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Summary. Pain management is an essential part of quality paediatric care and requires an organizational commitment. Regular assessment of pain is obligatory for adequate pain relief. For self-report both a pain faces scale and a Colour Analogue Scale are useful instruments. The Facial, Legs, Activity, Cry, Consolability scale is a simple and useful tool for behavioural assessment.

Pain can usually be well controlled with a combination of analgesics including paracetamol, NSAIDs, opioids and, if suitable, local/regional anaesthesia. The dosage of paracetamol required to provide analgesia is higher than the traditional dosage used for regulation of fever. Rectal administration of paracetamol gives a lower and more variable bioavailability compared with oral administration. There is growing experience with the use of NSAIDs in children and they are effective in the management of mild or moderate pain. Titration of opioids to analgesic effects and the use of nurse-controlled and patient-controlled continuous morphine infusion are, with proper education and supervision excellent methods of pain control. Local peripheral and central blocks decrease the need for anaesthetics during surgery and provide effective postoperative pain relief. Distraction and Guided Imagery are helpful instruments for procedural pain relief.

The Queen Silvia Children’s hospital is a 215-bed hospital in Gothenburg, the second largest city in Sweden. The hospital offers a full range of paediatric care: paediatrics, neonatology, paediatric surgery including cardiac surgery and transplant, anaesthesia, clinical physiology, radiology and child psychiatry. It provides service to paediatric patients on local, regional and national level.

Like in most places in the world there has been a rapid development in the management of paediatric pain in our hospital within the last 15-20 years. A number of changes have occurred simultaneously. Data have revealed that inadequate pain relief is not only inhumane but potentially have negative long-lasting consequences for the child. Pain assessment techniques for children have been developed allowing better evaluation of interventions. Rather than development of new drugs there has been a growing knowledge how to apply drugs for pain treatment in various age groups together with increased knowledge of pharmacokinetics in children.

Organisation
In the beginning of 1990s a group started in the hospital for improving pain relief. It consisted of one surgeon, two paediatric anaesthesiasts and nurses from surgical and emergency wards. The first steps taken were to introduce a faces pain scale assessment tool and to create a pain treatment manual for the staff in the surgical wards. Later the group has been enlarged to include nurses from all disciplines in the hospital, doctors and physiotherapists. Every month there is a meeting for this so called “pain management group”. Guiding principles for pain management, education efforts and research are then discussed. A member or an invited guest presents a specific topic and special cases are discussed.

The pain resource nurses act as pain management coaches or mentors for their colleagues in the wards. They are responsible for the pain assessment routines and pain relief, mediating knowledge and news to the staff. Since some years a full-time specialized pain resource nurse is employed and one doctor is now working with pain management for ten hours per week. The specialized nurse coordinates the pain management group, organises regular education for the staff and is consultative for the entire hospital. Regular basic teaching is run for the hospital nurse staff about physiology of pain, pain assessment, pharmacologic and non-pharmacological treatment of pain and information about procedural pain. Teaching about pain in children is offered doctors one day twice a year.

The manual for pain treatment has successfully been developed and is now available on the intra-net. It contains information about pain assessment by self-report and behavioural scales. There are guidelines for pharmacological pain relief with paracetamol, NSAIDs, morphine administration and regional blocks. In addition there is information about non-pharmacological pain relief and procedural pain. The manual can be used as an advisory tool, but in some wards the nurses can be licensed to use drugs temporary without a doctor’s ordination.

A policy for pain management has been compiled by the pain management group and is now approved by the hospital board. See below.

Assessment of pain
Pain assessment is essential for pain management; without proper pain assessment there can be no good quality pain relief. Every third hour pain has to be assessed and documented. If supplementary analgesics are provided a new assessment will be made after 10-20 minutes for intravenous administration and around 40 minutes for oral or rectal administration.

Assessment of pain in children is usually addressed from one of two aspects: self-reporting or behavioural. Several self-report methods are available in which the children describe their subjective experiences of pain. Faces pain scales are regarded as easily understood by the children, as they do not need to translate pain into numerical values. The scales may be valid from the age of 4 years, although the youngest may find it difficult to relate the faces to their own pain experience.

The faces pain scale used in our hospital was originally developed in Thailand by Dr Thara Tree-Trakarn and was one of the first published [1]. The reason for us to choose this scale was the distinct and expressive faces. Many children prefer this type of cartoon-like faces [2]. In addition, we performed a validation in cooperation with two hospitals in South Africa, where the scale was unknown to the children [3]. It was found to be a useful and valid instrument for measuring pain in children aged 4-12 years. A modified version of this scale has also been validated in England [4]. The scale
The Flacc Scale is scored from 0-2, which reflects five parameters: face, legs, activity, cry and consolability [8]. Each of the measurement of pain in 4-18 years children (Table 1) [7]. It has also been evaluated for peroperative pain children from 0 to 7 years [9]. It has been validated for evaluating postoperative pain [9]. The FLACC Pain Scale is an acceptable visual analogue scale for children [6]. Nine faces are presented in an ordered sequence from least to most distressed. Children older than 6-7 years are able to utilise these scales, which are practical tools for clinical use.

Specific types of distress behaviours like vocalisation, facial expression and body movement have been associated with pain and are helpful in evaluating pain in children with limited communication skills. However, it may be difficult to discriminate pain behaviours and behaviour resulting from other sources such as hunger or anxiety. Several behavioural pain scales have been developed. The Faces, Legs, Activity, Cry and Consolability (FLACC) pain scale has been validated for evaluating postoperative pain in children from 0 to 7 years (Table 1) [7]. It has also been evaluated for measurement of pain in 4-18 years children with cognitive impairment [8]. Each of the five parameters face, legs, activity, cry and consolability is scored from 0-2, which results in a total score between 0 and 10. We have chosen this scale because of its simplicity and clinical usefulness. In the neonatal ward a specific scale, the Premature Infant Pain Profile (PIPP) is used for preterm babies [9]. The PIPP is a seven indicator composite measure developed to assess acute pain in preterm and term infants.

**T**reatment of pain

The principals for pain treatment are to prevent pain by administering analgesics regular or continuous and to assess pain regularly. Non-opioids are used as basic analgesics and an opioid is added if non-opioids are not sufficiently effective. Regional blocks, if possible, are excellent to use for postoperative pain relief.

**Paracetamol**

Although paracetamol is an old drug the exact mechanism of action is unknown, but there is now more evidence for a central rather than a peripheral effect [10]. Adverse effects are unknown but caution is recommended in children with hepatic and renal failure.

The bioavailability of different formulations and routes of administration vary with age. Rectal absorption is slower and more erratic than the oral. However, in newborns, rectal bioavailability is higher than in older children [11].

Clinical use

Several recommendations concerning dosage exist which indicates that the best dosage regime is still unknown. Presently used dosages are shown in Table 2. The total dose for postoperative pain treatment is 90 mg/kg/day orally and 100 mg/kg/day rectally on the first day reduced to 80 mg/kg/day for the following 3-4 days [12]. For practical and pharmacokinetic reasons the dose is divided into four daily doses. Long-term rectal use is not recommended due to the large variability of absorption and likely discomfort with this form of administration. For neonates and febrile, dehydrated children the dosage is reduced to 60 mg/kg/day.

Propacetamol is an injectable prodrug of paracetamol, which is completely hydrolyzed within 10-15 minutes after administration; 1 g of propacetamol yields 0.5 g of paracetamol. The recommended intravenous dosage of propacetamol is 30 mg/kg four times daily. A burning sensation at the injection site is an adverse effect of intravenous administered propacetamol. An intravenous preparation of paracetamol 10 mg/ml, which does not give this sensation, has recently been released in Sweden. The recommended dose is 15 mg/kg four times a day. It is a safe and practical, although expensive analgesic in children with an intravenous access.

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Table 1. FLACC SCALE

<table>
<thead>
<tr>
<th>Categories</th>
<th>0</th>
<th>1</th>
<th>2</th>
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</thead>
<tbody>
<tr>
<td>Face</td>
<td>No particular expression or smile</td>
<td>Occasional grimace or frown, withdrawn, disinterested</td>
<td>Frequent to constant quivering chin, clenched jaw</td>
</tr>
<tr>
<td>Legs</td>
<td>Normal position or relaxed</td>
<td>Uneasy, restless, tense</td>
<td>Kicking, or legs drawn up</td>
</tr>
<tr>
<td>Activity</td>
<td>Lying quietly, normal position, moves easily</td>
<td>Squirming, shifting back and forth, tense</td>
<td>Arched, rigid or jerking</td>
</tr>
<tr>
<td>Cry</td>
<td>No cry (awake or asleep)</td>
<td>Moans or whimpers; occasional complaint</td>
<td>Crying steadily, screams or sobs, frequent complaints</td>
</tr>
<tr>
<td>Consolability</td>
<td>Content, relaxed</td>
<td>Reassured by occasional touching, hugging or being talked to, distractable</td>
<td>Difficult to console or comfort</td>
</tr>
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</table>
Nonsteroidal anti-inflammatory drugs
Nonsteroidal anti-inflammatory drugs (NSAIDs) exert the analgesic, anti-inflammatory and antipyretic effect by blocking cyclooxygenase and thereby the synthesis of prostaglandins and thromboxane. Pharmacokinetic results in infants and children indicate that a relatively higher dosage compared with that in adults is needed because of a higher volume of distribution but the elimination half-life is similar [13]. The NSAIDs are almost completely absorbed when taken enterally. For optimal effect, the timing of administration is important since NSAIDs require time to block prostaglandin synthesis and inhibit pain pathways. Preoperative administration is usually necessary in order to get immediate postoperative effect.

Adverse effects
The most important adverse effects are reduced platelet aggregation, inhibition of prostaglandin-mediated renal function, gastric irritation and hypersensitivity reactions. Routine use of NSAIDs in neonates is not recommended because the risk of developing renal failure and platelet dysfunction. NSAIDs should be used with caution in children undergoing surgical procedures which are expected to involve considerable dissection of tissues and in children with pre-existing coagulation defect [14]. Renal toxicity is low in healthy children but NSAIDs should be avoided in patients with renal disease, dehydration or heart failure. NSAIDs are contraindicated in children with allergic symptoms to aspirin. It is recommended to use them with caution in patients with asthma, in whom hypersensitivity symptoms are more common.

Clinical use
The NSAIDs are effective in the management of mild to moderate pain. In severe pain requiring opioid medication the administration of NSAIDs may improve analgesia. Although opioid-sparing effects with NSAIDs, have been described, studies remain inconclusive concerning a reduction in adverse effects [15-17].

Ibuprofen suspension 20 mg/ml and suppositories 60 and 125 mg are available in Sweden. It is used from the age of 6 months and the dosage is 5-10 mg/kg 3-4 times daily, maximum dosage 40 mg/kg/day. Diclofenac is available in suppositories and tablets 25 and 50 mg. It is usually used from the age of one year in a dose of 1-2 mg/kg 1-3 times daily, maximum dose 3 mg/kg/day. If enteral administration not is possible ketorolac is available for intravenous administration. Recommended dosage is 0.5 mg/kg i.v. 3-4 times daily [13].

Morphine
Morphine is by far the most commonly used opioid. The pharmacokinetic of morphine is well known in children of various age groups.

<p>| Table 2. PRESENTLY RECOMMENDED DOSES OF PARACETAMOL FOR POSTOPERATIVE PAIN RELIEF IN CHILDREN. ORAL ROUTE IS TO PREFER DUE TO WIDE VARIATIONS IN BIOAVAILABILITY |</p>
<table>
<thead>
<tr>
<th>Loading dose</th>
<th>Short term maintenance</th>
<th>Long term maintenance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oral</td>
<td>25-30 mg/kg</td>
<td>80 mg/kg/day</td>
</tr>
<tr>
<td>Rectal</td>
<td>35-40 mg/kg</td>
<td>80 mg/kg/day</td>
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| Figure 3 |

<table>
<thead>
<tr>
<th>Table 3. RECOMMENDED DOSES FOR INTERMITTENT INTRAVENOUS ADMINISTRATION OF MORPHINE</th>
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<tbody>
<tr>
<td>Age group</td>
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<tr>
<td>----------</td>
</tr>
<tr>
<td>0-3 months</td>
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<tr>
<td>3-12 months</td>
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<td>&gt; 12 months</td>
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The most important aspect is the prolonged half-life (4-8 hours) in newborn infants and the metabolic variability in infants up to the age of 6 months. From this age the morphine pharmacokinetics are similar to those in older children and adults with a plasma half-life of 2-3 hours [18].

Adverse effects
The respiratory depressant effect of morphine can be minimized by careful titration of morphine dosage to pain control and good routines for patient supervision. Since neonates have an increased sensitivity to the respiratory depressant effect of morphine they require reduced doses. Nausea and vomiting are the most common adverse effects of morphine. Unfortunately, there is no ideal single regime to completely avoid this effect. We use serotonin antagonists, antihistamines and phe-nothiazines both for prophylaxis and treatment of opioid induced nausea and vomiting. Other adverse effects are urinary retention, pruritus and constipation. Continuous infusion of morphine is an indication for a bladder catheter. Laxatives are given in case of more than 2-3 days of morphine administration.

Clinical use
The dosage of morphine should always be individualised. Intermittent intravenous administration can be used when pain is moderate and the need for an opioid is assumed to be of short duration. In order to avoid severe breakthrough pain a prescription for repeated by-the-clock administration is preferable. The dose has to be given slowly during 5-10 minutes and the effect evaluated after 10-15 minutes. If the effect is insufficient half of the dose has to be repeated until pain relief. For dosage see table 3.

Continuous administration is preferable if pain is prolonged or severe. With education and training of the staff continuous infusions can be safely used in ordinary wards. After loading doses of 100-200 mg/kg infusion rates of 10-40 mg/kg/h usually provide satisfactory analgesia. The infusion rate should always be titrated according to pain assessment. It can be nurse-controlled within a prescribed range. If the infusion rate needs to be increased a bolus dose should be given in order to decrease the time needed to obtain an adequate morphine level. In neonates the risk for respiratory depression limits the dose; loading doses of 30-50 mg/kg and infusion rates of 5-10 mg/kg/h are usually well tolerated.

(Nukelta | p. 22)
Patient Controlled Analgesia (PCA) is an attractive option for pain relief in children over 5-6 years [19]. Information about the method should always be given in advance and the responsible nurse must make sure that the child understands the idea and practicalities of self-administration. Loading doses of 100 mg/kg are given until the child appears comfortable. At start the routine is to set the infusion pump device to provide bolus doses of 20 mg/kg with a predetermined time interval of 8 minutes and maximum 4 doses hourly. A continuous infusion of 5 mg/kg/h is also provided since a low continuous infusion does not seem to increase the incidence of adverse effects [20].

All children have to be observed during 30 minutes after the administration of morphine concerning breathing rate, breathing depth and sedation. For infants less than 6 months breathing rate and sedation should be registered hourly and they should always have continuous supervision in the room. In children with continuous morphine administration controls have to be made every hour during the first day and, if the situation is stable, every third hour later. Equipment for ventilation and naloxone should be easily available and the dose of naloxone calculated in advance for the child. Special management protocols are used for nurse-controlled and patient-controlled infusions where the prescribed dose is noted, the nurse regularly signs doses and observations of breathing rate and depth and sedation. Assessments of pain are also entered.

Oral morphine administration requires a time-consuming titration because of variable bioavailability, between 10% and 50%. It may be considered in patients with a prolonged need for morphine. Common doses are 200-500 mg/kg 3-4 times daily.

Other opioids

When the individual child does not tolerate morphine and strong opioids are needed ketobemidone is used. This drug is very similar to morphine and can be used in equipotent doses [21]. In intubated and mechanically ventilated children continuous infusion of fentanyl is an alternative.

Codeine is prescribed in combination with paracetamol. About 5-10% of a given dose will be transformed to morphine. However, this ability is reduced in children less than 5 years and 5-10% of the population is unable to convert codeine to morphine. Codeine is used for the treatment of mild to moderate pain if paracetamol only is not enough and the use of NSAIDs is contraindicated. The recommended dosage is 1 mg/kg four times daily. It is mostly used in an outpatient setting.

Oxycodone in oral form is reported to have a better bioavailability than morphine, although there is a great inter individual variation in children [22]. It is prescribed in a dose of 0.05-0.10 mg/kg and is available in oral suspension of 1 and 10 mg/ml. In equipotent doses the respiratory depressant and other adverse effects are about the same as for morphine.

Regional anaesthesia

In children, central and peripheral blocks are mainly used as a supplement to general anaesthesia. Caudal block is commonly used for minor surgery below the umbilicus, such as lower abdominal urologic and lower limb surgery. It is a reliable and well tolerated method. Bupivacaine 2.5 mg/ml or ropivacaine 2 mg/ml at a dose of 1 ml/kg produce effective postoperative pain relief after lower abdominal surgery, while a dose of 0.5 ml/kg is usually sufficient for lower extremity and penile surgery. The duration of analgesia is around 4-6 hours. Ilioinguinal nerve block is used for postoperative pain relief following orchidopexy and inguinal hernia repair. Penile block is an effective method for circumcision. Infiltration of local anaesthetics in the operation wound is an underestimated, simple and often efficient method. If properly performed these techniques provides excellent analgesia during the first postoperative hours [23]. However, it is most important to administer systemic analgesics in appropriate time for optimal effect when the effect of the block wears off.

Continuous lumbar epidural block provides effective pain relief for infants and children undergoing major abdominal, genital-urologic and lower limb orthopaedic surgery. In newborns a catheter can be placed in the sacral canal and easily advanced to lumbar or thoracic level, which produces analgesia after abdominal and thoracic surgery for example, oesophageal atresia [24].

The following doses of bupivacaine have considerable safety margins:

- Newborn: single dose 1.5-2.0 mg/kg, continuous infusion 0.2 mg/kg/h
- Children: single dose 1.5-2.5 mg/kg, continuous infusion 0.4 mg/kg/h

For upper abdominal and thoracic surgery, a thoracic epidural approach can be used, but this is commonly reserved for older children, who can cooperate with the insertion in order to avoid neurological damage. Alternatively, a paravertebral block is a well-tolerated and effective method after thoracic and upper abdominal surgery [25]. Dosages of bupivacaine are the same as for epidural blocks.

With proper observation and management protocol epidural and paravertebral blocks can be safely administered on surgical wards.

Glucose

An effective, easily available and inexpensive method for procedural pain in neonates is 30% glucose on the tongue or, preferably, together with a pacifier [26]. The dose of 30% glucose is 0.5 ml for neonates < 2.5 kg and 1 ml for neonates > 2.5 kg. The dose can be repeated after 5 minutes. The maximal dose during an hour is 2 ml/kg.

Non-pharmacological pain relief

Good clinical pain practise includes a number of standard procedures that lead to pain reduction. Information to the child and the parents is of great importance. Children should be given developmentally appropriate explanations of what is going to happen to them. Explanations should be geared to a child’s level, using language that the child understands. Children should never be lied to or tricked into a painful experience.

Distraction and Guided Imagery are helpful methods for pain relief during procedural pain. Distraction refers to anything that takes attention away from the painful situation. In small children bright colours and sounding toys may distract, while older children often prefer video tapes. Singing, telling stories and blowing bubbles may also work. In Guided Imagery the child chooses a situation or an event that child likes to think about. An assistant helps the child to concentrate on the daydream by asking what happens in the child’s mind. The attention is focused to the child’s world of ideas in contrast to distraction, where the assistant manipulates the child. Relaxation can also reduce pain by changing stress or anxiety. Massage helps to improve circulation, loosens tight joints, decrease the levels of stress hormones and enhance an overall sense of relaxation and well-being.
Children’s Hospital

Pain is a subjective experience – only children themselves can know how much pain they are in. Because children find it difficult (or as infants may even be unable) to understand and communicate about the pain they are experiencing, we must tread very cautiously and respectfully when asking them whether they are in pain. Because children find it difficult (or as infants may even be unable) to say precisely what they are feeling, they may have difficulty communicating their pain to us. In such cases, therefore, we must rely on our knowledge and tried and true experience.

Our aims are that:

- All children/parents will, whenever possible, be asked at an early pointing time whether they are in pain and about their previous experiences of pain.
- All children who undergo repeated, painful procedures and/or who have ongoing pain will have their pain assessed using an appropriate pain assessment instrument.
- The pain will be evaluated and documented with regard to its intensity and duration and, whenever possible, with regard both to its nature and location, both at rest and during movement.
- All children with pain will receive adequate pain relief by pharmacological and/or non-pharmacological means.
- The pain relief provided will be evaluated and documented.

All medical care personnel will have knowledge about children’s pain, and all measures taken with respect to children’s pain will be based on state of the art scientific knowledge and tried and true experience.

REFERENCES


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