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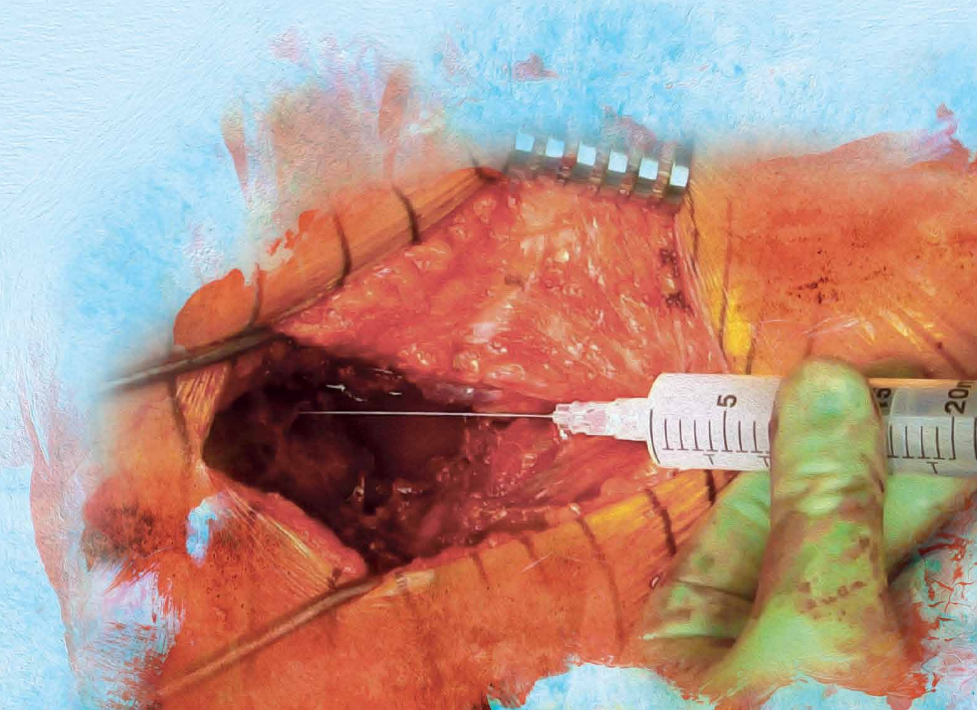
# CHANGING PARADIGMS IN SHORT STAY TOTAL JOINT ARTHROPLASTY



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# The Challenges of Perioperative Pain Management in Total Joint Arthroplasty

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## Abstract

Despite advances in the understanding of postoperative pain, approximately 80% of surgical patients still experience a meaningful level of pain, which can result in unnecessary stress and suffering; compromise the patient's progress, recovery, and outcome; and lead to poor function and the development of chronic pain. In arthroplasty patients, the goals of pain management include improving comfort and satisfaction, enabling patients to ambulate and move their joints soon after surgery, and, where appropriate, reducing the hospital length of stay. Opioid medications have been used for many years as the mainstay of pain management. These drugs, however, are associated with a range of adverse effects and complications, which can lead to increased hospital length of stay or readmission. Furthermore, as-needed administration of opioids allows for the repeated return of pain after the operation as each dose wears off. A balanced multimodal approach that combines different anesthetic and analgesic modalities in a rational way to target the distinct pain pathways, rather than relying predominantly on opioid drugs, is essential for effective control of postoperative pain, avoiding the risk of opioid-related adverse events and complications, reducing length of stay, and improving long-term outcomes.


Postoperative pain is one of the primary fears of patients who undergo surgery, and it is a valid concern. Despite advances in the understanding of postoperative pain, about 80% of surgical patients still experience a meaningful level of pain, which is poorly managed in approximately 50% of cases.[1-3] Not only does this pain cause unnecessary stress and suffering for patients, it also compromises their progress, recovery, and outcome. Over the long term, postsurgical pain can lead to poor function and even the development of chronic pain.[4] It is worth bearing in mind that all chronic pain begins as acute pain, and the intensity of acute pain is a predictor of continuing chronic postoperative pain.[5,6] For these reasons, pain is now considered to be the "fifth vital sign" that must be managed proactively.

Whereas inadequately controlled pain compromises outcomes, effective analgesia allows earlier participation in rehabilitation, more rapid attainment of functional milestones, and earlier discharge. Proper prevention and management of postoperative pain can result in a decrease of around 20% in the length of hospital stay.[7,8]

## Goals of Effective Pain Management

For patients who undergo arthroplasty, the goals of pain management have, therefore, several factors and extend beyond simply improving patient comfort and satisfaction. It is essential to enable patients to ambulate and move their joints soon after surgery, and, where appropriate, to shorten the length of stay, in many cases allowing patients to be discharged within 1 or 2 days. These goals are particularly important for rapid recovery programs after total hip arthroplasty (THA), total knee arthroplasty (TKA), and outpatient procedures. In managing the pain, however, it is also imperative to try to avoid introducing additional complications due to the anesthetic and analgesic medications that are administered.

Pain is now recognized as a complex phenomenon involving not only a host of biologic processes but also psychological and social factors that have to be taken into consideration.[9] Managing postoperative pain requires a collaborative approach that involves the orthopedic surgeon, anesthesiologist, pain-management specialist, nursing staff, and physical therapist working as a team to make the patient comfortable and help the patient progress through the recovery program.

## Achieving Postoperative Pain Management Goals

Certain underlying principles must be applied to achieve these goals. The first of these is a multimodal pharmacologic approach. Several different pain pathways have been shown to exist, and the need for appropriately balanced multimodal analgesia to block those diverse pathways is now well established. In addition to addressing the patient's acute-pain requirements, the patient's baseline opioid requirement should be determined and maintained. Only in this way can patients be kept comfortable throughout their hospital stay and even after discharge.

Comorbidities associated with the anesthetic and analgesic

**Author's Disclosure Statement:** The author reports that he is a speaker for and has received research support from Pacira Pharmaceuticals, Inc.

medications that these patients receive, such as nausea, constipation, anxiety, and sleep disturbance, also must be taken into consideration. These are very real problems that occur in many arthroplasty patients, often complicating their postoperative course.

Administering analgesic medications pro re nata (PRN), or as needed, allows for the repeated return of pain during the postoperative period as each dose of medication wears off. To avoid the crescendo effect that can occur with this constant reinitiation of pain pathways, analgesic medication should be administered according to an established schedule, rather than PRN.

## Importance of a Multimodal Approach

The perception of postoperative pain is influenced peripherally, at the site of tissue damage, transmitted through nerves at the spinal cord, and perceived centrally in higher and lower cortical levels. A balanced multimodal approach combines different medications in a rational way to target the distinct pain pathways, rather than relying predominantly on opioid drugs (**Figure**).

Opioids are associated with a range of adverse effects and complications that can lead to increased length of stay or readmission. Common complications include:

- Sedation, altered mental status, increased risk of falls, and an inability to participate in physical therapy;
- Postoperative cognitive dysfunction;
- Nausea, vomiting, ileus, and constipation;
- Urinary retention;
- Hypotension;
- Hypoxia.

Because older patients—such as those undergoing THA or TKA—are more susceptible to the adverse effects and complications associated with opioid drugs, minimizing or avoiding the use of opioids is especially important in these individuals.

Postoperative cognitive dysfunction, including disorientation, is particularly problematic and has been shown to be a predictor of both short-term and long-term adverse outcomes.[10,11] Cognitive dysfunction increases the probability of falls and aspiration pneumonia and is associated with longer hospital stay, a higher rate of discharge to a rehabilitation facility, and increased mortality. The use of intravenous (IV) opioids accounts for approximately 8% of intensive care unit admissions for respiratory depression and around 16% of respiratory deaths.[12]

By preemptively blocking the pain that will be stimulated at the outset of surgery and administering a multimodal analgesic regimen at appropriately scheduled time points, it is possible to eliminate the use of PRN opioids and to avoid these adverse events and complications (**Table**).

## Implementing Multimodal Pain Management

Balanced multimodal analgesia is not simply the administration of several analgesic agents, but rather the rational administration of medications that have complementary mechanisms of action. For example, an effective preoperative regimen may include celecoxib, acetaminophen, gabapentinoids, and oxycodone. Because the adverse effects of oxycodone are dose-related, it is prudent to reduce the dose in patients over the age of 75 years to avoid complications.

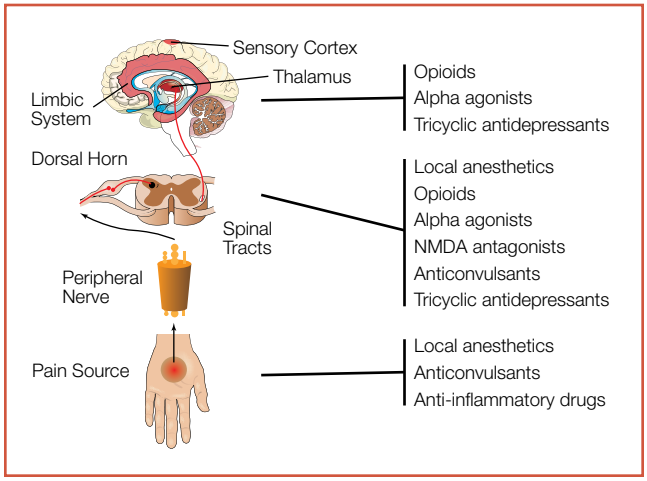


**Figure.** Combining medications that target different pain pathways and provide balanced multimodal analgesia.

Abbreviation: NMDA, N-Methyl-D-aspartate.
Courtesy of David St. Peter, MD, FHM, Pacira Pharmaceuticals, Inc.

As part of a multimodal regimen, acetaminophen, nonsteroidal anti-inflammatory drugs (NSAIDs), and cyclo-oxygenase 2 (COX-2) inhibitors have all been shown to reduce opioid consumption after major surgery.[13] In addition, IV acetaminophen and IV NSAIDs offer the advantage that they can be administered parenterally throughout the perioperative period, and patients can be discharged on the oral formulations. In a study involving 185 adult patients undergoing elective orthopedic surgery, 800 mg IV ibuprofen started preoperatively and administered every 6 hours significantly reduced both pain and morphine use.[14] Similarly, an analysis of randomized controlled trials that evaluated the effects of a single dose of systemic acetaminophen on pain outcomes in a large variety of surgical procedures found that systemic acetaminophen is an effective intervention to reduce postoperative pain.[15] Because acetamino-

**Table. Providing Perioperative Management of Surgical Pain While Minimizing the Use of Parenteral Opioids**

| |
|---|
| Preoperative preemptive analgesia<br>■ Blocking noxious signals prior to a surgical incision may lead to some degree of central nervous system protection against postoperative pain. |
| Regional/intraoperative anesthesia<br>■ Preoperative placement provides preemptive analgesia.<br>■ Periarticular or intra-articular injections provide local analgesia at the surgical site. |
| Postoperative analgesia<br>■ Improved analgesic efficacy allows earlier and more intensive rehabilitation, resulting in a decrease in length of stay and improved patient satisfaction. |

phen and NSAIDs appear to have different mechanisms of action, a combination of acetaminophen and an NSAID may offer superior analgesia compared with either drug alone.[16]

Regional anesthesia, rather than general anesthesia, has also been shown to be advantageous in arthroplasty, although femoral nerve blockade carries a significant risk of postoperative quadriceps weakness and falls.[17] Perioperative intra-articular injections have been shown to be an effective alternative to femoral nerve blockade. In a study involving 40 patients undergoing TKA with spinal anesthesia, a multimodal intra-articular regimen containing ropivacaine, ketorolac, and epinephrine provided comparable analgesia to femoral nerve block.[18] The intra-articular infiltration, however, was less expensive and easier to administer than the femoral nerve block.

Another randomized, prospective study in patients undergoing TKA compared peripheral nerve block with a multimodal periarticular injection regimen that included morphine, ketorolac, ropivacaine, and epinephrine.[19] All patients in this study also received a standard multimodal regimen of NSAIDs, gabapentin, and acetaminophen, together with PRN oxycodone immediate-release given orally and IV morphine or hydromorphone. Both groups had similar pain and satisfaction scores. Patients in the periarticular injection group had higher opioid use on the day of surgery (there was no difference thereafter), yet a shorter length of stay by almost half a day and less neurologic sequelae. Based in part on these observations, the Mayo Clinic, where the study was performed, changed from using peripheral nerve block to multimodal periarticular injections for routine knee replacement surgery.[19]

Recently, many institutions have added the long-acting local analgesic bupivacaine liposome injectable suspension (EXPAREL®, Pacira Pharmaceuticals, Inc) to the periarticular injection regimen. This agent has been shown to be beneficial for local analgesia for as long as 48 to 72 hours (people metabolize the drug at different rates, and variations in the precise duration of effect can be seen).[4]

Postoperatively, the analgesic regimen may continue the use of the preoperative medications, as noted above with respect to acetaminophen and NSAIDs, but they should be administered according to a set schedule, as opposed to PRN dosing.

## Summary

Given the current level of understanding of the pathophysiology of pain and the availability of effective anesthetic and analgesic medications, inadequate control of postsurgical pain is no longer acceptable. The adverse impact of poorly controlled pain on both clinical and economic outcomes has been clearly demonstrated.

Moreover, in the current health care environment, the emphasis on patient satisfaction is growing. Postoperative pain is a major determinant of satisfaction in patients undergoing arthroplasty, and it must therefore be identified and managed within institutions as a quality metric. Ultimately, through Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) scores, patient satisfaction regarding the level of pain after arthroplasty will affect an institution's reimbursement.

A proactive multimodal approach to the management of postoperative pain is essential for providing effective control of postoperative pain, avoiding the risk of opioid-related adverse events and complications, reducing length of stay, and improving long-term outcomes.

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# Current Postoperative Pain Management Protocols Contribute to the Opioid Epidemic in the United States

Michael A. Kelly, MD

## Abstract

There is growing concern about the emergence of an "opioid epidemic" in the United States, where the abuse of opioids has had a devastating impact on public health and safety. Around 250 million prescriptions for pain medication are now written each year in this country, and 46 people die from an overdose of a prescription pain medication every day. A very strong correlation has been shown to exist between therapeutic exposure to opioid analgesics and the abuse of those drugs. In addition, opioid-related adverse events are a leading cause of preventable harm in hospitals and, as a result, these events have become a focus of attention for the Joint Commission, which has issued a *Sentinel Event Alert* on the safe use of opioids. A variety of government organizations and expert groups, such as the American Society of Anesthesiologists Task Force on Acute Pain Management, now recommend multimodal analgesia and weighing the benefits and risks of systemic opioids. The Joint Commission also has recommended that strategies for pain management include a patient-centered approach that takes into consideration the accompanying risks and benefits—including the potential risk of dependency, addiction, and abuse.

There is growing concern among both the medical community and the public policy sector about the emergence of an "opioid epidemic" in the United States. The abuse of opioids has had a devastating impact on public health and safety in this country.[1] Around 250 million prescriptions for pain medication are now written each year in this country, and 46 people die from an overdose of a prescription pain medication every day.[1] It would be naive to believe there is no connection between those 2 statistics. In fact, a very strong correlation has been shown to exist between therapeutic exposure to opioid analgesics and the abuse of those drugs.[2]

One of the measures designed to combat opioid abuse may, in fact, have unintentionally fueled the problem. In many states now, physicians cannot phone in a prescription for controlled substances—they must provide patients with a written prescription to take to the pharmacy. Surgeons often, therefore, provide patients with more pain medication than they actually need so that they do not have to return to the hospital in the event that they experience more pain than expected.

This practice results in an alarming volume of unused drugs stored without supervision in homes around the country. These drugs are commonly shared intentionally with a family member at a later date for control of pain due to some other cause. An even more serious consequence, however, is that many of these drugs—prescribed, for example, for an older patient undergoing hip or knee arthroplasty—are discovered and either consumed by or sold by adolescent relatives of the intended recipient.

**Table 1. Characteristics of Patients Who Are at Increased Risk for Oversedation and Respiratory Depression Due to Opioid Drugs[a]**

| |
|---|
| Sleep apnea or sleep disorder diagnosis |
| Morbid obesity with high risk of sleep apnea |
| Snoring |
| Older age; risk is:<br>■ 2.8 times higher for individuals aged 61-70 years<br>■ 5.4 times higher for individuals aged 71-80 years<br>■ 8.7 times higher for individuals aged >80 years |
| No recent opioid use |
| Postsurgery, particularly if upper abdominal or thoracic surgery |
| Increased opioid dose requirement or opioid habituation |
| Longer length of time receiving general anesthesia during surgery |
| Receiving other sedating drugs, such as benzodiazepines, antihistamines, diphenhydramine, sedatives, or other central nervous system depressants |
| Preexisting pulmonary or cardiac disease or dysfunction, or major organ failure |
| Thoracic or other surgical incisions that may impair breathing |
| Smoker |

[a]© The Joint Commission, 2015.[3] Reprinted with permission.

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**Table 2. Expert Recommendations on the Use of Multimodal Approaches to Manage Postsurgical Pain**

| |
|---|
| The Joint Commission[3] |
| ■ "Use an individualized, multimodal treatment plan to manage pain" |
| National Action Plan to Prevent Adverse Drug Events[4] |
| ■ "Federal agencies should promote…nonopioid pharmacological therapies…as part of an overall pain management plan" |
| American Society of Anesthesiologists Task Force on Acute Pain Management[5] |
| ■ "Whenever possible, anesthesiologists should use multimodal pain management therapy" |

The need to combat the epidemic is now urgent, and orthopedic surgeons have an integral role to play by changing the way that postsurgical pain is managed.

## Addressing the Postsurgical Opioid Problem

Opioid-related adverse events are a leading cause of preventable harm in hospitals and, as a result, these events have become a focus of attention for the Joint Commission, which has issued a *Sentinel Event Alert*, "Safe Use of Opioids in Hospitals."[3] Respiratory depression is one of the main concerns when opioid drugs are used in certain patient populations, such as the elderly, obese patients, and patients with respiratory problems. The alert highlights several criteria that can increase the risk of oversedation and respiratory depression as a result of opioid use; many of these criteria are common in patients undergoing arthroplasty (**Table 1**).

In recent years, many surgeons have dramatically and effectively reduced their use of opioids by adopting multimodal analgesic regimens. A variety of government organizations, as well as expert groups such as the American Society of Anesthesiologists Task Force on Acute Pain Management, now recommend multimodal analgesia and weighing the benefits and risks of systemic opioids (**Table 2**).[3-5]

There are also steps that orthopedic surgeons can take when managing postsurgical pain to reduce the potential for misuse, abuse, and diversion of opioids. For many people who become addicted to opioids, their first lifetime exposure can be when these medications are prescribed for postsurgical pain.

Prescription opioid–related deaths are considered to be one of the nation's leading preventable public health problems.[4] Unfortunately, the outcome and process measures regarding these events are suboptimal—there is a need for surveillance that provides more meaningful and actionable detail about adverse drug events by:

- Capturing events on the basis of a validated process and outcome measures;
- Differentiating events that occur in the normal course of care from those arising from opioid misuse and abuse;
- Identifying events that occur during transitions of care.

## Consequences of Postsurgical Opioid Use

The process of misuse, abuse, and diversion of prescription opioids is highly destructive not only to individuals but to society in general. Controlled prescription drugs (CPDs) are used more commonly than any illicit drug except marijuana.[5] And among CPDs, pain relievers are the drugs most often used illicitly (**Figure 1**), and they are the drugs most frequently involved in drug overdoses.[6,7] Diversion of CPDs costs health care insurers up to $72.5 billion a year.[8]

The unintended consequences of postsurgical opioids are not restricted to older orthopedic surgery patients. A study looking at medical use and misuse of opioid medication among adolescent sports participants found that adolescent males who participated in organized sports were twice as likely to be

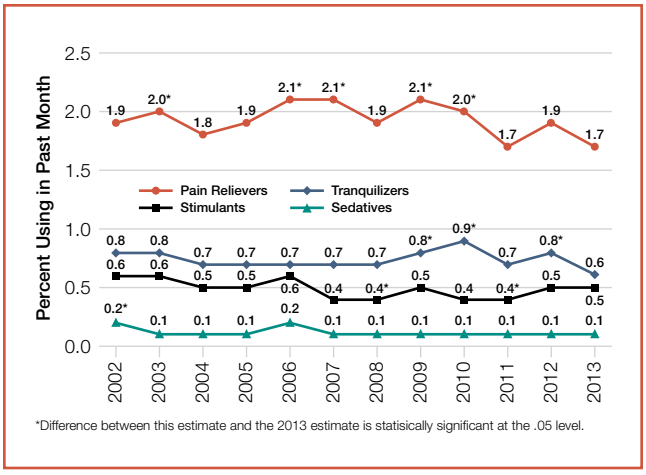


**Figure 1.** Prevalence of illicit use of different categories of controlled prescription drugs.

Reprinted from Substance Abuse and Mental Health Services Administration. *Results from the 2013 National Survey on Drug Use and Health: Summary of National Findings.*[7]

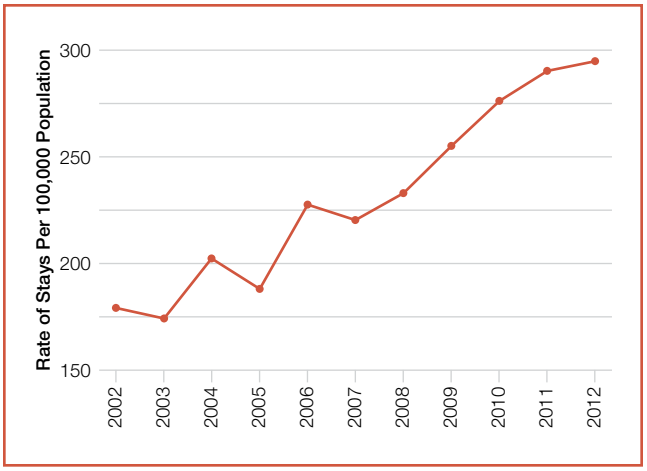


**Figure 2.** Rate of hospitalization for overuse of prescription opioid drugs, 2002–2012.

Reprinted from Kronick, 2014.[10]

prescribed an opioid compared with those not involved in organized sports.[9] The probability of medical misuse of an opioid drug as a result of taking too much medication was 10 times higher among sports participants, and the probability of misuse of an opioid drug for recreational purposes was 4 times higher among sports participants. The association between being prescribed opioids for legitimate medical purposes and misusing opioids cannot be ignored.

The rate of hospitalization and emergency room visits due to opioid overuse or abuse has been rising steadily for more than a decade. During the period 2002 to 2012, the number of hospitalizations for opioid overuse increased by around 60%, with a total of 709,500 hospitalizations in 2012 (**Figure 2**).[10] From 2006 to 2012, the number of emergency room visits involving nonmedical use of prescription opioids increased by 112%, from 84,671 to 179,787.[6] Policy-makers are aware of not only the clinical impact of this trend, but also the social and economic consequences. Clear-cut evidence shows that opioid prescriptions after surgery can lead to long-term use. A retrospective study of patients who had undergone elective surgery for cervical spine repair found that about one-third of patients were still using opioid drugs 1 year after their procedure.[11] Furthermore, 18% of patients who had not used opioid drugs prior to their procedure were using these medications 1 year later.

Similarly, a retrospective cohort study involving older patients (>65 years of age) who had undergone low-risk surgery and received an opioid prescription within 7 days of the procedure found that almost 10% of those individuals were still taking opioid medications 1 year later.[12] The investigators in this study reported a 44% increase in the likelihood of patients becoming long-term opioid users if they were given an opioid prescription after surgery, compared with patients who were not prescribed opioids. Given that the patients in this study had undergone low-risk surgery, these findings demonstrate how a relatively simple procedure can lead to significant, long-term harm when opioid drugs are prescribed.

In a prospective, longitudinal inception cohort study among patients undergoing a variety of procedures, including total hip or total knee replacement, 6% of subjects were shown to have continued on new opioid medications 150 days after surgery.[2] If this rate of opioid use is extrapolated across the 17.6 million people undergoing surgical procedures annually, the result is 1.1 million new opioid users each year.

The potential for diversion of opioid drugs after surgery was demonstrated by a prospective cohort study of patients undergoing outpatient upper-extremity surgery.[13] The majority of patients in the study received a prescription postoperatively for 30 analgesic tablets, with oxycodone, hydrocodone, and propoxyphene accounting for over 95% of those prescriptions. Across the 250 patients who completed the study, an average of 19 tablets per prescription were not consumed—a total of 4,639 leftover tablets across the study population.

According to a 2013 survey by the Substance Abuse and Mental Health Services Administration, 68% of people using pain relievers nonmedically obtained them from a friend or a relative (**Figure 3**).[7] And a 2009 survey of substances most easily bought by teenagers, conducted by the National Center on Addiction and Substance Abuse, revealed that adolescents can today buy prescription drugs more easily than alcohol.[14]

The chain of events that can be triggered when a prescription for an opioid drug is written often does not end with the opioid diversion. From 2007 to 2012, the number of individuals reporting heroin use during the past year almost doubled; evidence suggests that the increase in heroin use may be linked, at least in part, to opioid prescribing.[7] The reality on the streets is that heroin often costs less than opioids, which means regular opioid users have an economic incentive to transition to heroin and other recreational drugs.

## Summary

The challenges described above all underscore the importance of adopting approaches to postoperative pain management that do not rely predominantly on opioids. This drive to reduce opioid prescribing is now being prioritized at all levels, from Congress down to individual institutions. The governor of Vermont confronted the opioid crisis during a speech in January 2014,[15] and, 8 months later, the governor of Pennsylvania signed legislation and approved recommendations to combat that problem in that state.[16] Similarly, in his inaugural address in January 2015, the governor of Massachusetts vowed to continue to combat the opioid abuse epidemic.[17]

The US Department of Defense, the US Department of Veterans Affairs, the Centers for Disease Control and Prevention, and the US Department of Health and Human Services/Centers for Medicare and Medicaid Services have all adopted policies that support opioid-reducing or opioid-sparing approaches to pain management. The Joint Commission has noted that patients want pain-management approaches that do not lead

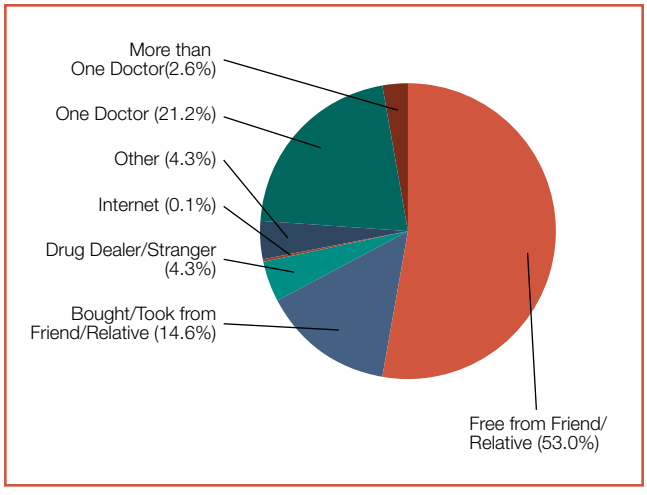


Figure 3. Sources of pain medications that were used nonmedically.

Reprinted from Substance Abuse and Mental Health Services Administration. *Results from the 2013 National Survey on Drug Use and Health: Summary of National Findings*.[7]

to dangerous addiction.[18] This is a preference that cannot be ignored. By the end of 2015, it is expected that 50% of reimbursement will be tied to value-based practice, and, by the end of 2018, that rate is estimated to increase to around 90%. In its revision of the pain-management standards, the Joint Commission has recommended that strategies include a patient-centered approach that takes into consideration the accompanying risks and benefits—including the potential risk of dependency, addiction, and abuse.

Perhaps the most important step that orthopedic surgeons can take to reduce the use of opioids is adoption of rational multimodal analgesia regimens that target different pain pathways. Such multimodal regimens provide effective pain management, reduce the use of opioid drugs, and have been shown to reduce the overall cost of care.

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# Do Regional Analgesia and Peripheral Blocks Still Have a Place in Joint Arthroplasty?

Fred D. Cushner, MD


## Abstract

The efficacy of regional anesthesia and peripheral nerve blocks in the management of postoperative pain has resulted in widespread use of this approach in hip and knee arthroplasty. With extensive clinical use, however, the limitations of this approach have become apparent. These limitations include delays for the surgeon, inefficient use of the operating room, muscular weakness, and associated delays in physical therapy. Periarticular injection of anesthetic and analgesic medications appears to offer comparable benefits to nerve blocks in joint arthroplasty without these limitations. The long-acting anesthetic bupivacaine liposome injectable suspension (EXPAREL®, Pacira Pharmaceuticals, Inc), in particular, has been shown to be highly effective in managing postoperative pain and reducing opioid consumption. Consequently, a growing body of data and extensive clinical experience now support replacing nerve blocks with periarticular injections.


Regional anesthesia and peripheral nerve blocks have become widely used as components of multimodal regimens to manage pain in hip and knee arthroplasty. However, as the understanding of optimal multimodal analgesia has evolved and new options for pain management have emerged, peripheral nerve blocks might no longer have a place in these procedures.

Initially, the effectiveness of methods such as femoral nerve block and sciatic nerve block made these approaches highly attractive. In clinical practice, however, they pose certain challenges, including delays in operating room time and in starting physical therapy, as well as an increased risk of falls. Improvement in multimodal analgesia regimens in recent years has reduced the incremental pain control achieved with nerve blocks, and the burden associated with these approaches may now outweigh their benefit.

One of the primary goals of pain management today is to ensure that patients are satisfied with their overall hospital or clinic experience, in part because that satisfaction is reflected in Press Ganey scores, which in turn affect the institution's reputation and profitability. Although patients generally are not sufficiently knowledgeable to understand the whole complex nature of a successful arthroplasty, they are able to determine how the wound looks and how much pain they are suffering. And, in general, the less pain they have, the greater their level of satisfaction with their surgical experience.

Continuous postsurgical administration of opioid analgesics as requested by the patient—often via intravenous (IV) patient-controlled analgesia (PCA) pumps—appears to be a logical way of achieving patient satisfaction. There is growing concern, however, about the disadvantages of this approach, which include opioid-related adverse events and risk of diversion.[1,2] Some 8% of intensive care unit admissions and 16% of respiratory deaths are accounted for by IV PCA.[1] Moreover, it is widely acknowledged that preventing the pain cascade before it occurs is far more effective than constantly trying to control the pain once that process has already been initiated—an approach that is commonly referred to as "chasing the pain."[1]

Nerve blocks provide one option for reducing this dependence on parenteral opioids and helping prevent initiation of the pain cascade. A study comparing outcomes in 100 patients undergoing total hip or knee arthroplasty who received a new total joint regional anesthesia (TJRA) protocol with 100 matched patients who received IV PCA with subsequent conversion to oral analgesics demonstrated improved pain control with the TJRA protocol on postoperative day 0 through postoperative day 3.[3] The proportion of patients able to ambulate and meet the criteria for hospital discharge on postoperative days 1 through 3 was also significantly higher than the proportion of control patients who were able to ambulate. Nevertheless, important factors must be taken into consideration when using peripheral nerve blocks.

## Clinical Considerations With the Use of Nerve Blocks

The use of nerve blocks in arthroplasty typically results in less efficient use of the surgeon's time: the surgeon often must wait longer while the patient is prepared for surgery and often must

**Author's Disclosure Statement:** The author reports that he is a consultant for Pacira Pharmaceuticals, Inc, and Smith & Nephew.

be available for a longer period of time postoperatively. The time required to administer the nerve block and wait for the block to take effect can also result in operating room delays, particularly in preparation for bilateral knee arthroplasty.

In addition, physical therapy often must be delayed after nerve block until full motor function is restored—sometimes an additional day—and a knee immobilizer is required to prevent injury associated with an increased risk of falls after nerve block.

Moreover, a learning curve is required for administering nerve blockade. Sometimes the block is incomplete, and the patient does not receive total pain relief.

## Evolution of Periarticular Injections

One approach that appears to offer comparable benefits to peripheral nerve blocks in joint arthroplasty without the problems described above is periarticular injection (PAI) of anesthetic and analgesic medications. The optimal medication or combination of medications for periarticular injection, however, is still evolving. Levobupivacaine (an S-enantiomer of bupivacaine) given by periarticular injection has been found to reduce opioid consumption but not pain scores.[4] A cocktail of ropivacaine, ketorolac, and epinephrine has also been shown to reduce morphine consumption, while continuous intra-articular injection of ropivacaine was found to reduce high intensity pain (pain score of 7 or higher) and improve initial ambulation.[5,6] Other medications that can be included in the periarticular injection cocktail include opioids and steroids, as well as antibiotics.[7]

In a more recent randomized clinical trial, 160 patients undergoing total knee arthroplasty (TKA) received either peripheral nerve blocks with an indwelling femoral nerve catheter and a single-shot sciatic block, or periarticular injections with ropivacaine, epinephrine, ketorolac, and morphine.[8] Whereas both groups had similar pain scores, patients receiving periarticular injections had a shorter length of stay and were less likely to have symptoms of nerve injury. On the day of surgery, opioid consumption was higher for patients receiving periarticular injections, but, thereafter, there was no difference.

In a small unpublished study carried out at the North Shore-LIJ Orthopaedic Institute to determine whether continued use of nerve blocks for TKA was worthwhile, 14 patients undergoing bilateral TKA were given femoral and sciatic nerve blocks for 1 knee and periarticular injections in the other knee. Pain scores were recorded each day after surgery, and only 4 patients exhibited a preference for the nerve blocks. The remaining patients either had no preference or exhibited a preference for the periarticular injections. No rebound pain was seen with either modality. Given the more time-consuming nature of the blocks, the lack of any clear superiority led to discontinuation of that approach in favor of PAIs at the institute.

## Beneficial Effects of Long-Acting Intra-Articular Injections

In 2009, distinguished orthopedic surgeon Chitranjan S. Ranawat, MD, a pioneer in periarticular injections, and colleagues reported: "Unfortunately, we have still not achieved the ideal technique; we have not eliminated the use of opioids, nor have we eliminated pain during the postoperative period entirely."[9] Since that time, however, new pharmacologic options have emerged, and the injection technique has been refined.

One addition to the anesthetic and analgesic armamentarium is bupivacaine liposome injectable suspension (EXPAREL®, Pacira Pharmaceuticals, Inc), a long-acting local analgesic that can be administered directly into the surgical site by the orthopedic surgeon.

A double-blind randomized trial comparing liposomal bupivacaine with a concentrated multidrug periarticular injection in 70 patients undergoing TKA without femoral nerve block found lower pain scores on postoperative days 0 to 2, reduced

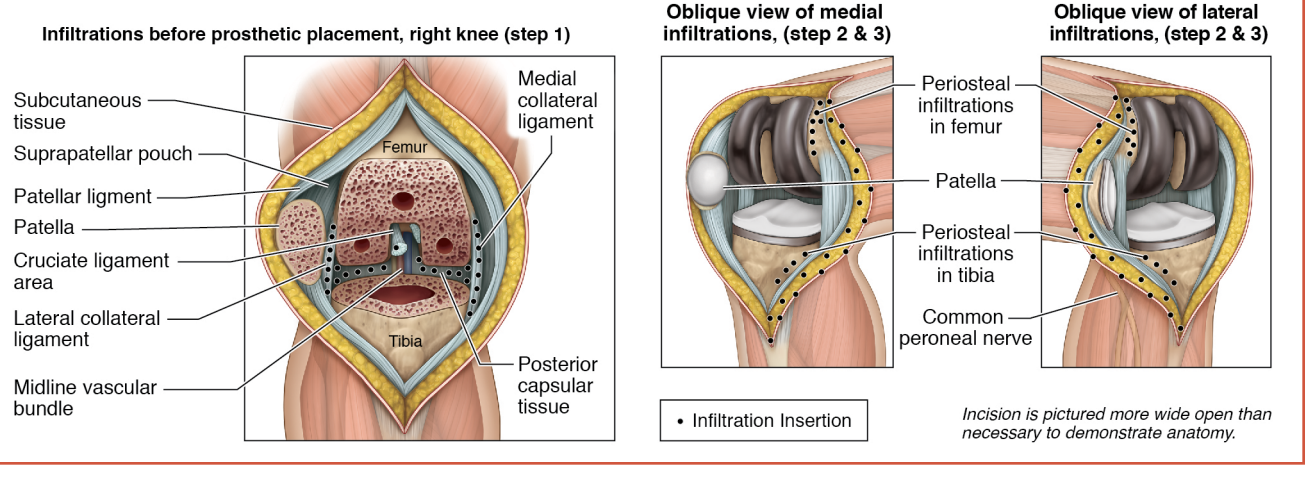


Figure. Stepwise approach to administering periarticular injections.
Reproduced with permission from the Best Infiltration Practices Working Group; Guideline Central.[13]

opioid consumption and adverse events, and improved patient satisfaction in patients receiving liposomal bupivacaine.[10]

Conversely, a retrospective comparison of liposomal bupivacaine with a standard multidrug PAI regimen in 150 patients undergoing TKA favored the multidrug regimen.[11] The recommended volume of each needle "stick" in these patients, however, was 1 to 2 mL, which may not have allowed for a sufficient number of sticks—because liposomal bupivacaine does not diffuse throughout tissues in the same manner as bupivacaine HCl, it is essential to use small-volume sticks so that enough injections can be administered to effectively cover the surgical area.

The recommended dose of liposomal bupivacaine is 266 mg, and the prescribing information recommends expanding the agent with up to 280 mL of normal saline. However, expanding the agent to as much as 100 mL allows for more needle sticks, which can enhance the effectiveness.

Clinical studies and extensive use of this medication in hip and knee arthroplasty have demonstrated the importance of injection technique in achieving optimal results. Although liposomal bupivacaine can be administered using an 18-gauge to 25-gauge needle, experience has shown that when using needles around 18 gauge, medication can leak back out of the tissue, and a smaller needle (around 22 gauge) is therefore essential. As noted above, the drug must be administered in multiple injections—including about 20 injections around the posterior capsule.

Distribution of the drug within the surgical site should follow a 20/10/20 system. For example, if 50 mL of solution is prepared, 20 mL should be injected into the posterior capsule, 10 mL around the periosteum in the fat pad, and the remaining 20 mL in the subcutaneous tissue.

The drug should be injected predominantly in the locations of the highest nerve density (**Figure**). The goal is to saturate the 6 zones of greatest innervation, namely:

- Suprapatellar/quadriceps tendon;
- Medial retinaculum;
- Patellar tendon/fat pad;
- Medial collateral ligament/medial meniscus/medial capsule;
- Cruciate ligaments;
- Lateral collateral ligament/lateral meniscus/lateral capsule.[12]

Because the full analgesic effect of liposomal bupivacaine may not be seen immediately, 30 mL of 0.25% bupivacaine HCl is commonly added to the regimen. Higher doses of bupivacaine HCl are not recommended.

In a study comparing liposomal bupivacaine with femoral nerve block in 72 patients undergoing TKA, the periarticular injections provided equivalent analgesia, with less opioid consumption and no quadriceps weakness.[14]

Another study comparing liposomal bupivacaine with femoral nerve blocks in 80 patients undergoing unilateral knee replacement found that patients receiving nerve block initially had slightly greater knee flexion, compared with patients receiving the periarticular injections.[15] Over the full postoperative period, patients who were given liposomal bupivacaine demonstrated improved ambulation and decreased length of stay. Pain scores were higher on postoperative day 0, but lower on days 1 to 3 in patients receiving liposomal bupivacaine. Immediate-acting bupivacaine HCl was not included in this study, which may explain the higher pain scores on day 0.

## Summary

Despite the efficacy of peripheral nerve blocks, the limitations of this approach in the clinical practice setting—notably delays for the surgeon, inefficient use of the operating room, muscular weakness, and associated delays in physical therapy—have become apparent. Periarticular injections offer comparable benefit without the same disadvantages. Therefore, there is little justification for continuing to use nerve blocks in arthroplasty. And, in fact, when a long-acting agent, such as liposomal bupivacaine, is included in the periarticular injection regimen, this method may be more effective than nerve blocks across a range of endpoints.

Demonstrating the superiority of one proven approach over another with respect to postoperative pain is difficult. Many factors can affect a patient's postoperative pain experience, pain scales are inherently subjective and inaccurate, and differences between proven regimens can be modest. Inconsistencies in the findings from comparative studies highlight the critical importance of good and methodical periarticular injection technique and the need to standardize the protocols for clinical trials assessing postoperative pain.

Whereas the efficacy of periarticular injection of liposomal bupivacaine has been unequivocally demonstrated in randomized clinical trials, one debate has emerged about the economic effects of this medication on the pharmacy budget. However, although the purchase price of liposomal bupivacaine is higher than the price for older analgesic drugs, the increased pharmacy cost has been shown to be offset by overall hospital costs, including decreased episodic care, reduced pharmacy and nursing time, less use of morphine, and shorter hospital length of stay.[16,17]

The use of periarticular injections instead of peripheral nerve blocks, which shifts some control over pain management from the anesthesiologist to the orthopedic surgeon, represents a cultural change. It is, however, a change that is consistent with a team approach—which tends to improve overall patient care—and that is supported by a growing body of data and extensive clinical experience.

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# Efficacy of Periarticular Injection With a Long-Acting Local Analgesic in Joint Arthroplasty

John W. Barrington, MD

## Abstract

Attention to patient satisfaction is critical in today's health care environment—satisfaction surveys inform the development of hospital performance standards and can influence an institution's rankings and reimbursement. The effectiveness of postoperative pain management can affect clinical outcomes and also influence the patient's perception of the overall surgical experience. Ample clinical-trial data now exist that demonstrate the benefits of periarticular injections as part of a multimodal regimen in patients undergoing joint arthroplasty. One option that surgeons now use widely is bupivacaine liposome injectable suspension (EXPAREL®, Pacira Pharmaceuticals, Inc), a long-acting local analgesic that the orthopedic surgeon can administer intraoperatively. The US Food and Drug Administration has approved liposomal bupivacaine for injection into the surgical site to produce postsurgical analgesia. The safety and efficacy of liposomal bupivacaine has been demonstrated in clinical studies in multiple types of surgical procedure, including double-blind, randomized, controlled clinical trials that involved over 1300 patients. In a case–control study comparing clinical and economic parameters before and after the introduction of liposomal bupivacaine as a component of the multimodal perioperative pain regimen for total joint arthroplasty, liposomal bupivacaine provided improved overall pain scores, an increase in patients reporting a pain score of 0, increased patient satisfaction, decreased length of stay, and a decrease in overall costs.

The importance of leaving arthroplasty patients feeling satisfied with their overall surgical experience should not be underestimated. Data collected through local and regional patient satisfaction surveys, including information sent to the Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS), informs the development of hospital performance standards and can influence rankings and reimbursement.[1,2]

Four key drivers of patient satisfaction are effective pain management, prevention of nausea and vomiting, enabling the patient to get out of bed and to move with physical therapy, and establishing personal communication. Effective pain management, in particular, is imperative, not only for the direct impact that it has on clinical outcomes and patients' perception of their experience, but also because it affects the other 3 parameters listed above.

## Underlying Principles of Effective Postsurgical Pain Management

It has been established for some time now that the perioperative pain pathway involves transduction of painful stimuli at the site of injury, transmission of pain signals along the peripheral and central nerve fibers, and the perception of pain within the brain.[3] Although individual analgesic medications exert effects at specific points along this pathway, the optimal goal of perioperative pain management is to prevent the pain before it even starts. Strategies to achieve this goal combine the minimization of soft-tissue trauma with multimodal analgesic regimens.

A vast body of data demonstrates that poorly managed postoperative pain can have serious consequences, such as prolonged hospital length of stay and rehabilitation,[4,5] elevated readmission rates,[6] increased cost,[7,8] and progression to persistent pain states.[9] Unfortunately, however, efforts to provide robust control of postoperative pain also result in serious consequences for many patients. Opioids, in particular, are commonly associated with nausea, vomiting, constipation, falls, respiratory depression, decrease in cardiac output, and numerous other adverse effects.[10] Femoral nerve blocks, which are widely used in lower-limb orthopedic surgery, can lead to quadriceps weakness, neuropathy, postoperative falls, and added costs.[11]

## Periarticular Injections in Joint Arthroplasty

Interest has grown in the use of periarticular injections for the

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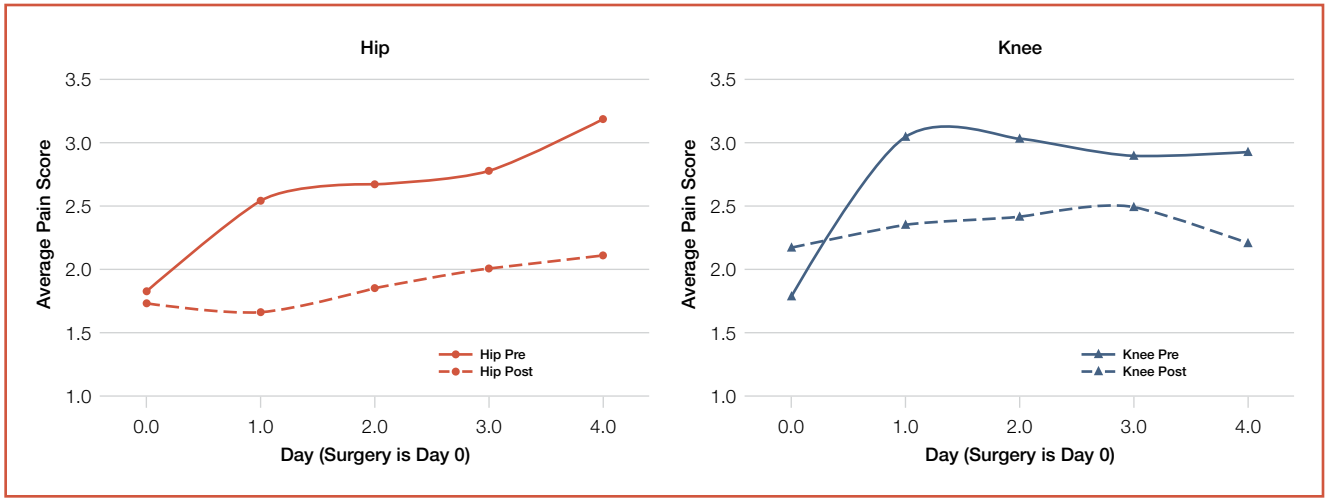


**Figure.** Improvement in average pain score by day after introduction of liposomal bupivacaine as a component of the multimodal perioperative pain regimen for total joint arthroplasty.
Texas Center for Joint Replacement; Plano, TX.

management of postoperative pain, and ample clinical trial data now exist that demonstrate the benefits of periarticular injections as part of a multimodal regimen in patients undergoing joint arthroplasty.

One option that many surgeons now use widely is bupivacaine liposome injectable suspension (EXPAREL®, Pacira Pharmaceuticals, Inc), a long-acting local analgesic that can be administered intraoperatively by the orthopedic surgeon. Liposomal bupivacaine is approved by the US Food and Drug Administration for injection into the surgical site to produce postsurgical analgesia. The safety and efficacy of liposomal bupivacaine has been demonstrated in more than 21 clinical studies in multiple types of surgical procedure, including 10 double-blind, randomized, controlled clinical trials that involved over 1300 patients.

The technique used when infusing liposomal bupivacaine influences the effectiveness of this medication. It is essential to inject small volumes of liposomal bupivacaine into soft tissue (rather than intra-articular injection) at multiple injection sites, using a small (22-gauge) needle. This process takes about 45 seconds to 1 minute, twice during the case, including while the cement is doing its final hardening. Administering this medication using a large-bore needle into only 1 or 2 injection sites is ineffective because it does not then diffuse all the way around the incision. Liposomal bupivacaine tends to remain where it is injected, and it therefore has to be placed in all of

**Table 1. Improvement in Clinical Outcomes After Introduction of Liposomal Bupivacaine as a Component of the Multimodal Perioperative Pain Regimen for Total Joint Arthroplasty**

| Pain Score | Before Liposomal Bupivacaine | After Liposomal Bupivacaine | *P* |
|---|---|---|---|
| Mean VAS, THA | 2.304 | 1.668 | <.0001 |
| Mean VAS, TKA | 2.493 | 2.210 | .000102 |
| Mean VAS, total | 2.414 | 1.978 | <.0001 |
| VAS = 0, THA | 40.39% | 53.53% | <.0001 |
| VAS = 0, TKA | 40.07% | 44.76% | <.0001 |
| VAS = 0, total | 40.20% | 48.76% | <.0001 |

Abbreviations: THA, total hip arthroplasty; TKA, total knee arthroplasty; VAS, visual analog scale.
Texas Center for Joint Replacement; Plano, TX.

**Table 2. Safety Measures Before and After the Introduction of Liposomal Bupivacaine as a Component of the Multimodal Perioperative Pain Regimen for Total Joint Arthroplasty**

| Complication | Before Liposomal Bupivacaine | After Liposomal Bupivacaine | *P* |
|---|---|---|---|
| Mortality | 0 | 0 | >.99 |
| Infection | 0.4% | 0.5% | .7384 |
| Hemorrhage/ hematoma | 0.2% | 0.2% | >.99 |
| Missed PT due to nausea | 0.9% | 0.5% | .2836 |
| Falls | 1.0% | 0.2% | .0207[a] |
| Deep vein thrombosis | 0.7% | 0.6% | .7809 |
| Pulmonary embolism | 0.5% | 0.9% | .2836 |
| Major cardiopulmonary event | 0.6% | 0.3% | .3165 |
| Pulmonary embolism/ cardiovascular event | 1.1% | 1.2% | .8339 |

[a]Statistically significant.
Abbreviation: PT, physical therapy.
Texas Center for Joint Replacement; Plano, TX.

the available soft tissues—anywhere there are nerve fibers affected by surgical trauma.

## Evaluation of Liposomal Bupivacaine in Hip and Knee Arthroplasty

Liposomal bupivacaine has been routinely used at the Texas Center for Joint Replacement (Plano, Texas) since 2012 as a component of a multimodal regimen in patients undergoing hip or knee arthroplasty. A case–control study was conducted at the center to compare a range of outcomes in more than 1000 patients who underwent total hip or knee arthroplasty after the widespread introduction of liposomal bupivacaine with more than 1000 patients who underwent total knee arthroplasty prior to the inclusion of this agent.[12]

### Study Description

All patients received the established multimodal analgesia regimen (nonsteroidal anti-inflammatory agent, analgesic medication, gabapentin, tramadol, and oral/intravenous opioids) and periarticular injection with bupivacaine HCl/epinephrine (with or without morphine and ketorolac). One group of 1124 patients received liposomal bupivacaine in addition to this multimodal regimen, whereas the other group of 1124 patients received only the established multimodal regimen.

The primary outcome measures were the mean pain scores at multiple time points, measured on a validated visual analog scale of 1 to 10, and the percentage of pain scores that were 0. A pain score of 0 means that perfect pain control had been achieved at that point in time; so this endpoint is a measure of the percentage of time during the hospitalization that patients had perfect pain control. Four different surgeons within the same practice conducted the procedures. To eliminate bias with respect to either the surgeon who had performed the procedure or the operating room technique that was used, all pain scores were collected by a consistent nursing staff and sent to Exponent, Inc, for independent analysis.

Secondary outcome measures focused on complications and safety (mortality, infection, hemorrhage and hematoma, missed physical therapy due to nausea and vomiting, falls, deep vein thrombosis, cardiopulmonary events, need for transfusions, and readmission rate), as well as on economic factors (length of stay, Press Ganey overall patient satisfaction scores, and costs).

### Improvement in Clinical Parameters

This study demonstrated significant improvement in overall mean pain scores in patients undergoing either hip replacement (2.30 in group without liposomal bupivacaine versus 1.67 in group with liposomal bupivacaine) or knee replacement (2.49 in group without liposomal bupivacaine versus 2.21 in group with liposomal bupivacaine; **Table 1**). There was also a significant improvement in the percentage of pain scores that were 0 for both groups: 40.4% without liposomal bupivacaine versus 53.5% with liposomal bupivacaine in the hip patients, and 40.1% without liposomal bupivacaine versus 44.8% with liposomal bupivacaine in the knee patients.

Although the established multimodal regimen used at this center prior to the introduction of liposomal bupivacaine was highly effective in controlling postoperative pain, a further improvement of around 20% to 25% was reported after the introduction of liposomal bupivacaine.

When the pain scores were assessed by the length of time after surgery, little difference was reported between the 2 regimens on day 0 (**Figure**). This would be expected, as all patients in both groups received bupivacaine HCl intraoperatively to provide analgesia during the initial postsurgical period. Beginning on postoperative day 1, however, pain scores were significantly lower in patients who received liposomal bupivacaine compared with those who did not receive liposomal bupivacaine.

No significant differences were seen between the 2 groups with respect to any safety measures, although a trend toward a reduction in falls was observed after the introduction of liposomal bupivacaine (**Table 2**).

### Improvement in Economic Parameters

Typically a cost is associated with the introduction of any new technology. The economic rationale for including the technology cannot be viewed simply from the perspective of purchase price; other factors must also be taken into consideration. One of the objectives of this study, therefore, was to look beyond the pharmacy budget and determine the wider economic impact of including liposomal bupivacaine in the multimodal analgesia regimen.

After the introduction of liposomal bupivacaine, a modest improvement in length of stay was observed (2.83 days in the group without liposomal bupivacaine versus 2.66 days in the group with liposomal bupivacaine). In addition, although the center already scored in the 97th percentile with respect

**Table 3. Economic Impact of the Introduction of Liposomal Bupivacaine as a Component of the Multimodal Perioperative Pain Regimen for Total Joint Arthroplasty**

| Cost Component | Total Cost Without Liposomal Bupivacaine | Total Cost With Liposomal Bupivacaine | Change in Cost With Liposomal Bupivacaine |
|---|---|---|---|
| Hospital supplies | $11,900,847 | $10,394,427 | ↓ $1,506,420 |
| Pharmaceuticals | $371,506 | $631,813 | ↑ $260,307 |
| Total costs[a] | $12,272,353 | $11,026,240 | ↓ $1,246,113 |

[a]Does not include additional estimated mean cost reduction of about $150 per patient associated with reduced hospital length of stay.
Texas Center for Joint Replacement; Plano, TX.

to Press Ganey evaluation of patient satisfaction prior to the widespread adoption of liposomal bupivacaine, the degree of dissatisfaction was further halved by inclusion of liposomal bupivacaine in the perioperative pain regimen.

Although there was an increase in the pharmacy budget of approximately $260,000 across more than 1000 patients—and thus around $260 per patient—a corresponding decrease of approximately $1.6 million—or $1500 per patient—was achieved by eliminating elastomeric pumps, patient-controlled analgesia pumps, and immobilizers (**Table 3**). The net savings realized after the introduction of liposomal bupivacaine, therefore, was more than $1.2 million, not including an estimated mean cost reduction of about $150 per patient associated with the reduced hospital length of stay.

## Summary

Periarticular injections have been shown to be a beneficial addition to multimodal regimens for the management of postoperative pain after joint arthroplasty. As postoperative pain is one of the main drivers of patient satisfaction in this setting, the use of periarticular injections may have a positive outcome, not only on clinical parameters, but also on economic parameters.

The value of incremental improvement in pain management, even in centers that already use robust multimodal analgesia regimens, is illustrated by this case–control study with liposomal bupivacaine. Evaluation of the inclusion of liposomal bupivacaine in the multimodal analgesia regimen supports the adoption of this technology as a component of the established standard of care for patients undergoing hip or knee arthroplasty. This medication provides improved overall pain scores, an increase in pain-free patients, increased patient satisfaction, decreased hospital length of stay, and decreased overall costs.

Dr. Barrington is Co-Director, Baylor Medical Center at Frisco Joint Replacement Center, Plano, Texas.

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# Closing the Gaps in Postsurgical Pain Management

Giles R. Scuderi, MD

## Abstract

Analgesic gaps—periods of inadequate pain control—commonly compromise the management of pain after joint arthroplasty. Such gaps can and should be prevented. The use of well-designed, balanced multimodal analgesic regimens that comprise a combination of agents working independently in both the peripheral and central nervous systems is an effective way to prevent gaps in pain control. Medications that have been shown to be beneficial as components of multimodal regimens include acetaminophen, cyclo-oxygenase 2 (COX-2) inhibitors, gabapentinoids, glucocorticoids, periarticular injections using agents such as bupivacaine HCl and bupivacaine liposome injectable suspension (EXPAREL®, Pacira Pharmaceuticals, Inc), and long-acting opioids. Multimodal analgesia should take into consideration not only the mechanisms of the individual medications, but also their timing of onset and duration of effect. And to avoid continual reestablishment of the pain pathways, it is also important to administer the medications on a scheduled basis rather than as needed.

A phenomenon that commonly compromises the management of pain after joint arthroplasty is the occurrence of periods of inadequate pain relief known as *analgesic gaps*.[1] It may take a significant period of time to reestablish pain control after such gaps, and these spikes in pain intensity can negatively impact patients' overall assessment of pain relief, as well as their reporting regarding satisfaction with the surgery.[2]

Analgesic gaps can sometimes occur as a result of administrative, systematic, or mechanical deficiencies, or due to changes in patient activity.[2] Very often, however, they are due to inadequacies relating to the analgesic regimen itself. Examples of medication-related analgesic gaps include poorly placed perineural block and either patchy spread or regression of the perineural block. In addition, administration of short-acting pain medications that must be requested or taken frequently can often result in repeated analgesic gaps.[2]

## Multimodal Analgesia Regimens for the Prevention of Analgesic Gaps

Managing the acute pain of surgery begins in the preoperative phase and continues throughout the intraoperative and postoperative phases. It is now recognized that multimodal analgesia with a combination of agents that work independently in both the peripheral and central nervous systems provides superior control of postsurgical pain, compared with traditional opioid-dependent analgesic regimens. The individual medications have additive and synergistic effects, and well-designed multimodal regimens, particularly if they include long-acting medications, may help prevent analgesic gaps.

The implementation of multimodal analgesia can be viewed within the context of the traditional pain pyramid (**Figure 1**). For optimal outcomes, the process should start with education of the patient about the management of their postoperative pain, and setting appropriate expectations—including steps that the care team is taking to prevent pain spikes. Another important, nonpharmacologic component of pain management that helps form the foundation of the overall pain management

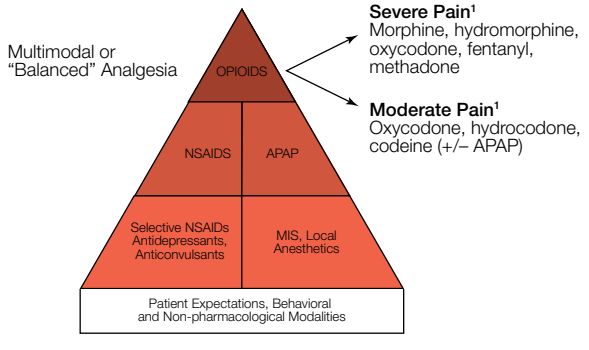


Figure 1. Paradigm for managing postoperative pain in patients undergoing joint arthroplasty.
Abbreviations: APAP, acetaminophen; MIS, minimally invasive surgery.
Adapted from World Health Organization.

**Author's Disclosure Statement:** The author reports that he is a speaker for and has received research support from Pacira Pharmaceuticals, Inc.

strategy is the use of minimally invasive surgical techniques. The ultimate goal of this pyramid approach, of course, is to avoid reaching the top of the pyramid—namely to provide a regimen that does not involve the use of opioid drugs. These agents are associated with widely recognized adverse effects, as well as an unacceptably high risk of dependence, addiction, and illicit use. In reality, however, opioids continue to play a role in pain management; nevertheless, proactive multimodal use of other components of the pain pyramid can significantly reduce the amounts of these drugs that are required and the accompanying risk of side effects.

**Table. Factors Affecting the Overall Cost of PCA in the Management of Postoperative Pain[6]**

| |
|---|
| Tangible items |
| ■ PCA pump |
| ■ Disposable tubing |
| ■ Syringes |
| Labor costs |
| ■ Pharmacy |
| ■ Nursing |
| ■ Biomedical/central supply personnel |
| Related functions |
| ■ Store, check, and maintain pumps |
| ■ Set up pumps and syringes |
| ■ Correctly program pumps using trained operators |
| Intangibles |
| ■ Additional costs involved in ensuring early patient ambulation |
| ■ Managing IV line issues |
| ■ Potential adverse events |

Abbreviations: IV, intravenous; PCA, patient-controlled analgesia.

## Patient-Controlled Analgesia

In an attempt to avoid analgesic gaps during the recovery period, patient-controlled analgesia (PCA) devices are often used to allow patients to control their postoperative pain by self-administration of intravenous (IV) opioids. This approach, however, often does not have the intended effect. When using PCA devices, there is significant potential for error, including incorrect PCA programming, device malfunctions, and over- or under-dosing errors.[2] Furthermore, in order to maintain an IV site for PCA delivery, patients need to have their IV restarted 2 to 3 times on average.[2]

Although PCA devices appear to help provide effective control of pain in many patients, their efficacy has not been unequivocally demonstrated, and they are both labor-intensive and costly to use. A Cochrane Review that looked at 49 randomized clinical trials found only moderate- to low-quality evidence that PCA is an efficacious alternative to non-PCA administration for postoperative pain control.[3] Yet it has been estimated that there can be as many as 125 steps—encompassing 6 to 8 different health care personnel—involved in acquiring, setting up, administering, and maintaining PCA systems.[2] Several tangible and intangible costs must be considered when assessing the financial burden of PCA devices (**Table**), and there appears to be general agreement among studies that use of this approach is more costly than non-PCA analgesia.[4-6]

## Nonopioid Analgesic Options

### Acetaminophen

Acetaminophen is an effective analgesic agent that inhibits prostaglandin synthesis in the central nervous system. In addition to the oral form, it is now available as an IV infusion. Acetaminophen is only a weak inhibitor of the cyclo-oxygenase (COX) enzyme, and it has no apparent anti-inflammatory effects and

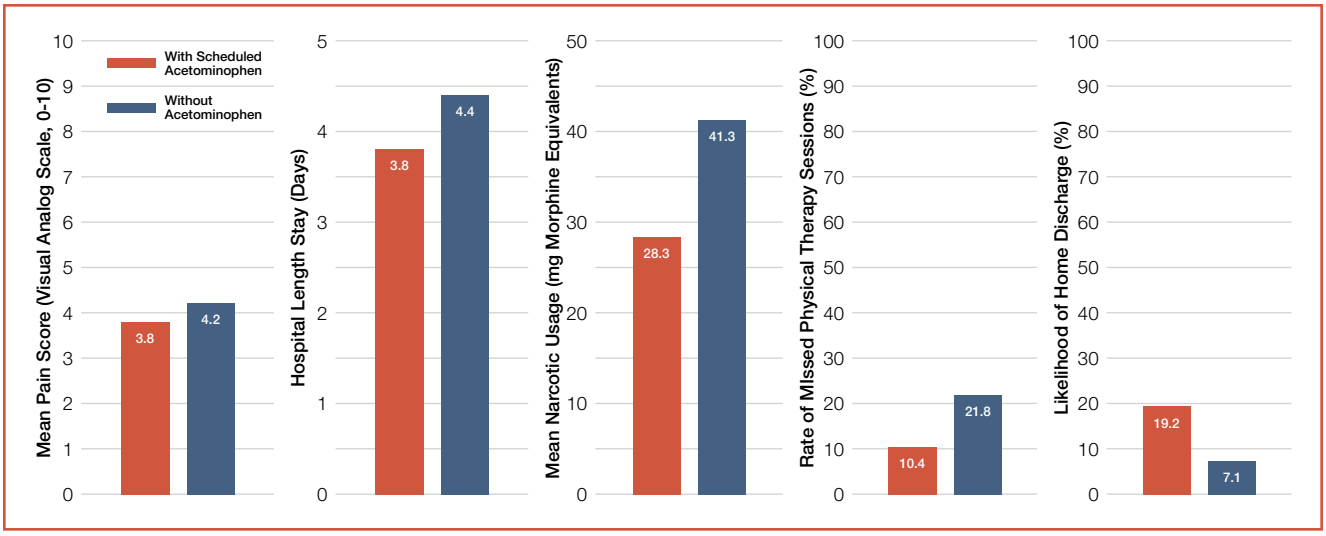


Figure 2. Effect on perioperative outcomes of adding scheduled intravenous acetaminophen administration to a standardized pain management protocol for older hip fracture patients.[9]
Presented at the American Academy of Orthopaedic Surgeons 2015 Annual Meeting.

very few side effects—it is not associated with nausea, vomiting, or respiratory depression. It can be beneficial when given both preoperatively and postoperatively. Although IV acetaminophen has a fast onset of action, it should be administered on a scheduled basis, rather than as needed. In total hip and total knee arthroplasty, IV acetaminophen plus morphine, administered via PCA, improved pain relief compared with placebo plus PCA morphine.[7,8] In addition, patients receiving IV acetaminophen required less morphine than patients who received placebo, and the duration of analgesia (determined by the time to first use of rescue medication) was longer with IV acetaminophen. Patients' global evaluation of satisfaction was also improved in the group that received IV acetaminophen. A more recent study found that adding scheduled intravenous IV acetaminophen to a standardized pain management protocol for older hip fracture patients reduces hospital length of stay, mean pain score, opioid usage, and the rate of missed physical therapy sessions, and is associated with a greater likelihood of home discharge instead of discharge to a secondary care facility (**Figure 2**).[9]

### COX-2 Inhibitors

Like other nonsteroidal anti-inflammatory drugs (NSAIDs), COX-2 inhibitors block the generation of prostaglandin and thromboxanes—important contributors to the inflammatory cascade. These agents are peripherally acting and may also have central analgesic effects through the inhibition of spinal COX.[10] These agents do not have the same platelet-inhibitory and gastrointestinal effects as other NSAIDs,[10] and they can therefore be given prior to surgery and continued during hospitalization and after discharge. Studies have shown that arthroplasty patients receiving a COX-2 inhibitor, such as celecoxib, have lower pain scores, improved range of motion on discharge, reduced requirement for opioids, and improved patient satisfaction without any increase in bleeding.[11-13] Continuation of COX-2 inhibitors for 3 to 5 days postoperatively has been found to be beneficial with respect to the resumption of normal activities, and to improve short-term pain control.[14,15]

### Gabapentinoids

The gabapentinoids, which include gabapentin and pregabalin, inhibit sodium-gated channels in nerves in the periphery, modify transmission of nerve impulses, and provide long-term enhancement of the inhibitory pain pathway. They have been shown to prevent postoperative hyperalgesia and persistent postsurgical pain for as long as 3 to 6 months,[16,17] and to reduce opioid consumption.[16] As part of a multimodal regimen, these agents potentiate the effects of some opioid drugs, and in older patients they can contribute to sedation and disorientation. Optimal dosing and duration of use of these medications in the postsurgical setting is unclear; it is prudent to start them at the lower dose and to avoid their use in patients over 75 years of age.

### Glucocorticoid Steroids

The glucocorticoids, specifically dexamethasone and methylprednisolone, are beneficial in decreasing the postoperative inflammatory response, and are effective as adjuvant therapy, together with acetaminophen, NSAIDs, and gabapentin.[18-20] These drugs have been found to prolong analgesia while reducing nausea and vomiting, with no increase in wound complications with short-term use.[20,21] They are often administered preoperatively by the anesthesiologist at the same time as administration of the spinal anesthetic.

### Periarticular Injections

In recent years, there has been increasing adoption of periarticular injections as part of the multimodal regimen. Important considerations when using periarticular injections are the precise locations of injection with respect to neural anatomy, the injection technique, and the specific combination—or cocktail—of agents.[22] Among the medications that are commonly used are bupivacaine HCl, which is highly effective for a short period of time, together with bupivacaine liposome injectable suspension (EXPAREL®, Pacira Pharmaceuticals, Inc), a long-acting local analgesic. The agents can be administered directly into the surgical site by the orthopedic surgeon. Their combined duration of effect extends from the immediate intraoperative period to as long as 48 to 72 hours postoperatively (people metabolize bupivacaine at different rates, and variations in the precise duration of effect can be seen), and, as part of a multimodal regimen, they therefore represent an attractive way of preventing analgesic gaps.

### Long-Acting Opioids

When opioid analgesic medications are necessary for the control of breakthrough pain, long-acting agents, such as extended release oxycodone tablets, are preferred. When included in the multimodal regimen at scheduled doses for the first 24 to 48 hours, these drugs improved postoperative pain, decreased the requirement for rescue medications, and decreased side effects.[23]

## Summary

Analgesic gaps are a serious problem after joint arthroplasty, and they can adversely affect patient satisfaction with their surgical experience. Although these gaps are commonplace, they can and should be prevented. Well-designed, balanced multimodal analgesia is perhaps the single most effective approach for avoiding these gaps and minimizing side effects.

Effective control of acute pain is pivotal in the prevention of persistent postsurgical pain. Acute pain is best managed on a scheduled basis, not as needed, as this leads to frequent reestablishment of the pain pathways. Therefore, it is essential that an appropriate multimodal regimen using a range of anesthetic and analgesic medications with different mechanisms is followed throughout the preoperative, intraoperative, and postoperative period. The regimen should also take into consideration both the timing of onset and the duration of effect of these medications, in order to provide overlapping analgesia after surgery.

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# Fast-Track Recovery and Outpatient Joint Arthroplasty

John W. Barrington, MD

## Abstract

There is a growing interest in performing joint arthroplasty on an outpatient or short-stay basis. Several factors make the hospital environment itself less than ideal for providing optimal health care, and follow-up of hospitalized patients represents a substantial time burden for the orthopedic surgeon. Essential components of a successful outpatient arthroplasty program include: robust screening of patients to ensure selection of appropriate candidates; preoperative patient preparation, including setting appropriate expectations; modification of surgical approaches where appropriate; and proactive, multimodal pain management to enable patients to walk earlier after surgery, so that they can be discharged home the same day.

There is a growing interest today in performing joint arthroplasty on an outpatient or short-stay basis. First, several factors make the hospital environment itself less than ideal for providing optimal health care. Patient care contends with different—sometimes conflicting—agendas as well as resistance to change. In many hospitals there is an increased risk of infection. Costs are much higher in the hospital than they are in the outpatient space, and the available resources are often limited. Hospital staff members typically do not report directly to the orthopedic surgeon, and the hospital administration frequently imposes compliance burdens on surgeons. Moreover, a low percentage of on-time starts in the operating room results in inefficient use of surgeons' time.

In addition, surgeons can spend a substantial amount of time performing rounds on their hospitalized patients. Each patient requires approximately 5 minutes, and an additional 5 minutes can be spent handling paperwork and other related tasks. So for each patient who stays in the hospital for 3 days, about half an hour will be required for performing rounds and related tasks. For a surgeon who performs 500 procedures each year, this time allocation totals around 250 hours per year. Eliminating that requirement by performing arthroplasty on an outpatient basis returns that time to the surgeon.

## Appropriate Candidates for Fast-Track and Outpatient Joint Arthroplasty

Outpatient arthroplasty is not appropriate for all patients, and rigorous screening to identify appropriate individuals is essential. For a patient to be considered a candidate for outpatient arthroplasty, there must be no concerns with respect to their cardiac, pulmonary, and renal histories. The hemoglobin level, for example, should be over 11 g/dL before a patient undergoes surgery in an outpatient center.

From a functional perspective, it is a good idea for the patient to be able to walk independently, even if the patient requires a walking frame. Patients require family support at home, with relatives who are helpful and able to take care of the patient. And it is prudent for the surgeon to be able to reach the patient after discharge if necessary; so the patient should reside within 2 hours of the surgery center.

## Essential Factors for Success

### Preparing the Patient for Outpatient Surgery

Taking into consideration the criteria described above, outpa-

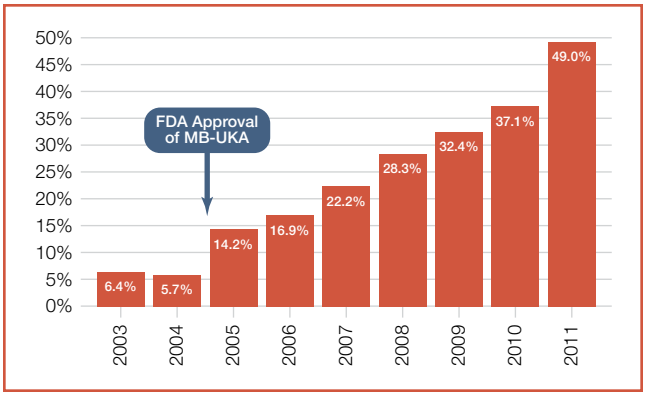


Figure. Trend toward increased utilization of unicompartmental knee arthroplasty.

Abbreviations: FDA, US Food and Drug Administration; MB-UKA, mobile-bearing unicompartmental knee arthroplasty.

Courtesy of M. Berend and K. Berend, Texas Center for Joint Replacement, Plano, TX.

**Author's Disclosure Statement:** The author reports that he is a consultant for Biomet, Inc, Iroko Pharmaceuticals, LLC, Mallinckrodt Pharmaceuticals, Pacira Pharmaceuticals, Inc, and Smith & Nephew.

tient arthroplasty can generally be offered to all appropriate non-Medicare patients and select Medicare patients. A discussion should take place with each patient to explain the overall plan for the procedure. The surgeon can let the patient know that the goal is for the patient to be comfortable. Once the patient is able to use the bathroom, eat a meal, and walk comfortably and safely with minimal or no support, the patient is ready to go home. When patients understand what is planned, they are generally amenable to a shorter stay.

It is helpful to explain new protocols for managing postoperative pain and to discuss the overall concept of outpatient surgery. This conversation may include evidence of success from the patient perspective, such as Press Ganey scores and Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) results. Patients can be made aware of the percentage of people who stay 23 hours and of other factors, such as the nurse-to-patient ratio at the center.

A preoperative visit at the patient's house by a nurse or physical therapist is worthwhile. At that time patients can be given printed materials that will help them understand the surgical procedure and what they should expect.

### Surgical Approaches

The surgical techniques used for outpatient arthroplasty are, in general, very similar to those used in other patients. Since US Food and Drug Administration approval of mobile-bearing unicompartmental knee arthroplasty (UKA) in 2004, however, the proportion of UKA procedures performed has increased steadily (**Figure**). The pain associated with UKA is much less than the pain with total knee arthroplasty, and use of this approach can, therefore, facilitate same-day discharge of patients.[1]

### Managing Postoperative Pain

If the intention is to enable patients to walk earlier after surgery, so that they can be discharged home the same day, it is imperative that effective management of postoperative pain is provided without analgesic gaps, or periods of inadequate pain control. A robust multimodal analgesic regimen is therefore required. A combination of analgesic medications with complementary mechanisms—such as celecoxib, oxycodone, pregabalin, dexamethasone, and intravenous acetaminophen—should be given preoperatively, together with tranexamic acid to prevent excessive bleeding. Intraoperatively, injection of bupivacaine HCl and bupivacaine liposome injectable suspension (EXPAREL®, Pacira Pharmaceuticals, Inc), as part of a multimodal regimen, has been found to reduce hospital length of stay.[2] Using these medications intraoperatively also reduces the requirement for postoperative opioids in many patients, in turn reducing the potential for opioid-related adverse events that may undermine the outpatient process.

## Summary

Outpatient or short-stay arthroplasty has clear-cut benefits for both the patient and the surgeon. Moreover, economic forces are driving increased adoption of this approach. The potential for growth in the use of outpatient or short-stay arthroplasty is illustrated by data from the Texas Center for Joint Replacement (TCJR; Plano, Texas), where approximately 95% of hip or knee arthroplasty patients now go home either the same day or the next day.

Nevertheless, such a shift requires investment and commitment. For example, TCJR has evolved its practice through a 10-year process to maximize the success of outpatient and short-stay arthroplasty procedures. Robust screening to ensure selection of appropriate patients; preoperative patient preparation, including setting appropriate expectations; modification of surgical approaches where appropriate; and proactive, multimodal pain management have all been integral components of this evolution.

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# Clinical and Administrative Approaches to Improving the Efficiency of Joint Arthroplasty and Reducing Hospital Length of Stay

Robert E. Booth, Jr, MD

## Abstract

In the current health care environment, it is more important than ever for orthopedic surgeons to strive for optimal efficiency and effectiveness. For maximum efficiency, patients can be preselected to limit patient types that commonly require a greater investment of the practice's time and resources. Structuring surgical practices for efficiency may involve rethinking the staffing model, anticipating problems that may occur with individual patients, and enhancing internal and external communications. Turnover time between patients must be measured and minimized, and activity in the operating room—including the surgeon's own technique—must be evaluated and refined where necessary. Clinical advances that can enhance efficiency should be considered. Among such advances are tranexamic acid, intravenous acetaminophen, and bupivacaine liposome injectable suspension (EXPAREL®, Pacira Pharmaceuticals, Inc). Intravenous acetaminophen and liposomal bupivacaine, in particular, can significantly improve efficiency by reducing the administration of opioid medication during the postoperative period, and thereby reducing opioid-related side effects. Liposomal bupivacaine has also been shown to shorten the hospital length of stay and, in many cases, eliminate the need for costly and inefficient nerve blocks.

Medicine has today, in some ways, entered a new era that requires health care professionals, including orthopedic surgeons, to change some of the ways they have been practicing. The factors that have pushed medicine in the direction that it is now moving, such as the Patient Protection and Affordable Care Act of 2010, appear to be based less on science and more on economics and politics. If orthopedic surgeons are to provide their patients with the same quality of care in this environment, they must become more efficient and more effective.

Improving efficiency requires setting clinical practice goals. These might include, for example, operating 100 days per year, spending 2 days a week in the office, and seeing 35 to 40 patients on each of those days. Those patients seen in the office might include 10 new patients who are interested in arthroplasty.

## Patient Selection for Improving Efficiency

For maximum efficiency, patients can be preselected to limit patient types that commonly require a greater investment of the practice's time and resources. Insurance compensation and legal liability cases would be excluded, and patients younger than 50 years of age would also be excluded unless they have sent radiographs in advance to ensure that their condition is one that the orthopedic surgeon can treat. Patients weighing over 300 pounds are more prone to complications that reduce efficiency.[1] And it can be difficult to provide satisfactory knee revisions within 1 year of the initial surgery.

An important part of practicing efficiently and evaluating how patients are likely to respond to treatment is quantifying their degree of arthritis. Thus, every new patient should be graded in a meaningful and reproducible way, such as the following:

1 = Arthroscopy
2 = A patient who might go home in 23 to 24 hours
3 = Standard, average knee
4 = A slightly more complicated situation, such as a valgus knee
5 = A person weighing over 300 pounds, or a knee revision

## Structuring the Surgical Practice for Success

Most challenges in joint arthroplasty can be anticipated. Therefore, one highly effective activity is a weekly meeting to review every patient scheduled for surgery during the following week, to ensure that all necessary documentation has been completed, and to identify any specific challenges that each patient may present.

**Author's Disclosure Statement:** The author reports no actual or potential conflict of interest in relation to this article.

Good communication is almost universally important, and another highly effective activity is for the surgeon to telephone every patient the evening before the procedure. Patients should not be expecting the call, in part because they will be waiting with an extensive list of questions that are best handled in person, but also because the surprise nature of the call enhances the relationship between the patient and the clinical team.

The ultimate goal for every surgeon, to be optimally efficient, is to use 2 operating rooms. By doing so, the surgeon can move from patient to patient without delay. But such a setup generally is not feasible. Therefore, turnover times must be closely monitored; the goal is to achieve the shortest possible time from applying the dressings to one patient to making the incision in the next patient.

Sometimes, however, the surgeon or the surgical process is the limiting factor. Speed of surgery influences both efficiency and outcomes.[2,3] It has been shown that complications are related to the length of surgery. The risk for infection and deep vein thrombosis, in particular, have been shown to increase as the duration of surgery increases. Although it may seem counterintuitive, higher surgery volume tends to produce lower complications and superior outcomes. This means that the procedure itself, within the operating room, must be tightly choreographed, and any factors that detract from surgical speed must be eliminated wherever possible. Even the way that surgical instruments are presented can cost precious time. They are typically handed to the surgeon like a fork across the dinner table. For optimal speed, every instrument should be introduced into the field in the position that it is going to be used.

Given the advances in analgesia over recent years, justification no longer exists for waiting until arthroplasty patients are experiencing postoperative pain and then administering rescue medication. Doing so is both inefficient and ineffective. Well-designed, balanced multimodal analgesia regimens are administered on a scheduled basis in a way that efficiently preempts reestablishment of pain pathways.

## Clinical Drivers of Improved Efficiency

One of the most important pharmacologic advances in terms of improving the efficiency and effectiveness of arthroplasty during recent years has been the introduction of tranexamic acid. In most instances, the use of tranexamic acid has completely eliminated the need for preoperative blood transfusions.

Anesthesia and analgesia are also critical factors in improving efficiency, and another key advance has been the introduction of intravenous acetaminophen. Although acetaminophen has only weak anti-inflammatory properties, intravenous administration of this analgesic agent can reduce opioid requirements and opioid-related side effects that can compromise efficiency.

The most significant advance, however, has been the introduction of bupivacaine liposome injectable suspension (EXPAREL®, Pacira Pharmaceuticals, Inc). This agent is a long-acting local analgesic that can be administered directly into the surgical site by the orthopedic surgeon. By providing effective analgesia for as long as 48 to 72 hours, depending on the individual patient's metabolism of the drug, liposomal bupivacaine significantly reduces the need to administer opioids and shortens the length of time to discharge. Liposomal bupivacaine also can markedly improve efficiency in some patients by replacing nerve blocks, which are costly and slow the surgery. When nerve blocks are considered necessary, an induction room should be provided for the anesthesiologist so that the blocks do not have to be performed in the operating room.

## Summary

In an era when factors that are changing the practice of medicine are increasingly based on economics and politics, it is incumbent on orthopedic surgeons to become more efficient and more effective if they are to maintain the same quality of care that they have come to provide in recent years. Embracing 3 fundamental principles makes it possible to improve efficiency and effectiveness without compromising the quality of care: limiting patient types that commonly require a greater investment of the practice's time and resources, rethinking practice structure and procedures to streamline patient management, and leveraging clinical advances—especially new medications—that contribute to improved outcomes and efficiency.

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