The Society for Vascular Surgery Expert Consensus Statement on Pain Management for Vascular Surgery Diseases and Interventions

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The Society for Vascular Surgery Expert Consensus Statement on Pain Management for Vascular Surgery Diseases and Interventions

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INTRODUCTION REGARDING PAIN MANAGEMENT IN VASCULAR SURGERY DISEASES AND INTERVENTIONS

In 1996, the American Pain Society (APS) introduced the concept of "pain as the fifth vital sign." This concept was accepted by several nursing societies and healthcare accrediting bodies to move towards early recognition and potential undertreatment of pain. The use of oral opioids was encouraged by national accrediting organizations, including the Joint Commission.[1] This trend peaked when the Federation of State Medical Boards recommended physicians be fined for the undertreatment of pain in 2004.[1] From 1990 to 2010, there was a four-fold increase in prescription of opioid analgesics in the US, and in 2012 almost 7% of US adults reported use of a prescription opioid in the prior 30 days.[2] Consequently, despite being only 5% of world's population, the United States consumes 80% of the world's opioids.[3]

With this historical perspective, it should not be surprising that the management of pain surrounding surgical procedures is a major topic of discussion among surgeons, surgical training programs, and surgical societies. Data regarding pain management specific to vascular patients, in particular, is lacking and is generally extrapolated from other surgical specialties. Thus, the guidelines in this document are a step towards the contribution of a "vascular voice" in the management of periprocedural pain. Recommendations introduced below will be as evidence-based as possible along with expert consensus when indicated. Notably, in 2023, the American College of Surgeons Vascular Verification Program (as a Society of Vascular Surgery Quality Program) addressed pain management in their hospital standards[4] and these have been referenced in this document including recommendations for:

1. *Dedicated pain management teams* with the ability to place nerve blocks and epidurals for acute pain management.
2. *Standardized processes* to include but not limited to:
    - *Preoperative optimization/surgery-readiness protocols for high-risk patients*…to assess multimodal patient needs, including nutrition, medication use, smoking cessation, and *pain control*, and
    - *Discharge and post-discharge protocols* to ensure *safe pain and wound management*, appropriate follow-up, and continuity of care
3. *Postoperative education* for the

- *Explanation of the expected course of postoperative care, including instructions regarding* wound management, diet, medications, *pain management*, lifestyle, and physical activity modifications
- *Signs and symptoms of complications* such as tachycardia, fever, shortness of breath, *excessive pain*, and vomiting, including when and whom to call, and
- Ongoing involvement in *treatment planning and access to care coordination*

Note: It is important for reference that in this document, the term "vascular care team" is defined as any member of the comprehensive vascular surgery team (surgeon, physician, physician assistant, nurse practitioner, nurse, surgical trainee, etc.) that provides treatment of pain for patients—including both non-interventional and interventional modalities for diagnosis, evaluation, treatment, and surveillance. As guided in this document, the ideal pain management approach in vascular surgery needs to include a team, as pain management in vascular surgery patients is often not episodic but occurs across the continuum in vascular surgery care, and often includes substantial reliance on advanced practice providers as integral members of those teams. This will involve a significant time commitment, sometimes through the lifetime of the vascular surgery patient. Thus, vascular surgery team members beyond the surgeon may have expertise and the time to offer for best pain management approaches and outcomes for the patient.

With such a well-defined team, philosophy, and approach, it is imperative that vascular care teams and hospitals that support vascular care engage in and address pain in the many settings and situations in which it occurs, for best practices and quality improvement. The recent organizational recommendations and the recognition that vascular teams need guidance regarding pain management were the motivations for this document. This document will therefore serve as a working outline to focus on the options for pain management in vascular patients and also will provide a supportive text for vascular surgeons when creating their own local implementation plans, policies, and documents regarding pain evaluation and treatment.

Pain and pain management are important aspects to providing quality vascular disease management as a substantial portion of patients that present for evaluation by a vascular surgeon will already have a chronic pain diagnosis.[5] A single institution study in 2014 concluded that 34% of peripheral arterial occlusive disease (PAOD) patients have chronic opioid use

preoperatively and revascularization only terminates 15% of that use; of concern is that 10% of those PAOD patients who were opioid naive preoperatively began chronically using opioids after the revascularization.[6] Preoperative opioid use in vascular surgery is known to be associated with significant clinical and economic burdens[7] and is associated with increased postoperative pain reporting and a higher rate of readmissions.[8] The above data highlight the need to understand and consider how vascular care teams with a multi-disciplinary approach can develop relationships within a system for quality care in pain management. This paper begins to collate the options and interventions to improve evaluation and management related to vascular pain and to help assure that vascular care teams, despite their best intentions, do not contribute to additional opioid use-related burdens such as loss of employment, mental health crises, motor vehicle accidents, falls, and deaths. An approach that supports trust between patients and surgeons is paramount.

With few randomized controlled trials regarding pain management education for patients prior to any type of surgery, and no trials specific to vascular surgery,[5] recommendations are necessary to insure appropriate and timely pain management plans for all involved.[9, 10] Of significant concern is the possibility of new persistent opioid use after surgery[11] and thus attention to treating pain appropriately and effectively with all available options is paramount for vascular care teams. Included in this goal is findings local and national support with oversight by states with prescription drug monitoring programs (PDMP) and patients' preoperative screening for opioid use and targets for intervention.[12]

Specific in these oversight recommendations are that targeted preoperative education has not been studied in vascular patients. Drawing on beneficial small studies from general surgery,[13] endocrine surgery,[14] and cosmetic surgery,[15] vascular surgery can develop targeted interventions for their own cadre of patients and patient needs. Again, with limited vascular specific evidence to draw from, this document encourages vascular care teams to develop local pain management care plans.

Authors of this paper recommend that all patients scheduled for vascular surgery should undergo procedure-specific education regarding the specific types of pain management that will occur in the hospital as well as after discharge with specific expectations regarding prescription pain

medications and the duration for which they will be prescribed. Patients that are chronically taking opioid analgesics preoperatively should be considered for referral to a chronic pain management specialist if they have not already seen one, and communication and collaboration with the primary care provider is essential. These peri-operative recommendations are supported by the multi-disciplinary clinical practice guidelines published in 2016 by the American Pain Society.[16]

The "PQRST"[17] approach is a useful method to investigate and categorize pain for a vascular etiology. By using the elements of provocation/palliation, quality, region/radiation, severity, and temporal relationships, pain can be evaluated for potential improvement via vascular interventions and also for reliability in outcome measurements and comparisons.

SUMMARY FOR THE INTRODUCTION REGARDING PAIN MANAGEMENT IN VASCULAR SURGERY DISEASES AND INTERVENTIONS

1. Preoperatively, all patients undergoing vascular surgery should undergo procedure-specific, targeted pain management education focusing on expected levels of postoperative pain as well as plans for management including opioid prescriptions and non-pharmacologic adjuncts; the goal for the pain plan should be to not necessarily eliminate pain but improve functionality.
2. The implementation of a vascular pre-operative pain management plan will require facility specific individualization with local experts and staffing as indicated.
3. Patients chronically taking opioid pain medications, if time allows, should be referred to outpatient pain management preoperatively to optimize postoperative opioid management and potentially share in the peri-operative pain adjustments that are unique to each patient and procedure.
4. The "PQRST" approach to evaluate pain is recommended so that educational materials can be developed with local specifications and collaborations. These materials should be provided in writing with specific instructions given for clear documentation including pain expectations peri-operatively.

I. PERI-OPERATIVE CONSIDERATIONS FOR PAIN RECOMMENDATIONS IN VASCULAR DISEASE

A. Pain Management as Part of Enhanced Recovery after Surgery (ERAS) Pathways

Enhanced Recovery After Surgery (ERAS®) pathways are coordinated, multi-disciplinary peri-operative care pathways with the aim of delivering high-quality care and accelerating recovery for surgical patients.[18, 19] The elements of each pathway are designed to make the patient a partner in their own care by educating and clearly setting expectations before surgery. This is of paramount importance for patients with vascular disease, particularly those who are opioid-dependent. Additionally, preoperative medical optimization along with reducing the physiologic stress and maintaining homeostasis during and after surgery speeds convalescence and allows patients to actively participate in returning to health.[18] These pathways are nascent within

vascular surgery,[20] but have been beneficial in many other surgical specialties over the last decade.

Various fast-track or general enhanced recovery pathways have been studied in patients undergoing open aneurysm repair, and the Society for Vascular Surgery in conjunction with the ERAS Society have developed a formally endorsed consensus statement for perioperative care in open aortic surgery and in infrainguinal bypass surgery.[21] Many of the strategies for improving pain management described throughout this document can be facilitated through these ERAS pathways. In non-vascular surgical cohorts, pre-operative education and counseling has been shown to increase adherence to peri-operative protocols, improve post-operative well-being, and decrease post-operative pain scores.[22-24] Furthermore, a key component to ERAS is multimodal pain control.[25] Although effectiveness will need to be borne out in future research specific to vascular cohorts, the current consensus statements for perioperative care include recommendations for preoperative counseling and expectation setting, regional analgesia, multimodal pain control including the use of non-steroidal anti-inflammatory drugs (NSAIDs), early mobilization, and a multidisciplinary approach to pain management, all of which will be discussed in more detail throughout this document.

B. Multimodality and Multidisciplinary Care Plans

Multimodal analgesia is vital in improved recovery after surgery, allowing patients to return to pre-procedure life as quickly as possible.[26, 27] Some key elements include the utilization of acetaminophen, NSAIDs, regional/local analgesia techniques, and other non-opiate modalities.[26] Improved pain management can be achieved with less opioid use with the administration of two or more drugs that are strategically selected to block pain receptors at various locations in the nervous system taking advantage of these synergistic effects.[26, 27]

Depending on the procedure, regional anesthesia with nerve blocks can be effective for pain management and can reduce length of hospital stay and postoperative opiate use.[26, 27] Epidural analgesia may be advantageous in thoracoabdominal and major lower limb surgery.[26] Applying a continuous epidural with or without opioids after open abdominal surgeries was shown to reduce complications in the respiratory system, decrease time for return to bowel function and provide better pain relief compared to intravenous opioids.[26] It has also been shown to cause fewer renal

and cardiovascular complications compared with opioid use,[28] but may be associated with increased length of hospital stay.[28] Intravenous lidocaine and ketamine can also be utilized depending on the pain management needs of the patient.[26] The use of acetaminophen, NSAIDs, gabapentin and pregabalin can also be effective depending on the patient population.[26, 28] These medications need to be considered on a case-by-case basis depending on the patient's other comorbidities. Opiates are still considered useful in managing post-operative pain, but by using these non-opioid drugs, the opioid dose and duration can be minimized or used for breakthrough only lessening the side effect profile.[26] By using combination therapy, patients get better pain control and faster return to activities of daily living.

Cross-disciplinary collaboration (physical therapy, anesthesiology and nursing together with the patient) is essential to improve outcomes.[26, 29] Managing patient expectations and reviewing the pain management plan (pre/during/post) can have a positive impact including reduced opioid requirements, faster recovery and improved patient satisfaction.[26] By utilizing these strategies better pain management can be achieved with less side effects and improved recovery.

C. Setting Expectations: Education as a Multimodal Team Approach

Key to preoperative planning for an elective intervention is determining where a patient is in relationship to pain (e.g., new, chronic, non-vascular, not entirely physical) using a bio-psycho-social pain assessment[30] as shown in Figure 1.[31]

It is paramount for vascular care teams to acknowledge the variety of factors involved in a patient's pain when determining peri-operative plans, especially if the patient has chronic pain. Using a coordinated and integrated approach to address these bio-psych-social elements is a best practice and has been documented to reduce pain severity, improve mood and overall quality of life, and increase function.[32, 33] The recommended management approach may involve one or more clinical disciplines for a coordinated treatment plan (Figure 2).[31]

Several factors impact perioperative pain management beyond just the physical biochemical pain pathways and by assessing the non-physical aspects, optimal pain control and expectations can be met, especially if planning a surgical intervention with long-term pain concerns. It is difficult to predict the level of pain the patient will experience and how well pain will be tolerated, underscoring the wide variability among patients in terms of the pain experience. As noted by

O'Donnell, "inadequate assessment and management of postoperative pain can result in patients experiencing anxiety, insomnia, increased stress, and limited mobility, in addition to or as a result of unrelieved pain.[3,6,7] Factors contributing to the problem of insufficient pain management include poor communication between patient and providers, unrealistic patient expectations, and lack of proper patient education."[8]

The consequences of poorly managed pain can lead to negative outcomes such as the development of chronic pain, deep vein thrombosis, atelectasis, and delayed resumption of normal daily and work activities.[9] Thus, there is evolving evidence that a "Whole Health Model"[34, 35] is a useful team approach to engage pain management with involvement of peers, integrative providers, and clinicians. As vascular disease is a systemic process, the "Whole Health" approach should be investigated at local facility levels for development of vascular surgery pre-operative pain education strategies to meet patient and physician expectations in verbal and written formats.

Of course, this peri-operative pain management ideal is both time and financially consuming but if the goal is optimal pain and clinical outcomes for vascular surgery patients then finding ways to implement this team approach is both appropriate and necessary. Preoperative education is a good place to begin as evidence is consistent in this being effective in reducing postoperative opioid consumption when it specifically involves appropriate opioid use and risks using a multi-modal approach. Studies also report that providing information about pain pathways and "natural opioids" is effective at reducing opioid use as long as it is coupled with information about opioids and their role in appropriate pain relief.[9]

I. SUMMARY OF PERI-OPERATIVE PAIN RECOMMENDATIONS IN VASCULAR DISEASE

1. Comprehensive multispecialty and multimodal approach when appropriate, with ancillary services, can help reduce length of stay and complications with better patient outcomes for vascular surgery patients. If possible, an ERAS approach is encouraged that focuses on procedure-specific pain modalities and enhanced recovery pathways.

2. Pre-operative planning for elective vascular procedures should focus on assessing the patient using a bio-psych-social model incorporating "Whole Health" strategies and collaborative care plans; shared-decision-making and focus on non-opioid use (if opioid naïve) is recommended and written documents that are of appropriate language, level of education and age of learner is recommended to support verbal interactions for full engagement of the patient and vascular care team. The strategies utilized should include individualized, multimodal, and multidisciplinary approaches as much as possible.

II. INTRA-OPERATIVE and POST-OPERATIVE PAIN RECOMMENDATIONS IN VASCULAR DISEASE

A. Intraoperative Analgesia

1. Choice of Primary Anesthetic Technique

Options for the primary anesthetic technique include general, neuraxial (spinal or epidural), peripheral nerve block, and local anesthesia. The latter three types can potentially avoid the adverse effects associated with drugs used for general anesthesia. Also, these techniques provide postoperative analgesia and reduce opioid requirements and associated adverse effects. A large international multicenter study found that the type of anesthesia used for endovascular aneurysm repair (EVAR) did not influence perioperative mortality and morbidity.[36] Conversely, a large retrospective study reported reduced mortality and morbidity with combined general and epidural anesthesia.[37] In patients undergoing EVAR, local or regional anesthesia was beneficial with regards to procedure time, intensive care unit admission, and postoperative hospital stay.[38] Another large observational trial compared anesthesia types and found that local/regional anesthesia was safe and effective for EVAR.[39] Local or regional anesthesia may be preferable as it has been associated with reduced postoperative complications and improved recovery.[38-40] However, another study in patients undergoing EVAR could not find reduced pulmonary complications with regional anesthesia.[41] Most likely, the use of modern general anesthetic techniques which include avoidance of deep anesthesia, muscle relaxation, and opioid-sparing approach allow rapid clear-headed recovery with minimal residual effects from anesthetic drugs.[42]

2. Intraoperative Opioids

Intraoperative analgesia is often provided with opioids.[43, 44] Opioids still play an important role as a component of an optimal balanced general anesthesia technique, particularly for major surgery.[42, 45] However, opioid-related adverse effects, including dizziness, drowsiness, nausea and vomiting, itching, ileus, urinary retention, constipation, and respiratory depression, can increase perioperative morbidity and mortality and delay recovery.[43, 46] High intraoperative opioid doses are associated with postoperative respiratory complications.[47, 48] Additionally, high opioid doses could increase the risk of opioid-induced hyperalgesia, which can worsen postoperative pain and paradoxically increase the amount of opioids requested and given.[43] In addition, concerns of opioid dependence contributing to the opioid crisis have increased the emphasis on limiting opioid use. Therefore, enhanced recovery protocols emphasize a "fast-track" anesthetic technique which includes limiting opioid administration.[49, 50] Significant opioid sparing can be achieved via a multimodal strategy that includes non-opioid analgesics.[51-55] For example, an intraoperative strategy could include acetaminophen, NSAIDs or COX-2 inhibitors, dexamethasone, and procedure-specific local anesthesia, either via surgical site infiltration or regional anesthesia, which includes peripheral nerve blocks and neuraxial blocks. Opioids are then used for breakthrough pain when necessary.[53]

3. Opioid Choice and Dose

The choice of intraoperative opioid is often based on empirical judgment.[42] Fentanyl is the most used opioid for intraoperative analgesia. During induction of general anesthesia, opioids blunt airway reflexes and diminish sympathetic stimulation associated with laryngoscopy and tracheal intubation. However, the duration of hyperdynamic response to airway manipulation usually lasts for no more than 5 minutes and may have negligible clinical consequences in relatively healthy patients. Therefore, lower opioid doses, such as fentanyl 0.5-1 mcg/kg, at induction of general anesthesia are recommended.[42, 43] Dosing should be modified based on patient characteristics, including limiting doses for elderly patients or those with renal or hepatic dysfunction, while opioid-tolerant patients may require relatively higher doses.[43] Although opioid-heavy anesthetic techniques have been traditionally used in patients with impaired myocardial function, similar hemodynamic control can achieved with other medications, such as esmolol, while avoiding opioid-related adverse events.[43]

During maintenance of general anesthesia, bolus doses of fentanyl 25-50 mcg are typically administered in response to tachycardia and hypertension in attempts to treat pain. However, these changes are not always from pain. For example, hypertension and tachycardia can occur during laparoscopy due to increased abdominal pressures and opioid administration in such situations is inappropriate. Attempts to achieve "tight" hemodynamic control should be avoided as that can result in use of larger opioid doses. Thus, opioids should be administered only after other causes of tachycardia and hypertension are ruled out.

When an opioid with very rapid onset and short duration are desired, remifentanil could be considered. Remifentanil is an ultra-short-acting opioid that is metabolized by plasma esterases and has a very short duration of effect, even after an infusion.[56] These properties make the drug appealing in the perioperative period but several studies have described associations with increased opioid tolerance[56] and opioid-induced hyperalgesia.[43, 44] While sometimes difficult to diagnose clinically, opioid-induced hyperalgesia can paradoxically worsen pain and lead to requests for additional analgesics, thus counteracting the original intent of providing better analgesia.[57] These drawbacks should be factored in when considering whether to use remifentanil. For surgical procedures with moderate or high levels of postoperative pain anticipated, other opioids may be preferable.

For postoperative analgesia, it is a common practice to administer longer-acting opioids, such as morphine or hydromorphone, toward the end of surgery. Hydromorphone may have some advantages in that it does not have active metabolites that can be problematic in renal failure and a meta-analysis demonstrated slightly improved analgesia when compared to morphine.[58] Based on dose-response studies of morphine,[59] hydromorphone 5-10 mcg/kg given approximately 20-30 minutes prior to tracheal extubation can provide adequate pain relief on emergence from anesthesia without delaying extubation. Attempts to titrate opioids to the respiratory rate during emergence from anesthesia can be clinically challenging due to the residual effects of volatile anesthetic agents and neuromuscular blockers.[43] While there are some theoretical advantages for some opioids over others, there is limited evidence to support any particular opioid as superior in the perioperative period.

4. Opioid-Free Anesthesia

In recent years, elimination of perioperative opioids, known as opioid-free anesthesia, has been studied. Opioid-free anesthesia involves the use of non-opioid analgesic adjuncts either alone or in combination.[44] Opioid-free anesthesia, while perhaps advantageous in theory, can be challenging in reality because many analgesic adjuncts are administered as fixed doses and have dosing limitations. There is no good approach to titration of analgesic adjuncts, as it is impossible to discern the level of nociception during general anesthesia. Although nociception monitoring may be used, its validity remains controversial.[44] The clinical benefits of opioid-free anesthesia have thus far not been demonstrated.[44] Furthermore, avoidance of intraoperative opioids does not necessarily lead to avoidance of postoperative opioids. Concerns of drug interactions and adverse effects of non-opioid agents must also factor into decisions. For example, magnesium can cause arrhythmias and potentiate neuromuscular blockade and increase the risk of residual paralysis, resulting in postoperative respiratory complications.[60] An intraoperative bolus of ketamine (0.5-1 mg/kg) can cause hallucinations and nightmares.[61] Dexmedetomidine can cause clinically significant hypotension and prolong readiness to discharge,[62, 63] as well as an increased risk of airway collapse and prolonged hypoxia.[64] A recent study assessing the role of dexmedetomidine as a component of opioid-free anesthesia technique had to stopped prematurely due to severe bradycardia.[65] Patients receiving dexmedetomidine had delayed tracheal extubation and prolonged stay in the post-anesthesia care unit in one study.[65] Overall, opioid-free anesthesia remains controversial and additional studies examining short- and long-term outcomes should be conducted.

To accomplish opioid-free anesthesia or even if the goal is simply to reduce the amount of total opioid given, effective non-opioid adjuncts must be used. One such agent is ketamine, which is an N-methyl-D-aspartate (NMDA) antagonist. Several reviews that found that perioperative ketamine can improve analgesia and reduce opioid consumption for 24-48 hours.[66, 67] However, the multicenter PODCAST trial found that low-dose ketamine intraoperative bolus doses did not improve pain but did increase the risk of hallucinations and nightmares.[61] Together this leaves the role of intraoperative ketamine somewhat unclear but it has utility in select patients, such as those who are opioid tolerant or conversely do not tolerate opioids.

5. Role of Intraoperative Nonopioid Analgesics

Intravenous acetaminophen is another non-opioid agent that may be given intraoperatively to select patients. Examples of patients who might stand to benefit include those who will have nasogastric tubes in place postoperatively or those who will be unable to take oral medications for other reasons. Studies have not consistently shown a reduction in opioid consumption with IV acetaminophen but it appears to reduce postoperative nausea and vomiting.[68] In patients able to take oral medications, PO acetaminophen may provide the same degree of analgesia at a fraction of the cost. A study comparing IV to PO acetaminophen after total joint arthroplasty found a small early difference in pain but no differences beyond 4 hours.[69] Studies specifically in vascular surgery are lacking.

NSAIDs, such as ketorolac, can be given as an IV bolus in appropriate patients. One randomized controlled trial in patients undergoing carotid endarterectomy found that ketorolac reduced pain during and after surgery.[70] A meta-analysis of the effects of perioperative ketorolac found that a single dose reduces postoperative pain and nausea and vomiting.[71] Concerns over increased risk of postoperative bleeding are often cited but a recent meta-analysis focusing on this topic concluded that ketorolac and other NSAIDs are unlikely to be the source of postoperative bleeding complications.[72]

Intravenous lidocaine is often given as a bolus with the induction of general anesthesia but its analgesic effects have been primarily studied when given as a continuous infusion. Evidence is inconsistent as to the benefit of lidocaine on postoperative pain[73] but in surgical procedures in which substantial inflammation is likely it represents a logical choice as its anti-inflammatory effects have been established.[74]

Surgical wound infiltration is another form of multimodal analgesia.[55] In a randomized controlled trial comparing epidural anesthesia to local anesthesia for abdominal aortic surgery, analgesia was similar, although anesthetic and analgesic medication doses were greater in the local anesthesia group.[75] Few studies in vascular surgery have been performed comparing local infiltration analgesia to other modalities but a meta-analysis in abdominal surgery patients found that local infiltration analgesia provided comparable results to epidural analgesia.[76] In situations where epidural analgesia is contraindicated or not desired, local infiltration analgesia with local

anesthetics is a good alternative. For optimal analgesia, surgical site infiltration should include meticulous, multilayer local anesthetic infiltration prior to closure of the surgical wound.

B. Postoperative Analgesia

1. Neuraxial and Paravertebral Block

Epidural analgesia provides excellent dynamic pain relief for patients undergoing major thoracic, abdominal, and lower limb surgical procedures. Epidural analgesia has been reported to decrease postoperative respiratory, cardiovascular, and gastrointestinal complications as well as venous thromboembolism.[16, 77] A randomized controlled trial in patients undergoing abdominal aortic surgery found that thoracic epidural anesthesia combined with light general anesthesia followed by postoperative epidural analgesia did not offer any advantages over either epidural analgesia alone or intravenous patient-controlled analgesia.[78] Epidural analgesia is recommended for patients with significant comorbidities such as chronic obstruction pulmonary disease (COPD) and cardiac disease undergoing major open thoracic and abdominal surgical procedures.[36, 79, 80] Epidural analgesia has been recommended by several professional associations including the Society for Vascular Surgery.[16, 81] Therefore, it is included in some enhanced recovery pathways.[28, 82, 83] Although epidural analgesia can be administered through patient-controlled analgesia systems, a continuous infusion of local anesthetic with or without opioid is most commonly used.[37]

Although overall epidural analgesia is safe, there are concerns of rare but catastrophic neurologic injuries resulting from epidural hematoma in patients with coagulation disturbances either due to patient comorbidities or perioperative administration of anticoagulant or antiplatelet drugs.[84-86] These concerns may be particularly relevant in the vascular surgery population. In recent years with the increased emphasis on enhanced recovery and use of minimally invasive surgical approaches, the role of epidural analgesia in vascular surgery is less prominent because it can delay ambulation and discharge, and non-opioid analgesic alternatives can provide similar recovery outcomes.[87-89] Epidural analgesia is being replaced at some centers with fascial plane blocks or surgical site infiltration.[51, 54]

The drawbacks of epidural analgesia, including hypotension, delayed ambulation, and urinary retention,[77] have led to the rise of alternative regional anesthesia techniques for vascular surgery. Paravertebral block provides similar analgesic efficacy, but does not cause significant sympathectomy and resulting hypotension, and therefore may be a good alternative to epidural analgesia.[80, 90] Paravertebral catheters placed by the surgeon under direct visualization are safe and effective in patients undergoing open abdominal aneurysm repair.[91] The ultrasound-guided paravertebral block is also effective for analgesia after abdominal surgery[90] and breast surgery,[92] although few studies have been performed specifically in vascular surgery.

It is the opinion of the authors that epidural analgesia and continuous paravertebral blocks still play a role in major open abdominal procedures, particularly in patient populations where postoperative analgesia may be challenging, such as opioid-tolerant patients, those with opioid use disorder, and those who do not tolerate opioids well.

2. Inter-fascial Plane Blocks

Regional anesthesia techniques for vascular surgery that may be technically simpler than the neuraxial blocks. These include peripheral nerve blocks for extremity surgery and the inter-fascial plane blocks, including transversus abdominus plane (TAP) block, rectus sheath block, and the erector spinae plane (ESP) block for thoracic or abdominal approaches.[54] TAP blocks provides somatic analgesia to the abdominal wall via blockade of the anterior rami of the lower 7 thoracic spinal nerves and generally cover the T10-L1 dermatomes, although the subcostal approach can provide more cephalad coverage from T6-T10.[93] The block is fairly easy to perform with consistent anatomy and a clear anatomical target. Evidence specific to vascular surgery is lacking but a meta-analysis found that ultrasound-guided TAP blocks provided a small degree of efficacy for laparotomy as might be seen in abdominal aortic aneurysm repair or other major open vascular surgery.[94] Rectus sheath blocks, which only cover midline incisions via blockade of the terminal muscular branches and anterior cutaneous branches of the thoracoabdominal nerves,[93] may be useful in some vascular surgery procedures. Repeated-dose rectus sheath blocks may have utility for midline laparotomy.[95] Erector spinae plane (ESP) blocks have recently emerged as a popular choice for many applications. The ESP block involves injecting local anesthetic into the inter-fascial plane just deep to the erector spinae muscles, where the dorsal branches of the spinal nerves are blocked[96] and some cadaver studies have

found that spread into the paravertebral space occurs,[97] potentially accounting for analgesia observed in anterior thoracic and abdominal surgeries. Case reports have described successful analgesia for open abdominal aortic aneurysm repair[98] as well as other vascular surgeries[99] but randomized, controlled trials in vascular surgery are lacking. While the ESP block appears promising in cardiac surgery[100] and open epigastric hernia repair,[101] more high-quality studies are needed. Bilateral blocks must be performed to cover a midline incision, which may be a limitation when block performance time is a factor. Another adjunctive therapy for pain management after thoracoabdominal aneurysm repair is intercostal nerve cryoablation, which has been shown to be safe and effective in a small series.[102]

For any of the blocks described above a single-shot or continuous catheter technique may be performed to extend the duration of analgesia. This typically requires additional training in regional anesthesia and comes with its own advantages and disadvantages. Placement of catheters is associated with a failure rate that may be underestimated based on subjective measures alone.[103] Nevertheless, they provide one method of providing analgesia beyond the duration of the primary block. While continuous blocks theoretically could provide extended analgesia and would logically produce higher patient satisfaction, outcomes for continuous blocks have not always been favorable. A randomized, controlled pilot study found that patients who received a continuous ESP block for thoracic or breast surgery showed only small improvements in quality of recovery scores compared to placebo.[104]

3. Opioid Management in Postoperative Period

Despite efforts to reduce perioperative opioid use in light of the worldwide opioid crisis, opioids remain a major component of managing moderate-to-severe postoperative pain. Patient-controlled analgesia (PCA) has been shown to result in greater patient satisfaction than intermittent bolus opioids.[105]

A recent systematic review and network meta-analysis concluded that the choice of PCA opioid influences sedation potential and patient satisfaction; however, the incidences of postoperative nausea and vomiting and pruritus were not affected.[106] In this study, the incidence of respiratory depression was too low to draw meaningful conclusions and tramadol was associated with significantly lower patient satisfaction compared to other opioids.

Potential concerns associated with medication errors, such as transcribing, prescribing, programming, dispensing, and monitoring, exist with opioid administration.[107, 108] These errors increase the risk of opioid overdose and can result in significant adverse outcomes.[107] However, enhanced recovery pathways promote early oral intake and may facilitate oral opioid administration, which could help reduce adverse events associated with intravenous opioids.[16, 49] PCA opioids may make it difficult to achieve early ambulation, which is critical for enhanced recovery.[109] We recommend minimizing IV opioids and reserving them for severe pain in situations where oral opioids are not possible or practical. As discussed earlier, it is imperative that non-opioid analgesics be administered on a scheduled basis.

In most vascular surgery patients, extended-release opioids should not be initiated in the postoperative period. A study of overdose deaths from opioids in South Carolina in 2018 found that one of the risk factors for overdose death was the prescription of extended-release opioids for opioid-naïve patients.[110] In general, the Centers for Disease Control has recommended short-acting opioids for the shortest duration necessary be prescribed for chronic noncancer pain and found that extended-release opioids increased the risk of overdose without evidence of benefit.[111] While these recommendations did not specifically address acute postsurgical pain, the avoidance of extended-release opioids seems even more important in the postoperative setting where the duration of pain is typically limited and substantial opioid tolerance has not yet occurred.

A good general approach[112] for post-operative pain management medications is listed in table 1. This guide focuses discussions and decision-making around five principles to individualize the regimen to meet both the physician and patient expectations (Table 1).

4. Management of the Opioid-Tolerant Patient

Opioid-tolerant patients undergoing vascular surgery deserve some special consideration. It should be noted that most studies discussed in this section did not focus on vascular surgery. Patients taking opioids on a chronic basis have been shown to have longer lengths of stay, greater hospital costs, and greater 30-day readmission rates than their opioid-naïve counterparts.[7, 113] Others have also found that opioid tolerance affected outcomes negatively and led to more readmissions, largely a result of poor pathway compliance.[114] The exact daily dose of opioids beyond which outcomes are worse is not entirely clear. Some authors have found that

preoperative opioid use alone, regardless of dose, was associated with poor outcomes at 1 year[115] and others have reported that patients taking higher chronic doses of opioids had greater odds of readmissions than those taking lower doses but both had greater odds than opioid-naïve patients.[116] Because of the potential for worse outcomes, these patients should be identified prior to surgery and a preoperative analgesia plan should be discussed along with realistic expectations set. The role of opioid tapering prior to surgery is controversial.[117] While some studies have shown improved outcomes in patients whose opioids are tapered,[118, 119] a recent study highlighted the risks of increased mental health crises and hospital encounters associated with opioid tapering. The overall benefit remains unknown and there is a lack of evidence specifically in the vascular surgery population. It has been recommended that an opioid-sparing strategy that emphasizes non-opioid analgesics be implemented.[120, 121] Strong consideration of regional anesthesia or potent infusions such as ketamine should be made for these patients when possible and the involvement of a dedicated acute pain service should be strongly considered.[122] Perioperative ketamine infusions have been recommended by national guidelines for patients who are opioid tolerant, albeit with the limitation of low-level evidence.[123] The involvement of a dedicated acute pain service has been shown to reduce opioid consumption after some surgery types, including pancreaticoduodenectomy[124] and ventral hernia repair.[125] Proactively involving the acute pain service can help coordinate care and improve outcomes. Preoperative notification is ideal.

II. SUMMARY OF RECOMMENDATIONS FOR INTRAOPERATIVE AND POSTOPERATIVE ANESTHESIA AND ANALGESIA IN VASCULAR DISEASE

1. Optimal perioperative pain management for vascular surgery procedures should include opioid-minimizing strategies that incorporate nonopioid analgesics. The role of opioid-free anesthesia and analgesia strategies remains uncertain.
2. Patients undergoing vascular surgery should receive scheduled acetaminophen and NSAIDs in the perioperative period unless contraindicated.
3. Regional anesthesia should be used whenever possible to improve vascular postoperative pain control and reduce reliance on opioids.
4. Epidural anesthesia can provide effective pain control in open vascular surgical procedures and still has a role in this setting, especially in patients who are opioid tolerant or have a history of experiencing opioid-related side effects.
5. Skeletal muscle relaxants, such as cyclobenzaprine, methocarbamol, metaxalone, and tizanidine, could possibly benefit some vascular patients but few data exist in the perioperative setting to support their use.[126]
6. There is minimal published evidence supporting the use of lidocaine patches in vascular surgery.
7. Individualized pain regimens should be used for vascular patients that addresses variety of prescribing modalities, frequent reassessments to adjust dosages, and having good attention to detail with clear patient instructions to gauge expectations.
8. Consideration should be made to consulting an acute pain service if available for patients taking opioids preoperatively and for those with a history of opioid or substance abuse.

III. PAIN MANAGEMENT FOR SPECIFIC VASCULAR PROCEDURES

Of the available literature for pain evaluation and management, each vascular disease territory has unique considerations. Notably the proportion of nociceptive, ischemic, inflammatory, and neuropathic pain mechanisms is specific to each anatomic region with approaches to such pain adjusted accordingly peri-operatively. Table 2 provides a summary of these recommendations.[5]

Pain management techniques and decisions can affect other parameters such as length of hospital stay as well as graft patency and so each anatomic and pathologic state requires discussion

individually. Thus, the following sections review the pertinent pain management recommendations based on each anatomic and/or disease specifics.

A. **Pain management for patients with abdominal aortic aneurysms (AAA)**

Unlike patients with chronic pain associated with a vascular condition, such as patients with advanced peripheral arterial disease, or chronic venous ulceration, patients with abdominal aortic aneurysms are far less likely to have pain associated with their disease prior to treatment. However, post-operative pain control can vary significantly depending on open or endovascular aneurysm repair.[127, 128] Patients undergoing endovascular aortic aneurysm repair (EVAR) are prescribed less post-operative opioids compared to open aneurysm repair (OAR).[129, 130] Recent literature identifies interventions for both EVAR and OAR that decrease intensity and duration of post-operative pain. In addition, similar to ERAS protocols, pathways can be implemented as part of a comprehensive post-operative pain management plan to decrease pain and length of stay in this patient population.

1. Management of pain for endovascular abdominal aortic aneurysm repair (EVAR)

Given the less-invasive nature of EVAR, post-operative pain is less well-described in this patient population. However, with increasing focus on quality metrics and patient experience, any factor that lengthens a patient's postoperative stay, or increases the likelihood of readmission, should be carefully considered for improvement. Same-day EVAR, and even planned same-day patients (goal hospital stay < 24 hours) have been found to have a shorter length of stay (0.7 vs. 2.6 days) than historical EVAR patients with no increase in readmission at thirty days.[131] Same-day EVAR has been associated with a higher use of the emergency room post-operatively compared to longer index stay patients (15% vs 6% ED utilization).[131] Recent systematic review of EVAR for same-day surgery suggests that migrating to this treatment modality on a patient-centered basis would free up substantial hospital beds with associated annual cost savings of almost 2.5 million dollars.[132]

A comparison of all patients undergoing EVAR over a two-year period in the United Kingdom by anesthetic type demonstrated that regional anesthesia (RA) was associated with a lower risk of in-hospital death compared to general anesthesia (GA, adjusted Hazard Ratio 0.37).[41] Although time to discharge was shorter for RA and local anesthesia compared to GA, median

length of stay was the same among all three groups, as was rate of post-operative complications. Other multi-institutional studies have shown patients with local anesthesia have a shorter operative time and length of stay compared to patients with GA, without significant differences in 30-day morbidity or mortality.[38, 39]

Percutaneous (pEVAR) versus cut-down (cEVAR) for EVAR is associated with a lower utilization of in-hospital opioid medication (17 MME vs 32 MME), and patients undergoing pEVAR report a lower pain score at discharge compared to cEVAR patients.[128] A prospective, randomized multi-institutional trial found a lower adjusted pain score in patients undergoing pEVAR vs cEVAR.[133] A retrospective comparison of patients undergoing pEVAR vs cEVAR found shorter hospitalization, lower groin complications, and lower total postoperative IV acetaminophen dose in patients undergoing pEVAR.[134] Fast-track protocols for patients undergoing EVAR, including the use of percutaneous access, avoidance of GA, non-ICU admission and next-day discharge was associated with shorter procedure time, shorter hospital stay, and lower postoperative groin pain (1.2 vs 4.0 average pain scale).[135]

Protocols for post-operative pain management in patients undergoing EVAR are limited. A single study identified on average only 1.1% of patients utilize routine NSAIDs following EVAR.[128] A prospective, randomized, double-blind, placebo-controlled of patients undergoing EVAR found that pre-operative methylprednisolone was associated with a lower incidence of postoperative systemic inflammatory response (measured by systemic inflammatory response criteria and C-reactive protein).[136] Clinically methylprednisolone administration was associated with a shorter time to discharge compared to placebo (median 2 vs 3 days). Opioid use after EVAR varies. At discharge, median MME prescribed amongst different single and multi-institutional studies range from 60-100 MME.[128-130] Utilization of <20 MME after EVAR is associated with a lower length of stay.[128] In a multi-institutional study of opioid prescribing for common vascular procedures, factors associated with >200 MME prescribed at discharge included younger patient age, prolonged length of stay, prior tobacco use and prior amputation.

2. Management of pain for open abdominal aortic aneurysm repair (OAR)

Open aneurysm repair (OAR) presents different problems for both intraoperative and postoperative analgesia. Epidural based analgesia is effective at providing post-operative pain

control, with some evidence of decreased respiratory complications, improved time to ambulation, and shorter length of stay. Data on other regional perioperative analgesia and anesthesia is lacking. Trade-offs included specialized teams to place the regional blocks, pathways for post-operative monitoring of regional anesthesia, and concern for mobility restrictions.

Regional block can include neuraxial anesthesia such as epidural anesthesia (EA) and paravertebral blocks as well as interfascial plane blocks such as transversus abdominis plane block or rectus sheath block. Local anesthetic can be administered as a single dose, or via catheter infusion in the case of EA or regional catheters (Table 1). Contemporary retrospective analysis of patients undergoing OAR with EA and GA, versus GA alone, found that addition of EA was associated with improved 30 day survival (HR 0.73), lower 30 day re-intervention (odds ratio, OR, 0.65), as well as lower rate of post-operative bowel ischemia, pulmonary complications or dialysis (OR 0.54, 0.62, and 0.44 respectively).[36] A similar retrospective study found increased likelihood of discharge to home with concomitant use of neuraxial anesthesia.[37] Post-operative pain with both rest and activity is lower for patients with concomitant EA after OAR when compared to GA and IV analgesia alone.[79] This is most prominent on post-operative days one and two.. These recent findings are supported by a Cochrane review which found that use of EA in OAR was associated with decreased postoperative pain scores, duration of postoperative ventilation, and major postoperative complications.[137]

Use of other regional blocks (Table 3) has been associated with similar postoperative improvements in pain and recovery, with shorter length of ICU stay.[91] Paravertebral blocks are associated with decreased postoperative opioid consumption, and higher likelihood of no post-operative opioid use (OR for no use on postoperative day 1 of 214.7 for SA patients).[91] A recent prospective double-blind study of TAP block with ropivacaine infusion versus placebo for patients undergoing retroperitoneal abdominal aortic surgery found patients with TAP block had lower post-operative opioid use at 24 and 48 hours following surgery.[138] Meta-analysis of patients with transversus abdominal plane (TAP) block in abdominal surgery demonstrated less postoperative opioid use than non-TAP patients.[139] A Cochrane Systematic Review found a paucity of data regarding TAP blocks and rectus sheath (RS) blocks in patients undergoing abdominal surgery, with noted postoperative opioid consumption and pain scores in patients with

TAP and RS blocks, but with no comparison to other regional modalities such as EA or SA.[140] A more recent article does show a reduction in the need for opioid pain medications when RS block is used as an adjunct in OAR.[141] A summary of these regional options is shown in table 3.

MME at discharge for patients undergoing OAR ranged from < 200 in one integrated health network study of VQI data, to a mean of 320 MME for patients in a single urban hospital setting.[128-130] A phone survey at 5-7 days of patients undergoing OAR identified only a 61% utilization of their discharge opioid medication.[129]

3. Quality of life outcomes for Aneurysm Repairs with Recommended Discharge Medications

Patients undergoing both OAR as well as EVAR report similar quality of life outcomes following their surgery.[127] However, patients undergoing OAR experience greater pain in the immediate postoperative period, and subsequently receive higher doses of opioid medication at discharge. For patients undergoing EVAR percutaneous access and local and regional anesthesia are associated with decreased postoperative opioid utilization and shorter time to discharge. For patients undergoing OAR, epidural anesthesia is associated with a shorter hospital stay and decreased postoperative pain. Multiple studies have demonstrated success with postoperative opioid prescriptions of 60-100 MME for EVAR, and 135-240 MME for OAR. Acetaminophen and NSAIDs are likely under-utilized in both EVAR and OAR cohorts. A previous study has recommendations regarding the modality and amount of discharge pain medication following EVAR and OAR (Table 4). These frequencies were based on opioid use of the median of the 2nd quartile within their population of over 1900 patients.[130] Factors associated with top quartile MME at discharge included younger age, prolonged length of stay, and any tobacco use. Factors associated with >200 MME at discharge included younger age, prolonged length of stay, prior tobacco use and prior amputation.[130]

A. Summary of Pain Management Recommendations for Aneurysm Repair

1. FOR EVAR

a. Utilizing percutaneous arterial access over femoral cut-down whenever possible to reduce the risk of postoperative groin pain.

b. Consideration of local anesthesia for appropriate patients to decrease length of stay.

c. Routine use of acetaminophen and NSAIDs and highly selective use of gabapentinoids can be considered also as a part of a multimodal opioid-sparing analgesia strategy.

2. FOR OAR

a. Use of mid-thoracic (T6-T9) epidural anesthesia intraoperatively and postoperatively can decrease postoperative pain and opioid use following open aneurysm repair when feasible; although interfascial plane blocks, such as erector spinae plane blocks, are increasingly being used, there is currently insufficient evidence to recommend for or against these regional analgesic techniques.

b. We recommend routine use of acetaminophen and NSAIDs as a part of a multimodal opioid-sparing analgesia strategy.

B. **Pain Management for Patients with Lower Extremity Vascular Diseases**

1. Peri-operative management in lower extremity arterial procedures

a. Amputations

Complexity of amputation pain ranges from ischemic pain (pre-operative) to surgical pain (peri-operative) and phantom limb pain (post-operative). Pain management should be tailored to meet the spectrum of pain etiology. Multimodal pain management is suggested during different stages of the amputation process as described by De Jong.[130] There is however no clear evidence that choice of analgesic techniques intraoperative or postoperative impacts outcomes long-term.[5]

In the perioperative setting of lower extremity amputations, regional anesthesia (i.e., spinal, epidural) is underutilized compared to general anesthesia. A retrospective study demonstrated regional anesthesia group had higher comorbidities including diabetes, coronary artery disease,

end stage renal disease, and congestive heart failure but there was no significant 30-day mortality or MACE with either anesthesia utilization.[142]

Immediate post-operative pain management after major amputation requires significant analgesic uses. Utilization of regional anesthesia and combination of multi-modal therapy could potentially decrease immediate post-operative use of narcotics. A retrospective study reviewed intraoperative placement of perineural catheters for post-amputation patients with PAD. This study found 40% decrease in use of opioids in patients with catheters compared to traditional amputees.[143]

Nerve stimulation is safely used in chronic pain management (i.e., shoulder and back pain) with effective relief that can last up to 60 days. Immediate pain relief allows the patient to better participate in physical therapy, improving strength and mood. In a case series by Rauck and colleagues, 14 of 16 patients felt immediate pain relief, nine of which continued to use the system for 2 more weeks.[144] At the 4-week post operative follow up, patients with nerve stimulator demonstrated 81-83% of pain relief compared to no nerve stimulation therapy.[145] Overall, with minimal side effects of pain during lead implantation and removal, and bandage irritation, it is a well-tolerated modality.

Another major obstacle to postoperative amputation pain is with phantom limb. Epidural anesthesia may aid in pain control immediately post procedure and perineural catheters have shown to reduce the concurrent use of opioids, but it is not effective for the prevention of long-term phantom pain. Gabapentin used for up to 6 months did not reduce the pain acutely, however, was found to be effective for preventative treatment. New research for post-amputation pain management shows targeted muscle re-innervation can reduce phantom limb and neuroma pain and if performed at the time of initial amputation may prevent pain development or is useful secondarily for the treatment of established pain.[146] Literature is still lacking, however, in psychological therapies and the role of cognitive behavior therapy to assist in post-amputation pain inteventions.[147]

b. Lower extremity bypass

For lower extremity bypass, further research is required on the comparison of general anesthesia versus regional. Three main types of anesthesia are used for infrainguinal bypass surgery including general anesthesia (GA), epidural anesthesia (EA), and spinal anesthesia (SA). Consideration of anesthetic choice becomes an important aspect for pain control to improve patient outcome.

Singh et al, compared patient outcomes undergoing lower extremity bypass under GA, EA, and SA from the NSQIP database.[148] This retrospective study showed GA had increased risks of graft failure, cardiac events, pneumonia, return to OR, and length of operating time compared to EA or SA.[148] Some studies have shown that patients receiving an epidural anesthetic have had decreases in intraoperative blood loss, postoperative catabolism, and thromboembolic events. These patients were also noted to have improved vascular graft blood flow and postoperative pulmonary function.[149] Christopherson et al demonstrated a significantly lower rate of graft occlusion among patients receiving an epidural anesthetic, but general anesthesia was found to be associated with an increased risk of regrafting or thrombectomy when data was adjusted for comorbidity and heparin use.[150] However, Pierce et al. performed a retrospective study that looked at 264 patients and compared general anesthesia (fentanyl/nitrous oxide/isoflurane or enflurane) with spinal anesthesia (hyperbaric tetracaine with phenylephrine) and epidural anesthesia (2% lidocaine induction with 0.5% bupivacaine maintenance).[151] This study suggested that the type of anesthetic given for femoral to distal artery bypass did not significantly affect 30-day occlusion rate, limb salvage rate, or hospital length of stay.[151]

2. Post-operative Management in lower extremity arterial procedures

Post-operative opioid use in patients undergoing lower extremity bypass was higher with preoperative opioid users compared to opioid naive patients. In a 30-day follow up, 61% of preoperative opioid users were still using compared to 28% of opioid naive users. This study also found that there are still a significant number of opioid-naive patients still using opioids 30 days after the surgery. This finding emphasized the need for education for the patient and the prescribers.[152] Avoiding chronic pain states for lower extremity arterial disease processes is therefore very important and pre-emptive analgesic strategies can reduce the emergence of such

states that can impact the patient's to quality of life and also contribute to recurrence of vascular disease pathology conditions.[5]

3. Pain Management for Lower Extremity Wounds

Management of wounds is based on etiology and if venous, arterial, or a combination of both are present; the complexity of such management is beyond this paper but references to guide the pain approach are listed. In general, the approach should be patient-oriented and a multifaceted approach using pharmacological and topical medications for wound dressing changes and systemic medications between dressing cares is usually required. Local wound care dressings should focus on only dressing changes that are absolutely necessary and goal should be atraumatic dressings and include physical therapies such as compression if possible. Patient education is vital to avoid anxiety surrounding wound care and involves a person-oriented and multifaceted approach.[153] This can involve cognitive strategies, therapeutic alliances, and empowerment to best achieve a shared expectation by patient and the vascular care team. Examples of such techniques involve positive thinking, imagery, reflective listening, "time out" acknowledgements, and active functional focused therapy. See figure 3, and Table 5 from Woo[154] that summarizes an ideal integrated patient-oriented, multimodal, and multidisciplinary approach for complex wound care pain management:

Table 5

Figure 3

B. **Summary of Pain Recommendations for Lower Extremity Vascular Disease and Interventions**

1. For amputations, practitioners should recognize different stages (i.e., perioperative vs postoperative) of the amputation process and apply appropriate multimodal pain management approaches.
2. For lower extremity bypass, multiple anesthesia options are available. Data on outcome are equivocal; therefore, benefits and risks of each type of anesthesia should be tailored to the patient based on comorbidities and compliance.
3. Patient and physician input must develop the goals for wound care (palliative versus curative) based on etiology of the wounds and develop pain interventions to meet those expectations.
4. The whole health of the patient (cognitive, emotional, personal, sensory, and contextual) should guide the modalities utilized for wound pain interventions.
5. Creating a multi-disciplinary approach with skin integrity teams, wound specialty centers, and possibly palliative care can generate the best integrated framework for the pain management plan in lower extremity wound care.

C. **Pain Management for Patients with Peripheral Venous Lower Extremity Disease and Interventions**

There are multiple modalities in treatment of chronic venous insufficiency (CVI) using combination of endovascular approach (i.e., laser, radiofrequency, foam), high ligation, phlebectomy, and sclerotherapy. Efficacy of various treatment modalities have been demonstrated in addressing symptomatic CVI. In addition to various treatment options, there are various anesthetic approaches to preoperative and postoperative management.

Most contemporary vein centers perform these cases with tumescent local anesthesia only (no sedation) and immediate ambulation, thus eliminating the hemodynamic risks of sympathectomy associated with a conduction block (epidural or spinal anesthetic) and the cardiac and pulmonary risks associated with general endotracheal anesthesia. There is a common belief of reduced risk of deep vein thrombosis (DVT) from local anesthesia use because venous tone is maintained intraoperatively and the calf muscle pump is engaged immediately after the procedure.[155] However, evidence of DVT risk after venous procedure secondary to anesthetic choice is lacking. In case radiofrequency venous closure, DVT episodes were not associated with types of anesthesia, postoperative mobilization, age, sex, or associated vein procedures.[156] A prospective observational cohort study using ACS-NSQIP data demonstrated saphenofemoral junction procedures and open venous surgery as independent risk factors for venothrombotic events (VTE) in outpatient procedures. However, analysis showed general anesthesia did not have significant effect and was not considered a risk factor for VTE after outpatient procedure.[157]

In the outpatient setting, there are several procedural anesthetic choices, including:

1. Tumescent Anesthetic

Tumescent anesthesia describes the practice of injecting a very dilute solution of local anesthetic combined with epinephrine and sodium bicarbonate into tissue until it becomes firm and tense (tumescent). Typical tumescent local anesthesia consists of a solution of 445 mL of 0.9% saline, 50 mL of 1% lidocaine with 1:100,000 epinephrine, and 5 mL of 8.4% sodium bicarbonate. Advantages include a reduction in blood loss through both epinephrine-induced vasoconstriction as well as hydrostatic compression from the tumescent effect. Tumescent lidocaine is absorbed very slowly from subcutaneous tissue producing lower, and more delayed, peak blood levels compared to other routes, as well as extended postoperative analgesia.[158] A recent study reviewed 979 patients with 1229 limb procedures and use of tumescent volume. Study showed that an average of 425 ml of tumescent per limb or 10-12 ml/cm of saphenous vein provided adequate anesthesia.[159]

2. *Regional/Spinal Anesthesia*

A study observed improved peri and post-procedure pain scale after EVLT of GSV using a combination of femoral nerve block and tumescent compared to tumescent injection alone.[160] This study with a sample of 60 patients showed no significant complication or increase in procedural length. Another study evaluated 506 procedures with femoral or sciatic nerve block

for EVLT for vein closure. Peri and post-operative pain scales remain low consistent with prior study. This study observed 21 cases of mild to moderate motor block in the post-procedure, but all patients were discharged without delay.[161] A retrospective study with 175 patients looked at the efficacy of tumescent with and without spinal anesthesia for RF ablation of GSV and stab phlebectomy. Study showed significantly lower pain scale in spinal block group. However, anesthesia related side effects such as headache, nausea-vomiting, DVT, and urinary retention was higher in the spinal block group.[162] While these techniques have value, they are uncommonly used in the outpatient management of patients with superficial venous disease but may be useful on patients undergoing more extensive procedures in the hospital facility setting. Kim, et al showed that vein procedures are relatively safe procedures, but high-risk patients might benefit from the avoidance of general anesthesia when possible, to minimize the occurrence of adverse events.[163] In fact, with the advent of non-thermal treatment of venous sealing systems, tumescent use may not be necessary and require the use of only local skin anesthetic.

Pre-procedural sedation with oral agents, and/or IV sedation during the procedure can occur if credentialed personnel can be involved who can assist in pain control and anxiety management. In patients undergoing low- to moderate-risk outpatient procedures with low anesthetic risk (ASA III or less, majority of patients class II), preprocedural sedation with 2.5-10 mg of oral diazepam was shown to be safe and effective in 5783 patients undergoing either varicose vein ablation or iliac vein stenting in an office-based laboratory (OBL).[164] Deep sedation and general anesthesia are also appropriate options for higher-risk patients but require more stringent monitoring and safety procedures that are available in hospitals but could be prohibitive in outpatient settings.[164] While the use of moderate procedural sedation may be beneficial for patients undergoing more complex procedures, requirements for use of these medications in non-facility settings vary greatly by jurisdiction. No federal standards currently exist, making it important to understand local regulations prior to offering these modalities. Patients undergoing more complex procedures, or with higher ASA physical status scores, may benefit from having their procedures performed in a facility setting (hospital or ambulatory surgical center).

C. Summary for Pain Recommendations for Lower Extremity Venous Disease and Interventions

1. For venous procedures, the use of tumescent anesthetic is safe, if indicated, in an outpatient setting.
2. General anesthesia, regional anesthesia, and tumescent anesthesia are all alternatives for a subset of patients undergoing more extensive venous procedures.

3. Pre-procedural oral anxiolytics may be beneficial for patients undergoing low- to moderate-risk outpatient vascular procedures.

D. Pain Management for Cervical and Upper Extremity Vascular Disease and Procedures

1. Carotid Surgery

The choice of optimal anesthetic for carotid endarterectomy (CEA) remains controversial. Rich and Hobson[165] reported satisfactory results of CEA under regional anesthesia over a 5-year period in 1975. While local/regional anesthesia (LRA) has not been conclusively shown to be superior to general anesthesia in terms of periprocedural complications (34642940),[166] LRA has been examined as an adjunct for improved pain control. A superficial cervical plexus block can provide sufficient coverage for a CEA but pain resulting from retraction at the inferior surface of the mandible is better managed with the addition of a mandibular block.[167] This also results in a reduced intravenous pain medication requirement by the patient through the procedure and in the recovery unit.[167] Use of cervical block may also result in fewer cardiorespiratory complications, and allows for close observation of any neurological changes during the procedure to guide shunt use during CEA under LRA.[168] Improvement in hemodynamic swings seen with general anesthesia have also been appreciated.[168] A large retrospective review of the VQI database showed that transcarotid artery revascularization (TCAR) stenting and CEA performed under local/regional anesthesia had similar rates of myocardial infarction (MI), with a significant reduction in the MI rate in patients undergoing CEA with local/regional anesthesia compared to general anesthesia (GA).[169] Likewise, a review of NSQIP data showed improvement in the composite outcome of stroke, MI and death when utilizing LRA as opposed to GA,[170] though a 2021 Cochrane review of 16 RCTs involving 4839 patients did not support this conclusion.[166]

Performance of transfemoral carotid stenting has been shown to have an increased risk of complications when performed under GA as opposed to under local anesthesia.[171]

While superficial cervical plexus block has not been conclusively shown to reduce postoperative pain and opioid requirements, a small prospective trial in 2020 evaluated 98 consecutive patients undergoing CEA under regional anesthesia, randomizing patients to either ultrasound guided superficial cervical plexus block (SPB) or intermediate cervical plexus block (IPB). Patients undergoing IPB had a decreased need for postoperative pain medications and less reported pain by several subjective measures.[172] This study has not been replicated, but the technique may be a useful adjunct for patients at higher risk for opioid misuse after CEA; SPB and IPB can both be used in tandem with GA when needed.

Postoperative opioid prescription use after carotid revascularization has also been examined, and patients generally use less than what has been prescribed for both CEA and TCAR.[173] This has been attributed to some prescribers having a poor understanding of what is required post operatively or concerned pain will become uncontrolled once the patient has exhausted prescribed tablets.[173] Some institutions have implemented guidelines for opioid prescribing for these procedures. By incorporating preoperative counseling on pain management, patients may have a better understanding of recovery expectations and what is required for analgesic control including utilization of over-the-counter adjuncts like acetaminophen and non-steroidal anti-inflammatory drugs.

2. Upper extremity dialysis access procedures

Arteriovenous fistula (AVF) creation or arteriovenous graft (AVG) placement is considered in patients requiring long term dialysis access. These patients often have many medical comorbidities which need to be considered when selecting an anesthesia regimen. Pain management for patients with chronic kidney disease and end-stage renal disease is challenging as nearly 60% of patients with advanced renal disease have chronic pain of which 50% rate the pain as moderate to severe and 22% use chronic opioids.[112] Of patients on dialysis, 64% of dialysis patients use opioids but there is significant regional variation with only 9.5% use in Hawaii and 41% in West Virginia.[174] This suggests prescribing differences rather than patient characteristics and thus makes appropriate pre-operative evaluation and post-operative pain

management by vascular care teams even more crucial as dialysis access creation and interventions are planned. Shared decision making and expectation exploration preemptively by the proceduralist, the nephrologist, and the primary care physician should be considered and may need to include chronic pain specialist as indicated.

Dialysis access creation procedures are performed under either local anesthesia (LA) or locoregional anesthesia (LRA), and studies have shown LRA to be superior to local anesthesia both for pain control and for conduit patency. A meta-analysis published in 2020 evaluating a total of 565 patients found that there was an increase in brachial artery diameter with LRA and an improvement in AVF primary patency, in addition to a decreased need for postoperative oral narcotics.[175] A retrospective study of VQI data showed an improvement in usage of the dialysis access conduit at one year after surgery with LRA compared to GA for brachiocephalic fistulas, with fewer readmissions, and an improvement in 3-month rates of fistula use in patients receiving LRA as opposed to local anesthesia.[176]

Pre-operative chronic pain can also affect the post-operative pain management in the dialysis population. One group saw that patients receiving general anesthesia were more likely to receive opioids in the post-operative period compared to those receiving local anesthesia and sedation.[177] Patients with an AVG received more opioid medication in this same time period than those with an AVF.[177] Alternative pain medication use was low and it was seen that the appropriate patients would benefit from the use of acetaminophen during the postoperative period.[177] Opioids should be reserved for procedures resulting in more severe pain, such as tunneling or if pain is refractory to other agents[177] but again may be challenging if there is chronic pre-operative use. The use of NSAIDs for the dialysis population is avoided due to the risk-profile and acetaminophen is generally useful for more minor procedures if there is no concomitant liver disease.[112] Consideration should be for zero post-operative prescriptions if local or regional anesthesia is effective for the limited pain in the immediate procedural interventions. A guide for prescriptions postoperatively for dialysis access creation is listed below in Table 6[178] as one of only a few vascular surgery specific pain recommendations available to date.

D. <u>Summary of Pain Management for Cervical and Upper Extremity Vascular Disease and Procedures</u>

1. Local/regional anesthesia including but not limited to cervical plexus and mandibular blocks may be considered in patients undergoing carotid endarterectomy for better postoperative pain control.
2. Counseling and patient education about expectations for postoperative pain and use of over-the-counter adjuncts can reduce the number of opiate tablets required with equivalent pain management for upper extremity vascular procedures.
3. Patients undergoing dialysis access interventions should have these performed preferentially under locoregional anesthesia to optimize access patency, reduce readmissions, and minimize need for postoperative oral narcotics.

IV. Special Situations of Non-Reconstructable Vascular Disease States

A. Lower Limb CLTI and Usefulness of Spinal Cord Stimulation (SCS)

Insufficient blood supply to the tissue, whether from acute or chronic causes, results in ischemia to extremities and peripheral tissues. This section will focus on spinal cord stimulator (SCS) use for non-reconstruct able chronic ischemia. Occlusive peripheral vascular disease can progress to CLTI, which can have devastating consequences for the patients. Patients can have symptoms that include severe ischemic pain, non-healing ulcers or sores, and gangrene.[179] Treatment of chronic and critical peripheral arterial disease in the lower extremities can be difficult and refractory to first-line therapies, including reconstructive vascular surgery. Basic treatment goals for these patients are improving blood flow, pain control, improving patient function, and preventing the worsening of ischemia or infection.[179]

Unfortunately, some CLTI patients may not be candidates for revascularization.[180] Even with optimal candidates, reconstructive vascular surgery can still fail leading to disease progression and amputation of the limb. Patients that progress to amputation have (CLTI), Fontaine stages 3-4 or Rutherford stages 4-6. Another option for these patients is the use of neurostimulation of the spinal cord. This treatment modality has been reported to decrease pain and even reduce amputation rates.[181] For a complete discussion of current options for pain management for extensive CLTI, the informed evidence regarding SCS must have consideration.

1. Introduction to SCS

Neuromodulation with SCS has been utilized to effectively treat chronic pain throughout the body since the 1960s.[182] The first reported use of SCS to treat PAD was by Cook *et al.* in 1976.[183] Neuromodulation is achieved by placing a cylindrical or paddle lead into the epidural space. The cylindrical lead is placed percutaneously through a needle either in the office or surgical setting. Whereas, paddle leads get their name because of their width, and are placed surgically, normally by neurosurgeons.

SCS implantation should be performed by someone properly trained in interventional pain management or spinal surgical interventions.[182] Unless otherwise specified, we will be referring only to the percutaneous approach for this text.

Permanent implantation of a SCS is usually preceded by a trial implantation. During a trial of SCS a cylindrical lead is implanted into the epidural space percutaneously and the lead(s) are guided fluoroscopically within the space to lay over a targeted area of the spinal column. An externally placed pulse generator is used during the trial. During the trial period the patient's pain and function are assessed. There are varying definitions of a successful trial; the Neuromodulation Appropriateness Consensus Committee recommends a patient experience greater or equal to 50% pain relief during the trial. Objective measurements of activities of daily living, sleep, and walking tolerance may also be recorded.[182]

2. Outcomes for Chronic Limb Threatening Ischemia (CLTI) with SCS

Currently, SCS is FDA approved for post-laminectomy syndrome, chronic regional pain syndrome, chronic painful peripheral neuropathy, multiple sclerosis, post-herpetic neuralgia, and phantom limb pain, but more recently there is and expanding body of literature supporting use of SCS for chronic limb threatening ischemia and chronic refractory angina. Ubbink and Vermeulen completed a Cochrane review on the use of SCS for non-reconstructable CLTI that was published in 2005 and updated in 2013.[181] The review included six controlled trials, totaling 444 patients, comparing SCS with conservative treatment to conservative treatment alone. The results of the pooled data showed:

- Limb salvage at 12 months was significantly higher in the SCS groups with a number needed to treat (NTT) of 9.
- In the SCS groups, pain relief was improved, and fewer analgesics were used.

- More patients improved to Fontaine stage II in the SCS groups compared to the conservative only groups. (NNT=3)
- No significantly different effect on ulcer healing was observed.
- The patients receiving conservative treatment alone had a higher incidence of gastrointestinal bleeding, dizziness, and nausea.

The authors concluded that "There is evidence to favor SCS over standard conservative treatment alone to improve limb salvage and clinical situations in patients with NR-CCLI (non-reconstructable chronic critical limb ischemia.) The benefits of SCS must be considered against the possible harm of relatively mild complications and costs."[181] The conclusions of this review have been criticized by some because some of the individual studies did not show statistically significant outcomes.[182]

3. Improved Patient Selection for SCS

A way to improve results and outcomes is to select patients for SCS implantations that have the highest chance for improvement. One way to select better patients is to get a baseline transcutaneous oxygen pressure (TcPO2) measurement of the patient's lower limb. Normal toe TcpO2 value is > 60 mmHg, and a TcpO2 of less than 40 has been associated with impaired wound healing.[184] Two of the studies used in the above-mentioned Cochrane review used TcpO2 measurements and performed sub analysis of the patients based on these values. The SCS-EPOS study had 3 groups of patients: patients getting SCS with TcpO2 of 10-30 mmHg or TcpO2 of <10 mmHg that increased to >20 mmHg with stimulation, patients getting SCS outside of those criteria, and patients receiving medical treatment only.[185] They showed statistically significant limb salvage at 12 months in combined SCS groups compared to medical management (p=0.003). Even more significant, is when selecting patients based on TcpO2. When selecting patients based on TcpO2 they had 78% limb survival compared to 55% in the other SCS group and 45% in the medical management group.[185]

B. Thromboangiitis Obliterans [Buerger's Disease]

The management of pain in patients with thromboangiitis obliterans can be challenging, and there are limited numbers of studies with small numbers of study subjects and low to moderate

evidence for investigated therapies. Options for these patients remain limited and in addition to any therapy the mainstay for improvement and preventing further progression is cessation of tobacco by the patient. The treatment for pain for those with ulcerations is similar to those without wounds and when present, healing and closure of the wounds is often associated with improvement in pain levels. While common medications including cilostazol, clopidogrel, and pentoxifylline are prescribed in the treatment of thromboangiitis obliterans, no studies have been conducted to directly study these agents in the thromboangiitis obliterans population. Studies conducted have included prostacyclin and prostaglandin analogues, aspirin and folic acid based on the theory of this disease having an immunologic etiology. This showed that the intravenous, but not oral, prostacyclin analogue iloprost, had improvement in ulcer healing and significant resolution of rest pain compared to aspirin. Folic acid was not shown to have significant improvement in healing or pain as compared to placebo in patients with thromboangiitis obliterans and hyperhomocysteinemia.[186] Despite the role autoimmune influences are believed to exist, there is no evidence to indicate the use of steroids or cyclophosphamide in these patients.[187] While non-medical therapies can be utilized such as acupuncture, physical therapy, herbal remedies, and meditation can be added to the patient's treatment, significant studies are not identified on search of the literature.

In those who do not have revascularization options or who revascularization is not adequate for the relief of pain, there are several recommended options. The first and best evidence for therapy is that of prostanoid therapy (Iloprost) which has been shown to be superior to sympathectomy.[188] If not available or ineffective, opioid pain medications are indicated for these patients and should be anticipated to be a chronic regimen and consideration to specialty pain service or palliative care should be made. Other medications and therapies that may be effective include peripheral analgesics, antidepressants, local analgesia, neural blocks, epidurals, spinal cord stimulators, sympathectomy, immunoadsorption therapy, and bosentan.[189] Options for sympathectomy include open, laparoscopic, and percutaneous although no comparison studies have compared these modalities one to the others, which may be in part due to the known superiority of prostanoid therapy.[187]

C. Neurogenic Thoracic Outlet Syndrome (TOS)

Neurogenic TOS can be difficult to diagnose and, with a diagnosis that is often delayed, patients can have a higher pain burden. Often, neurogenic thoracic outlet syndrome is managed conservatively. This can include physical therapy, postural training, ergonomic evaluation, heat, ultrasound therapy, and trigger point injections. [190, 191]

An anterior scalene injection with lidocaine is a useful diagnostic tool that can also be used to predict surgical outcomes which is a useful tool to guide patient selection, especially in the neurogenic TOS.[190, 192] If indicated, surgical decompression can be utilized similar to what is recommended for the arterial or venous type.[193] If TOS does meet surgical indications, regional block including erector spinae injections have been shown to decrease the post-operative opioid requirements and shortened length of stay.[194] Botulinum neurotoxin can be utilized in patients who want to avoid or delay surgery due to its ability to treat neuropathic pain and weakening of the muscles that impinge on the brachial plexus trunks.[190, 191, 195] It is also used as a second line for patients who did not improve with physical therapy.[190, 195]

Intraoperative adjuncts to decrease postoperative pain in nTOS patients have been studied to a limited extent. In a small retrospective series, the instillation of intrapleural bupivacaine was associated with decreased postoperative narcotic use after transaxillary first rib resection for nTOS.[196] Similarly, in a small non-randomized series of 10 patients undergoing combination interfascial blocks, compared to 20 patients not receiving these blocks, interfascial blocks were associated with a significantly decreased need for postoperative oral narcotics (31857230). These techniques may be useful adjuncts for patients undergoing these operations, but as yet no randomized prospective data exist to support their routine use.

After surgery it is important to utilize a multi-agent approach to improve recovery and reduce length of stay. Pain experienced after decompression surgery is multifactorial including inflammatory reaction, tissue trauma, and muscle spasms.[193] Using oral opioids in addition to ibuprofen with muscle relaxers or benzodiazepines have been show to decrease pain score per patients and length of stay.[191, 193, 197] This also reduces the opioid side effect profile which includes symptoms such as nausea, sedation and constipation.[193] Postoperative pain and opioid use was also reduced in patients who underwent regional blocks prior to surgery making sure to select techniques that do not interfere with the motor function of the arm.[197] Physical therapy is

also recommended to improve symptoms post-operatively.[193] For patients with refractory neuropathic symptoms and pain after decompression, medical treatment, and physical therapy, two case reports have suggested that either spinal cord or peripheral nerve stimulation may provide relief.[198, 199]

IV. Summary for Pain Management for Non-Reconstructable Vascular Diseases

1. Spinal cord stimulators (SCS) can be a helpful modality in non-operable or failed operative vascular disease for treating pain, improving healing of skin ulcerations and possible limb salvage. Early referral is important since too low TcPO2 (<20 mm HG) results in poorer outcomes. Identifying a local practitioner who is familiar with the selection, implantation and management of this device may be difficult; non-vascular evidence does suggest that this modality for vascular disease management needs more focused investigations for possible usefulness.

2. For thromboangiits obliterans (TAI): Tobacco cessation is essential to reduce the risk of amputation. Cilostazol, clopidogrel, and pentoxifylline are medical treatment options but currently minimal data exist to support them. Intravenous (not oral) prostacyclin and prostaglandin analogues (e.g., ilioprost and clinprost) can improve ulcer healing and rest pain and prostanoid therapy is superior to sympathectomy. Refractory pain is chronic pain and may require chronic opioid therapy and referral to a pain management specialist.

3. For neurogenic thoracic outlet syndrome (nTOS): Utilizing anterior scalene blocks with local anesthetic can guide the diagnosis and treatment planning in neurogenic thoracic outlet syndrome. This in addition to nTOS directed physical therapy which should be done prior to any surgical intervention. Repeating this block with botulinum neurotoxin can be done to avoid surgery and provide longer pain relief. Utilizing a multi-agent pain regimen on discharge including muscle relaxers, non-steroidal anti-inflammatory drugs, acetaminophen, and short duration of opioids with postoperative physical therapy improves recovery after surgical decompression for nTOS.

V. VASCULAR SURGERY PAIN MANAGEMENT CONTEXUALIZATION AND QUALITY IMPROVEMENT

A. Pain in the Era of the Opioid Epidemic

While prescription opioids can be an important part of acute and chronic pain management, there are significant risks including addiction, overdoses, and death. In the late 1990s, opioid prescribing increased dramatically, in part due to misinformation about drug safety and pressure from accrediting bodies who promoted pain as the fifth vital sign.[200] Opioids shifted from one possibility of many to the expectation and perceived gold standard in pain treatment. We now know that alongside the increase in opioid prescribing, there has been a steady increase in drug addiction and overdose deaths.

Opioid addiction is a common problem, even in opioid-naïve patients, after surgery. The new chronic use of opioids after surgery in the United States is 6% and does not differ between major and minor operations.[201] Each additional refill of opioid medication after surgery increases the rate of misuse by 70%,[202] and over half of opioid misusers identifying their own prescriptions or those of friends and family as a common source for their non-medical use of prescription drugs.[203] Of the nearly 71,000 drug overdose deaths in 2019, synthetic opioids were involved in 70%.[204] Vascular care teams therefore must be aware and proactive in using or finding alternatives to opioid pain medications when planning vascular procedures; the vascular community must invest in system level interventions to avoid contribution to the already concerning opioid environment for patients and the public.

B. Addressing Pain Disparities

The discussion of pain management in vascular surgical patients requires commentary to the disparities in healthcare known to exist.[205, 206] As surgeons and their delegates are significant contributors to the prescription of opioid pain medications in the United States, there is need to acknowledge the importance of our vascular care team in pain management for our patients.[207] There is complexity in finding the balance between treating surgical pain (acute, chronic, or the former superimposed on the latter) due to the burden of vascular disease and other comorbid conditions and the risks of the use of opioid pain medications including addiction, overdose, diversion, and death.[207, 208] Vascular surgeons must be cognizant of the well-studied and documented inherent biases that can lead physicians to undertreat pain in certain social groups to avoid perpetuating the pattern. These biases can be subtle, based on assumptions we may have over time. Among the false beliefs noted in studies are notions that certain socioeconomic categories experience less pain, have higher pain tolerance, or that the patient is being dishonest in their reported pain levels based on stigmatizing [209] [210] Several studies completed over the past

two decades for inpatient and outpatient settings have shown that post appendectomy, breast surgery or even in chronic pain conditions, categories of patients have been prescribed lower doses of oral and intravenous pain medications despite no difference in pain scores.[205, 211] We must increase awareness of biases or situational factors in vulnerable groups that may affect pain management and treatment patterns and improve the disparity gap that exists amongst our patient population while prescribing opioid and other pain medications responsibly.

C. Quality Metrics and Quality Improvement Processes for Pain Management

For background, in 2002, The Center for Medicare and Medicaid Services (CMS) partnered with the Agency for Healthcare Research and Quality (AHRQ) to develop and test the HCAHPS (Hospital Consumer Assessment of Healthcare Providers and Systems) survey. With the first public reporting of HCAHPS results, hospitals subject to the Inpatient Prospective Payment System (IPPS) for annual payments had to collect and submit HCAHPS data to receive their full IPPS annual payment update; these payments required collection of data from 29 survey questions of which three questions dealt with pain evaluation and treatment. Interestingly, CMS announced that it will, however, remove the three pain questions from the patient experience survey starting with October 2019 discharges This CMS change was in response to recommendations from the President's Commission on Combating Drug Addiction and the Opioid Crisis.

Prior to the changes to HCAHPS survey, the last decade has seen more research and survey questions on pain. A summary of relevant studies is listed below to provide opportunities for vascular care teams to develop their own local approaches to pain management based in quality improvements:

1. Schwartz et al. compared patient satisfaction score to analgesic administration in an emergency department environment.[212] This study showed mere administration of pain medication did not correlate with patient satisfaction. Kahn et al.'s review of 182 postsurgical and post-trauma patient surveys found that patient satisfaction was more dependent on "patient perceptions of interactions with health team members" than on pain control.[213] However, there is evidence that an integrated, multidisciplinary, and patient-centered approach to pain control has

better success for both increasing patient satisfaction and decreasing the medical component of opioid overuse in the era of opioid crisis.

2. Titsworth et al., implemented pain management intervention consisting of a successful approach using a multimodal, interdepartmental, standardized analgesia protocol with process improvements from pre-admission to discharge for neurosurgical patients.[214] Study demonstrated improved pain documentation rate, multimodal pain medication usage, reduction postop day#1 pain score (mean pain scale scores 4.31 vs 2.94; p = 0.000), and significant reduction of monthly usage of naloxone.

3. In the trauma population, Elkbuli et al., developed a collaborative approach to improving pain management utilizing a three-pronged approach: (1) development of a dedicated nurse leadership program, (2) collaboration with pain management providers, and (3) modification of admission order set.[215] Results showed increased HCAHPS score below 5th percentile to 30th-93rd percentile after the implementation of the protocol. In addition, opioid oral dosages/total opioid dosages increased by 28.3%, whereas opioid intravenous dosages/total opioid dosages decreased by 47.9%.

4. Kaiser Permanente (KP) developed a pain quality improvement initiative based on a human centered approach across 21 medical centers.[216] This multidisciplinary approach identified a pain management bundle of six themes: lack of trust, delay, miscommunication, lack of reassessment, perceived ineffectiveness, and misconception. They conducted multiple Plan-Do-Study-Act (PDSA) cycles, refining the identified nursing practices related to pain management into a bundle. A pre-/post-test design was used to assess the impact the bundle on patient satisfaction with inpatient pain management. Implementation of the six themed bundle led to an increased pain satisfaction score with statistically significant changes to HCAPHS score between 2008 and 2013.

5. In the post-surgical setting, Naqib et al., developed a multicomponent intervention to improve pain management in the immediate postoperative period.[217] The author used an established framework to identify local barriers and to implement solutions in the post-anesthesia care unit (PACU). Their intervention included creation and distribution of clinical pathways for pain management with multimodal recommendations and educational pain management workshops

for the staff. Although the study was underpowered, the result trend from the study showed a decrease in number of patients requiring long time for pain management, decreased PACU stay, and decreased prolongation due to uncontrolled pain management.

6. Supporting local facility expert collaboration and pain management processes for best outcomes is a 2021 study by Billings et al. who performed a pre-post interventional quality improvement study for 4905 peri-operative patients across surgical disciplines (~3% were vascular surgery patients).[218] This study focused on discharge with opioid prescriptions and used guidelines from the national Opioid Prescribing Engagement Network (OPEN).[219] They found that such guidelines were useful with postoperative patients in that the post-implementation cohort had 190% increased odds of receiving a guideline concordant opioid prescription at discharge. This in tangible terms was 5,734 fewer 5 mg oxycodone tablets which would have been over-prescribed during the 6-month intervention time frame. However, the success of their study required close attention with local targeting and facility specific elements to effect change that required real-time, data-driven feedback. Such studies reinforce this document's recommendations that standardized plans and templates are most successful if there is engagement by the Vascular Surgery teams to use high-reliable organizational concepts guided by specific local characteristics and experts rather than using other facility templates as a whole with edits.

Implementation of pain management programs as seen in above process improvement examples requires a system of groups working as a collective for a common goal. First, improving pain management performance requires "systems thinking," where experts consistently emphasize the need for a system-wide, collaborative, and interdisciplinary approach to pain management. Second, there is rapidly growing evidence in pain management, therefore, it is imperative to review the latest evidence prior to implementing quality improvement activity. Third, institutionalizing pain management requires formation of a multidisciplinary committee of key stakeholders, analyzing current pain management practice performance, and improvement through continuously evaluating performance. Fourth, institutions need to understand current pain management practices. Retrospective data such as prior patient survey data, medical records, current staff attitude and knowledge to identify deficiencies and improvements.

Design of a quality initiative for pain management

1. Establish project team
    1. Identify individuals with knowledge/interests (e.g., MD, RN, PA, NP, patients)
    2. Identify administration who will support the change
    3. Define roles
2. Determine objectives and goals
    1. Identify goals that are manageable, measurable, and achievable
3. Establish Scope of measurement
    1. Define level of measurement (i.e., unit vs organizational level)
4. Determine resources
    1. Identify funding needs and resources to support the project (QI department).
    2. Create timeline and deadline for each project milestone
5. Measuring data
    1. Ensure data quality (accuracy, completeness, relevancy, etc.)
    2. Implement established assessment tools (i.e., McGill Pain Questionnaire, SF-36 health survey)
6. Assess and analyze data
    1. Select appropriate improvement tools to analyze data (i.e., run chart, histogram, etc.)
    2. Statistical data analysis (in-house vs consultant)
    3. Display and dissemination of data

National surgery organizations such as the American College of Surgeons (ACS) are beginning to support pain management program development for surgeons and facilities such as the online learning module *Optimizing Perioperative Pain Management* which could be a reference for vascular care teams and programs as they develop their own local plans.[220]

V. SUMMARY RECOMMENDATIONS FOR VASCULAR SURGERY PAIN MANAGEMENT CONTEXUALIZATION AND QUALITY IMPROVEMENT

1. Limit opioid medications as much as possible and utilize non-opioid medications and modalities as first-line approach. Some situations and vascular diseases may require opioids for temporary or long-term usage and chronic opioid use requires attentive long-term plans and engaged multidisciplinary oversight.
2. Quality initiatives should be used to create individualized facility pain management approaches utilizing local expertise to implement available evidence and recommendations as outlined for vascular diseases with patient-centered approaches that address disparities.

VI. ROLE OF COMPLEMENTARY AND NON-PHARMACOLOGICAL ANALGESIC MODALITIES IN VASCULAR DISEASE PAIN MANAGEMENT

In addition to pharmacological opioid-sparing multimodal analgesia including regional analgesia techniques, there are several non-pharmacological techniques and strategies that are useful for pain control. These modalities complement pharmacological therapies and should be offered to patients when possible as they have no adverse effects.

One such modality is acupuncture, which has its origins in ancient Chinese medicine. It is considered a safe technique when applied by a trained and experienced acupuncturist. One meta-analysis of the effects of acupuncture on various chronic pain conditions found that benefits experienced by patients from acupuncture were mostly sustained at 12 months, which can help set expectations related to results.[221] There is scant evidence for acupuncture specifically in vascular surgery patients.

Yoga is an activity with ancient Indian roots that involves the combination of mind, body, and spirituality in the form of stretching, breathing control, and meditation. It can be effective in various chronic pain conditions, although studies in vascular surgery are lacking. In a randomized controlled trial in patients who had undergone coronary artery bypass grafting, those in the yoga group experienced significantly better outcomes including better improvement in ejection fraction, body mass index, and blood glucose at 12 months.[222] Meta-analyses on yoga's effects on chronic pain have been generally positive,[223, 224] although most studies focused on osteoarthritis pain.

Lastly, peripheral nerve stimulation has recently emerged as a promising technique for postoperative pain and could potentially be useful in chronic pain. This modality involves the percutaneous implantation of a lead followed by delivery of an electric current via an external pulse generator. In a randomized controlled trial of 66 patients who were undergoing major foot or ankle surgery, peripheral nerve stimulation reduced both pain ratings and opioid consumption during the first 7 days.[225] However, this therapy has not yet been studied in vascular surgery patients and many challenges remain including high costs and lack of insurance coverage.

Palliative care and non-operative management with need for suitable pain interventions for advanced non-operative vascular conditions may occur.[226] This is especially pertinent in the situations of progressive chronic limb threatening ischemia. Quality of life with goal setting to guide pain control with sedation effects is a unique and challenging process that should involve pain and palliative care (or hospice) referral sooner than later.[227] Prevention of abandonment is important as surgical teams have much to offer in the trajectory of end-of-life care even when operative interventions are no longer indicated. Addressing expectations for pain control involve a multi-disciplinary team to focus on the unique vascular condition and the vascular surgeon and team are vital to meeting this goal for the patient and the family.

VI. SUMMARY OF ROLE OF COMPLEMENTARY AND NON-PHARMACOLOGICAL ANALGESIC MODALITIES IN VASCULAR DISEASE PAIN MANAGEMENT

1. Non-pharmaceutical options have evidence to be successfully utilized for pain management in vascular disease.
2. Vascular care teams should utilize local expertise to find alternative approaches for patient pain management beyond prescription medications.
3. Palliative care teams can offer valuable assistance in pain management for vascular care both in chronic and end-of-life situations. Early involvement of palliative care team approaches in care plans for vascular patients with advanced disease states is encouraged and can add a layer of support for pain evaluation and management. Vascular care teams have a vital role in assisting in the care plan especially for vascular patients with chronic conditions that have involved surgical interventions in the past.

VII. WHEN TO CONSIDER REFERRAL OF A VASCULAR PATIENT TO A CHRONIC PAIN SPECIALIST

While clinical acumen and an understanding of the literature is often adequate for routine postoperative pain management, a minority of surgical patients present significant challenges when it comes to achieving good analgesia. Issues such as which medications to prescribe, what doses to use, duration of prescription, and the risks to be aware of arise frequently and guidance is needed. Some of the patient populations that warrant additional attention include opioid-tolerant patients, patients with substance use disorder (SUD) or opioid use disorder (OUD), patients taking medication-assisted treatment (buprenorphine, methadone, or naltrexone), and patients with postoperative pain that persists beyond the typical duration. For these patient groups, recognition of the potential for both chronic postsurgical pain (CPSP) and persistent opioid use after surgery is critical to allow for early intervention and referral to a chronic pain physician.

Patients with both SUD and OUD present challenges in the perioperative period. Using data from a large insurance claims-based database, Brummett and colleagues[1] found that the adjusted

odds ratio of persistent opioid use, defined as filling of an opioid prescription between 90 and 180 days after surgery, in patients with SUD or alcohol abuse who underwent any surgery was 1.34 (95% CI 1.05-1.72).[228] A similar large database study by Sun and colleagues[2] concluded that patients with drug abuse history (SUD) had much greater odds of persistent opioid use (OR 3.15, 95% CI 2.24-4.40) than surgical patients who did not have SUD.[229] In this latter study, the risk of persistent opioid use was greater in certain surgeries, which included total knee arthroplasty and open cholecystectomy.[229] While vascular surgery was not included in their dataset, it would be reasonable to separate major, open vascular procedures from minor or less painful vascular procedures in terms of pain expectations. For these patients, preoperative expectation setting is important. Promising patients that "you won't have any pain" or "this doesn't usually cause much pain" does them a disservice and potentially sets them up for problems. A preoperative discussion of the maximum duration of opioids that will be prescribed may be useful. Strong consideration of consultation of an acute pain service should be made if such a service exists in the hospital. Acute pain physicians have expertise in managing opioids, nonopioid analgesics, and may be able to recommend regional anesthesia techniques or non-pharmacological strategies to decrease perioperative pain. If open surgery is planned or it is anticipated that standard postoperative opioid prescriptions may not be adequate, preoperative consultation of a chronic pain specialist affiliated with the surgeon's hospital can be very helpful in designing a perioperative analgesia strategy for patients with SUD and OUD.

For patients taking medication-assisted treatment scheduled for open vascular surgery or with high levels of preoperative pain, expert consultation with a chronic pain physician is recommended. In general, buprenorphine and methadone should be continued throughout the perioperative period for these patients because of the risk of relapse in the time leading up to surgery. These recommendations are supported by consensus statements and expert opinion,[230, 231] though randomized, controlled trials comparing different strategies have not been performed. Nonopioid analgesics should be maximized while minimizing opioids. In some select cases an opioid-free perioperative strategy may be indicated but this decision should be made in consultation with the patient's prescriber, a chronic pain specialist, and the anesthesiologist.

For patients taking prescribed opioids on a chronic basis, studies have shown that even low exposure to opioids in the 12 months prior to surgery increases the chance of postoperative readmission in the Medicare population.[116] This risk appears to increase with increasing opioid exposure. While no firm daily morphine milligram equivalent (MME) cutoff that requires a pain specialist can yet be found, patients taking extended-release opioids or a daily MME of 90 should be strongly considered for consultation. The Centers for Disease Control and Prevention (CDC) in its 2016 guideline for prescribing opioids in the United States recommended that clinicians not prescribe greater than 90 daily MME or justify the dose if they believe the benefits outweigh the risks at those doses.[111] In that guideline a recommendation was made to consider more frequent follow-up care if the daily MME was 50, which corresponds to roughly 7 tablets of oxycodone 5 mg per day.[111] Authors of this paper suggest liberal referral to pain specialists and encourage proactive relationship building across disciplines prior to the acute need for assistance. Indications for consultation to the pain specialist should be individualized and are especially indicated if any of the following are present: failure to achieve outcomes of therapy after 6 weeks of opioid titration, unexpectedly high-doses ($\geq$90 morphine milligram equivalents), non-compliance with agreements for pain prescriptions, behavior suspicious for diversion, adverse effects of opioid therapy, hyperalgesia, desire for detoxification using buprenorphine, and especially if significant pre-operative chronic opioid use or history of opioid concerns.[232]

VII. SUMMARY OF RECOMMENDATIONS FOR A VASCULAR SURGERY PATIENT REFERRAL TO A CHRONIC PAIN SPECIALIST

1. Vascular surgeons are encouraged to find local pain specialist partners to develop best practice referral plans for collaboration proactively.
2. Management for vascular patients who have chronic opioid use, substance use disorder, opioid use disorder on medication-assisted treatment, and chronic post-surgical pain will require multi-disciplinary approaches especially if possible before vascular surgery procedures are planned. Encouragement of referral to pain specialist should be proactive and liberal.

VIII. CONCLUSIONS REGARDING PAIN MANAGEMENT FOR VASCULAR SURGERY DISEASES AND INTERVENTIONS

Optimal pain management for vascular disease as outlined in this document is unique to the vascular diagnosis and anatomic location. Chronic pain in vascular patients is often complex, with patients often having multiple co-morbidities. Pain management interventions for the vascular patient may often require a multidisciplinary approach to maximize pain relief, function, and quality of life. Consideration of interventional and psychological treatments have a role to focus on treating the whole patient involving a multi-modality approach across care settings to best meet patient and physician expectations. The goal is of course for non-opioid medication usage with realizations that opioids will likely have a role in some vascular disease processes. Vascular care teams are encouraged to use the outlined information and references that have been collated to guide individualized approaches in their own unique medical systems. Building relationships to assess and manage the pain is encouraged via outreach to local pain experts, anesthesia colleagues, palliative care teams, and the primary care system.

It is clear via the outline of recommendations above that there is gap in medical evidence for pain recommendations specifically for vascular disease. Extrapolation from other surgical specialties and pain experts has supported most of the above recommendations in this document. Thus, this document's summary of recommendations should be the call to action for the vascular surgery community to address the research gaps specific to vascular surgery acute and chronic pain situations. Only with high-quality evidence will the best pain management practices for vascular surgery diseases and interventions occur to provide the best outcomes for our vascular surgery patients.

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ADDITIONAL RESOURCES

Additional resources are available at the American College of Surgeons Surgical Patient Education website, How to Safely Manage Pain After Surgery,[233] including a patient handout, "Safe and Effective Pain Control After Surgery: My Pain Management Plan,"[234] which can be printed and distributed to individualize peri-operative pain care.

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Table 1. General approach for management of postoperative pain medications.

Principle for pain management	Description
"By mouth"	Oral administration is the safest and therefore usually preferred. If ingestion/absorption is uncertain, analgesics need to be given by alternative routes such as transdermal, rectal, or subcutaneous.
"By the clock"	For continuous or predictable pain, analgesics should be given regularly. Additional "breakthrough" or "rescue" medications should be available on an "as needed" basis in additional to regular dose.
"By the ladder"	Pharmacologic management proceeds stepwise from nonopioids to low-dose opioids. The drug should be used at its full tolerated dose before moving to the next level.
"For the individual"	The "correct" dose for strong opioids is the amount needed to relieve the pain without producing intolerable side effects. Evaluation of benefit and toxicity is essential.
"Attention to detail"	Side effects of opioids should be explained and managed actively; e.g. constipation and nausea with anticipatory prescribing of a bowel regimen and antiemetic.

Table 2. Mechanisms of pain prevalence in specific vascular surgery populations.

Vascular disease	Prevalence	Pathological process	Postulated pain mechanisms involved
Peripheral arterial disease	12% of general population	Atherosclerotic occlusion of peripheral arteries leading to tissue ischemia	Nociceptive (early) Ischemic (late) Neuropathic (late)
Aortic aneurysms	Dependent on age, sex, and ethnicity; 25/100,000 men and 12/100,000 women	Dilation caused by degeneration of elastic laminae likely secondary to atherosclerosis	Nociceptive
Carotid artery disease	Dependent on age, sex, and ethnicity	Atherosclerotic plaques leading to occlusion of the vessel lumen with atheroemboli	Usually pain free Nociceptive (after open operation)
Varicose veins	Dependent on age and sex and genetics.	Valvular insufficiency leading to pressure and dilation of superficial veins.	Nociceptive Inflammatory Ischemic
Chronic regional pain	20/100,000	Minor peripheral damage leading to peripheral sensitization and inflammation with changes in muscle and bone to facilitation in descending pain modulation.	Neuropathic (with or without autonomic involvement) Inflammatory
Thoracic outlet syndrome	Unclear	Compression of veins (2%), arteries (1%), and brachial plexus (95%) passing through thoracic outlet	Ischemic Neuropathic
Phantom limb and stump pain	50-80% of amputees	Transection of nerve(s) at amputation leads to axonal sprouting and changed peripheral responses to stimuli, neuroma formation, sympathetic afferent coupling, and peripheral and eventually, central sensitization.	Neuropathic (with or without autonomic involvement)

Table 3. Regimens for regional anesthesia in open aneurysm repair.

	Medication	Infusion
Epidural		
Standard	Bupivacaine, ropivacaine +/- opioid	Continuous and PCA dosing
Regional block		
Interfascial plane block (ES, RS, TAP) 1. single shot 2. continuous with catheter	Ropivacaine	Unilateral or bilateral catheters, no PCA dose
Spinal		
Spinal anesthesia	Bupivacaine	Single injection

Erector Spinae (ES), Rectus Sheath (RS), Transversus Abdominal Plane (TAP)

Table 4. Recommended post-operative pain medication at discharge for patients undergoing aneurysm repair.

Procedure	Low dose	Standard dose	High dose
EVAR	NSAIDs/acetaminophen only	NSAIDs/acetaminophen only	5 tabs oxycodone/10 tabs tramadol
OAR	NSAIDs/acetaminophen only	15 tabs oxycodone/25 tabs tramadol	25 tabs oxycodone/40 tabs tramadol

EVAR (Endovascular aortic aneurysm repair), OAR (Open aneurysm repair), NSAIDs (Non-steroidal anti-inflammatory medication)

Table 5. Multimodal approach to pain management.

Patient-oriented and multifaceted approach to pain management

Strategy	Objectives
Pharmacological	Topical: topical ibuprofen (dressing not available in USA); morphine, topical lidocaine Systemic for nociceptive pain: aspirin, nonsteroidal anti-inflammatory drugs, acetaminophen for mild to moderate pain; opioids for moderate to intense pain Systemic for neuropathic pain: serotonin and norepinephrine reuptake inhibitors (SNRIs), anticonvulsants For chronic pain: 1) anticonvulsants 2) antidepressants 3) benzodiazepines 4) N-methyl-d-aspartate (NMDA) receptor antagonists 5) nonsteroidal anti-inflammatory drugs 6) opioid therapy (e.g. oral, transdermal, transmucosal, internasal, and sublingual) 7) skeletal muscle relaxants, and 8) topical agents (e.g. lidocaine, capsaicin, and ketamine) Adjuvant medications include steroids, anxiolytics, antidepressants, hypnotics, anticonvulsants, antiepileptic-like gabapentinoids, membrane stabilizers, sodium channel blockers, and NMDA receptor antagonists for the treatment of neuropathic pain
Local wound care	Atraumatic dressing to prevent painful removal; moisture interactive dressing to avoid wound desiccation; anti-inflammatory dressing materials; barrier to protect peri-wound skin; topical or systemic antimicrobial dressings/agents for infections
Physical therapies	Heat/cold compresses; massage; exercise; electrical stimulation; topical or hyperbaric oxygen therapy
Education	Web-based learning; face to face education; explaining mechanism of pain; dispel misconceptions about pain; address concerns about addiction; emphasize the availability of multiple strategies
Anxiety reduction	Relaxation; imagery; distractions; education; music therapy; support groups
Cognitive therapy	Cognitive behavioral therapy; problem-solving skills; positive thinking
Therapeutic alliance	Communication techniques (e.g. reflective listening, goal setting, aligning expectations, sympathy)
Empowerment	Allow individual to call "time out"; respect individual choice; maximize autonomy; active participation; functional focused therapy

Table 6. Quantity of opioid pills used for management of acute postoperative pain by 80th percentile and number of patients per procedure who used no opioids.

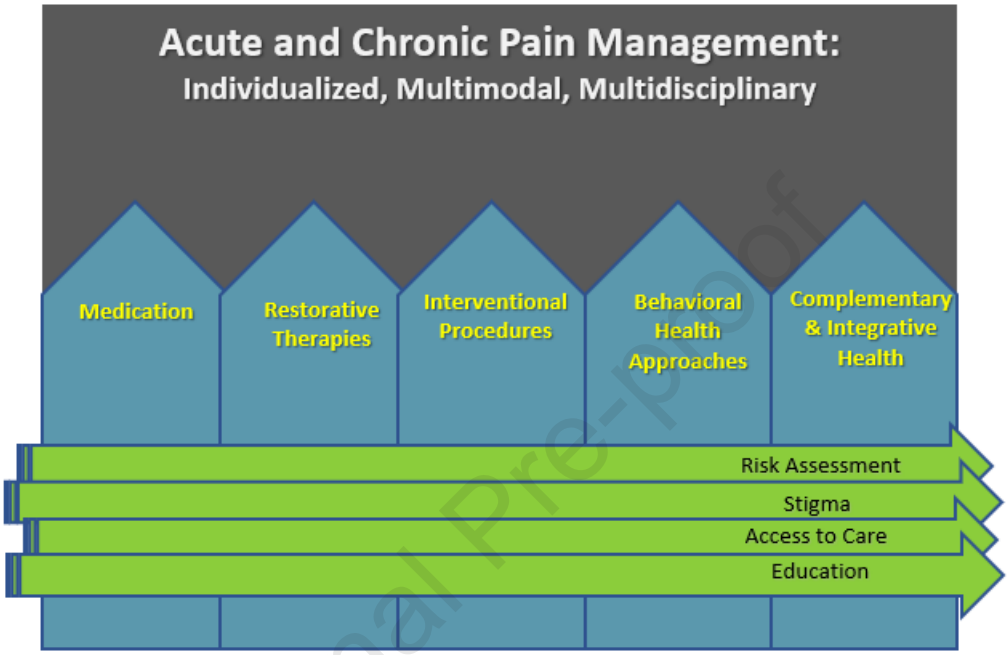
Procedure	80th percentile pills used	Zero opioids used, No. (%)	Recommended quantity (maximum)
Brachiobasilic or brachiocephalic fistula (n = 33)	6	12 (36)	0-6 (12)
PD catheter (n = 6)	10	0 (0)	0-10
Single-stage or stage 2 BVT (n = 5)	5	1 (20)	0-5 (15)
Upper arm graft (n = 5)	15	2 (40)	0-15
Radiocephalic AVF (n = 5)	4	3 (60)	0-4

AVF, Arteriovenous fistula; *BVT,* basilic vein transposition; *PD,* peritoneal dialysis.
Recommended quantities were determined by a range including up to the 80th percentile of all patients and an upper limit of the highest amount consumed (excluding outliers) by procedure.

Figure 1. Whole Health Approach: The Biopsychosocial Model of Pain Management. From the Department of Health and Human Services Pain Management Best Practices, https://www.hhs.gov/sites/default/files/pmtf-final-report-2019-05-23.pdf

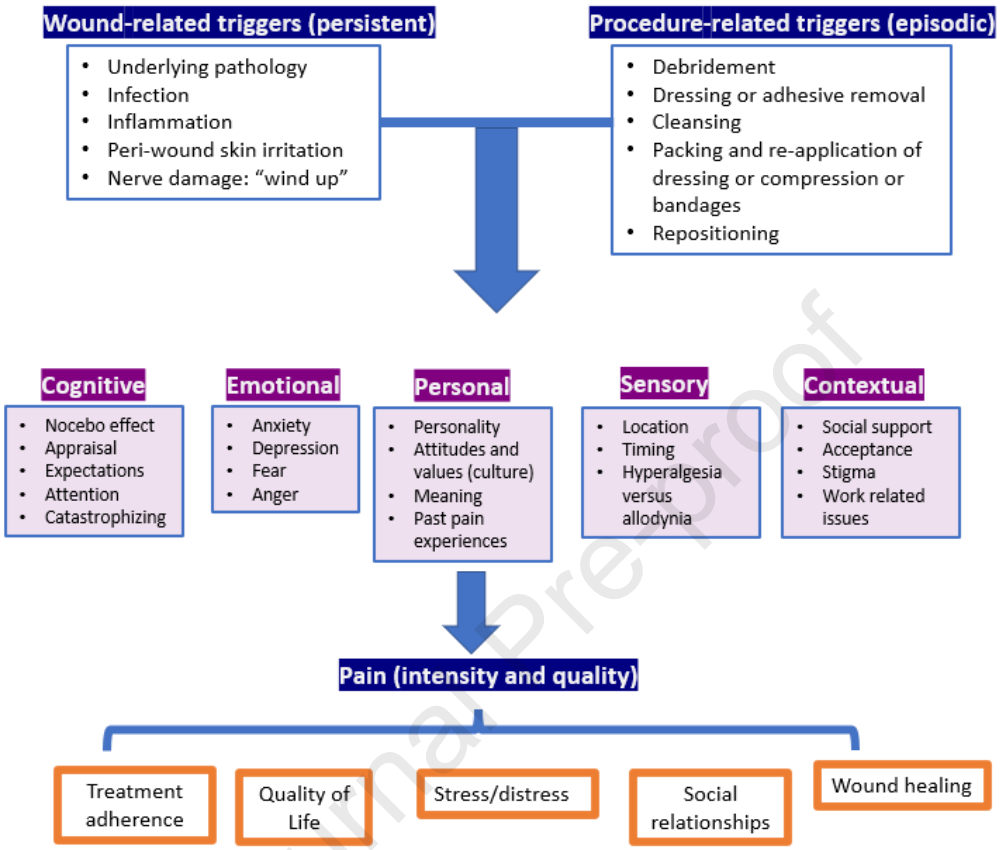
Whole Health Approach:
The Biopsychosocial Model of Pain Management

Figure 2. Acute and Chronic Pain Management requires five treatment approaches informed by four critical topics. From the Department of Health and Human Services Pain Management Best Practices, https://www.hhs.gov/sites/default/files/pmtf-final-report-2019-05-23.pdf



Acute and Chronic Pain Management Requires Five Treatment Approaches Informed by Four Critical Topics

Figure 3. Integrated wound-related pain model.



APPENDIX A: SAMPLE PAIN EXPECTATION POLICY to be used PRE-OPERATIVELY

Sample from: Vascular and Endovascular Surgery Pain Management Policy for Patients from Froedtert and the Medical College of Wisconsin (written by Laura Needler, APNP)

Goal of treatment for patient

As part of our ongoing promise to provide high quality care for our patients and community, our Vascular Surgery pain policy is outlined below. Our goal is to continue to deliver ideal pain management plans for patients with vascular disease while combining responsible prescribing practices.

You will be given the Vascular Surgery Pain Education Handout once scheduled for surgery.

- Pain medications before surgery will be ordered based on your specific situation.
- You will not be given more than a 0 to 7-day supply of pain medications when you leave the hospital. The number of days depends on when your surgery was. Treatment with pain medication begins on the day of surgery.
- Decreasing the total number of pain pills will be discussed while inpatient and at outpatient visits.
- Vascular Surgery will not prescribe new long-acting pain medications.
- Anti-anxiety and/or anti-panic will not be ordered along with pain medications unless you were already taking one at home.
- Pain medications from other doctors will not be refilled on discharge or in clinic.
- Unless you are seen in clinic, pain medications will not be refilled or given. We have to the right to reject refills based on your exam.
- Pain medications are not to be used to help you sleep.
- Pain medication will not be refilled or given after business hours, nights, weekends, or holidays.
- If a refill is provided, the dose may change. You will be given a step-by-step guide to decrease the number of pills you take daily. The goal is to eventually control your pain with over-the-counter medications.

- No pain medications will be given 4 weeks after surgery. If you need more pain control, a referral to chronic pain management will be made for you.

Pain Management After Your Vascular Surgery

Things You Can Do for Pain at Home

1. Try taking over-the-counter acetaminophen (Tylenol) as instructed on bottle. Taking it scheduled can be helpful. Do not take more than 3000 mg in a day. **If you have liver disease, talk to your primary care doctor before taking.**
2. Talk with your vascular surgery team about the use of ice and heat.
3. Elevate your limb above the level of your heart (ok to do this at night when sleeping). Do not elevate your leg if you have had a below or above knee amputation as this may lead to your hip or knee becoming stuck in a position.
4. Swelling can increase pain. Wear a Tubi-Grip stocking or ACE wrap if instructed. Wear it during the day and remove at night.
5. Breath in and then out 5 times, deeply and slowly. Repeat 10 times.
6. Meditation: Go to https://www.meditainment.com/pain-management-meditation
7. Distract yourself with activities likely watching television, playing a game, reading a book, or listening to music.
8. Shower daily, as allowed by your surgeon, to relax.
9. Ask your team about the use of medications such as ibuprofen or naproxen.
10. Take your other pain medications, like gabapentin (Neurontin), pregabalin (Lyrica) or duloxetine (Cymbalta), as written, NOT as needed.

Opioid Pain Management

***Only take opioid pain medications for severe pain.**

***They will only be prescribed on discharge if needed. If you are given them, the strength may be lower than what you received while in the hospital.**

1. Use the tools above before taking opioid pain medications.
2. Take opioid medications “as needed.” Do not take them if you are not in severe pain.
3. Try to decrease how often you take them each day.
4. Take your bowel regimen as written below.

Risks of Opioid Use

Short-Term Risks: weakness, poor judgment, itching, nausea, constipation.

Long-Term Risks: dependence (body needs to have the drug or else you feel bad) and tolerance (body gets use to the dose). Increasing dose can lead to breathing difficulty and death.

Driving while taking opioid medications is against the law

Opioid Refill Policy

1. **You have to be seen in clinic before a new refill can be given**. If pain is that bad, we need to make sure there isn't something wrong!

2. Call the Vascular Surgery office from 8:00 AM to 4:30 PM, Monday through Friday. We will get back to you within one business day. Same-day appointments are not guaranteed.

3. A urine drug screen may be ordered.

4. We have the right to deny prescriptions for opioids or refills.

Bowel Regimen

If you are prescribed an opioid pain medication (such as oxycodone), you must take a bowel regimen to prevent constipation. You should skip or decrease the dose if you have loose stools or diarrhea. Try these over-the-counter medications. Take as written on the bottle:

1. Miralax
2. Metamucil (psyllium fiber)
3. Bisacodyl
4. Senna or Senna-S
5. Colace (stool softener)
6. Rectal suppository

***If you are pregnant or nursing, or thinking of becoming pregnant, please do NOT follow these guidelines listed above. And if you are pregnant, tell your surgeon right away.**

APPENDIX B: MEDICATION Duration Worksheet for PREOPERATIVE DISCUSSIONS *Sample from: Vascular and Endovascular Surgery* MEDICATION Duration Worksheet for PREOPERATIVE DISCUSSIONS *from Froedtert and the Medical College of Wisconsin (written by Laura Needler, APNP)*

Surgery Type / Disease Process	Opioid Duration (opioid-naive patient)
EVAR, TEVAR	None
Carotid Endarterectomy, TCAR	None
Angiogram without rest pain	None
Femoral Endarterectomy, EVAR/TEVAR with femoral cutdown, Thrombectomy with femoral cutdown, Endovascular intervention with brachial cutdown	0-3 days
Toe amputations	0-5 days
TMA	0-5 days
BKA, AKA	0-7
Ax-Fem, Fem-Fem, Lower extremity bypass	0-7
Open AAA repair, Open mesenteric bypass, Open Aortic graft explantation	0-7
First Rib resection	0-3 days
Carotid subclavian bypass	0-3 days
Thrombolysis without ongoing rest pain	0-3 days
Skin grafting	0-7 days for dressing changes
Venous ulcerations s/p debridement	0-7 days for dressing changes
Chronic ischemic rest pain	0-7 days, chronic pain referral
Median arcuate ligament release	0-3 days
Temporal artery biopsy	None