Chapter

55

Acute Postoperative Pain Management

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As the acute pain attending physician, you are asked to develop a perioperative pain management plan for a 13-year-old, 51 kg boy, who presents for a thoracotomy for re-repair of a coarctation of the aorta that was initially repaired two years ago. At baseline, the patient reports left chest pain along the previous incision and occasional muscle tightness along the left chest. He states that he does not have any prescribed analgesics for the pain, but rates it as a 2/10 burning pain at rest, increasing to 5/10 intermittently, associated with muscle tightness that he cannot assign a numeric score to. There are no identifiable inciting or alleviating factors. When you probe further, he states that he has taken codeine that was left over from a dental procedure, and occasionally takes hydrocodone that he gets from family members. He is otherwise healthy. His blood pressure is 122/67 on his right arm and 74/40 on his right leg.

How Is Pain Classified?

Pain is generally an adaptive response to tissue injury, but can become its own maladaptive disease state. As such, pain may be classified as either adaptive or maladaptive.

Nociceptive and inflammatory pain are two types of adaptive pain responsible for detecting tissue damage and aiding in healing and prevention of continued tissue injury, respectively. Nociception involves the perception of hot, cold, or sharp sensations in response to chemical, thermal, or mechanical injury.

Inflammatory pain is an immune-mediated response to injury from infection or tissue trauma. The infiltration of immune cells and inflammatory mediators encourages healing, but the discomfort associated with this infiltration dissuades the person from exposing the tissue to continued injury.

Neuropathic pain and dysfunctional pain (sometimes referenced with the misnomer "functional pain") are maladaptive pain states that include ongoing pain without an ongoing noxious stimulus. When present, inflammation is usually absent or minimal; although in maladaptive pain, it occurs as a result of altered neural processing, rather than the cause of the pain itself.

What Mechanisms Underlie Each Type of Pain?

Nociception occurs via receptors termed *nociceptors*. They are free nerve endings that are present through most tissues of the body and respond to noxious stimuli. Mechanical stimuli are carried towards the central nervous system via the faster A∂ fibers, and chemical and thermal stimuli are carried via the slower C fibers. Pain perception can then be modulated by descending pathways that affect the perception of pain by the central nervous system.

Inflammatory pain occurs through an interplay of tissue injury and a cascade of inflammatory mediators to produce the associated redness, swelling, and hyperalgesia. Ions, bradykinins, and other mediators are released from damaged cells. These, along with cytokines, prostaglandins, neurotrophic growth factors, and neurogenic factors, such as the neuropeptides substance P and calcitonin gene-related peptide (CGRP), act as either sensitizing agents that increase the sensation of pain, or act to directly stimulate nociceptors and cause pain spontaneously.

Neuropathic pain generally occurs with direct injury to nerves, either peripherally or centrally. Patients will describe neuropathic pain in a variety of ways that range from dysesthesia (hyperalgesia and allodynia) to paresthesia (tingling, numbness). Itching and burning are commonly described by patients.

Dysfunctional pain encompasses a variety of pain syndromes including fibromyalgia, "functional abdominal pain," irritable bowel syndrome, headaches, and other syndromes where there is substantial pain without

https://doi.org/10.1017/9781108668736.056 Published online by Cambridge University Press

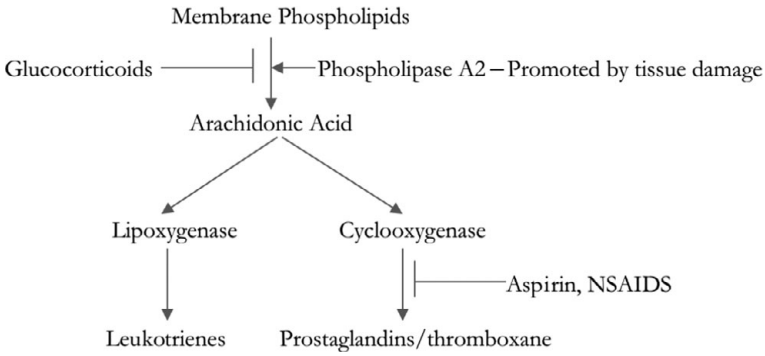

Figure 55.1 The arachidonic acid pathway. Illustration by Adam C. Adler, MD

an ongoing noxious stimulus. The term "Amplified Pain Syndrome" is sometimes used to describe this collection of pathologic pain syndromes defined by a predisposition of the body to a heightened pain experience in the absence of a known noxious stimulus.

What Nonopioid Strategies Are Used to Treat the Different Pain Types?

Generally, an appropriate strategy for perioperative pain control includes a multimodal approach that consists of pharmacologic and nonpharmacologic techniques that target various levels of the pain pathway.

Regional and neuraxial anesthesia are safe and effective for the management of postoperative pain in children that targets either the dorsal root ganglia or peripheral nerves, and should be performed whenever possible, particularly for children with chronic pain. This may include caudal/epidural blocks, paravertebral blocks, plexus blocks (brachial, lumbar), or peripheral nerve blocks. Continuous catheters have been demonstrated to be safe, and to improve pain recovery in children, and should be used when children undergo procedures associated with significant and prolonged pain.

Antinociceptive agents include nonsteroidal antiinflammatory medications (NSAIDs), such as ibuprofen and ketorolac, acetaminophen, and glucocorticoids (e.g., dexamethasone) (Figure 55.1). Nonsteroidal antiinflammatory agents prevent the synthesis of prostaglandins via inhibition of cyclooxygenase in the central nervous system and the periphery in addition to their antiplatelet and antiinflammatory effects. Acetaminophen works similarly to NSAIDs, but without the antiplatelet and antiinflammatory effects. Both of these types of medications may have an additive analgesic effect. Dexamethasone has been shown to improve pain control, reduce opiate requirements, and prolong the effect of regional anesthetic techniques.

Neuropathic agents include gabapentinoids, such as gabapentin and pregabalin, the voltage-gated sodium channel blocker lidocaine, alpha-2 agonists, such as dexmedetomidine and clonidine, as well as the NMDA-antagonist ketamine.

Gabapentin reduces calcium currents by decreasing spontaneous firing at voltage-gated calcium channels in the central nervous system. While its ability to prevent neuropathic pain is debatable, gabapentin is effective in the treatment of various forms of neuropathic pain. For this reason, it is commonly used as an adjunct in surgeries with a higher likelihood of neurologic injury, such as spinal fusion surgeries, and can be given prophylactically in patients with a neuropathy who present for surgery.

Dexmedetomidine and clonidine act at alpha-2 receptors in the substantia gelatinosa of the dorsal horn of the spine, and work to inhibit the perception of somatic pain via inhibitory pathways. Generally administered systemically as part of a multimodal approach to analgesia, clonidine can be administered as part of a regional or neuraxial technique to strengthen or prolong the analgesia provided. Particularly useful in children is the fact that both clonidine and dexmedetomidine can serve as useful premedication when administered orally or intra-nasally.

Ketamine is a noncompetitive NMDA antagonist that has been shown to prevent hyperalgesia and decrease perioperative pain intensity. This seems to happen through its prevention of sensitization to pain via NMDA antagonism in the central nervous system. It also works to decrease release of glutamate, an excitatory neurotransmitter involved in pain sensation, at nerve terminals.

https://doi.org/10.1017/9781108668736.056 Published online by Cambridge University Press

The evidence for its opiate-sparing effect is mixed, partly due to the heterogeneity of available studies; but it does seem to decrease opiate requirements in patients with chronic pain.

Lidocaine works at the level of neurons to block sodium channels and increase the depolarization threshold. This mechanism underlies its ability to decrease the propagation of pain signals, as well as its antiarrhythmic property to increase the threshold for spontaneous electrical activity and signal propagation within the cardiac conduction tissue. Studies have shown efficacy in the treatment of pain in adults and children. One concern specific to pediatrics is the potential for accumulation of monoethylglycineexylidide (MEGX), a lidocaine metabolite with a longer half-life. MEGX poses the greatest risk to neonates and children with renal dysfunction.

Other agents, such as the tricyclic antidepressants (TCA) and selective serotonin norepinephrine reuptake inhibitors (SNRI) (amitriptyline and duloxetine), as well as mixed-mechanism analgesic tramadol (opiate + SNRI) fit into the category of neuropathic agents.

What Are the Dosing Guidelines for Common Opiate-Based Analgesics?

While opiate conversion tables are common, they are limited because they are based on the equivalence of a single dose of medication. Accumulation of drug, as well as drug metabolites, is not accounted for. This would seem particularly relevant when comparing short-acting opioids, like remifentanil and fentanyl, to longer-acting opioids, like morphine and hydromorphone. Additionally, medications such as fentanyl may have a short duration of action when administered as a single dose, yet have a relatively prolonged context-sensitive half-life when compared to other opioids with a single dose short duration of action. Thus, while opiate conversion tables serve as a useful guide for opiate administration, they should be approached cautiously, and with an understanding of their limitations.

How Do You Assess Pain in Children in the Postoperative Period?

Pain scales represent a popular topic with regards to assessment of recovery in children, but provide only a portion of pain assessment (e.g., PQRST assessment). As a whole, pain scales measure pain intensity, which represents a small part of a postoperative recovery assessment that should focus on functional benchmarks, such as nutritional intake, ambulation, bowel movements, activities of daily living, etc. Nonetheless, these scales allow us to track pain recovery and to track response to interventions.

Self-reported pain is preferred and should be sought when developmentally appropriate. This is not possible in many young children, and guidelines focus on the use of an appropriate pain scale. Several barriers exist, though, when it comes to pain intensity assessment in children. First, a multitude of scales exist, but many lack validation. Second, even when validated scales are used, inconsistency exists in the use of a developmentally appropriate scale.

In neuro-developmentally intact children, the Face, Legs, Activity, Cry, and Consolability Pain Assessment Tool (FLACC) or the COMFORT Scale can be used from the newborn period through seven years of life. The Faces Pain Scale (FPS-R) can be used from 4 years old onwards, as can the FLACC and COMFORT scales. And from the age of seven, children should be able to properly use either the Visual Analogue Scale (VAS), Numeric Rating Scale (NRS), or the FPS-R.

What May Be the Consequence to the Suboptimal Treatment of Postoperative Pain?

While no direct link has been established, particularly in children, prolonged pain or higher pain scores postoperatively have been linked to persistent postsurgical pain (PPSP). It is difficult to establish whether a common predisposition leads to both higher postoperative pain and persistent pain, or if the inadequate treatment of pain leads to a protracted pain trajectory, but nonetheless the association exists.

For both thoracotomies and orthopedic surgeries, higher pain scores in the first 24 hours were associated with PPSP. A similar association was found for scoliosis and pectus surgeries.

How Do You Assess Pain in Children with Cognitive Impairment?

Children with cognitive impairment suffer a greater pain burden, and yet their pain is more likely to be underappreciated. As with neurodevelopmentally

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intact children, the assessment of pain should focus on the patient's comfort and a recovery towards baseline function. Additional barriers exist in the assessment of pain in these patients. For instance, pain behavior may differ in children with cognitive impairment, part of which may be due to physical limitations that are present along with this cognitive impairment. For example, someone using the FLACC scale may underestimate pain in the setting of flaccid paralysis of the lower extremities.

Strategies exist to account for these confounding factors. Several scales with varying degrees of clinical utility have been created for the assessment of pain in nonverbal children and those with varying degrees of cognitive impairment. The Noncommunicating Child's Pain Checklist – Postoperative Version (NCCPC-PV), the Individualized Numeric Rating Scale (INRS), the Pediatric Pain Profile (PPP), and the revised Face, Leg, Activity, Cry, and Consolability scale (r-FLACC) represent commonly reported scales. As parents have the greatest knowledge of their own child's pain behaviors, parental input becomes important in defining pain categories for several of these scales (INRS, PPP, r-FLACC). The r-FLACC is the most studied of these scales, and may have the most clinical utility, in part due to a shorter observation time when compared to some scales, optional parental input, and provider familiarity with the commonly used FLACC scale.

Is There a Role for Patient-Controlled Analgesics Postoperatively?

Patient-controlled analgesics (PCAs), whether with intravenous or nerve catheter-based delivery methods, have an established place in the postoperative care of adult patients. Adolescents prefer to be in control of their analgesic management and PCAs can be effectively administered to them as well. Further, "as needed" pain medication doses are often interpreted by nursing staff as "as little as possible"; therefore, parent/nurse-controlled analgesia (PNCA) is more effective than PRN or "as needed" dosing.

PCAs are safe in young children. PNCA is safe in children under age six years. Patient-controlled PCAs allow the child to direct their pain control and may reduce anxiety surrounding pain by providing more autonomy.

Patients with PCAs, especially nurse/parent-controlled PCAs, should be monitored continuously. Suggested PCA doses can be found in Chapter 1.

How Do You Evaluate a Patient on a Patient-Controlled Analgesia Pump?

For each patient, the individual pain plan should be reviewed in addition to the recent PCA usage.

If the patient has pain but there is little usage of the PCA, it must be understood why (i.e., side effects, dose not working, anxiety associated with usage).

If the pain is not relieved with the use of the PCA bolus, consideration for increasing the dose may be warranted. If the pain returns prior to the next dose being available, the interval between bolus doses may require adjustment.

If the pain is not well controlled with sole use of a PCA, addition of adjuncts to the pain regimen should be considered.

What Are Common Side Effects of Postoperative Pain Therapies?

Opioid analgesic side effects such as nausea, vomiting, constipation, pruritus, and analgesic tolerance are to be expected following major surgery in which opioids are used as the primary analgesic. Additionally, opioid-induced hyperalgesia (OIH) is of particular interest in this patient as his pain has persisted, he has continued to use opioids, and he is undergoing a second painful procedure.

OIH can be separated from tolerance to opioids by a change in pain sensitivity as both can occur in patients who received opioids acutely or chronically. While not available in our patient, cold pressor testing can be used to determine pain sensitivity and therefore diagnose OIH.

For patients who have OIH, detoxification is possible using a single dose of buprenorphine/naloxone sublingually. Supportive care is important as opioid withdrawal may occur.

Are There Special Considerations with Regard to the Treatment of Pain in Patients with Congenital Heart Disease?

Children with congenital heart disease present a unique population for the management of acute postoperative pain. Unlike children with healthy cardiorespiratory status, the physiology of children with congenital heart disease can be impacted by common vital sign changes associated with acute pain.

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This patient has uncontrolled postoperative pain from his initial operation. Nociceptive pain from tissue damage associated with the thoracotomy that is planned for him can lead to intensified, continued pain as reoperation is a risk factor for development of chronic postsurgical pain. Acute postoperative pain is associated with hypertension and tachycardia in addition to discomfort but is also life threatening given fresh suture lines. Additionally, inspiratory effort limited by pain increases the risk of developing atelectasis and eventually pulmonary infection especially if secretion clearance is poor.

Single ventricle physiology is another example of cardiorespiratory interdependence and one in which pain treatment can also impact physiology. Postoperative pain can result in increased pulmonary vascular resistance. Further, if splinting occurs, a paucity of negative intrathoracic pressure is generated with each breath and venous return to the lungs is compromised. Consequently, cardiac output can suffer. Treatment of pain with opioids may lead to hypoventilation, hypercarbia, elevated pulmonary vascular resistance, poor preload and, again, poor cardiac output.

What Is the Incidence of Persistent Pain After Surgery in Children?

Chronic postsurgical pain following surgery in childhood is approximately 16% after three months and 3% many years later. Specifically, persistent pain following thoracotomy is defined as pain that recurs or persists along a thoracotomy incision for at least two months.

Suggested Reading

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