CE

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Multimodal Pain Management for Major Joint Replacement Surgery

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Effective pain management for orthopaedic major joint replacement is key to achieving earlier recovery, better functioning, and high rates of patient satisfaction. In an effort to decrease opioid dependency, practitioners are turning to multimodal pain management, which involves the use of multiple analgesic agents and techniques. To utilize this technique, a patient's history of and preoperative consumption of medications to treat pain impacts the success of this regimen. Multimodal pain management involves the use of nonsteroidal anti-inflammatory drugs, acetaminophen, *N*-methyl-D-aspartate antagonists, gabapentin, serotonin inhibitors, regional techniques, and opioids as needed. It is necessary for the nurse to understand the mechanism of pain and how the multimodal adjuncts target the pain response to benefit the patient's perioperative course as well as his or her postoperative and discharge management.

Introduction

Several decades ago, major joint replacement of the knee, hip, and shoulder was considered a medical breakthrough. Now, hundreds of thousands of these orthopaedic surgeries are performed annually. In 2014, there were more than 400,000 total knee replacements, 230,000 total hip replacements, (Gwam et al., 2017), and 45,000 total shoulder replacements (Trofa, Rajaee, & Smith, 2014) performed to treat osteoarthritis, relieve pain, restore function, and improve quality of life—increases of 100%–300% since 1990. As the population continues to age, obesity rates rise, and technological innovations advance, the demand for major joint replacements is projected to skyrocket nationally (Kurtz, Ong, Lau, & Bozic, 2014; Padegimas et al., 2015). Despite the noted growth in these surgical procedures, the lack of attention paid to nursing interventions to relieve postoperative pain and reduce complications is surprising. Increasing evidence suggests that poorly managed perioperative pain may cause postoperative complications, implant failure, and hospitalization. Therefore, effective pain management for orthopaedic joint replacement is key to achieving earlier recovery, better functioning, and high rates of patient satisfaction. This article provides an overview of multimodal pain management in patients who undergo major joint replacement surgery.

Pain and the Opioid Crisis

The Centers for Disease Control and Prevention (CDC) estimates that more than 126 million adults, or approximately 56% of the adult population, suffer from some form of pain ranging in severity and occurrence (daily or near daily) (Makary, Overton, & Wang, 2017; Nahin, 2015). Treating their pain has resulted in a record number of prescriptions (Makary, Overton, & Wang, 2017; Nahin, 2015; Roth, Boateng, Berken, Carlyle, & Vadivelu, 2018), including highly addictive opioids as an adjunct for pain relief in adults suffering from chronic pain. As a result, Bohnert, Guy, and Losby (2018) reported a 300% increase in opioid-related deaths from 1999 to 2016. This statistic includes illicit opioid use but also includes the use opioids for the relief of chronic pain in nonsurgical patients who have such diseases as rheumatoid arthritis and osteoarthritis. The danger posed by opioids has placed healthcare providers in the precarious position of balancing the drug's use for pain relief and its potential long-term impact on patients' lives.

In 2016, the CDC responded to the growing opioid crisis in the number of patients suffering from acute and chronic pain and the overuse of opioids by publishing national guidelines to aid in prescription practices (Dowell & Haegerich, 2016). According to the CDC guidelines, four key questions are important to consider when prescribing opioids as a treatment for pain: the effectiveness of opioid use, the perceived risks and benefits, an acceptable criterion for dosing patterns, and strategies to control the risk for long-term use and addiction.

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In an effort to decrease opioid dependency, practitioners are turning to multimodal pain management, which involves the use of multiple analgesic agents and techniques that act on different pain mechanisms to provide pain relief and improve quality of life with less opioid consumption (Brooks, Freter, Bowles, & Amirault, 2017). In addition to decreasing opioid use, multimodal pain management techniques used postoperatively reduce prolonged sedation for the orthopaedic surgical patient. The techniques also alleviate many adverse side effects of opioids including nausea, vomiting, itching, and respiratory depression (Wick, Grant, & Wu, 2017).

Mechanisms of Pain

Pain is a noxious stimulus that begins in injured nerve fiber endings and is transmitted via the central nervous system where it is perceived by the brain via primary nociceptor fibers (Type A, B, or C) through the dorsal horn of the spinal cord where a response is mediated. Type A delta fibers and C fibers are the mediators of the pain response and sensation. This activity projects the response upward to the spinal cord and finally the thalamus. The activation of the pain response involves the efferent pathway where neurons take the painful sensation back from the level of the spinal cord to the site of injury at the peripheral nociceptors (Barash, 2013; Marks et al., 2009; Nagelhout & Plaus, 2014; Parvizi & Bloomfield, 2013). The tissue injury mediates the release of substances such as bradykinin, histamine, lactic acid, prostaglandins, serotonin, glutamate, and most importantly, substance P as well as an excitatory ion channel (vanilloid receptor) secondary to tissue injury manifesting in an inflammatory response and the pain sensation (Barash, 2013; Nagelhout & Plaus, 2014).

The nurses' understanding of the role of opioids, nonsteroidal anti-inflammatory drugs (NSAIDS), acetaminophen, serotonin inhibitors, gabapentin, *N*-methyl-D-aspartate (NMDA) antagonists, and local anesthetics in the multimodal pain management of the orthopaedic surgical patient is crucial to positive patient outcomes (Barash, 2013; Marks et al., 2009; Nagelhout & Plaus, 2014; Parvizi & Bloomfield, 2013). A patient's physiologic responses to pain include activation of the body's sympathetic nervous system resulting in increased heart rate, increased oxygen consumption, hypertension, increased cardiac output, changes in the rate and depth of respiration, slowing of the gastrointestinal and genitourinary tract leading to nausea, vomiting, difficulty in urination, and finally the increased secretion of cortisol. The use of NSAIDS and aspirin interferes with the inflammatory process and the activation of prostaglandins thus limiting the magnitude of the inflammatory pain response. Serotonin works with inflammatory mediators as well and is useful in the treatment of chronic pain. The use of local anesthetics hinders the ion channel's response to pain from the afferent pain fibers diminishing the perception of pain for the patient. Acute pain is most often addressed with opioids, which target five opioid receptors to modify pain signals and diminish pain perception (Barash, 2013; Marks et al., 2009; Nagelhout & Plaus, 2014; Parvizi & Bloomfield, 2013).

Pain Medication and the Preoperative Assessment

The use of opioids for surgery patients often begins well before surgery. Many joint replacement candidates delay surgery for as long as possible, often on the advice of their physicians. Instead, they opt for a regimen of anti-inflammatory and pain medication for weeks to years. A preoperative patient assessment is an opportunity for healthcare providers to identify baseline pain levels, current pain medication intake, successful past pain medication strategies, and past medical and surgical histories, all of which support our ability to educate the patient and are used by the anesthesia provider to formulate a personalized plan of care for perioperative pain management (American Society of Anesthesiologists [ASA], 2012). Ideally, healthcare providers will seek further detailed responses related to each question including (1) pain levels at rest and with activity; (2) type of pain whether acute or chronic; (3) type, route, frequency, and quantity of pain medication consumed, (4) over-the- counter medications, medications prescribed to the patient, and any medications the patient takes that are not prescribed to the patient, (5) adverse effects associated with the pain regimen, (6) extent of pain relief various modalities achieve, and (7) alternative pain strategies such as acupuncture, chiropractic, yoga, aromatherapy, and hypnosis. The medical, surgical, and pharmacological intake that occurs during the preoperative assessment assists the provider to develop the clinical profile of the patient and guides the formulation of a perioperative plan of care including a multimodal pain management plan.

Armed with information regarding previous pain medication consumption, healthcare providers must consider whether their patients are opioid naïve or opioid tolerant (Food and Drug Administration, 2018) as they develop a multimodal pain regimen for proactive pain management rather than the traditional reactive approach. Studies have shown that opioid-tolerant patients or patients who receive opioids on a daily basis, often develop an exaggerated pain hypersensitivity known as opioid-induced hyperalgesia (Cooney & Broglio, 2017; Soffin, Waldman, Stack, & Liguori, 2017). Pain management for the opioid-tolerant patient requires combined anesthetic technique such as anesthetic infiltration or regional anesthesia. Although neither will eliminate the need for opioids in the orthopaedic surgical patient, they may result in decreased opioid consumption rates (Schwenk, Pozek, & Viscusi, 2018). More recently, consensus guidelines support the use of ketamine infused at subanesthetic doses as a perioperative pain adjunct for opioid-tolerant patients due to its potent analgesic properties (Schwenk et al., 2018).

Opioid-naïve patients (patients not receiving opioids on a daily basis) report lower postsurgical opioid consumption rates (Schwenk et al., 2018). However, despite their relatively low opioid consumption rates immediately following surgery, there is evidence that the potential for opioid abuse remains. In a retrospective study of more than 1 million opioid-naïve patients from 2008 to 2016, Brat et al. (2018) noted that each opioid refill increased the potential for opioid misuse by more than

40%. Thus, healthcare providers must promote nonopioid pain control options and consider the need for opioid prescription refills with extreme caution.

Modalities and Techniques for Perioperative Pain Management

Table 1 outlines the techniques utilized for multimodal pain management therapies for the orthopaedic surgery patient, which often include NSAIDS such as aspirin, naproxen, ketorolac, celecoxib, meloxicam, diclofenac, and ibuprofen (ASA, 2012; Brookse et al., 2017; Canata, Casale, & Chiey, 2016; Chou et al., 2016; Donahue, Bradbury, Zychowicz, & Muckler, 2018; Song, 2017). Analgesia resulting from NSAID administration is due to inhibited synthesis and release of prostaglandins and inhibited cyclooxygenase 2 (COX-2) that result in a suppressed inflammatory response (Elmallah et al., 2018). A 10-year database review from 2006 to 2016 of total hip and knee arthroplasties (N = 1,540,462) showed that NSAIDS, as part of a multimodal regimen, were effective and resulted in improved patient outcomes including decreased opioid consumption (Memtsoudis et al., 2018). Although nonopioid analgesics such as acetaminophen and ketorolac are commonly incorporated into multimodal pain management plans, healthcare providers must consider the gastrointestinal side effects, such as bleeding, and an increased risk for renal failure, stroke, and heart attack that are associated with NSAIDS (Food and Drug Administration, 2015).

NMDA Antagonists: Ketamine as Part of a Multimodal Pain Management Plan

Ketamine can be used as part of multimodal pain management. Intravenous ketamine infusions and boluses have been successfully used in a multimodal approach to manage pain for orthopaedic surgery throughout the perioperative period (Alviar, Hale, & Dungca, 2016; Chin & Lewis, 2018; Kadic et al., 2016; Martinez et al., 2014). Ketamine, an NMDA receptor antagonist and dissociative agent, is a potent analgesic and yet lacks respiratory depressant effects (Kadic et al., 2016). Low-dose ketamine infusions have been shown to lower pain scores and decrease opioid consumption rates (Kadic et al., 2016; Martinez et al., 2014; Zhang, Shi, & Jia, 2018). Thus, the use of these infusions is recommended for surgical pain in opioid-tolerant orthopaedic patients, patients with sickle cell pain, and patients with sleep apnea (Schwenk et al., 2018). The common dosage of an intraoperative intravenous ketamine infusion and bolus ranges from 0.1 to 0.5 mg/kg/hour and 0.3–0.5 mg/kg, respectively (Schwenk et al., 2018; Vadivelu et al., 2016).

Gabapentin as Part of a Multimodal Pain Management Approach for Orthopaedic Surgery

Oral gabapentin is often included as a component of multimodal pain regimens. Gabapentin is an anticonvulsant originally developed to treat epileptic seizures resistant to traditional therapies. Although the mechanism is not fully understood, gabapentin is believed to alter neurotransmission by interrupting voltage-gated calcium channels in the dorsal horn of the spinal cord. This leads to decreased effects due to hyperexcitability in those regions caused by tissue damage (Hah et al., 2018).

Studies have shown that gabapentin is effective in decreasing the need for postoperative opioids in orthopaedic surgical patients. Specific to procedures on lower extremities, research has shown that patients who receive gabapentin preoperatively as well as during the postoperative period report lower pain scores, require lower doses of opioids for breakthrough pain, and experience better range of motion and activity than those patients who do not receive the medication (Clarke et al., 2014; Mardani-Kivi, Mobarakeh, Keyhani, Motlagh, & Ekhtiari, 2013). However, gabapentin has side effects that may limit its use with some patients. The literature suggests that the use of gabapentin to treat or prevent pain may be associated with dizziness, drowsiness, and confusion. This is more likely to occur in older patients. It appears that dose plays a large role in the development of these side effects, and using the lowest effective dose, specific to individual patients, decreases that risk (Fleet et al., 2018).

Continuous Peripheral Nerve Block for Perioperative Pain Control

A continuous peripheral nerve block (CPNB) is a regional anesthesia technique that involves the administration of local anesthetic to a targeted nerve through an indwelling percutaneous sheath that remains in place

Table 1. Common Nonopioid Components of Multimodal Analgesic Approaches to Surgical Pain Control

Modality	Medications	Mechanism of Action
NSAIDs	Aspirin, ibuprofen, ketorolac, celecoxib, naproxen	inhibited synthesis and release of prostaglandins Inhibited COX-2
NMDA antagonists	Ketamine	Antagonize NMDA receptor; dissociative agent; potent analgesic properties
Gabapentinoids	Neurontin, Lyrica	Alters neurotransmission in the dorsal horn of the spinal cord
Continuous peripheral nerve block	Bupivacaine, ropivacaine, Exparel, lidocaine	Direct neural blockade at the site of peripheral nerve sheath

Note. NMDA = *N*-methyl-D-aspartate; NSAIDs = nonsteroidal anti-inflammatory drugs.

for an extended period of time (Ilfeld, 2017). As compared with a single-shot technique, indwelling catheters have demonstrated decreased postoperative pain scores and lowered opioid consumption and opioid-related side effects for patients undergoing both upper and lower extremity orthopaedic procedures. Researchers have also found that the use of indwelling catheters is associated with earlier ambulation and joint mobility (Arsoy et al., 2017; Ilfeld, 2017; Ullah, Samad, & Khan, 2014). Recently, the use of liposomal local anesthetics has become common. These longer acting formulations allow for sustained release of local anesthetic at the nerve sheath for several days (Ulrich, Lavandero, Woods, & Early, 2014).

When caring for a patient receiving a CPNB, nurses should be aware of potential postoperative complications associated with its use. The most common complications include the development of a hematoma, falls, and infusion-induced local anesthetic toxicity (Elmallah et al., 2016; Elmallah et al., 2018). Although the incidence of hematomas has decreased in recent years with the use of ultrasound-guided techniques for placing catheters, nurses should closely monitor patients with bleeding disorders or those on anticoagulant therapy (Gwam et al., 2018; Ilfeld, 2017). Although it does not appear that patients receiving single-injection femoral nerve blocks are at a greater risk for falls, research has suggested that patients receiving a femoral CPNB for lower extremity surgery are four to five times more likely to fall during the postoperative period (Elmallah et al., 2016; Elmallah et al., 2018; Gwam et al., 2018; Ilfeld, 2017). Although infusion-induced local anesthetic toxicity is a rare adverse effect of CPNB, the ASA recommends that all nurses caring for patients receiving CPNB be able to recognize signs of local anesthetic toxicity (Ilfeld, 2017). These include changes in cognition, perioral paresthesia, audio-visual disturbances, cardiac rhythm disturbances, and potential respiratory and cardiovascular collapse (El-Boghdadly, Pawa, & Chin, 2018).

Postoperative Multimodal Pain Management on the Surgical Unit

A multimodal pain management regimen should continue as a patient transitions from the postanesthesia care unit to the postoperative unit. This includes the considerations associated with PNBs and continued use of medications to treat neuropathic pain such Keppra or gabapentin, acetaminophen, NSAIDs, and the sparingly use of opioids. Special consideration should be given to opioid-tolerant patients, whose postoperative course for pain management can be challenging.

Patients who receive PNBs demonstrate earlier mobilization, decreased length of stay (LOS), and greater participation in physical therapy (Gaffney, Pelt, Gililland, & Peters, 2017). However, the need to establish fall prevention strategies is essential as patients who receive a femoral nerve block are at increased risk for fall due to decreased quadricep strength (Elmallah et al., 2016). The nurse caring for patients with a PNB in place for more than 48 hours must be aware of the increased risk for both catheter site inflammation and infection (Nicolotti, Lotti, Fanelli, & Compagnone, 2016). Nurses should monitor PNBs carefully, observing for signs and symptoms of local anesthetic toxicity, and take measures to protect the insensate extremity from injury due to PNB (Bromberg, Dennis, & Gritsenko, 2017).

The continued postoperative use of oral medications such as acetaminophen, NSAIDs, and gabapentin also plays a role in postoperative pain management. Acetaminophen is considered safe and effective at a dosage of less than 3 g/day (Malec & Shega, 2015) but should be used cautiously in patients with poor hepatic function. Gabapentin can be titrated in doses of 1,200–3,600 mg/day given in three doses. Attention to the side effects associated with these medications should be considered especially in the elderly population (Devin et al., 2014; Gaffney et al., 2017; Malec & Shega, 2015). The scheduled dosing regimen of these pharmacologic adjuncts should reduce the need for opioids as well as limit the manifestation of physiologic derangements associated with opioid use.

When considering a plan that includes long-acting opioid medications, healthcare providers should use opioids sparingly in the early postoperative period. Some patients may require medication for the treatment of breakthrough acute pain. Nurses should be aware of the untoward side effects of this class of drugs, which include nausea, vomiting, constipation, ileus, respiratory depression, pruritis, delirium, and urinary retention (Parvizi & Bloomfield, 2013).

Alternative nonpharmacological pain control methods include the application of ice or the use of a cooling system to decrease postoperative pain (Ni et al., 2018). Patients can continue with around-the-clock application of ice after discharge to assist in pain management (Trasolini, McKnight, & Dorr, 2018).

Discharge Considerations

Pain management can affect LOS and discharge status. A multimodal pain management strategy, initiated while the patient is in the hospital, should continue after discharge, with the goal of decreasing opioid consumption. A study of shoulder surgery patients who received hospital-initiated PNBs demonstrated reduced opioid consumption for up to 7 days postoperation. Patients who continue on multimodal therapy after discharge reported significantly decreased pain at postoperative appointments and fewer pain-related hospital visits.

Nurses should develop realistic pain control expectations with patients. Opiates are useful, when judiciously used, to reduce a patient's pain and remove barriers to rehabilitation. Rather than a one-size-fits-all approach, opioid prescriptions at discharge should be tailored to patients' preoperative pain assessment and providers and nurses should take into consideration methods used to control preoperative pain, including opioid consumption during hospitalization. An interdisciplinary

pain management team guided by the patient's surgeon can determine safe prescriptions at discharge.

A postdischarge management plan may benefit from the inclusion of routine follow-up calls from nurses; these calls can reduce readmissions as well as aid in the identification of pain control needs and surgical complications while triaging the need for a return office visit to address those issues (Trasolini et al., 2018). Follow-up appointments should include the assessment of the patient's analgesic needs, the potential for surgical complications, and attempts to identify other etiologies of pain if present.

Conclusion

The use of a multimodal pain approach in the orthopaedic major joint replacement patient is an effective technique to guide care throughout the operative continuum. It is important for healthcare providers to have a clear understanding of the patient's previous history of pain management, if applicable, in order to utilize the technique. Nurses involved in care for this population need to have adequate education on the multimodal pain adjuncts including medications to aid in the plan of care for the patient.

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