optimise pain management in those patients who are likely to need repeated NGT placement. NGT insertion has been little studied in children. In the adults, topical anaesthesia and lubricants have been shown to reduce pain and facilitate placement (77, 78). 10 % nebulized lidocaine also shown as effective in adults, but a recent RCT did not find any benefit from it in children between 1 and 5 years (79). In addition to that, nebulized lidocaine slightly increased the incidence of epistaxis in adults, but combined with vasoconstrictors such as topical phenylephrine or co-

caine, on the other hand, reduced that risk. These findings have not yet been confirmed in children. Indirect evidence suggests that the use of psychological/behavioural techniques may be of benefit in older children.

Traumatic laceration of the skin and scalp are frequently seen in paediatric population. When it comes down to minor laceration, a combination of pharmacological and non-pharmacological techniques is likely to be sufficient. For repair of simple low-tension laceration, tissue adhesives should be considered as they are less painful, quick to use, and have a similar cosmetic outcome to sutures or adhesive skin closures (steri-strips) (80). Topical anaesthetic preparations, such as LAT gel (lidocaine-adrenaline-tetracaine) if available, should be used rather than injected LA whenever possible, as they are less painful to apply. Buffering injected lidocaine with sodium bicarbonate should also be considered (64). Hair apposition technique (HAT) should be considered for scalp lacerations as it is less painful than suturing, does not require shaving, and produces a similar outcome (81). If injected lidocaine is used, pretreatment of the wound with a topical anaesthetic preparation, for example, LAT gel, reduces the pain of subsequent injection (82). 50 % nitrous oxide can also be useful when talking about reducing pain, anxiety, and distress in cooperative children (83). Psychological techniques such as distraction are also likely to be out of help (50).

Children with burns often require repeated, often extremely painful, dressing changes. Initial dressing changes are most often performed under general anaesthesia. If a child remains very distressed, this option may be favoured for procedures that are yet to come. Sometimes, in the early stages of burn pain management continuous infusion of potent opioids, such as morphine, is required. Both pharmacological and non-pharmacological techniques should be used in the management of painful dressing changes. The evidence base for managing burn pain in children is small and incomplete. Opioids are used extensively and should be given as necessary by intravenous or other routes (84). There is evidence for distraction with children using a variety of devices – such as helmet Visual Reality devices or hand-held multimodal devices where the child is an active participant in the game they are playing being more effective than standard distraction when burns dressings are being changed (85,86). Nitrous oxide is used extensively for single painful procedure in children who are able to cooperate. On the other hand, multiple or frequent administration may lead to bone marrow toxicity.

Botulinum toxin, in paediatric population, is often used to relieve muscle spasm which is associated with cerebral palsy. There is very little evidence for pain management strategies in this area. One observational study, which investigated the level of pain felt by children undergoing this procedure with local anaesthetic cream and 50 % nitrous oxide was identified. In this study, half the children experienced tremendous pain, but the rest of them managed well with combination of the two (87). Further research is needed. In practice, most children are likely to be offered general anaesthesia or sedation.

To summarise the story, procedural pain management does not only have humane aspect in paediatric population, but it also prevents numerous complications, child's negative attitude in following contacts with medical staff, percentage of chronic pain suffering patients, as well as cost of the treatment itself.

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Контроль процедурного болю у дітей різного віку

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Резюме. Підсумовуючи сказане, контроль процедурного болю несе не лише гуманний аспект серед педіатричного контингенту, а й запобігає численним ускладненням, негативному ставленню дитини при наступних контактах з медичним персоналом, знижує відсоток потерпаючих від хронічного болю, а також вартість самого лікування. Хороша оцінка болю сприяє запобіганню та/або ранньому розпізнаванню болю, а також ефективному його контролю. При лікуванні процедурного болю у немовлят, дітей старшого віку і підлітків важливі не тільки перевірені знеболюючі стратегії, але й відповідні підготовчі заходи, які сприяють зниженню передуючої та процедурної тривожності. Родичі, ігрові терапевти, середній медичний персонал, а також інші члени команди повинні бути в цьому задіяні.

Ключові слова: процедурний біль, діти, лікування, медицина болю

Контроль процедурной боли у детей всех возрастов

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Резюме. Подытоживая сказанное, контроль процедурной боли несет не только гуманитарный аспект в педиатрическом контингенте, но также предотвращает многочисленные осложнения, негативное отношение ребенка к следующим контактам с медицинским персоналом, снижает долю пациентов, страдающих хронической болью, а также стоимость самого лечения. Хорошая оценка боли способствует предотвращению и/или раннему распознаванию боли, а также эффективному управлению болью. При лечении процедурной боли у младенцев, детей старшего возраста и подростков важны не только проверенные анальгетические стратегии, но и надлежащие подготовительные меры, которые способствуют уменьшению упреждающего и процедурного беспокойства. В это должны быть вовлечены родственники, игровые терапевты, медсестры и другие члены команды.

Ключевые слова: процедурная боль, дети, лечение, медицина боли