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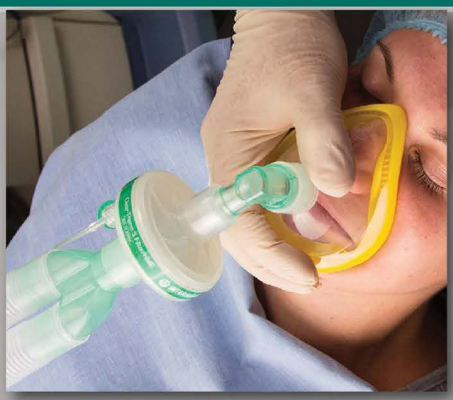

Yearbook

Indian College of Anaesthesiologists
Whole Constituent of
Indian Society of Anaesthesiologists
(Member of the World Federation of
Societies of Anaesthesiologists)

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CHAPTER 4

Pain in Children: Assessment and Management Strategies

Sharmila Ahuja

INTRODUCTION

With better understanding of mechanism of pain transmission and improved knowledge of pharmacokinetics and dynamics, management of pain in children has made appreciable advances in recent years. Poorly controlled postoperative pain can result in adverse physiological responses such as neuroendocrine stress response and hemodynamic changes, and chronic effects like longer recovery time, psychological trauma and development of chronic pain. For these reasons, the concept of postoperative pain, its assessment and provision of pain relief has become an integral component of pediatric anesthesiology practice today.[1]

Chronic pain in children is not very well recognized and centers for diagnosis and management of chronic pain are slow to develop.

Despite all advancements in this field, pain in children remains undertreated. *The reasons and barriers to treatment of pain in children include:*

- Lack of knowledge for assessment of pain and methods of pain relief.
- Fear of adverse effects of analgesic agents such as respiratory depression, nausea and vomiting.
- Reluctance to address the problem of pain in children, as it is considered time consuming, involves additional effort and a proper set-up and training to deal with pediatric pain.

This article will be addressing assessment of pain in children, management strategies of postoperative pain and procedure-related pain.

ASSESSMENT OF PAIN IN CHILDREN

Assessment of pain in children and neonates has been a major dilemma for clinicians. However, a reliable method for assessing pain in children is necessarily the first step in providing adequate pain relief as well as for evaluating the efficacy of analgesic regimens. The difficulty in obtaining an accurate measurement of pain in pediatric patients may be due to:

- Difficulty in obtaining reliable self-reports of pain experience and interpretation of such reports.
- Limited ability to understand pain related questions and provide appropriate verbal response due to limited vocabulary.
- Limited research on pain-related physiology and behavior in pediatric patients.[1]

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Despite these difficulties, measurement of pain in children has made great advances in the last decade. Strategies for assessment of pain in children can be broadly divided into subjective and objective categories.

- *Subjective*: Self reporting methods.
- *Objective*: Assessment by observers which includes measurement of:
  - Physiological variables
  - Behavior scales
  - Biological markers.

Subjective Methods of Pain Assessment

Subjective or self-reported methods are cognitive measures of pain, and attempt to evaluate the intensity and nature of pain experienced by the child. These methods are adaptation of techniques already established in adults and have been shown to be better suited for the older child (>5 year of age), although some innovative modifications have led to their successful use in children as young as 3 years of age. These include:

- Modified visual analog scale
- Color graded scale
- Self-reporting with words.

Visual Analog Scale

A 10 cm line marked "no pain" at one end and "worst possible pain" at the other end is widely used in adults. Its applicability and reliability studied in children showed that 50% children between ages 3 and 7 years had no difficulty in understanding the concept of visual analog scale (VAS), other studies have demonstrated a clear relationship between VAS and objectively assessed behavior as indicator for pain.[2] Attempts to simplify the "scale" method of subjective pain assessment in children have been used and are reported to have lowered the minimum age at which it could be used. A modified scale with happy/sad facial drawings combined with a verbal or observer (nurse) scoring system has been used by many workers in children as young as 3 years **(Fig. 4.1)**.[3]

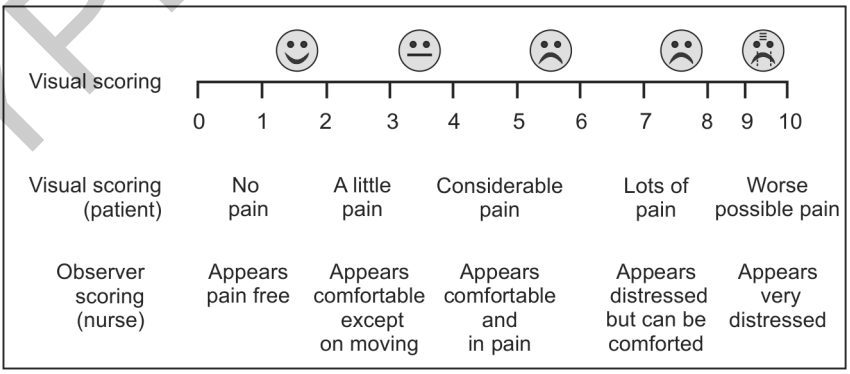

Fig. 4.1: Modified visual analog scale

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Color Graded Scale

In this, children depict their pain by coloring in a body outline using different colored crayons to grade pain from "no hurt" to "worst pain". It has been shown that red (closely followed by black) is the color most frequently used by children to describe their pain.[4]

Verbal Scale (Self Reporting with Words)

This is a simple scale designed for use in children where a word graphic rating is used. In this, the child indicates "how much pain" on a line with five verbal anchors.[5]

Objective Methods of Pain Assessment

Objective methods of pain assessment are suitable for the infant, neonate and preschool child, and include:

- Behavioral measures of pain
- Measurement of physiological variables, and
- Biological markers.

Behavioral Measures

Behavior measures of pain assessment mainly fall into three main areas: vocalization, facial expression and body movement. Behavioral pain scales comprising of these three criteria have been used successfully by various workers for assessment and management of acute postoperative as well as cancer pain in children 6 months to 6 years of age. Further, these workers have shown that the behavioral scales have good correlation with nurse observer rated VAS scores.[6]

Analysis of vocalization: Crying has face validity as a measure of pain in infancy and has been regarded as the best dependent variable for the study of pain in infants. The simplest measure of cry is its duration. Tape recorded measurements as well as video recorders have been used for this purpose. However, due to other factors influencing "cry" and inter-observer variability, 'cry' cannot be used as a single objective measure of pain.[7]

Facial expression: Izard and coworkers[8] designed an objective method for classifying different facial expressions in neonates and infants. In neonates, the expression associated with pain was "brows down and together, nasal root broadened and bulged, eyes tightly closed and the mouth angular and square". This was validated by other workers. Grunan et al.[9] in a study involving neonates, undergoing heel lance identified nine specific facial movements. Of these, brow bulge, eye squeeze, nasolabial furrow and lip parting were documented in 96–98% neonates.

Body movements (*Motor responses*): Reflex withdrawal of limb was found to be the most common response to heel lance in neonates. However, it is important to remember that newborns respond to any stimulus by a generalized body movement and this is altered by different behavioral states.

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Behavioral Scales

A combination of vocalization, facial expression and body movement has been used by various workers to formulate objective pain rating scales for assessment of pain in infants and toddlers.

- The Children's Hospital of Eastern Ontario Pain Scale (CHEOPS)[10] rates 6 behaviors—crying, facial expression, verbal expression, torso position, touch and leg position. This scale was used originally to assess postoperative pain, and has been validated by many workers in children, as young as 1 year of age.

Postoperative Pain Scale by Attia et al.[11] **(Table 4.1)** consists of 10 behavioral indices and has been used successfully by the author for assessment of postoperative pain in children 6 months and above undergoing cleft lip surgery.[12]

- *The Pediatric Objective Pain Scale* by Norden[13] consists of five indices—arterial blood pressure, crying, movement, agitation and posture. This scale has been validated by several workers for assessing postoperative pain following herniotomy, orchidopexy and circumcision.
- *AIIMS Pain Discomfort Score*[14] also known as the 'AIIMS Pain Scale' is a comprehensive scale using both subjective and objective criteria. It combines

Table 4.1 Pain assessment score[11]

P		*0 (Poor)*	*1 (Mediocre)*	*2 (Satisfactory)*
PS 1	Sleeping during preceding hours	None	Short naps, between 5 and 10 minutes	Longer naps 10 minutes
PS 2	Facial expression of pain	Marked, constant	Less marked, intermittent	Calm, relaxed
PS 3	Quality of cry	Screaming, painful high pitched	Modulated, can be distracted	No cry sound
PS 4	Spontaneous motor activity	Thrashing around agitated	Moderate agitation	Normal
PS 5	Spontaneous excitability and response to ambient stimulation	Tremulous, clonic movements	Excessive reactivity to any stimulation	Quiet
PS 6	Constant and excessive flexion of fingers and toes	Very pronounced marked and constant	Less marked intermittent	Absent
PS 7	Sucking	Absent/ disorganized sucking	Intermittent and stops with crying	Strong rhythmic with pacifying effect
PS 8	Global evaluation	Strong hypertonicity	Moderate	Normal
PS 9	Consolability	None after 2 min	Quiet after 1 minute of effort	Consoled before 1 minute
PS 10	Sociability (eye contact, response to voice, smile)	Absent	Difficult to obtain	Easy and prolonged

Cumulative scores
20 = Comfortable
15–19 = Satisfactory analgesia
0–14 = Unsatisfactory analgesia

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Table 4.2 AIIMS pain discomfort score is a comprehensive scale using both objective and subjective criteria

Parameter	*Criteria*	*Grading*
Respiratory rate	<+20% of preoperative baseline value +20–50% of preoperative baseline value >50% of preoperative baseline value	0 1 2
Heart rate	+10% of preoperative baseline +20% of preoperative baseline +30% of preoperative baseline	0 1 2
Discomfort	Calm Restless Agitated	0 1 2
Crying	Not crying, responding to water/food and parental presence Crying but responding to tender loving care Crying and not responding to tender loving care	0 1 2
Pain at site of operation	No pain Vague Can localize pain	0 1 2
Maximum score = 10 0–3 = Mild pain 4–6 = Moderate pain 7–10 = Severe pain		

physiological and behavioral parameters and has been found very useful in assessing pain in the preschool age group **(Table 4.2)**.

Measurement of Physiological Variables

Changes in heart rate, blood pressure, ventilation rates are used widely in conjunction with behavior scales for assessment of pain in neonates and children.[14] In newborns undergoing heel lancing or circumcision, heart rate and blood pressure were markedly increased during and after the procedure. These changes were found to decrease when pain relief was provided in the form of local anesthesia.[15]

Fall in transcutaneous oxygen levels have been found in neonates and younger children during painful surgical procedures such as circumcision and such changes were found to be preventable by providing local analgesia.[16]

Palmar sweating has been validated as a reliable physiological measure of the emotional state of term neonates. Marked changes in palmar sweating have been observed during heel lance in term neonates.[17] In older children, palmar sweating index has been used to measure degree of distress during painful surgical or dental procedures.

Biological Markers

Anand et al. carried out detailed hormonal and metabolic studies in premature and full-term neonates undergoing surgery under regional anesthesia.[18] They documented marked release of catecholamines, glucagon, cortisol and other corticosteroids along with suppression of insulin secretion. This resulted in breakdown of carbohydrate and fat stores causing prolonged hyperglycemia

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and increased levels of lactate, piruvate and ketone bodies.[19] These stress responses were decreased by halothane anesthesia in term neonates undergoing painful procedures and abolished by fentanyl anesthesia[20] in preterm neonates undergoing ligation of patent ductus arteriosus. Further, these neonates had fewer complications in the postoperative period. Similar changes have also been documented in older infants and children undergoing various surgical procedures.

In conclusion, it is evident that there is no single gold standard to measure pain in children. A combination of cognitive (Self reporting), behavioral and physiological changes are used by clinicians for assessing pain efficacy of analgesic regimens in pediatric patients.

MANAGEMENT STRATEGIES FOR POSTOPERATIVE PAIN IN CHILDREN

Strategies for postoperative pain control in children vary according to the age of the child, severity of pain, type of surgery and above all the facilities available for providing and monitoring the efficacy and side effects of the analgesic regime/method used. Psychological considerations play a very important role in reducing the distress of the child in pain. Comforting, holding, cuddling, use of dummies can be used by parents/nurses or caregivers to pacify the child.[21,22] For younger children, activities such as drawing and puppet play have been used successfully to divert the attention of the child. Establishing an Acute Pain Service goes a long way in providing safe and reliable analgesia in children. The success of an acute pain service for children has been proven at established centers such as Great Ormond Street Hospital[23] London and has revolutionized the postoperative pain management in children. *The requisites for establishing an acute pain service are:*

- Developing protocols to suit local needs
- Must address patient medication, pain assessment and patient observations during analgesic medication
- Dedicated consultants and clinical nurse specialists.

Minor Surgery

In most institutions around the world, a minor surgical procedure although performed under general anesthesia, is done on day care basis. Providing satisfactory analgesia with minimal side effects is a major consideration for day care surgery.[24] Opiates are generally avoided in day care surgery due to their undesirable side effects such as nausea, vomiting, delayed respiratory depression, all of which may delay the discharge of the child.

The use of local anesthetic techniques such as peripheral nerve blocks, plexus blocks, central neuraxis blocks with a long-acting agent (bupivacaine) provides excellent pain relief with minimal side effects. The blocks are generally performed after induction of general anesthesia by an experienced anesthesiologist, the dose varying according to weight of the child and type of block. The common blocks performed for various surgical procedures and suggested dosages of bupivacaine for these blocks are enumerated in **Table 4.3**.[25]

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Table 4.3 Common nerve blocks

Block	*Volume of bupivacaine (0.25)%*	*Nerve*	*Surgical procedure*
Axillary	0.5 mL/kg	Brachial plexus	Arm and hand surgery
Axillary	0.6 mL/kg	Intercostal nerves	Thoracotomy laparotomy
Inguinal	0.2 mL/kg	Ileoinguinal, ileohypogastric	Herinotomy, orchidopexy
Penile	0.1 mL/kg	Dorsal nerve of penis	Circumcision
Femoral/3 in 1 block	0.5 mL/kg	Femoral nerve	Surgery on thigh
Caudal extradural	0.5–1 mL/kg	Extradural	Herniotomy, orchidopexy, circumcision, hypospadias

Source: Adapted from Lloyd Thomas–Clinical Pediatrics.[25]

Care must be taken to ensure that subsequent analgesia is provided before the effect of the block wears off. This can be done effectively by supplementing with simple analgesics like paracetamol, 10–15 mg/kg 6 hourly or nonsteroidal anti-inflammatory drugs (NSAIDs) such as ibuprofen, 2.5–5 mg/kg 8 hourly and diclofenac, 1–1.5 mg/kg 12 hourly. These analgesic drugs can be given either orally or as suppositories, while the child is under general anesthesia.

Important considerations to be taken into account are:

- Parental consent must be taken before using suppositories
- Dosage must be adjusted when used by this route (paracetamol 20-25 mg kg/6 hours)
- NSAIDs should be avoided in neonates
  Diclofenac is not recommended in infants less than six months of age.

Major Surgery

With increasing knowledge and experience in use of regional anesthesia techniques in children, pediatric pain management has undergone a major revolution in the past few years. These techniques range from local infiltration and peripheral nerve blocks to field blocks, caudal and lumbar extradural blocks. The local anesthetic agent of choice is bupivacaine because of its efficacy and long duration of action. Toxicity has been reported with bupivacaine and the recommended maximum safe dose of 2 mg/kg in a 4-hour-period must never be exceeded. Caudal epidural block requires special mention, as it is a widely used regional technique in children. The single injection 'caudal' has an excellent efficacy and safety record.[25] Use of adjuvants with local anesthetic agents minimizes side effects while providing excellent pain relief. Opiates are not preferred due to the undesirable side effects like nausea, vomiting and respiratory depression. Ketamine (0.25 mg/kg)[26] and midazolam (50 μg/kg)[27] have been reported to prolong the duration of analgesia when used as adjuvants. By using the caudal approach to the epidural space, it is possible to extend the block to cover dermatomes as high as T10. When a more extensive block is required, a catheter can be fed upwards to the desired level. This is possible in infants and neonates as the epidural space is less densely packed with fat thereby

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allowing the catheter to be inserted from the sacrococcygeal area to the thoracic and lumbar region.[23] In older children, lumbar epidural block provides excellent pain relief following major surgery. Continuous infusion using mixture of local anesthetics and opiates is used successfully in specialized units. Because of the complexity of the technique, technical problems, risk of respiratory depression and other undesirable side effects such as urinary retention, this technique should be limited to those centers where facilities for continuous monitoring, supervision and expertise is available.

Systemic Analgesia with Opioids

Continuous intravenous infusion with morphine and fentanyl is used successfully in dedicated centers. However, this technique has certain problems in that continuous supervision by trained personnel is a must. Besides standard monitoring, observations for frequent pain assessment, sedation score, respiratory rate, volume infused and other side effects such as nausea, vomiting must be followed strictly for safe and effective use of continuous intravenous analgesia with opiates. Patient controlled analgesia through PCA pumps can be used effectively in children as young as 4 years. In younger children nurse controlled analgesia (NCA) can be used where bolus doses are given by nursing staff over and above a continuous background infusion after assessing level of discomfort or before procedures known to cause discomfort, such as changing position or physiotherapy.[25]

Important considerations for PCA/NCA are:

- Availability of trained personnel
- Continuous monitoring for sedation, respiratory depression, nausea vomiting essential
- Antiemetics for prevention and treatment of nausea vomiting must be included in protocol
- Must be tailored to the individual patient.

Use of Non-narcotic Analgesics

Nonsteroidal anti-inflammatory agents (NSAIDs) are widely used for treatment of mild to moderate pain in children. These agents are particularly useful for supplementation of analgesia with regional/local anesthesia techniques.

Agents used commonly in children are:

Paracetamol, used orally or rectally in a dose of 10–15 mg/kg, maximum dose should not exceed 60 mg/kg/day. IV dose should be given according to post-gestational age, 28–32 weeks 10 mg/kg, 32–36 weeks 12.5 mg/kg and ≥36 weeks 15 mg/kg.

Ibuprofen in dosage of 5–10 mg/kg, maximum dose 40 mg/kg/day

Diclofenac in dosage of 1–2 mg/kg; maximum daily dose 3 mg/kg. Diclofenac is available as suppositories in strengths of 12.5 mg, 25 mg, 50 mg and 100 mg. However, suppositories are not recommended for children less than 12 months old.

Ibuprofen and diclofenac are not recommended in infants less than 12 months of age and one must lookout for gastrointestinal, hematological and renal side effects whenever these agents are used.[22]

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Role of Parent and Patient Information

Prior information and discussion about the various analgesic techniques with parents play a vital role in pain management in children. Information given via audiovisual aids and pamphlets should include need to treat pain and the various methods of managing pain. Preoperative patient education and preparation helps to reduce anxiety and has been seen to reduce postoperative pain.[24]

Procedure Related Pain

Certain medical procedures (both therapeutic and diagnostic) that are performed on children may be unpleasant or painful and cause a lot of distress and anxiety to the child as also to the parents. This may then result in a child fearful of undergoing future procedures and a lifetime of unpleasant memories.

These procedures include venous cannulation, cleaning of a wound, removal of sutures and more invasive interventions like lumbar puncture. *The approach to management of procedural pain includes the following*:

- Adequate explanation of the procedure to the parent and to the child (who can understand) in simple understandable language.
- Parental support and presence should be encouraged.
- Procedure should be performed in a safe clean area away from bedside if possible, to minimize contamination and development of fear of 'bedside'.
- All equipments required for the procedure should be prepared in advance to reduce any delay in performing the procedure.

Depending on procedure, a combination of psychological and pharmacological techniques may be used.[28] Simple procedures may be performed by using distraction method and play along with local anesthetic creams.

If the procedure is a painful one, analgesia should be provided before performing the procedure. Oral/rectal paracetamol in appropriate dosages **(Table 4.4)** along with soothing and cuddling may suffice for minor less painful procedures. Newer drugs such as dexmedetomidine is being used successfully for sedoanalgesia techniques during some radiological procedures. Intranasal dexmedetomidine in a premedication dose of 2 μg/kg has resulted in excellent sedation in children without causing adverse hemodynamic effects.[29]

Table 4.4 Dosing schedule for minor analgesics

	Drug	*Dose (mg/kg)*	*Dose interval (hrs)*
Paracetamol			
Oral	Antipyretic Analgesic	10 15–20	6
Rectal	Antipyretic Analgesic	15 20–25	6
Intravenous		10–15 (based on post-gestational age)	8
Ibuprofen	Oral	5	6
Diclofenac	Oral Rectal	1 1	8–12 8–12
Ketorolac	Intravenous	0.2–0.5 (from 1 yr)	6 (max 8 doses)

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Table 4.5 Suggested doses of patient controlled anesthesia (PCA)/nurse controlled anesthesia (NCA)

Morphine	*PCA*	*Day of operation*	*Thereafter*	*NCA*
Loading dose (μg/kg)	50–100	50–100	50–100	50–100
Background infusion (μg/kg)	0–2	4–8	0–4	10–20
Bolus dose (μg/kg)	10–20	10–20	10–20	10–20
Lockout interval (mins)	5–10	10–20	5–10	30
4 hours dose limit (μg/kg)	400	400	400	400
Source: Lloyd Thomas, et al. Hospital for sick children, great ormond street, London, UK				

If drugs are given for sedation, facility for monitoring and resuscitation must be present. These include availability of source of oxygen, suction apparatus and emergency resuscitative drugs. Presence of an anesthesiologist is desirable whenever the child requires deeper level of sedation.

Nonpharmacological methods for facilitating performance of procedures in children have been used successfully by pediatric care givers. These include:

- Distraction tactics such as music, play, storytelling, etc.
- Relaxation techniques may be tried in older children by prior suggestion and use of breathing exercises.
- Guided imagery use of distraction and relaxation by trained personnel whereby the child is guided through sensory image which has produced a pleasant sensation in the past.
- Massage: This may be performed by the parent or a trained friendly person. It involves gentle massage of soft tissues to produce a sense of wellbeing.[28]

FUTURE PERSPECTIVES IN PAIN MANAGEMENT

Day care surgery has presented a new set of challenges and goals for the anesthesiologist. Newer innovations in pain management include target infusion techniques, patient controlled regional anesthesia (PCRA) systems, newer drug delivery system such as transdermal iontophoresis, transmucosal or intranasal delivery of drugs and further advances in opioid therapy. The final aim, needless to say, is to 'provide effective analgesia with minimal side effects' **(Table 4.5)**.

CONCLUSION

It is imperative for care givers involved in management of pediatric pain to expand and update knowledge in the field, use appropriate tools and techniques for assessment and intervention by adopting a multimodal and multidisciplinary approach, and above all, involve parents and family in the entire process of pain management.

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KEY POINTS

- Children feel as much pain as adults following tissue injury, trauma, operative procedures and simple medical procedures (procedure related pain).
- Assessment of pain in children is an important step in providing/initiating pain relief and evaluating efficacy of analgesic regimes.
- Pain in children may be assessed by 'subjective' or self-reporting methods and 'objective' pain scales which include physiological variables, behavior scales and biological markers.
- Strategies for pain control in children vary according to age, type and severity of pain, type of surgery and facilities available for providing pain relief and monitoring thereof.
- Establishing 'Acute Pain Service' goes a long way in providing safe and reliable analgesia in children.
- Providing satisfactory analgesia with minimal side effects is the mainstay of pain management for day care or minor surgical procedures.
- Regional anesthesia techniques, peripheral nerve blocks, plexus blocks, neuraxis blocks (ranging from caudal to lumbar extradural blocks) provide excellent pain relief. Systemic analgesia with opioids in dedicated centers provides good pain relief in the form of PCA and NCA.
- Procedure related pain from venous cannulation, wound dressing, suture removal, lumbar puncture cause distress and discomfort to child and parents. Nonpharmacological methods such as distraction tactics, cuddling and soothing along with LA creams suffice for simple procedures.
- Pharmacological approach with analgesics and sedatives may be required for more painful procedures. Paracetamol is the most common agent used by oral/rectal route.
- Use of sedative agents demand monitoring and resuscitative facilities. Agents for sedation include midazolam and more recently dexmedetomidine given under supervision only in calculated dosages.

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