ACUTE POST OPERATIVE PAIN MANAGEMENT

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Summary: The management of acute postoperative pain is a vital component of the surgical management of any condition. Pain is also one of the primary concerns of the surgeon because of its close ties with clinical outcome and acute postoperative patient well-being. The advantages of effective postoperative pain management include patient comfort and therefore satisfaction, earlier mobilization, fewer pulmonary and cardiac complications, a reduced risk of deep vein thrombosis, faster recovery with less likelihood of the development of neuropathic pain, and reduced cost of care. Assessment of the degree of pain, monitoring and reassessment are components of postoperative pain management. There are various modalities and drugs available for pain relief; the knowledge of the effects, dosage and precautions can ensure that the post operative pain relief is efficient and safe.

Introduction:

Acute postoperative pain is defined as pain that is present in a surgical patient after a procedure. Such pain may be the result of trauma from the procedure or procedure-related complications. It is characterized by being high threshold and well localized and transient, and there is a definite relationship between the response and the stimulus.

Adequate pain relief is a major concern and area of focus in the present day. Pre-operatively, one of the most common questions asked by patients pertains to the amount of pain they will experience after the surgery. Pain is also one of the primary concerns of the surgeon because of its close ties with clinical outcome and acute postoperative patient well-being. The advantages of effective postoperative pain management include patient comfort and therefore satisfaction, earlier mobilization, fewer pulmonary and cardiac complications, a reduced risk of deep vein thrombosis, faster recovery with less likelihood of the development of neuropathic pain, and reduced cost of care.(1-2)

The failure to provide good postoperative analgesia is multifactorial. Insufficient education, fear of complications associated with analgesic drugs especially opioids, poor pain assessment, and inadequate staffing are among its causes.

Mechanism of acute postoperative pain

Peri-operative pain results from inflammation caused by tissue trauma (ie, surgical incision, dissection, burns) or direct nerve injury (ie, nerve transaction, stretching, or compression). The patient senses pain through the afferent pain pathway (Fig. 1) which is the target of various pharmacologic agents. Pain impulses are transmitted to the dorsal horn of the spinal cord, where they make contact with second-order neurons that cross to the opposite side of the cord and ascend via the spinthalamic tract to the reticular activating system (RAS) and thalamus. The localization and meaning of pain occurs at the level of somatosensory cortex. (3)

![Pain pathway](image1)

![Pain assessment scale](image2)

Figure 1: Pain pathway

Figure 2: Pain assessment scale (Visual analogue and numerical)
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**Pain assessment tools**
Assessment and continual reassessment of pain is an essential component of postoperative pain management. Monitoring of postoperative pain should be considered as the 5th vital sign. It is usually performed by the following two methods
- **Self-reporting**
- **Use of behavioral observational scales** (for those who are unable to perform self-reporting)

Self-reporting depends upon the cognitive ability of the patient to understand that pain severity is to be measured along a continuum. The rating scales that can be used are:
- **Verbal rating scales** (VRS - consists of a list of adjectives describing different levels of pain intensity; from 'no pain' to 'extremely intense pain'),
- **Numerical rating scales** (NRS- involves asking the patient to rate his or her pain from 0 to 10 or from 0 to 100 with the understanding that 0 is equal to no pain and 10 or 100 is equal to worst possible pain),
- **Visual analogue scales** (VAS - a series of faces showing the severity of pain) have been used extensively in the acute and research setting to measure pain. They provide simple, efficient and minimally intrusive measures of pain intensity. (Figure 2)

**Monitoring of postoperative pain should be considered as the 5th vital sign**

**Pain assessment in children:** An assessment of pain intensity and character in children is very difficult as compared to adults. Children between 3 to 8 years of age are capable of quantifying their pain by using visual analog pain scale or Wong Baker Faces scale. (4,5) In children, who are unable to talk, pain reporting is usually dependent on their parents, who know their child’s behavioral response to pain. Some observational tools are also used to assess pain in this group. These tools are based upon scoring facial expressions, ability to be consoled, the level of interaction, limb and trunk motor responses, and verbal responses. The following are examples of behavioral pain scales;

- Face, Legs, Activity, Cry, Consolability (FLACC) tool (0 to 10 scoring, validated from 2 months to 7 yrs age)
- Neonatal/Infants Pain Scale (NIPS) has been used mostly in infants less than 1 yr of age.
- CRIES: Assesses Crying, Oxygen requirement, Increased vital signs, facial Expression, Sleep.

**Therapeutic modalities**
The traditional way of acute pain management is to palliate pain, give minimal doses only when needed, and administer one medication at a time. The most modern, or recent thinking is to provide multimodal techniques of pain relief. Multimodal techniques for pain management include the administration of two or more drugs that act by different mechanisms for providing analgesia. These drugs may be administered via the same route or by different routes. The rationale for multimodal pain management is to provide effective pain relief for the patient with less reliance on opioids. Another important concept in pain management is the use of scheduled medications and techniques that allow the patient to get the dose on demand; either through a patient-controlled analgesia device or scheduled oral or parenteral administration. And lastly, the utilization of regional analgesia whenever possible has provided a breakthrough in pain management. (6-8)

To provide high quality pain care to surgical patients, a dedicated interdisciplinary team consisting of surgeons, nurses, anesthesiologists, pain specialists, and pharmacists should be assembled and included throughout the course of patient care. The goal of this service is to prevent pain, rather than to act after the pain is established to try to relieve it.

Preoperative patient evaluation and planning is integral to peri-operative pain management. Proactive individualized planning integrating pain management into the peri-operative care of patients is essential. Patient factors to consider in formulating a plan include type of surgery, expected severity of postoperative pain, underlying medical conditions (e.g., presence of respiratory or cardiac disease, allergies), the risk–benefit ratio for the available techniques, and a patient’s preferences or previous experience with pain.
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Preventive analgesia

The concept of "preemptive" analgesia, ie, analgesics administered prior to surgical incision or stimulus, remains controversial. (9) A more encompassing approach to the reduction of acute and chronic postoperative pain is the concept of "preventive" analgesia. (10,11,12) The aim of preventive analgesia is to reduce sensitization by preoperative, intra-operative, and postoperative noxious stimuli, by treatments administered at any time in the peri-operative period. A preventive analgesic is effective when postoperative pain or analgesic consumption is reduced beyond the duration of action of the treatment drug or technique.

While numerous classes of drugs are used to treat pain, 3 categories in particular—acetaminophen, non steroidal anti-inflammatory drugs (NSAIDs), and opioids—are most often used for the treatment of pain, along with adjuvants (eg, muscle relaxants, anticonvulsants). Each of these drugs is associated with different adverse events and with varying degrees of efficacy.

Nonopioid Analgesics

Nonopioid analgesics, including nonsteroidal anti-inflammatory drugs (NSAIDs) and acetaminophen, play an important role as first-line agents in the management of mild-to-moderate pain. NSAIDs, in particular, have proven to be a popular method for analgesia in the postoperative setting. Their ease of dosing, widespread availability, parental acceptance, lack of opioid-type adverse effects, and the relative comfort of the practitioner in prescribing non opioid analgesics support their role in postoperative pain management. When used in combination with opioids, these agents exhibit "opioid-sparing" effects. Consequently, the patient is likely to experience fewer adverse effects associated with both analgesics.

Acetaminophen (Paracetamol)

This is an inhibitor of prostaglandin synthesis and is commonly used in the treatment of mild postoperative pain; however, compared to other agents, its analgesic potency remains low and ceiling effects may be observed. In general, acetaminophen is the least potent, while NSAIDs and opioids offer stronger analgesic effects.

Intravenous acetaminophen is more frequently used in the peri-operative period and can also be used in patients in whom oral or rectal administration is not an option. Intravenous acetaminophen has a more rapid and predictable onset of effect (5 to 10 minutes) and time to peak concentration (15 minutes) in most patients compared with rectal or oral administration (onset 10 to 60 minutes or more).

Nonsteroidal anti-inflammatory drugs (NSAIDs)

Both nonselective NSAIDs and those that act selectively on the COX-2 isoform of cyclooxygenase may be administered for perioperative pain control. Oral NSAIDs commonly used for postoperative pain include ibuprofen and diclofenac. Nonselective NSAID – Ketorolac is available for intravenous (IV) use. Administration of ketorolac reduces opioid consumption by 25 to 45 percent and thereby lowers opioid-related side effects such as ileus, nausea, and vomiting. NSAID administration in the operating room should be delayed until hemostasis has been achieved. Currently, there is only one COX-2 selective NSAID on the market, celecoxib, which has efficacy similar to the nonselective agents.
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Caution/ adverse effects:

- Common adverse effects of NSAIDs include bleeding and gastrointestinal and nephrotoxic effects. NSAIDs are contraindicated in patients who are susceptible to renal or hepatic disorders, have increased bleeding risks, or are on other nephrotoxic agents or anticoagulants; use should also be avoided in neonates.

- A major difference between opioids and NSAIDs is that unlike opioids, NSAIDs have a ceiling dose. There is a point when increasing the dose of NSAIDs does not result in additional analgesic benefits but significantly increases the risk of side effects. Each medication has a maximum dose that should not be exceeded. (15-18)

Some common NSAIDs and their associated maximum daily dose are listed in Table 2.

NSAIDs have a ceiling dose. Beyond this dose, increasing the dose of NSAIDs does not result in additional analgesic benefits but significantly increases the risk of side effects.

Table 1. Dosing for Acetaminophen (oral and IV)

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Dose Given Every 4 Hours</th>
<th>Dose Given Every 6 Hours</th>
<th>Maximum Total Daily Dose of Acetaminophen (by Any Route)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adults and adolescents (≥13 years old)</td>
<td>650 mg</td>
<td>1,000 mg</td>
<td>4,000 mg in 24 hours</td>
</tr>
<tr>
<td>weighing ≥50 kg</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adults and adolescents (≥13 years old)</td>
<td>12.5 mg/kg</td>
<td>15 mg/kg (Up to 750 mg)</td>
<td>75 mg/kg in 24 hours (up to 3,750 mg)</td>
</tr>
<tr>
<td>weighing &lt;50 kg</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Children ≥2 to 12 years old</td>
<td>12.5 mg/kg</td>
<td>15 mg/kg</td>
<td>75 mg/kg</td>
</tr>
</tbody>
</table>

- A reduced dose of acetaminophen should be used for low-weight adults and adolescents (body weight 33 to 50 kg) and in patients with mild or moderate hepatic insufficiency, chronic alcoholism, malnutrition, or dehydration.

- Patients with severe renal insufficiency (creatinine clearance ≤ 30 mL/min) may receive the usual dose, but not more often than once every six hours. Acetaminophen is contraindicated in patients with severe hepatic insufficiency or severe progressive liver disease. (13,14)

Table 2. Dosing of commonly used non opioid analgesics

<table>
<thead>
<tr>
<th>NSAID agent</th>
<th>Usual dose (mg)</th>
<th>Dosing interval (hours)</th>
<th>Maximum daily dose in adults (mg)</th>
<th>Pediatric dosing (mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ibuprofen</td>
<td>400-800</td>
<td>6</td>
<td>2400</td>
<td>5-10 (max 40 mg/kg/day)</td>
</tr>
<tr>
<td>Diclofenac</td>
<td>50</td>
<td>8</td>
<td>150</td>
<td>2-3 in divided doses (max 200 mg)</td>
</tr>
<tr>
<td>Naproxen</td>
<td>250</td>
<td>6-8</td>
<td>1500</td>
<td>5 (max 1000 mg/day)</td>
</tr>
<tr>
<td>Ketorolac (IV/IM)</td>
<td>30</td>
<td>6</td>
<td>120</td>
<td>0.5-1 (max 20 doses)</td>
</tr>
<tr>
<td>Celecoxib</td>
<td>200</td>
<td>12</td>
<td>400</td>
<td>&gt;2 yrs, 10-25 kg, 50 mg BID</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&gt;25 kg, 100 mg BID</td>
</tr>
</tbody>
</table>
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Opioid Analgesics

With proper dosing and appropriate assessment and monitoring, opioid analgesics are effective for the treatment of moderate-to-severe postoperative pain. Opioids act as agonists on central and peripheral opioid receptors.

Routes of administration:
They may be administered by many different routes: oral, rectal, sublingual, transdermal, subcutaneous, intramuscular, intravenous, or neuroaxial. The intramuscular or subcutaneous route is very often prescribed; however, it is an unpredictable delivery system and also causes much discomfort for patients. Oral opioids can be very effective and can be used to rapidly wean a patient off parenteral therapy, thereby allowing earlier discharge from the hospital. While transdermal fentanyl patches add to the total narcotic dosage, they also provide an alternative route for administration of pain control agents.

Commonly used Opioids:
The opioids commonly used are morphine, meperidine, fentanyl, and hydromorphone. All of the narcotics, with the exception of remifentanil, have active metabolites that can result in an enhanced effect with impaired excretion or prolonged use. The metabolites of meperidine may cause seizures as they accumulate, and in the elderly patient, meperidine may cause psychosis or delirium as a result of its atropine-like effect on the central nervous system.

Morphine has been extensively studied for the management of pain after major surgery in adults and children. It is considered a favorable choice because it is well tolerated and can be given through several different routes of administration, although oral administration is typically avoided because of variable bioavailability. Other opioids that have been utilized in this setting include fentanyl, hydromorphone, codeine, and tramadol. Fentanyl and hydromorphone are suitable alternatives to morphine secondary to their ease of titration when given parenterally. Because codeine and tramadol have the ability to produce weaker analgesic effects, use is typically limited to the management of moderate to moderately severe pain associated with minor procedures. Additionally, tramadol has been associated with increased postoperative nausea and vomiting, further restricting its use. (19,20)

Opioid Dosing
The recommended dosing for opioid analgesics for the management of postoperative pain in adults and children can be found in table 3. These agents should be administered around the clock, rather than as needed, to avoid “chasing” increases in pain severity.

Patient-controlled analgesia
- Patient-controlled analgesia is used widely for the management of postoperative pain. Opioids are the most commonly used analgesic in this mode.
- The advantages of this modality are that the patient can obtain pain relief without waiting for a caregiver, no painful injections are required, and the patient retains a certain amount of control.
- The safety of this system depends on the proper functioning of the pump and its use by the patient alone, not someone else such as a well-meaning family member.
- The patient has to be conscious to activate the system.
- Continuous intravenous infusion administration results in a more constant blood level, a better level of analgesia may be provided, but the safety factor may be lost.
- In this mode, it would be prudent to carefully reassess the patient with hemodynamics and respiratory monitoring and sedation score to titrate the infusion rates (Table 4).

Cautions/ adverse effects:
- Common side effects of opioids include nausea and vomiting, constipation (exacerbated by increased periods of immobility that often follow surgical procedures), sedation, and pruritis. These adverse
effects may be more pronounced in the elderly. Tolerance often develops to most of these side effects over time, with the main exception being constipation. A stimulant laxative should be prescribed when initiating opioids due to decreased peristalsis.

- Respiratory depression and hypotension are serious side effects of opioid therapy. The risk of severe respiratory depression is increased in the first 24 hours following surgery and with higher doses of opioids. An opioid antagonist, such as naloxone, should always be available in case of respiratory depression associated with over treatment with an opioid medication.

The recommended dose of naloxone for reversal of respiratory depression associated with overdose is 0.5 mL of naloxone 0.4 mg/mL added to 10 mL of normal saline, given by IV push every 2 minutes. The exact dose of naloxone should be titrated for each patient to minimize severe pain crises.

### Table 3. Doses of commonly used opioid analgesics

<table>
<thead>
<tr>
<th>Opioid</th>
<th>Route of administration</th>
<th>Dose</th>
<th>Frequency</th>
<th>Onset of action</th>
<th>Pediatric dosing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morphine</td>
<td>Oral</td>
<td>10-30 mg</td>
<td>3-4 hrs</td>
<td>30-60 min</td>
<td>0.15-0.3 mg/kg</td>
</tr>
<tr>
<td></td>
<td>IM</td>
<td>5-20 mg</td>
<td>4-6 hrs</td>
<td>10-20 min</td>
<td>0.1 mg/kg</td>
</tr>
<tr>
<td></td>
<td>IV bolus</td>
<td>2-10 mg</td>
<td>4-6 hrs</td>
<td>10-20 min</td>
<td>0.1 mg/kg</td>
</tr>
<tr>
<td></td>
<td>IV continuous infusion</td>
<td>0.1-0.15mg/kg/hr</td>
<td>4-6 hrs</td>
<td>5-10 min</td>
<td>0.05-0.1 mg/kg</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10-30 mcg/kg/hr</td>
</tr>
<tr>
<td>Fentanyl</td>
<td>IV bolus</td>
<td>1-2 mcg/kg</td>
<td>1-2 hrs</td>
<td>5-7 min</td>
<td>0.5-2 mcg/kg/hr</td>
</tr>
<tr>
<td></td>
<td>IV infusion</td>
<td>1-2 mcg/kg/hr</td>
<td>-</td>
<td>24-48 hrs</td>
<td>12-50 mcg/hr</td>
</tr>
<tr>
<td></td>
<td>Transdermal patches</td>
<td>25-200 mcg/kg/hr</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Meperidine</td>
<td>PO/IM/IV/SC IV infusion</td>
<td>25-100mg</td>
<td>3-4 hrs</td>
<td>10-20 min</td>
<td>1-1.8 mg/kg</td>
</tr>
<tr>
<td></td>
<td></td>
<td>15-35mg/kg/hr</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tramadol</td>
<td>PO</td>
<td>50-100mg</td>
<td>4-6hrs</td>
<td>30-45 min</td>
<td>1-2 mg/kg</td>
</tr>
</tbody>
</table>

### Table 4. Patient controlled analgesia dosing

<table>
<thead>
<tr>
<th>Opioid</th>
<th>Concentration</th>
<th>Bolus dose</th>
<th>Basal infusion</th>
<th>Lock out interval</th>
<th>Hourly max limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morphine</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adult</td>
<td>1mg/ml</td>
<td>0.5-3 mg</td>
<td>0.5-2 mg/hr</td>
<td>6-8 min</td>
<td>0.15-0.2 mg/kg</td>
</tr>
<tr>
<td>Child</td>
<td>1mg/ml</td>
<td>0.01-0.02 mg/kg</td>
<td>0.01-0.04 mg/kg/hr</td>
<td>5-15 min</td>
<td>0.1-0.15 mg/kg</td>
</tr>
<tr>
<td>Fentanyl</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adult</td>
<td>10-50 mcg/ml</td>
<td>0.5-2 mcg/kg</td>
<td>0.5-3 mcg/kg/hr</td>
<td>6-8 min</td>
<td>2-4 mcg/kg</td>
</tr>
<tr>
<td>Child</td>
<td>10 mcg/ml</td>
<td>0.5-1 mcg/kg</td>
<td>0.25-1 mcg/kg/hr</td>
<td>6-10 min</td>
<td>1-2 mcg/kg</td>
</tr>
</tbody>
</table>

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Table 5. Recommended level for placing epidural catheter

<table>
<thead>
<tr>
<th>Surgery</th>
<th>Site of catheter placement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thoracic surgeries</td>
<td>T4-6</td>
</tr>
<tr>
<td>Upper abdominal, flank incision, nephrectomy</td>
<td>T6-8</td>
</tr>
<tr>
<td>Mid abdominal, colorectal surgeries</td>
<td>T9-10</td>
</tr>
<tr>
<td>Major Gynaecological procedures, pelvic dissection</td>
<td>T9-10</td>
</tr>
<tr>
<td>Labour analgesia, lower limb surgeries</td>
<td>Lumbar</td>
</tr>
</tbody>
</table>

Epidural analgesia

Epidural analgesia is considered by many as the gold standard analgesic technique for major surgery. It has the potential to provide suitable patients with complete analgesia for as long as the epidural is continued. This is usually achieved with a combination of epidural local anaesthetic and an opioid. Epidural techniques are particularly effective at providing dynamic analgesia, allowing the patient to mobilize and resume normal activities unlimited by pain. Parenteral opioids, even with patient-controlled delivery systems, cannot predictably provide the same quality of analgesia. In particular, pain on movement (dynamic analgesia) is generally less well controlled.

Epidural technique of pain management has demonstrated other benefits beyond the analgesia. There are evidences that it decreases the cardiovascular morbidity by decreasing the blood pressure, the cardiac work, and the myocardial oxygen demand, decreases the pulmonary morbidity, decreases the incidence of thromboembolism, delays postoperative ileus. There is also evidence of decreased hospital stays and decreasing cost. All these are very important advantages of epidural analgesia. (21-25)

Some guidelines for placement of the epidural catheter in relation to the major surgery are given in Table 5.

Dosing of Epidural analgesics

Bupivacaine and ropivacaine are the two most commonly used local anaesthetics for epidural anaesthesia. For bolus dosing either 0.2% bupivacaine or 0.2% ropivacaine may be employed with 1 ml/kg for “kiddy caudals” and 0.3-0.5 ml/kg for thoracolumbar epidurals. For continuous intraoperative epidural infusion, 0.1–0.2% of either bupivacaine or ropivacaine is generally used, in dose of 0.2 mg/kg/h (in neonates & infants) and 0.4 mg/kg/h (in older children & adults). For postoperative pain relief, adjuvants such as morphine, fentanyl, clonidine, and recently dexmedetomidine have all been used with varying success. Fentanyl (2 μg/ml) added to 0.1% bupivacaine for postoperative continuous epidural infusions is justifiably popular in adults. Ropivacaine 0.1% with Fentanyl 1-2 mcg/ml is more commonly used in children. (26)

Cautions/ adverse effects:

Patients must be monitored closely throughout the period of epidural analgesia. Monitoring should include: heart rate and blood pressure; respiratory rate; sedation score; temperature; pain score; degree of motor and sensory block. An increasing degree of motor weakness usually implies excessive epidural drug administration. However, it can indicate very serious complications including dural penetration of the catheter, or the development of an epidural haematoma or abscess. Acute pain service or the anaesthesiologist must be contacted if any of the following signs/symptoms are present in a patient; high block >T3, back pain, dense motor block, sedation, respiratory depression, fever, hypotension and signs of local anesthetic toxicity.

Retaining epidural catheters in situ for longer than 3 days is likely to increase the risk of epidural abscess formation. In centers where epidural analgesia is in common use and an acute pain service supervises their management, the complication rate has been shown to be the same as that for other forms of analgesia, such as patient-controlled analgesia, in patients after major surgery. (27)

Conclusion

- A wide range of modalities are available for pain relief in the post operative period.
- Regardless of the modalities utilized for postoperative pain relief, it is equally important to have a smooth transition from parenteral or regional techniques onto the oral administration of analgesics.
before discharge of the patient. (28) An overlap between the oral administrations as well as the parenteral or epidural analgesics should be done. A prescription of scheduled oral medication, with a breakthrough, short-acting medication for pain should be available during the weaning period from parenteral or regional techniques of pain management.

- Careful attention to the dose and regular monitoring can ensure safe administration of analgesics.

References