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Goals and Objectives to Optimize the Value of an Acute Pain Service in Perioperative Pain Management

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Abstract

As newer pharmacologic and procedural interventions, technology, and data on outcomes in pain management are becoming available, effective acute pain management will require a dedicated Acute Pain Service (APS) to help determine the most optimal pain management plan for the patients.

Goals for pain management must take into consideration the side effect profile of drugs and potential complications of procedural interventions. Multiple objective optimization is the combination of multiple different objectives for acute pain management. Simple use of opioids, for example, can reduce all pain to minimal levels, but at what cost to the patient, the medical system, and to public health as a whole?

Many models for APS exist based on personnel's skills, knowledge and experience, but effective use of an APS will also require allocation of time, space, financial, and personnel resources with clear objectives and a feedback mechanism to guide changes to acute pain medicine practices to meet the constantly evolving medical field. Physician-based practices have the advantage of developing protocols for the management of low-variability, high-occurrence scenarios in addition to tailoring care to individual patients with high-variability, low-occurrence scenarios.

Frequent feedback and data collection/assessment on patient outcomes is essential in evaluating the efficacy of the Acute Pain Service's intervention in improving patient outcomes in the acute and perioperative setting.

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Introduction

Our nation's medical leaders recognized and mandated the reduction of pain scores towards the end of the last millennium. Unfortunately, while the goal was worthy, the pathway that pain management in the United States followed contributed to the tragic outcome that is the opioid epidemic [1].

Effective acute pain management with minimal morbidity and mortality and that allows our patients to become functional members of the community requires more than the prescription of opioids. Unfortunately, pain management is wide in scope of practice, but minimally taught in medical schools. Pain management designed to optimize functional outcomes after surgery requires an in depth knowledge of the types of pain, pain trajectories, pharmacology of the different analgesic agents, and interventional pain management (regional anesthesia) and its role in multimodal analgesia. Acute pain should not be considered only as a symptom, but rather a pathophysiologic process [2].

Acute pain management is a discipline. Its effective implementation requires a structured Acute Pain Service (APS) with meaningful goals and objectives and the allocation of the necessary resources in order to provide it with the flexibility to not only meet those goals on an individual level (customized patient care), but to also influence outcomes on a higher, more systems-based level. In addition, the APS is a product that must evolve to meet the constantly ever-changing medical environment.

This chapter will delineate the tactical and strategic objectives of a hospital-based APS as it pertains to perioperative pain management (for all surgical disciplines), explore the different goals when determining how to optimize pain management, describe the potential APS implementation models, and explain how a well run APS can not only tailor pain management regimens to individuals based on their specific needs but also influence the morbidity of poorly managed pain from a public health perspective.

Tactical and Strategic Objectives of an Acute Pain Service

The implicit goal of the APS is reduction in the intensity of acute pain. Theoretically, and from the perspective of a single objective optimization problem, this is an incredibly simple task, as nearly all patients will cease complaints of pain given sufficient quantities of opioid. Yet clinical experience immediately demonstrates that the decisions guiding acute pain management are NOT simple problems of optimizing single objectives (e.g. pain score), as respiratory arrest is not an acceptable side effect or risk, nor are the myriad other challenges inherent to any analgesic strategy commonly acceptable [3–5].

Acute pain medicine is thus differentiated from simple symptom management by virtue of its goal of multi-objective optimization: decrease pain intensity while simultaneously improving functional capacity [6–8]. In this rubric it is not sufficient to achieve a pain intensity rating of zero in a patient too somnolent to get out of bed; nor is a patient in moderate pain during engagement in aggressive physical therapy a failure of acute pain management. Yet between these two extremes exists a wide range of potential pain/function state combinations, the values of which often remain unclear.

Multi-objective optimization (MOO) is a common challenge throughout all of medicine. Recent therapeutic advances, and evidence in support thereof, have helped transition the APS from an ‘if this then that’ single-objective approach to one that is much more multifaceted and focused on enhancing the overall trajectories of pain and function [9–11]. In many modern implementations this is covered as part of ‘ERAS’ pathways, which commonly maintain a core constituency in optimizing analgesia [12–15].

While recognition of the importance of multi-objective optimization is increasingly common, data to support MOO decisions are not readily available. Evidence is generally constructed at a population level rather than personalized for the individual patient. Further, such evidence often considers either single interventions or general composite practices. While both approaches to formulating evidence in support of treatment are helpful, neither are designed to directly inform personalized decision-making for individual patients [16, 17]. Further, existing frameworks for studying such interventions often do not consider the role of sequential decision making even for single-objective optimization challenges, where prior experience with a given analgesic intervention may alter future analgesic decisions [18–20]. For instance, when confronted with the patient suffering from refractory pain, how does the failure of a given intervention (e.g. high-dose morphine PCA) alter the next analgesic recommendation?

The lack of data on MOO places both surgical teams and APS between proverbial rocks and hard spots. An approach minimizing opioid analgesics may promote a potentially faster recovery, less opioid misuse, lower rates of nonunion [77]....but also a miserable, unsatisfied patient along with a perception of dispassionate care. Contrariwise, aggressive analgesic use may lead to perceptions of compassionate care, yet also lead to slower recovery, increased length of stay, and increased opioid exposure potentially leading to opioid dependence and/or use disorders [21–25]. But which risks apply to which patients? Where in lies the cut-offs in the utility of care offered by different analgesic strategies? For a given patient, what are the tangible, measurable rewards resulting from good analgesia?

One important advance in addressing such shortcomings is the evolving use of patient-reported outcomes (PRO’s) [26, 27]. While pain assessment has historically focused on pain intensity, PRO’s expand the assessment of pain into a multidimensional approach that considers the impact of pain on patient function [28]. One of the more common implementations of PRO’s, the National Institutes of Health’s Patient Reported Outcome Measurement Information Systems (PROMIS), covers domains of physical health, mental health, and social health, thus permitting assessments of pain intensity and pain interference to be considered alongside other relevant domains such as cognitive function, psychosocial illness impact, self-efficacy, and ability to participate in social roles and activities [29, 30]. Given very rationale concerns over increasing survey burden, PROMIS’ development leveraging item response theory and its utilization of computer adaptive testing have made it possible to significantly advance the efficiency of data acquisition, permitting clinically-useful tools that are also linked to more formal research instruments that can aid in translation of research findings.

Despite the considerable advantages of a multidimensional pain assessment, the additional dimensions present a conundrum: if we are unsure how best to optimize a single objective (e.g. pain intensity), are we ready for optimization across multiple PRO's? With the advent of electronic health records, analyses of large mixtures of PRO's, and their associated perioperative decisions, should theoretically supply sufficient material for considering analytical optimizations. However, this approach will require movement beyond traditional statistical methods, instead considering mathematical approaches to decision optimization such as Markovian methods and Q-learning strategies. This may ultimately require a reconsideration of what it means to practice 'evidence-based medicine' by virtue of the need to expand the traditional statistical toolbox of EBM methods.

It is tempting to dismiss this conundrum as a 'big data' problem best left to the data science community. However, as those best positioned to eventually use the potential decisions, physicians can begin laying the foundation on leveraging this framework today. For starters, querying patients on their recovery priorities may offer important insights into perceived barriers and opportunities in enhancing their recovery. This also affords opportunities to reinforce the realities and postoperative recovery, and offer context for realistic expectations following surgery. In making analgesic decisions, such discussions can revisit the agreed-upon priority schedule as evidence of patient-oriented performance.

Current Patient-Oriented Performance Goals

Prioritization of acute pain management goals may vary by practice, but the most commonly used and quantifiable goals include reduction in pain scores balanced against improved physical rehabilitation metrics, reductions in iatrogenic complications, patient satisfaction, shorter length of stay, and optimized cost-effectiveness of treatment.

Compounding the issue of reduction in pain scores as a patient-oriented goal is the difficulty in pain assessment. Numeric and qualitative scales exist to quantify pain, but despite attempts to the contrary, these scales are subjected to various, inconsistent interpretations and personalized to the individual patient. A more balanced approach to the assessment of pain incorporates other aspects of function, such as with the Defense and Veterans Pain Rating Scale (DVPRS) and the DoD/VA Pain Supplemental Questions (Figure 1). This assessment tool focuses on the patient's pain level within the context of other dimensions of wellbeing such as mood and sleep [31]. The DVPRS has been preliminarily validated in the military population.

Many other outcomes are easily quantifiable. For example, the range of motion during physical therapy sessions and the achievement of certain milestones, especially after orthopedic surgery is an easily measured data point. Improved mobilization can influence the incidence of complications such as deep vein thrombosis/pulmonary embolism, prolonged ileus (mostly after bowel surgery) or arthrofibrosis.

The growing popularity of patient satisfaction surveys has contributed to the perception that satisfaction is an acceptable global measure of healthcare quality. This is despite very poor correlation between outcomes and patient satisfaction scores. [32]. Because Medicare

reimbursement currently is based on patient satisfaction, it needs to be addressed. Patient satisfaction is strongly influenced by physician-patient communication, continuity of care, and staff responsiveness [33–35]. Interestingly, the development of a hospital-acquired condition was not associated with decreased satisfaction scores, and but rather to the response to such a condition [36]. While patient satisfaction should not be the primary goal, its measurement may be used as a crude gauge of medical provider responsiveness to the patient's pain and effective communication between the patient and the medical providers

Implementation Models for the Acute Pain Service

Acute Pain Services usually start out as a rudimentary group of individuals with technical prowess in regional anesthesia (“stochastic model”), but can evolve to a well-planned and interdisciplinary organization of individuals who operate with defined objectives, resources and team members (“deterministic model”) [2]. In the stochastic model, acute pain management is usually offered in the setting of perioperative pain management, and interventions, such as nerve blocks, are performed out of necessity or enthusiasm by a few medical providers.

Once the benefits of acute pain management is recognized by the institution, resources are then allocated to the further development of an APS with a deterministic model, which incorporates protocols and systems-based practice to allow for more efficient and consistent care of the patient. An APS with a deterministic model has the capability to stratify patients into low-variability, high-occurrence, protocol-based management (less labor-intensive resource allocation) and high-variability, low-occurrence, individualized care (more intensive resource allocation) in order to better allocate resources [2].

Though APS is variable in its structure across institutions, it is mainly either physician-led or nurse led. A nurse-led APS tends to focus on standardization of pain assessment/management, patient education, research and auditing and occurs when a physician is not available to lead the APS. In this model, a physician pain specialist can assist with education of medical providers and practice-based recommendations for protocol implementation [37].

However, an APS benefits from physician leadership, especially one in which the physician owns a skill set that includes, but is not restricted to, regional anesthesia (RA). A physician-led APS can provide expertise to address the more complex patient scenarios such as acute-on-chronic pain, addiction, and palliative care, consulting the relevant specialists as deemed appropriate. In addition, the physician can optimize the risk-benefit ratios of interventional and pharmacologic pain management modalities for individualized care of the patient. The physician team that understands the expected pain trajectory is more apt to determine and act upon the differential diagnosis for undermanaged pain (e.g., breakthrough pain from compartment syndrome, incorrect location of indwelling regional anesthetic catheter, inappropriate dosing of analgesics based on patient comorbidities).

For an APS to be effective in managing pain and add value in the institution, there are basic requirements it must satisfy [37].

1. Availability of pain management specialists to provide consultation and intervention for severe acute pain around the clock
2. Regular assessments of pain severity at rest and with movement. In an APS that provides RA, this includes rounding (more than once a day) to assess efficacy of interventional modalities and reduction of side effects of analgesic modalities
3. Pathway development with surgical teams, ward nurses and consultant services (PT/OT), pharmacy to assist patients with goals for functional recovery and pain management
4. Continued education of all medical providers on safety, efficacy, and fiscally-sound analgesia
5. Patient education of pain assessment, available treatment options and their potential adverse effects, and appropriate expectations for analgesia
6. Quality control through auditing on APS performance in order to determine effectiveness and adverse events from analgesic intervention in order to make decisions and affect any changes to pain management protocols and plans

Which specialty should lead the APS? With training in multimodal analgesia, opioid pharmacology, and regional anesthesia, anesthesiologists (specifically individuals who are fellowship trained in Acute Pain Medicine and Regional Anesthesiology) would be most suitably prepared for the safe and effective implementation of an APS.

The same group of physicians that performs the intervention must be the individuals that follow-up on the patients during rounds in order to avoid issues with (dis)continuity of care and lack of ownership. For instance, some models of APS have the non-pain specialist anesthesiologist in the operating room perform an epidural while the APS or chronic pain team follows up on the patient. These models may result in less optimal management of the patient's pain due to lack of uniformity in practice. Patient follow-up also allows the APS to help the primary surgical team to determine optimal pharmacologic intervention, such as recommendations for non-opioid pain medications (acetaminophen, non-steroidal anti-inflammatory agents, NMDA antagonists, neuropathic agents, muscle relaxants, and alpha-2 agonists) as well as more effective choice and dosing of opioid medications. Whether the APS is responsible for pain medication prescription or the surgical team is the primary prescriber of pain medications (with recommendations provided by APS) should be an agreement between APS and the primary service since preferences, and coordination, vary widely among different surgical teams. In general, having the APS manage all pain prescriptions allows for more seamless transitions from regional analgesia to systemic pain medications but may lead to significant safety issues if the care is not coordinated appropriately. In addition, APS can assist the primary service in safer opioid prescription practices. Regardless, it is incumbent upon the APS to follow patients beyond the recovery room and monitor progress even in the case of arrangements whereby the APS does not order followup analgesics; otherwise, the APS has no mechanism to both understand the longer-range impact of their interventions, nor obtain the patient-specific feedback that is critical to improving global performance.

The development and sustainability of a well-organized APS does require appropriate resource allocation. Allocation of time, space, personnel, equipment and money should be based on efficiency, safety, and cost-effectiveness in improving patient outcomes.

Dedicated time not only involves the extra time that regional anesthetics are performed outside of the operating room setting, but also dedicated time to the APS members to round and consult on patients. Time includes the earlier arrival time of patients prior to surgery if a regional anesthetic is part of the multimodal pain management plan in order to avoid intraoperative time delays. Procedures should be placed preoperatively prior to surgery for two reasons. First, intraoperative anesthetic doses for general anesthesia and even neuraxial anesthesia may be reduced with well-placed preoperative nerve blocks, thereby reducing the side effects of these intraoperative anesthetic modalities. Secondly, placing a block in the postoperative period when the patient is in pain poses many difficulties. Postoperative sedation for a patient who is in pain in order to perform a procedure may result in apnea after the regional anesthetic removes the inciting pain; similar issues may emerge due to lagging effects of intraoperative or pre-block analgesics already administered in the recovery room. Regardless, these problems will inevitably lead to longer recovery room stays that can readily lead to OR's unable to leave the room at the end of the case due to full recovery rooms. In addition, placement of postoperative blocks in the recovery area will result in less efficient use of the recovery area when timing of the postoperative block is not predictable. APS members need time for administrative duties (billing, protocol creation and modification, committee roles), educational activities (both continuing medical education for the APS member and education of non-pain specialist medical providers and patients), and research efforts (quality improvement projects).

Dedicated space is a location where procedures can be performed with all the necessary equipment (ultrasound, kits, local anesthetics, nerve stimulators, airway devices, etc) and monitoring capability (e.g. capnography, electrocardiography, blood pressure). Performing regional anesthetics in the operating room is an inefficient and costly practice. A dedicated procedural space adjacent to the preoperative holding area can also function as an expanded preoperative holding area if the rooms are not being utilized for procedures. In addition to clinical space, individual office space is needed for the performance of administrative duties and meeting space for interdisciplinary, educational, or research meetings.

Core personnel in an APS may vary by need and accessibility of different disciplines. However, the basic APS unit will require input from physicians and nurses specialized in acute pain management. Pain resource nurses can help educate and interface with patients and other medical providers, standardize protocols for pain assessment and documentation, and collect data, which includes the identification of adverse outcomes from pain management (or lack of). If interventional techniques are offered as part of multimodal analgesic regimens, then nurses familiar with procedures and sedation must be trained appropriately to perform time-outs, administer sedation, apply appropriate monitoring, and recognize procedure-related side effects.

A truly functional APS requires multi-disciplinary input from many specialties, while not necessary to round on a daily basis with the APS team, can provide valuable input to

systems-based practice. These other specialty members include surgeons, primary care physicians, pharmacologists, physical and occupational therapists, psychiatrists, addiction specialists, palliative care providers, and equipment technicians.

Personalized Care

While evidence-based protocols can be created to provide a framework for acute pain management specific to certain surgeries or conditions, they do not factor in the different comorbid conditions of each patient. Just as no one-shoe size fits all, acute pain management must be tailored to the individual patient to optimize the risk: benefit ratio of specific pain management modalities. Conditions such as opioid use disorder, central sensitization, opioid tolerance, obstructive sleep apnea, infection, organ system dysfunction (cardiovascular/ pulmonary/hepatic/renal/ gastrointestinal/ neurologic/ hematologic/ musculoskeletal/ psychiatric), and cancer will each pose different challenges towards effective pain management while minimizing pharmacologic and procedure-related complications. For example, should a patient with previous history of opioid abuse currently being managed for addiction on buprenorphine be admitted for elective joint arthroplasty, the APS can coordinate buprenorphine dosing with the addiction specialist, recommend either buprenorphine continuation or discontinuation prior to surgery (and offer guidance on perioperative opioid management in either case), and help the primary team implement the most effective multimodal analgesic techniques to avoid the potential for re-addiction (regional anesthesia with use of non-sedating analgesics, avoidance of opioids on an as-needed basis).

Recently, the use of the pain trajectory, which characterizes the course of the patient's pain over time, has led to increased insight into the course of postoperative pain [10, 11, 38]. Anticipating the pain trajectory for individual surgical procedures, physicians may then tailor the duration of analgesic techniques (e.g. catheter as opposed to single injection regional anesthetic). Not all patients have declining pain scores with time after undergoing an operation. In fact, a large proportion of patients have pain scores that remain the same or even increase with time. Recent studies have demonstrated that age, gender, type of surgery, and preoperative chronic opioid use influences the postoperative pain course [39, 40].

The personalized care of the patient benefits from a physician-based APS team with the clinical knowledge and experience to adapt pain management techniques to the individual patient's medical profile, to constantly elicit feedback about the efficacy of analgesic techniques (in order to provide a differential diagnosis and respond appropriately to undermanaged pain), to recognize those patients risk factors for persistent pain after surgery/ trauma, to anticipate potential shortcomings of analgesic techniques based on patient comorbidities, and to enable a smooth transition from the inpatient to outpatient setting with regards to appropriate analgesic prescriptions (may involve communication with outpatient nursing entities, rehabilitation centers, or hospice).

Public Health Considerations

Opioids

In the treatment of acute post-surgical pain, opioids are a mainstay in treatment. Though effective in pain control, they are tainted with numerous and undesirable side effects. These side effects not only increase the morbidity and mortality of the patient, but also the overall cost of health care. The APS can help to limit these negative outcomes with balanced multimodal drug and interventional regimens.

Opioid-related adverse drug events (ORADEs) can cost a great deal to treat and consequentially result in an extended hospital stay; promoting increased depletion of health care resources [41]. The incidence of ORADEs ranges from 1.8% to 13.6% with an increased cost of 7.4% to 47% when comparing patients with ORADEs to those without [42,43]. Not only is monetary cost increased, but real danger exists to the patients, with patients who have ORADEs experiencing a 1.9 to 3.4 times greater risk of mortality [42, 44].

The occurrence of opioid-associated nausea and/or vomiting can range from 1.8% to 16%, and the resultant cost increase for a patient with nausea/vomiting ranges from 10.1% to 215% [41]. Regarding constipation, there is 30-70% reported incidence [45]. These unfavorable gastrointestinal events can contribute to treatment cessation [46]. To decrease unfavorable gastrointestinal-related events, data has shown that 13% of those surveyed stopped their opioid therapy while being treated for acute pain, and 16% reduced the dosage [47]. A correlation exists between inadequate treatment of acute pain and an elevated risk of chronic pain development [46], sleep impairment, and even the development of psychological sequelae such as post-traumatic stress disorder and depression [48, 49]. Unmitigated postoperative pain can decrease mobility of the patient, increasing complication risks such as deep venous thrombosis, pulmonary embolism, or pneumonia, all of which can contribute to the overall increase in cost of patient care [50].

Most importantly, we must account for opioid's effect on respiratory drive. A review of the anesthesia closed claims analysis revealed respiratory depression was implicated on some level in 92 claims from 1990–2009, of these 77% resulted in extensive cerebral injury or even death. Of the respiratory depression events that occurred, 88% were within 24 h of surgery, and 34% involved concurrent nonopioid medications with sedating effects such as gabapentanoids [51]. In another study, Weingarten et al reported the incidence of post-operative, opioid-induced respiratory depression as 1.6 *per* 1,000 with 58% occurring within 12 hours of release from anesthetic care. In this study, the presence of obstructive sleep apnea was found to increase this risk [52].

Uncontrolled and persistent acute pain has been linked to chronic pain; associated with this are clinical, psychological, and social concerns involving the limitation of complex activities, decreased work performance, decline in quality of life, and stigma [53]. In the 1990s, leading pain medicine specialists pushed for improved management of pain, which was supported by randomized clinical trials [54,5] short-term effectiveness of pain reduction and improved function in noncancer nociceptive and neuropathic pain with short duration

(less than 12 weeks) opioids regimens. There was a surge in opioid prescriptions in the United States with a per capita increase in prescriptions of 7.3% from 2007 to 2012 [56]. With the escalation in the number of prescriptions, the undesirable sequelae of opioid use skyrocketed as well. Serious adverse effects included opioid use disorder (addiction) and overdose (hypoxic brain injury, death). More than 165,000 individuals died from opioid related overdose in the United States between the years of 1999 and 2014 with multiple resulting Morbidity and Mortality reports published by the CDC in the past decade acknowledging the increased burden of opioid use in the United States [1, 57–64]. As perspective, while the incidence of cancer and heart disease (leading causes of death in the US) have decreased markedly over the last decade, the rate of deaths tied to opioid pain medication has substantially increased [65]. In the attempt to better provide analgesia and reduce the acute to chronic pain transition, opioids must be prescribed judiciously and responsibly.

Chronic Post Surgical Pain

Chronic Post Surgical Pain (CPSP) is a serious health concern, due to the extended usage of post-operative opioids along with analgesic adjuvants (i.e. gabapentinoids) possibly resulting in dependence and addiction [66, 67]. Moderate to severe pain continuing for a minimum of three months following all surgeries occurs in 6% to 10% of patients [68] and approximately 20% of patients following total joint arthroplasty [69]. CPSP can have a noteworthy effect on quality of life. Measurements taken using the Short Form Health Survey (SF36) has shown those with CPSP after arthroplasty of a total joint have a notably decreased quality of life [70]. Central sensitization can also play a part in the level of pain both pre and postoperatively [71, 72].

Althaus et al developed an index highlighting five predictors contributing to CPSP: pain at the operative site prior to surgery, any pre-existing chronic pain in the body, uncontrolled post-operative pain, capacity overload, and coexisting symptoms of stress [73]. High dose opioids taken preoperatively makes the risk of increased pain and protracted recovery more likely [74]. The use of low dose and/or weak opioids (tramadol) may induce hyperalgesia prior to surgery and serve to intensify postoperative pain [75].

Evidence suggests that pain predicts pain [76], whether that relationship is preoperative pain to postoperative pain, postoperative pain to CPSP, or most importantly, making the progression from preoperative pain and traversing all the way to CPSP.

Effective acute pain management with the use of balanced analgesia can be performed with the leadership of an APS in order to not only tailor the correct analgesic regimen to individual patients, but also to influence outcomes on more global issues such as the ORADEs, the opioid epidemic, and CPSP.

Putting it all Together: APS in Orthopedic Surgery

Elective Joint Surgery

For low-variance, high-volume elective surgeries, due to the consistent perioperative course of these patients, the APS can create specific protocols and frameworks to promote efficient

patient care. These frameworks would include the type and duration of regional anesthetic, intraoperative optimization of pain and minimization of anesthetic side effects, and postoperative multimodal analgesics (see Table 1 for a sample guideline).

Protocols allow medical staff to know what to expect and allow for a routine. They allow for better preparedness so that on the day of the surgery, enough nursing and staff resources will be allocated to the procedural suite to minimize delays in the patient arriving in the operating room. The minimization of variance permits more reliable scheduling and resource allocation, together enhancing economic efficiency of the elective total joint service line. Protocols also allow for monitoring of process measures; tracking of iterative changes to protocols can further demonstrate which specific tasks yield significant improvements to patient care.

Should practice changes occur, such as the implementation of enhanced recovery after surgery (ERAS), the APS can likewise adjust protocols that would support that mission, such as conversion of a sciatic nerve block for knee arthroplasty to an iPACK block.

Trauma Surgery

In cases of orthopedic trauma, pain management must be individualized to the patient, their comorbidities, and their anticipated perioperative course. An APS can contact the trauma surgeons to discuss patients that may benefit from regional anesthetic techniques to minimize pain, even well before the patients are scheduled for the operating room. Patients with traumas of limbs in which frequent visits to the operating room are anticipated can be managed comfortably with continuous nerve catheters if the injuries are isolated to the limbs (See Table 2 for regional anesthetic techniques for limb trauma). Thoracic epidural or paravertebral blockade for patients with rib fractures or exploratory laparotomies, whose pain prevents them from optimizing their oxygenation and ventilation, can simultaneously improve comfort while potentially minimizing post-trauma complications.

In addition, patients at risk for compartment syndrome should have a steady and analgesic level (not too dense) of a local anesthetic infusion that does not mask the excessive pain or motor dysfunction that may be markers for the diagnosis of compartment syndrome. Performed well and with appropriate oversight, this approach may even allow for earlier detection of compartment syndrome pathophysiology by better defining pain due to somatic surgical pain (present in an poorly-functioning block) versus ischemic pain occurring despite otherwise intact somatic sensory blockade. In the case of a patient complaining of pain in the absence of a block, baseline probabilities favor existence of anticipated somatic pain that is often treated with several rounds of escalating doses of opioids which may delay recognition of observed pain intensity out of proportion to the anticipated postoperative course. In addition, continuous nerve block catheters must be tunneled well away from the surgical site.

This patient population also may, in certain circumstances, have a higher incidence of substance abuse (opioid/cocaine/alcohol) which poses different challenges for pain management. Patients with current opioid abuse will have a high tolerance to opioids and rely on different analgesic modalities for effective pain management.

Orthopedic oncology

In orthopedic oncology, the type and extent of surgery is often quite different for each patient, and APS communication with the surgical team prior to surgery is very crucial in offering the correct regional anesthetic and pain management plan. Excision of larger soft tissues may benefit from single injection or continuous regional anesthetic techniques. For excision of bony tumors, continuous techniques would allow for superior analgesia. In patients whose anticipated surgery in large (hemipelvectomy, forequarter amputation, rotationplasty), multiple continuous catheters may be needed to provide complete coverage and neuropathic medications/mirror therapy/NMDA antagonists may need to be initiated earlier in the course of pain management in order to reduce the potential for phantom limb pain. And in the case of inoperable orthopedic malignancy, the APS can still provide the patient with pain relief and organize with the patient and their family a discharge pain management plan for end-of-life care. Further work is necessary to highlight the potential role of regional anesthetics in minimizing tumor growth and metastatic progression via immunomodulation through mu-opioid and adrenergic receptor-mediated pathways.

Future of APS

In recent times, much of the focus of research in acute pain has focused on regional anesthesia, where public and publishing incentives often favor development of ‘new’ nerve block needle placements and trajectories. While there has also been growing attention in recent times to interventions which modulate the kinetics of a nerve block, these areas of focus miss some very important points to address

- Which patients are best served by which type of block (or which pharmacologic analgesic intervention)?
- How long should performed blocks (or any analgesic intervention) last?
- At what intensity should analgesia be to optimize both analgesic efficacy and safety?

No matter how novel or helpful the block, the block will fail to realize its full potential if the parameters for optimal use cases are not fully elucidated. Given this, the most striking advances yet to come are probably not very...striking. Rather, the most impact will likely follow methodological incorporation of acute pain medicine principles into broader frameworks of perioperative care.

Ongoing refinement of block processes, along with education and technological advances surrounding block placement, will continue to make simple nerve blocks simpler. Variations of old interventions are nothing new...but application and additional considerations, as well as new teams with different training backgrounds and practice cultures, nevertheless lead to increasing complexity necessitating further sub-specialization in acute pain medicine.

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DoD/VA PAIN SUPPLEMENTAL QUESTIONS

For clinicians to evaluate the biopsychosocial impact of pain

1. Circle the one number that describes how, during the past 24 hours, pain has interfered with your usual **ACTIVITY**:

0 — 1 — 2 — 3 — 4 — 5 — 6 — 7 — 8 — 9 — 10
Does not interfere Completely interferes

2. Circle the one number that describes how, during the past 24 hours, pain has interfered with your **SLEEP**:

0 — 1 — 2 — 3 — 4 — 5 — 6 — 7 — 8 — 9 — 10
Does not interfere Completely interferes

3. Circle the one number that describes how, during the past 24 hours, pain has affected your **MOOD**:

0 — 1 — 2 — 3 — 4 — 5 — 6 — 7 — 8 — 9 — 10
Does not affect Completely affects

4. Circle the one number that describes how, during the past 24 hours, pain has contributed to your **STRESS**:

0 — 1 — 2 — 3 — 4 — 5 — 6 — 7 — 8 — 9 — 10
Does not contribute Contributes a great deal

*Reference for pain interference: Cleveland CS, Ryan KM. Pain assessment: global use of the Brief Pain Inventory. *Ann Acad Med Singapore* 23(2): 129-138, 1994.

v 2.0

Figure 1.
Department of Defense and Veterans Pain Rating Scale (DVPRS) Supplemental Questions

Table 1**Frameworks for Total Joint Arthroplasty**Preoperative:

- 1 Continuous cervical paravertebral catheter (C5-6) for shoulder arthroplasty, continuous femoral catheter and single injection sciatic nerve block for knee arthroplasty, continuous lumbar (L1-2) epidural or lumbar paravertebral for hip arthroplasty
- 2 All continuous peripheral nerve catheters will be loaded with 20 milliliters of ropivacaine 0.5% in divided doses, all epidurals will be loaded with 10ml of ropivacaine 0.5% in divided doses
- 3 All continuous catheters will be attached to infusion pumps with ropivacaine 0.2% to be set at a basal infusion of 5ml per hour with a patient-controlled bolus of 5ml every 60 minutes as needed for pain

Intraoperative:

- 1 General anesthesia for total shoulder arthroplasty, spinal anesthesia with sedation for knee arthroplasty (lower spinal dose if patient to be discharged on the day of surgery), epidural anesthesia with sedation for non-revision hip arthroplasty (general anesthesia for revision hip arthroplasty)
- 2 Bladder catheterization should only be reserved for revision surgery or for patients with a need for intraoperative urine volume monitoring
- 3 Intravenous acetaminophen 1 gram one dose
- 4 Intravenous ketorolac 30mg
- 5 Intravenous dexamethasone 0.1mg/kg
- 6 Anti-emetic prophylaxis with intravenous ondansetron
- 7 If possible, limit intravenous fluids to less than 1 liter
- 8 If patient with chronic use of opioids, consider 0.1–0.3mg/kg ketamine

Postoperative

- 1 APS checks on patient in the recovery area, confirm that the patient has satisfactory pain control, confirm knee immobilizer if patient had femoral block
- 2 Patient education on the bolus option for nerve catheter
- 3 Celebrex 100–200mg orally bid scheduled for pain
- 4 Acetaminophen 1 gram orally four times a day (2 to 3 times of day if patient is greater than 75 years old) scheduled for pain
- 5 Tramadol 50mg every 8 hours as needed for pain ordered
- 6 If pain is not adequately managed with tramadol, acetaminophen and celecoxib, then oxycodone 5–10mg as needed every 4 hours may be given for pain.
- 7 If the patient's pain is not adequately controlled despite these modalities, contact the Acute Pain Service
- 8 Anticipated discharge date of shoulder arthroplasty—the day after surgery unless otherwise specified. Patients are discharged home with ambulatory pump for their cervical paravertebral catheter. Anticipated discharge date for knee and hip arthroplasty is three days after surgery. Regional anesthetic infusion to be removed on the second day after surgery to allow for titration of opioid analgesics.
- 9 Upon discharge, patients will be given scripts for a 3 week supply of either tramadol or oxycodone

Table 2

Location of surgery or trauma	Type of Regional anesthetic
Shoulder , Proximal humerus	Cervical paravertebral or Interscalene
Distal humerus	Cervical paravertebral or proximal infraclavicular
Forearm, wrist, hand	Supraclavicular or proximal infraclavicular
Femoral neck fracture or femoral shaft fracture	Femoral catheter tunneled cephalad
Patellar fracture	Femoral catheter
Tibial Plateau fracture, tibial shaft fracture	Femoral and sciatic catheter, infusion only