A framework for perioperative care in lower extremity major limb amputation: a consensus statement by the Enhanced Recovery After Surgery (ERAS) Society and Society for Vascular Surgery

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ABSTRACT

The Society for Vascular Surgery elected an international, multidisciplinary panel of experts to review the literature and provide evidence-based suggestions for coordinated perioperative care for patients undergoing major limb amputation due to nonreconstructable chronic limb-threatening ischemia. Structured around the Enhanced Recovery After Surgery (ERAS) core elements, 33 suggestions were made and organized into preadmission, preoperative, intraoperative, and postoperative sections. (JVS-Vascular Insights 2024;2:100156.)

Keywords: Major limb amputation; Peripheral artery disease; Perioperative care; Analgesia and anesthesia; Guidelines; Enhanced recovery after surgery

Chronic limb-threatening ischemia (CLTI) is a broad term to define a heterogeneous group of patients with varying degrees of ischemia, wounds, and foot infection who are at risk of delayed would healing and limb amputation.[1] With an aging population and increase in the prevalence of diabetes, CLTI and limb loss are increasing worldwide.[2,3] There are considerable practice variations in how limb preservation is attempted, how limb amputation is performed, and how patients with amputations are rehabilitated.[4] Lower extremity amputations are associated with significant rates of perioperative morbidity and mortality. Thirty-day postoperative mortality ranges from 4% to 22%. At 1, 3, and 5 years, overall mortality rates are reported to be 15%, 38%, and 68%-77%, respectively.[5–7]

The medical, social, and economic burdens of a major amputation are high, and efforts to control perioperative events can reduce adverse events and overall burden associated with the index operation.[8] Multidisciplinary team care is a well-accepted and effective strategy in the management of high-risk, high-need patients.[9] Health care systems can expect a 39%-56% amputation

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Doc review statement: Independent peer review and oversight has been provided by the members of the SVS Document Oversight Committee (Marc Schermerhorn, Chair, Britt Tonnessen, Vice Chair, Trissa Babrowski, Allan Conway, Leo Daab, Brittany Fraser, Peter Henke, Vikram Kashyap, Ahmed Kayssi, Chris Kwolek, Steven Maximus, Erika Mitchell, Patrick Muck, Firas Mussa, Kenton Rommens, Palma Shaw, Chris Smolock, Ravi Veeraswamy, Chandu Vemuri, and Grace Wang).

Additional material for this article may be found online at www.jvsvi.org.

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The editors and reviewers of this article have no relevant financial relationships to disclose per the Journal policy that requires reviewers to decline review of any manuscript for which they may have a conflict of interest.

2949-9127

https://doi.org/10.1016/j.jvsvi.2024.100156

rate reduction after implementing a multidisciplinary amputation prevention program.[10,11] Important tools for success in limb preservation and amputated limb care are pathways that facilitate organized care algorithms and referrals.[9]

The concept of multidisciplinary care to control perioperative physiology and maintain homeostasis in order to attenuate stress and accelerate convalescence was first described in 1997.[12] Enhanced Recovery After Surgery (ERAS) pathways have been shown to be beneficial in the distillation of best practices for many surgical specialties. More recently, ERAS pathways have been developed for open aortic surgery and lower extremity bypass surgery.[13–15] Vascular surgery patients, specifically patients with CLTI facing major limb amputation, present unique challenges due to their multiple comorbidities and mobility limitations compared with the general population. This combination of factors results in complex management strategies, increased utilization of health care resources, prolonged hospitalizations, and rehabilitation needs.[16] A coordinated, multidisciplinary care pathway that encompasses ERAS principles would be particularly useful for patients undergoing major limb amputation, but unfortunately, there are not enough published data to support the development of a formal guideline. To reduce unwarranted clinical practice variation and to potentially enhance clinical care, this document is a synthesis of the existing literature for best practices and provides a literature-derived framework for the perioperative care of vascular patients undergoing major limb amputation. This report also highlights the gaps in the literature and suggests areas where research is needed to enhance our understanding and improve the care for this patient group.

METHODS

Formation of the guideline development group and selection of topics. The Society for Vascular Surgery formed a multidisciplinary, international guideline development group (GDG) that consisted of vascular surgeons, anesthesiologists, and advanced practice providers with expertise in enhanced recovery and vascular pathophysiology. The GDG was consulted for advice on appropriate items to be included, with the final decision being made by the lead authors (K.L.M. and H.D.B.). The selected topics for the consensus statement were allocated to authors for literature summary depending on each individual's expertise. The final content was agreed upon by all authors.

Literature search strategy. A third-party team of investigators and a reference librarian specializing in literature reviews assisted the GDG in identifying and categorizing the existing effectiveness and comparative effectiveness literature on ERAS protocols relevant to vascular surgery. The librarian executed and documented the search in July 2019 (Appendix 1, online only). GDG members then repeated the original literature search and searched reference lists to include any new publications until January 1, 2023, though some relevant references may have not have been included because this was not done with the methodologic rigor of an independently performed systematic review. The databases queried included PubMed, CINAHL, and ClinicalTrials.gov. Systematic reviews, randomized controlled trials (RCTs), and observational cohort studies reporting on adults (≥18 years) undergoing lower extremity vascular surgery and reporting on any one or combinations of the ERAS guideline items were included. The included studies were carefully reviewed by the GDG who unanimously agreed upon them.

Quality assessment, data analyses, and consensus generation. Suggestions for best perioperative practices were made based on the supporting literature specific to this patient population, and at times supporting literature extrapolated from other surgical populations. Assessment of the quality of evidence was judged to be high, moderate, or low. Where nonvascular literature was used as a primary basis for suggestions, the quality of evidence was extrapolated to this population and indicated in each section. Because of this, while some of the practice suggestions are based from a high-quality evidence base and are unlikely to change, other suggestions are merely from expert consensus or low-quality evidence and may change if more rigorous research is performed.

The Grading of Recommendations, Assessment, Development and Evaluation (GRADE) system was used to judge the literature, but formal recommendations using the GRADE system were not made because of the lack of consistently high-quality data derived from this specific patient population and inability to make evidence-based recommendations.[17]

RESULTS

The literature search yielded 3460 citations. There were 109 studies that addressed ERAS interventions, as either individual core elements or combinations of elements, in vascular surgery patients, and another 18 studies that included mixed cohorts, including vascular surgery patients. Most of these studies involved vascular patients with abdominal aortic pathology. Structured around the ERAS core elements, 33 suggestions for best perioperative practices were made and organized into preadmission, preoperative, intraoperative, and postoperative sections (Table).

Preadmission and preoperative recommendations

Patients with CLTI arrive at major amputations through several scenarios: (1) the patient is not physiologically appropriate for revascularization or there is no revascularization option, making primary major amputation

Table. Best practice suggestion and level of evidence for each Enhanced Recovery After Surgery (*ERAS*) element

ERAS element	Suggestion	Evidence level
Preadmission		
(1) Patient information, education, and counseling	Patients should receive dedicated verbal and written preoperative education and counseling.	Low[a]
(2a) Screening, assessment, and optimization: nutritional deficiency	Screen for malnutrition and treat nutritional deficiency preferably with oral regimens.	Moderate[a]
(2b) Screening, assessment, and optimization: anemia	Evaluate the cause of and treat chronic preoperative anemia.	Low
(2c) Screening, assessment, and optimization: frailty	Screen for frailty as a routine part of preoperative patient assessment.	Moderate
(2d) Screening, assessment, and optimization: delirium	Screen for delirium risk and implement preoperative practices to minimize onset of delirium as a routine part of practice.	Low
(2e) Screening, assessment, and optimization: psychosocial	Routinely screen for depression.	Low
(2f) Screening, assessment, and optimization: tobacco and alcohol	(i) Prescribe smoking cessation therapy before surgery	High[a]
	(ii) Recommend alcohol cessation before surgery.	Low[a]
(2g) Screening, assessment, and optimization: medical risk	Evaluate and optimize comorbidities before elective surgery and consider medical risks before urgent surgery.	High
(2h) Screening, assessment, and optimization: glycemic control	All patients should have a baseline HbA1c level before revascularization. In patients with elevated HbA1c levels, antihyperglycemic treatment should be initiated and/or titrated with the assistance of a specialist.	High
(3) Preoperative antiplatelet, anticoagulation plan	Continue aspirin throughout the perioperative period.	High
Preoperative		
(4) Fasting	Avoid overnight fasting; encourage clear fluids up to 2 hours and light foods up to 6 hours before the induction of general anesthesia.	High[a]
(5) Carbohydrate loading	(i) Patients without diabetes should receive a preoperative carbohydrate drink.	High[a]
	(ii) Patients with stable diabetes should receive a preoperative carbohydrate drink alongside their antidiabetic medication.	Low[a]
(6) Venous thromboembolism prophylaxis	Routinely use either low-dose unfractionated heparin or low-molecular-weight heparin with calf-length intermittent compression devices, when possible, starting before surgery or within 24 hours of surgery end, and continuing throughout the hospitalization.	High[a]
(7) Preanesthetic sedative and analgesia medication	(i) Do not routinely use sedatives to reduce anxiety preoperatively.	Low[a]
	(ii) Routinely use preoperative administration of acetaminophen, NSAIDs, and gabapentinoids as part of a multimodal opioid-sparing analgesia strategy.	Low[a]
	(iii) For opioid-dependent patients, maintain outpatient pain regimen in the perioperative period.	Moderate[a]
(8) Antimicrobials	(i) Consider the use of bundles programs to reduce SSI.	Low
	(ii) Prophylactic IV antibiotic dosing should begin 30-60 minutes preoperatively with redosing intraoperatively for procedures greater than 4 hours or with substantive intraoperative blood loss, and extend no more than 24 hours postoperatively.	High
(9) Prevention of nausea and vomiting (PONV)	Risk assess for PONV, routinely use multimodal PONV prophylaxis based on assessment, and use PONV rescue with a different class of antiemetic.	High[a]

(Continued on next page)

Table. Continued.

ERAS element	Suggestion	Evidence level
(10) Standard anesthetic protocol	Consider regional anesthesia as a singular strategy, or an adjunct to general anesthesia, for the short-term postoperative pain control benefit and possible prevention of phantom limb pain.	Moderate[a]
(11) Surgical techniques	(i) In patients with functional status that allows for at least transfers, preserve the knee joint in as many cases as possible, accepting that some may need revision or conversion to an above-knee amputation.	Low
	(ii) Neuroma and associated phantom limb pain should be prevented by either epineural closure with transposition and reimplantation, or targeted muscle reinnervation.	Low
(12) Drainage of the surgical site, wound care	(i) Do not routinely use surgical drains.	Low
	(ii) Use negative pressure wound therapy in complex stump closures and/or open wounds at the stump site.	Low
Postoperative		
(13) Multimodal analgesia, opioid-reducing strategies	Routinely use multimodal analgesic regimens to improve pain control and reduce opioid consumption.	Moderate
(14) Urinary drainage	Avoid the use of urinary catheters.	Low
(15) Glycemic control	(i) Glycemic goal of 180 mg/dL or less during the perioperative period.	Moderate
	(ii) Routinely use diabetic and nutritional counseling as part of interdisciplinary care for diabetic patients.	High
(16) Early mobilization strategy	Use a formal plan for early mobilization immediately postoperatively, with early physical therapy involvement.	Low
(17) Postoperative limb care strategies	No preference between soft and rigid dressings. When using rigid dressings, removable rigid dressings may be more suitable.	Low
(18) Posthospitalization rehabilitation	Patients who aim to be community ambulators after amputation should be discharged to an acute rehabilitation hospital.	Low
(19) Mental health management	Assess for and make appropriate referrals to treat depression and anxiety related to limb loss.	Moderate

HbA1c, Hemoglobin A1c; *IV*, intravenous; *NSAID*, nonsteroidal anti-inflammatory drug; *SSI*, surgical site infection.
[a]Denotes some of the evidence is extrapolated from nonvascular patient cohorts.

appropriate; (2) the patient has undergone endovascular or open bypass interventions without success, and amputation is the best option to control pain or tissue loss; (3) the patient presents acutely with sepsis due to a foot infection, and source control is the primary objective, which results in a staged major amputation.

For the most part, regardless of indication, patients undergoing major limb amputation for CLTI have similar clinical characteristics and risk profile to those getting worked up for infrainguinal bypass surgery. Evidence-based best practice suggestions are based on the same published literature and can be extrapolated to this population. Suggestions 1-9 are included in Table, and detailed justifications can be found in the paper by McGinigle et al.[14]

Preoperative counseling is a vital part of preparing a potential amputee to adjust to a major amputation.[18] Counseling with a current functional amputee can be very effective. Multiple factors affect the psychosocial adjustment to amputation: age, gender, type of amputation, perceived or functional value of body part, premorbid personality, past coping skills, expectations for rehabilitation, social support, family support system occupational and vocational demands, and type and extent of other systemic diseases. A prediction tool based on data from the Department of Veterans' Affairs, AMPREDICT, has recently been developed as a web-based prediction tool that can provide probabilities of successful transition to mobility in patients who are being counseled on major lower extremity.[19] Informing the patient of their probability to achieve independence in the 12 months after amputation allows for shared decision-making and, more importantly, allows the patient to understand their mobility prognosis during the strenuous recovery period.[20,21] Evidence is currently lacking to support that preoperative rehabilitation will improve postoperative outcomes in patients with lower extremity major amputation.

Intraoperative recommendations

Standard anesthetic protocol. Patients undergoing lower extremity amputations, either as a primary procedure or as a secondary procedure after failed revascularization attempts, often have multiple morbidities and geriatric syndromes including frailty and sarcopenia. This predisposes the group of patients to an increased risk of postoperative morbidity and mortality. A recent systematic review showed the 5-year mortality after below-knee and above-knee amputations to range from 40% to 90%.

Although the role of regional anesthesia has gained popularity in recent years, there is little evidence to guide decisions around the choice of anesthesia favoring regional (spinal, epidural, or peripheral nerve blockade) or general anesthesia over the other. Regional anesthesia may have some advantages over general anesthesia, including maintenance of the body's physiological response to surgery, improved stump flow, reduction in blood loss, improvement in pulmonary function, and a reduction in myocardial ischemia.

The short-term benefits of regional anesthesia are thought to be superior to general anesthesia for early acute postoperative pain management and for pulmonary complications in patients who already suffer with poor functional status and limited respiratory reserve, which is often compromised by the use of opioids and the effects of residual neuromuscular blockade associated with general anesthesia. Opioids, given orally, intravenously, or neuraxially, although have been shown to reduce phantom limb pain in the short term, have a number of notable adverse side effects such as nausea and vomiting, urinary retention, constipation, sedation, dizziness, and respiratory depression in a primarily elderly population.[22]

Furthermore, in a study of 45,492 lower limb extremity amputations performed in the National Surgery Quality improvement database (40,026 [88.0%] received general anesthesia and 5466 [12.0%] regional anesthesia), regional anesthesia had lower rates of sepsis and reoperations.[23] There are data from two large database retrospective analyses to suggest that the type of anesthesia given for lower extremity amputation does not significantly affect cardiac morbidity or 30-day mortality. However, recent data suggest that the use of regional anesthesia may provide long-term relief of phantom and residual limb pain.[24]

A single-injection peripheral nerve block in the amputated limb can result in short-term resolution of both the cortical abnormalities and phantom pain.[25] However, the effects are usually short-lived.[24] A continuous peripheral nerve block reduces phantom limb pain as well as physical and emotional dysfunction 1 to 6 months after amputation.[26,27] Evidence of optimal regional anesthetic choice (single injection vs continuous blockade) and possible long-term benefit remains elusive.

Anticoagulation concerns are common in the perioperative period for vascular amputation patients, which may preclude the use of central neuraxial techniques. The use of perineural analgesia eliminates such concerns, while still providing the benefits of a regional blockade of painful somatic stimuli postoperatively. Perineural analgesia (peripheral nerve catheters) can be easily inserted intraoperatively by the surgeon, are simple to administer, have minimal risks associated with them, and avoid the hemodynamic fluctuations in a susceptible population.[28]

Preoperative pain, opioid use, and anxiety are directly correlated to degree of perceived postoperative pain. Optimal pain control throughout the hospitalization, particularly in patients requiring guillotine amputation, is essential. For staged amputations, a strategy of single injection blocks for guillotine amputations, followed by a continuous peripheral block for formal amputation, has been described.[29]

When deciding about the choice of anesthesia, it is imperative to follow local protocols/guidelines regarding the use of regional anesthesia and consider adapting anesthetic regional techniques to account for patients' hemodynamic and coagulation status.

Suggestion: Consider regional anesthesia as a singular strategy, or an adjunct to general anesthesia, for the short-term postoperative pain control benefit and possible prevention of phantom limb pain.

Level of evidence: Moderate.

Surgical techniques. The primary objective of major lower extremity amputation is to produce a stump, which will proceed to primary, uncomplicated wound healing, allow for early and complete rehabilitation, and offer the best potential for a well-fitted prosthetic. There are three types of major amputation most often performed: below-knee amputation, through-knee amputation, and above-knee amputation. Various musculocutaneous flaps have been described to allow for coverage after the amputation has been performed with none showing superiority and the most common being a posterior flap for below-knee amputation, an anterior patellar tendon-based flap for through-knee amputation, and a fish mouth flap for above-knee amputation. In a systematic review and a separate RCT, perioperative use of a tourniquet reduced intraoperative blood loss and transfusion requirements in patients undergoing transtibial amputation without increasing ischemic complications and need for revision surgery.[30–32]

The main guiding philosophy is that amputation should be performed at the most distal possible site where healing is likely to occur and that the knee joint should be preserved in as many cases as possible. Residual limb length is an important concept in both above- and below-knee amputations as length allows improved gait and prevention of contractures. Optimal tibia length in below-knee amputations ranges from 12 to 17 cm depending on height, with 10 cm being the minimal

length for ideal prosthesis fitting. Longer residual tibia lengths allow for decreased energy expenditure during the gait cycle and enhanced mobility. In above-knee amputation, every effort should be made to preserve as much femur as possible, with maximum length 10 cm proximal to the knee joint to allow adequate room for a prosthetic knee.[33,34]

Shared decision-making between the surgeon and patient is also important for determining amputation level.[35,36] For example, nonambulatory patients are unlikely to have the goal of ambulation with a prosthetic, and it may be more desirable to undergo above-knee amputation to minimize the risk of joint contracture and skin breakdown of the distal stump. Even among patients who are ambulatory preoperatively, only 50%-60% will be able to ambulate after limb amputation, so clinical (ie, obesity, frailty, and dementia) and social (ie, family support and poor access to physical therapy) factors that affect rehabilitation goals must be considered.[37–39] Often, with a patent profunda femoris artery, a below-knee amputation will heal and should be attempted; however, even with ideal management, episodes of skin-flap ischemia and suture-line infection cannot always be avoided. Wound complications due to ischemia or infection after lower extremity amputation for CLTI account for up to 49% of readmissions after major limb amputation.[40,41] These problems can be minimized by careful selection of amputation level, preoperative treatment of infected ischemic limbs, and the use of antibiotic prophylaxis.[42,43] Wound breakdown due to ischemia may be a primary problem or may occur because of excessive pressure. Small areas of wound breakdown often heal with conservative management. Ischemic failure with or without infection usually requires revision. A failed below-knee amputation may often be revised to a higher level while still retaining the knee joint if enough viable soft tissue is present, or it may necessitate above-knee amputation.[41,44,45] Converting a below-knee to higher level amputation should not necessarily be seen as a failure, and it is preferable to attempt to preserve the knee joint if feasible for long-term limb functionality.

In the infected limb, there is evidence from several studies that guillotine amputation is the best method for eliminating the infection before definitive amputation as a second-stage procedure is performed.[46,47]

Post-amputation terminal neuromas and associated phantom limb pain (TNPLP) occur in up to 25% of amputees and can significantly limit ambulation and quality of life. Despite a large body of literature, outcomes on prevention of TNPLP are widely varied. Surgical prevention strategies can be divided into two categories: target deficient and target reassignment. Target deficient strategies involve either performing an end closure of the epineurium to close the exposed nerve fascicles of the severed nerve or transposition of the severed terminal nerves into bone, muscle, or fascia so as to avoid exposed pain receptors growing more superficially into the skin. Physiologic target reassignment, most commonly described as targeted muscle reinnervation, involves rerouting the amputated terminal nerves to the motor endplates in nearby muscles via end-to-end neurorrhaphy allowing regeneration of new myoelectric sites and prevention of pathologic central reorganization and TNPLP.[48–51]

Suggestion: In patients with functional status that allows for at least transfers, preserve the knee joint in as many cases as possible, accepting that some may need revision or conversion to an above-knee amputation.

Level of evidence: Low.

Suggestion: Neuroma and associated phantom limb pain should be prevented by either epineural closure with transposition and reimplantation, or targeted muscle reinnervation.

Level of evidence: Low.

Drainage of the surgical site, wound care. Hemostasis should be meticulous, so that wound drains can be avoided: these probably increase the incidence of wound infection and breakdown.[52] The skin must never be sutured under tension and may be left open if there is local infection. If the patient has gross infection of the foot or limb at the time of surgery and a staged approach is not being performed, the infected and necrotic tissue should be well wrapped and isolated from the field at the time of operation to prevent direct contamination of the surgical incision. Incisions must be well healed before weight bearing.[53] Diabetic patients are almost twice as likely to have reamputation as are nondiabetic patients.[54]

In general, the selection of wound dressing should be based on wound characteristics, including location, inflammation, and amount of exudate. Unfortunately, there is no published literature to support certain open or surgical wound management strategies for different situations, so surgeons are left using general wound care principles. A multitude of agents with theoretical healing benefits have been added to wound dressings, including collagen, zinc, enzymes, copper chlorophyll, honey, avocado oil, and others with little proof of benefit.

Negative pressure wound therapy (NPWT) devices are designed to apply controlled suction to a wound bed at continuous or intermittent pressure settings to stimulate wound and/or surgical incision closure. NPWT has been used over surgical wounds left open, resulting in the clinical impression of a favorable response,[55–58] but it is less clear if their use as a strip vac over a closed surgical incision is beneficial.

Suggestion: Do not routinely use surgical drains.

Level of evidence: Low.

Suggestion: Use NPWT in complex stump closures and/or open wounds at the stump site.

Level of evidence: Low.

Postoperative recommendations

Multimodal analgesia, opioid-reducing strategies. As reviewed in the infrainguinal bypass perioperative framework, regional anesthesia is thought to be superior to general anesthesia for early acute postoperative pain management, but evidence for improved patient satisfaction is limited.[15] There is good-quality evidence to support multimodal analgesia for postoperative pain relief after surgery. These techniques combine regional anesthetic techniques and nonopioid analgesics such as acetaminophen, nonsteroidal anti-inflammatory drugs, and gabapentinoids at multiple points in the pain pathway.[26]

Suggestion: Routinely use multimodal analgesic regimens to improve pain control and reduce opioid consumption.

Level of evidence: Moderate.

Urinary drainage. Although mobility and independent toileting is limited after major limb amputation, indwelling catheters should not be used for convenience. If there is no need for continuous postoperative urine output monitoring or risk of wound contamination in the setting of a high above-knee amputation site, then catheters should not be used in an effort to reduce the risk of urinary tract infection.[59]

Suggestion: Avoid the use of urinary catheters.

Quality of evidence: Low.

Glycemic control. Patients may benefit from incorporating a dietician to provide nutritional counseling, a nurse diabetic educator, and endocrinology for patients who have known diabetes mellitus. Perioperative hyperglycemia in vascular surgery patients has previously been defined as a glucose value of greater than 180 mg/dL within 72 hours of surgery.[60] Detailed justifications can be found in the paper by McGinigle et al.[14]

Suggestion: Glycemic goal of 180 mg/dL or less during the perioperative period.

Quality of evidence: Moderate.

Suggestion: Routinely use diabetic and nutritional counseling as part of interdisciplinary care for diabetic patients.

Quality of evidence: High.

Early mobilization strategy. Patients facing major limb amputation due to CLTI are likely to have a poor baseline functional status. Setting appropriate goals and focusing on mobility at every opportunity are imperative to a successful postoperative recovery and are associated with long-term independence and survival.[61] Mobility is not necessarily limited to ambulation and can include any active limb exercise, such as dynamic range of motion, sitting at the side of the bed, or pivoting to a bedside chair.[62]

Suggestion: Use a formal plan for early mobilization immediately postoperatively, with early physical therapy involvement.

Level of evidence: Low.

Postoperative limb care strategies after transtibial amputation. The primary goals for wound management after transtibial amputations are to protect the wound to allow for healing, management of edema, reduction in knee contraction, and ultimately transition to a prosthesis. Published literature is primarily historical case series linked to different wartime practices.[63–68] A Cochrane review of 9 RCTs and uncontrolled trials without consistent criteria for the selection of dressing or outcome measures and involving 436 patients showed no superiority of rigid dressings when compared with soft dressings (SDs).[69] Specifically, there was no difference in wound healing, edema, adverse events, length of hospital stay, time to walking, or readiness for prosthesis.[69] Physical therapy is typically initiated immediately after surgery, but protocols for weight bearing, gait training, and prosthesis fitting are not standardized.

The general, contemporary categories of dressings and postamputation limb management are as follows.

Soft dressing. This dressing is typically gauze bandaging with or without a rigid removable limb protector. The reported benefit of SD is the ease of application and low cost. The potential disadvantages are uneven pressure causing skin damage, tendency of the dressing to loosen or fall off, and risk of joint contracture (the benefit of a knee immobilizer in reducing a contracture has not been evaluated in literature, although this risk could theoretically be mitigated with consistent use of the device).[63] Suture/staple removal is performed at 3 to 4 weeks postoperatively, followed by shrinker stocking compression to allow optimization of a residual limb for prosthetic fitting.[70]

Thigh level right plaster dressings without an immediate prosthesis. A sterile sock to cover the incision, followed by padding and a plaster cast, is applied in the operating room and changed every 1 to 3 weeks. Low-quality studies comparing SD with thigh high casting did not show any statistical benefit to wound healing, postoperative pain, prosthetic use, time to rehabilitation, or hospital length of stay.[63,71,72] Disadvantages include limited ability to evaluate postsurgical healing.

Thigh level right plaster dressings with an immediate prosthesis. This type of cast has a connector with a pylon and a foot applied immediately in the operating room. The dressing is weight bearing once the cast is dry, allowing for more rapid gait training and physical therapy. The benefits in case studies are reduced rehabilitation time and a quicker time to prosthetic fitting. The disadvantages include reduced access for wound checks, possible mechanical tissue trauma from inside the cast, and increased expense with the need of a skilled prosthesis team.[63] A retrospective analysis of 37 patients getting immediate prosthesis compared with 35 patients who had traditional SD showed no statistical difference in the rate of skin breakdown or wound infections, but there was possibly a lower fall risk.[73]

Removable rigid dressing. This type of dressing is shorter than a thigh level casting with or without a prosthesis. The advantage of this rigid dressing over the others above is the ability to evaluate the incision more frequently. One controlled trial did find an advantage with reduced edema.[74] A review that included 5 RCTs and 10 retrospective studies concluded that non-weight-bearing removable rigid dressings are superior to SD when evaluating injury due to falls, contracture development, edema, healing time, prosthetic fitting, and pain.[75]

Suggestion: No preference between soft and rigid dressings. When evaluating rigid dressings, removable rigid dressings may be more suitable.

Level of evidence: Low.

Posthospital rehabilitation. Rehabilitation for the patient with a major lower extremity amputation should include coordinated care that addresses the medical, logistical, and psychosocial issues faced by the amputee with the goal of preparing the patient to function to their best potential. Post-acute care decisions largely appear to be made on the basis of medical and family support factors. Approximately one quarter of patients with amputations are discharged home[76] but would be optimally placed in an inpatient rehabilitation facility (IRF) if they have the capacity to participate and train. Studies have demonstrated that placement in IRF leads to improved ambulation and overall reduction in disability.[77,78] IRF affords patients' 24-hour inpatient care in addition to ≥3 hours of core physical/occupational therapy per day, unlike skilled nursing facilities that have minimal physical therapy and physician resources, or home where outpatient physical therapy is often limited to three times per week. Controlled for patient characteristics and comorbidities, a retrospective analysis of 464 patients undergoing limb amputation reported attaining a prosthetic improved survival.[79] Postamputation mobility, which is facilitated by active rehabilitation and referral to prosthetists, is a modifiable risk factor for survival, but unfortunately, it is estimated that only 40% of patients undergoing limb amputation attain a prosthetic.[79,80]

Suggestion: Patients who aim to be community ambulators after amputation should be discharged to an acute rehabilitation hospital.

Level of evidence: Low.

Mental health management. The psychological insult and high prevalence of depression among patients undergoing limb amputation is well documented, yet there is a paucity of data regarding implementation of standardized therapies to improve these outcomes.[81,82] Depression occurs in up to two thirds of patients who have undergone major limb amputation. Anxiety is diagnosed in 25% to 57% of patients. Related to the psychological trauma of limb loss, 83% of patients who have undergone a major amputation will attend a psychiatric clinic at least once after their surgery.[83,84] Current interventions, such as "Amputees Unanimous: a 12-step program," are designed to provide the amputee encouragement, support, and optimism for the future through a multimodal approach.[85] Access to quality outpatient care including formal psychosocial support and prosthetics can improve mental and physical outcomes.[86]

Suggestion: Assess for and make appropriate referrals to treat depression and anxiety related to limb loss.

Level of evidence: Moderate.

SUMMARY AND CONCLUSION

The purpose of this consensus statement is to provide a framework from which to build a multidisciplinary program to implement best perioperative practices for patients undergoing major limb amputations as a result of diabetes or vascular disease. As demonstrated in other specialties and in existing single institution amputation care pathways,[87,88] forming clinical teams to enhance patient optimization and shared decision-making, focus on physiologic stress minimization, and reduce variation in postoperative convalescence promises to improve the safety and outcomes for patients undergoing major limb amputation operations.

This consensus statement defines current standards based on the available medical literature, which is sparse and of low quality overall. None of the amputation-specific suggestions were supported by high-quality evidence. Dedicated focus on this high-risk group of patients and studies of high methodological quality are urgently needed. The lines of research to be developed could include any of the ERAS elements or combined elements but are particularly needed in preadmission optimization, prehabilitation, regional anesthesia and analgesia strategies, management of phantom limb pain, optimal postoperative limb care, early mobility protocols, and postdischarge transitions including rehabilitation.

AUTHOR CONTRIBUTIONS

Conception and design: KM, HD
Analysis and interpretation: KM, LO, AS, AV, JG, KA, SA, MT, KD, IS, MD, CS, RU, SH, ES, HD
Data collection: KM, LO, AS, AV, JG, KA, SA, MT, KD, IS, MD, CS, RU, SH, ES, HD
Writing the article: KM, LO, AS, AV, JG, KA, SA, MT, KD, IS, MD, CS, RU, SH, ES, HD
Critical revision of the article: KM, LO, AS, AV, JG, KA, SA, MT, KD, IS, MD, CS, RU, SH, ES, HD
Final approval of the article: KM, LO, AS, AV, JG, KA, SA, MT, KD, IS, MD, CS, RU, SH, ES, HD
Statistical analysis: Not applicable
Obtained funding: Not applicable
Overall responsibility: KM

DISCLAIMER

The Society for Vascular Surgery (SVS) develops evidence-based documents as a resource to assist members in the practice of vascular surgery. The recommendations contained herein are based on a recent review of published evidence and expert opinion. They reflect the available body of evidence, and their applicability reflects the limitations of those data and are subject to reassessment and revision as new knowledge emerges. Given these limitations, consensus documents do not represent a statement of the standard of care, nor do they substitute for clinician judgment or supplant patient preference or shared decision-making. The SVS recognizes that departure from these recommendations could be warranted when, in the reasonable judgment of the treating clinician, such a course of action is indicated by the clinical presentation of the patient, limitations of available resources, advances in knowledge or technology, or patient preference. The reader must rely solely on their own judgment to determine which practices and procedures, whether included in this document or not, are appropriate for them, their patient, their institution, or their practice.

DISCLOSURES

K.L.M. reports consulting fees from Shockwave Medical, Vascular Technologies, and Medtronic; and research funding from National Institutes of Health (NIH) and NovoNordisk Foundation. L.A.O. reports consulting fees from Gore, Reflow Medical, and Penumbra; and research funding from Shockwave Medical, Medtronic, and Abott. S.A. reports consulting fees from Gore and research funding from Veteran Affairs. R.D.U. reports consulting fees from Merck and AcelRx, research funding from NIH, and is Vice President of the Enhanced Recovery after Surgery, USA Society. H.D.B. is on the global advisory board of Merck and NMD Pharma and the scientific advisory board of Senzime. The remaining authors report no conflicts.

REFERENCES

1. Conte MS, Bradbury AW, Kolh P, et al. Global vascular guidelines on the management of chronic limb-threatening ischemia. *Eur J Vasc Endovasc Surg*. 2019;58:S1–S109.e33.
2. Sun H, Saeedi P, Karuranga S, et al. IDF Diabetes Atlas: global, regional and country-level diabetes prevalence estimates for 2021 and projections for 2045. *Diabetes Res Clin Pract*. 2022;183:109119.
3. Tonnies T, Rathmann W, Hoyer A, Brinks R, Kuss O. Quantifying the underestimation of projected global diabetes prevalence by the international diabetes federation (IDF) diabetes atlas. *BMJ Open Diabetes Res Care*. 2021;9:e002122.
4. Behrendt CA, Sigvant B, Szeberin Z, et al. International variations in amputation practice: a VASCUNET report. *Eur J Vasc Endovasc Surg*. 2018;56:391–399.
5. Fortington LV, Geertzen JH, van Netten JJ, Postema K, Rommers GM, Dijkstra PU. Short and long term mortality rates after a lower limb amputation. *Eur J Vasc Endovasc Surg*. 2013;46:124–131.
6. van Netten JJ, Fortington LV, Hinchliffe RJ, Hijmans JM. Early postoperative mortality after major lower limb amputation: a systematic review of population and regional based studies. *Eur J Vasc Endovasc Surg*. 2016;51:248–257.
7. Lopez-Valverde ME, Aragon-Sanchez J, Lopez-de-Andres A, et al. Perioperative and long-term all-cause mortality in patients with diabetes who underwent a lower extremity amputation. *Diabetes Res Clin Pract*. 2018;141:175–180.
8. Keszler MSWK, Miranda A, Hopkins MS. Multidisciplinary amputation team management of individuals with limb loss. *Curr Phys Med Rehabil Rep*. 2020;8:118–126.
9. Meza-Torres B, Carinci F, Heiss C, Joy M, de Lusignan S. Health service organisation impact on lower extremity amputations in people with type 2 diabetes with foot ulcers: systematic review and meta-analysis. *Acta Diabetol*. 2021;58:735–747.
10. Rogers LC, Andros G, Caporusso J, Harkless LB, Mills JL, Sr, Armstrong DG. Toe and flow: essential components and structure of the amputation prevention team. *J Am Podiatr Med Assoc*. 2010;100:342–348.
11. Rubio JA, Aragon-Sanchez J, Jimenez S, et al. Reducing major lower extremity amputations after the introduction of a multidisciplinary team for the diabetic foot. *Int J Low Extrem Wounds*. 2014;13:22–26.
12. Kehlet H. Multimodal approach to control postoperative pathophysiology and rehabilitation. *Br J Anaesth*. 1997;78:606–617.
13. Ljungqvist O, Scott M, Fearon KC. Enhanced recovery after surgery: a review. *JAMA surgery*. 2017;152:292–298.
14. McGinigle KL, Spangler EL, Ayyash K, et al. A framework for perioperative care for lower extremity vascular bypasses: a consensus statement by the Enhanced Recovery After Surgery (ERAS®) Society and Society for Vascular Surgery. *J Vasc Surg*. 2023;77:1295–1315.
15. McGinigle KL, Spangler EL, Pichel AC, et al. Perioperative care in open aortic vascular surgery: a consensus statement by the Enhanced Recovery After Surgery (ERAS) Society and Society for Vascular Surgery. *J Vasc Surg*. 2022;75:1796–1820.
16. Brooke BS, De Martino RR, Girotti M, Dimick JB, Goodney PP. Developing strategies for predicting and preventing readmissions in vascular surgery. *J Vasc Surg*. 2012;56:556–562.
17. Guyatt GH, Oxman AD, Vist GE, et al. GRADE: an emerging consensus on rating quality of evidence and strength of recommendations. *BMJ*. 2008;336:924–926.
18. Butler DJ, Turkal NW, Seidl JJ. Amputation: preoperative psychological preparation. *J Am Board Fam Pract*. 1992;5:69–73.
19. Czerniecki JM, Turner AP, Williams RM, et al. The development and validation of the AMPREDICT model for predicting mobility outcome after dysvascular lower extremity amputation. *J Vasc Surg*. 2017;65:162–171.e3.
20. Norvell DC, Suckow BD, Webster JB, et al. The development and usability of the AMPREDICT decision support tool: a mixed methods study. *Eur J Vasc Endovasc Surg*. 2021;62:304–311.
21. Norvell DC, Thompson ML, Baraff A, et al. AMPREDICT PROsthetics-predicting prosthesis mobility to Aid in prosthetic Prescription and rehabilitation planning. *Arch Phys Med Rehabil*. 2023;104:523–532.
22. Falzone E, Hoffmann C, Keita H. Postoperative analgesia in elderly patients. *Drugs Aging*. 2013;30:81–90.
23. Mufarrih SH, Qureshi NQ, Schaefer MS, et al. Regional anaesthesia for lower extremity amputation is associated with reduced postoperative complications compared with general Anaesthesia. *Eur J Vasc Endovasc Surg*. 2021;62:476–484.
24. Ilfeld BM, Khatibi B, Maheshwari K, et al. Ambulatory continuous peripheral nerve blocks to treat postamputation phantom limb pain: a multicenter, randomized, quadruple-masked, placebo-controlled clinical trial. *Pain*. 2021;162:938–955.
25. Birbaumer N, Lutzenberger W, Montoya P, et al. Effects of regional anesthesia on phantom limb pain are mirrored in changes in cortical reorganization. *J Neurosci*. 1997;17:5503–5508.
26. Ahuja V, Thapa D, Ghai B. Strategies for prevention of lower limb post-amputation pain: a clinical narrative review. *J Anaesthesiol Clin Pharmacol*. 2018;34:439–449.
27. Jahangiri M, Jayatunga AP, Bradley JW, Dark CH. Prevention of phantom pain after major lower limb amputation by epidural infusion of diamorphine, clonidine and bupivacaine. *Ann R Coll Surg Engl*. 1994;76:324–326.
28. De Jong R, Shysh AJ. Development of a multimodal analgesia protocol for perioperative acute pain management for lower limb amputation. *Pain Res Manag*. 2018;2018:5237040.
29. Li H, Cho DH, Tokhner V. Unique Considerations for complete surgical analgesia for below-the-knee amputations. *Cureus*. 2021;13:e14224.

30. Wolthuis AM, Whitehead E, Ridler BM, Cowan AR, Campbell WB, Thompson JF. Use of a pneumatic tourniquet improves outcome following trans-tibial amputation. *Eur J Vasc Endovasc Surg*. 2006;31:642–645.
31. Choksy SA, Lee Chong P, Smith C, Ireland M, Beard J. A randomised controlled trial of the use of a tourniquet to reduce blood loss during transtibial amputation for peripheral arterial disease. *Eur J Vasc Endovasc Surg*. 2006;31:646–650.
32. Cagney D, Byrne J, Fulton G, Manning B, Redmond H. O42: the role of tourniquets in transtibial amputation for peripheral vascular disease: a systematic review & meta-analysis. *Br J Surg*. 2021;108:znab117.042.
33. Bell JC, Wolf EJ, Schnall BL, Tis JE, Potter BK. Transfemoral amputations: is there an effect of residual limb length and orientation on energy expenditure? *Clin Orthop Relat Res*. 2014;472:3055–3061.
34. Geertzen JHB, de Beus MC, Jutte PC, Otten E, Dekker R. What is the optimal femur length in a trans-femoral amputation? A mixed method study: scoping review, expert opinions and biomechanical analysis. *Med Hypotheses*. 2019;129:109238.
35. Columbo JA, Davies L, Kang R, et al. Patient experience of recovery after major leg amputation for arterial disease. *Vasc Endovasc Surg*. 2018;52:262–268.
36. Suckow BD, Goodney PP, Cambria RA, et al. Predicting functional status following amputation after lower extremity bypass. *Ann Vasc Surg*. 2012;26:67–78.
37. Forsyth A, Diamond K, Judelson D, Aiello F, Schanzer A, Simons J. Predictors of ambulatory status at 1 year following major lower extremity amputation. *J Foot Ankle Surg*. 2023;62:943–950.
38. Chopra A, Azarbal AF, Jung E, et al. Ambulation and functional outcome after major lower extremity amputation. *J Vasc Surg*. 2018;67:1521–1529.
39. Columbo JA, Nolan BW, Stucke RS, et al. Below-knee amputation failure and poor functional outcomes are higher than predicted in contemporary practice. *Vasc Endovasc Surg*. 2016;50:554–558.
40. Hickson LJ, Rule AD, Thorsteinsdottir B, et al. Predictors of early mortality and readmissions among dialysis patients undergoing lower extremity amputation. *J Vasc Surg*. 2018;68:1505–1516.
41. Curran T, Zhang JQ, Lo RC, et al. Risk factors and indications for readmission after lower extremity amputation in the American College of Surgeons National Surgical Quality Improvement Program. *J Vasc Surg*. 2014;60:1315–1324.
42. Schultz GS, Sibbald RG, Falanga V, et al. Wound bed preparation: a systematic approach to wound management. *Wound Repair Regen*. 2003;11(Suppl 1):S1–S28.
43. Dumville JC, McFarlane E, Edwards P, Lipp A, Holmes A, Liu Z. Preoperative skin antiseptics for preventing surgical wound infections after clean surgery. *Cochrane Database Syst Rev*. 2015;2015:Cd003949.
44. Phair J, DeCarlo C, Scher L, et al. Risk factors for unplanned readmission and stump complications after major lower extremity amputation. *J Vasc Surg*. 2018;67:848–856.
45. Khouqeer A, Uribe-Gomez A, Sharath SS, Kougias P, Barshes NR. Wound complications and reoperations after transtibial amputation of the Leg. *Ann Vasc Surg*. 2020;69:292–297.
46. Cheun TJ, Jayakumar L, Sideman MJ, et al. Short-term contemporary outcomes for staged versus primary lower limb amputation in diabetic foot disease. *J Vasc Surg*. 2020;72:658–666.e2.
47. Lepow BD, Zulbaran-Rojas A, Park C, et al. Guillotine transmetatarsal amputations with staged closure promote early ambulation and limb salvage in patients with advanced chronic limb-threatening ischemia. *J Endovasc Ther*. 2024;31:687–696.
48. Bogdasarian RN, Cai SB, Tran BNN, Ignatiuk A, Lee ES. Surgical prevention of terminal neuroma and phantom limb pain: a literature review. *Arch Plast Surg*. 2021;48:310–322.
49. Ives GC, Kung TA, Nghiem BT, et al. Current state of the surgical treatment of terminal neuromas. *Neurosurgery*. 2018;83:354–364.
50. Economides JM, DeFazio MV, Attinger CE, Barbour JR. Prevention of painful neuroma and phantom limb pain after transfemoral amputations through concomitant nerve coaptation and collagen nerve wrapping. *Neurosurgery*. 2016;79:508–513.
51. Valerio IL, Dumanian GA, Jordan SW, et al. Preemptive treatment of phantom and residual limb pain with targeted muscle reinnervation at the time of major limb amputation. *J Am Coll Surg*. 2019;228:217–226.
52. Coulston JE, Tuff V, Twine CP, Chester JF, Eyers PS, Stewart AH. Surgical factors in the prevention of infection following major lower limb amputation. *Eur J Vasc Endovasc Surg*. 2012;43:556–560.
53. Sumpio B, Shine SR, Mahler D, Sumpio BE. A comparison of immediate postoperative rigid and soft dressings for below-knee amputations. *Ann Vasc Surg*. 2013;27:774–780.
54. Chahrour MA, Habib JR, El Moheb MN, et al. Incidence and Predictors of surgical site infection complications in diabetic patients undergoing lower limb amputation. *Ann Vasc Surg*. 2022;81:343–350.
55. Armstrong DG, Lavery LA. Negative pressure wound therapy after partial diabetic foot amputation: a multicentre, randomised controlled trial. *Lancet*. 2005;366:1704–1710.
56. Zayan NE, West JM, Schulz SA, Jordan SW, Valerio IL. Incisional negative pressure wound therapy: an effective tool for major limb amputation and amputation revision site closure. *Adv Wound Care*. 2019;8:368–373.
57. Chang H, Maldonado TS, Rockman CB, et al. Closed incision negative pressure wound therapy may decrease wound complications in major lower extremity amputations. *J Vasc Surg*. 2021;73:1041–1047.
58. Vaddavalli VV, Savlania A, Behera A, Rastogi A, Kaman L, Abuji K. Prophylactic incisional negative pressure wound therapy versus standard dressing after major lower extremity amputation: a randomised controlled trial. *Eur J Vasc Endovasc Surg*. 2022;64:579–580.
59. Gould CV, Umscheid CA, Agarwal RK, Kuntz G, Pegues DA. Guideline for prevention of catheter-associated urinary tract infections 2009. *Infect Control Hosp Epidemiol*. 2010;31:319–326.
60. Long CA, Fang ZB, Hu FY, et al. Poor glycemic control is a strong predictor of postoperative morbidity and mortality in patients undergoing vascular surgery. *J Vasc Surg*. 2019;69:1219–1226.
61. Zil EAA, Patel K, Goldfarb M, Aziz F. Postoperative decline in ambulatory function after lower extremity bypass is associated with higher short- and long-term mortality. *J Vasc Surg*. 2022;75:2002–2012.e3.
62. Arias-Fernández P, Romero-Martin M, Gómez-Salgado J, Fernández-García D. Rehabilitation and early mobilization in the critical patient: systematic review. *J Phys Ther Sci*. 2018;30:1193–1201.
63. Smith DG, McFarland LV, Sangeorzan BJ, Reiber GE, Czerniecki JM. Postoperative dressing and management strategies for transtibial amputations: a critical review. *J Rehabil Res Dev*. 2003;40:213–224.
64. Little JM. The use of air splints as immediate prostheses after below-knee amputation for vascular insufficiency. *Med J Aust*. 1970;2:870–872.
65. Wu Y, Keagy RD, Krick HJ, Stratigos JS, Betts HB. An innovative removable rigid dressing technique for below-the-knee amputation. *J Bone Joint Surg Am*. 1979;61:724–729.
66. Wilson P. Early weight-bearing in the treatment of amputations of the lower limbs. *J Bone Joint Surg Am*. 1922;4:224–247.
67. Berlemont M. Experience of early fitting of lower limb amputees at Helio-Marin establishments in Berck. *Ann Med Physique*. 1961;4:213–218.
68. Weiss M. *The prosthesis on the operating table from the neurophysiological point of view. Report of the workshop panel on lower extremity prosthetic fitting. Committee on 224 Journal of Rehabilitation Research and Development. February 1966*. 40. Prosthetics Research and Development National Academy of Sciences; 2003.
69. Kwah LK, Webb MT, Goh L, Harvey LA. Rigid dressings versus soft dressings for transtibial amputations. *Cochrane Database Syst Rev*. 2019;6:Cd012427.
70. Arya SEG. Principles of lower extremity amputation: Etiology, goals, limb length decisions and impact on prosthetic management. In: *Prosthetic Restoration and Rehabilitation of the Upper and Lower Extremity*. Demos Medical Publishing; 2014:9–20.
71. Mooney V, Harvey JP Jr, McBride E, Snelson R. Comparison of postoperative stump management: plaster vs. soft dressings. *J Bone Joint Surg Am*. 1971;53:241–249.
72. Baker WH, Barnes RW, Shurr DG. The healing of below-knee amputations: a comparison of soft and plaster dressing. *Am J Surg*. 1977;133:716–718.
73. Ali MM, Loretz L, Shea A, et al. A contemporary comparative analysis of immediate postoperative prosthesis placement following below-knee amputation. *Ann Vasc Surg*. 2013;27:1146–1153.
74. Mueller MJ. Comparison of removable rigid dressings and elastic bandages in preprosthetic management of patients with below-knee amputations. *Phys Ther*. 1982;62:1438–1441.

75. Reichmann JP, Stevens PM, Rheinstein J, Kreulen CD. Removable rigid dressings for postoperative management of transtibial amputations: a review of published evidence. *PM R*. 2018;10:516–523.
76. Gabel J, Jabo B, Patel S, et al. Analysis of patients undergoing major lower extremity amputation in the vascular quality initiative. *Ann Vasc Surg*. 2018;46:75–82.
77. Stineman MG, Kwong PL, Kurichi JE, et al. The effectiveness of inpatient rehabilitation in the acute postoperative phase of care after transtibial or transfemoral amputation: study of an integrated health care delivery system. *Arch Phys Med Rehabil*. 2008;89:1863–1872.
78. Dillingham TR, Yacub JN, Pezzin LE. Determinants of postacute care discharge destination after dysvascular lower limb amputation. *PM R*. 2011;3:336–344.
79. Shutze W, Gable D, Ogola G, et al. Sex, age, and other barriers for prosthetic referral following amputation and the impact on survival. *J Vasc Surg*. 2021;74:1659–1667.
80. Shutze W, Gable D, Ogola G, Eidt J. Prosthetic outcomes after amputation and the impact of mobility level on survival. *J Vasc Surg*. 2024;80:873–881.
81. Baby S, Chaudhury S, Walia TS. Evaluation of treatment of psychiatric morbidity among limb amputees. *Ind Psychiatry J*. 2018;27:240–248.
82. Peters CML, de Vries J, Steunenberg SL, Ho GH, Lodder P, van der Laan L. Is there an important role for anxiety and depression in the elderly patients with critical limb ischemia, especially after major amputation? *Ann Vasc Surg*. 2019;58:142–150.
83. McKechnie PS, John A. Anxiety and depression following traumatic limb amputation: a systematic review. *Injury*. 2014;45:1859–1866.
84. Darnall BD, Ephraim P, Wegener ST, et al. Depressive symptoms and mental health service utilization among persons with limb loss: results of a national survey. *Arch Phys Med Rehabil*. 2005;86:650–658.
85. Amorelli C, Yancosek K, Morris R. Amputees unanimous: a 12-step program. *Prosthet Orthot Int*. 2019;43:293–300.
86. Pasquina CP, Carvalho AJ, Sheehan TP. Ethics in rehabilitation: access to prosthetics and quality care following amputation. *AMA J Ethics*. 2015;17:535–546.
87. Scarlet S, Isaak RS, McGinigle KL. Design and implementation of an enhanced recovery after surgery (ERAS) pathway for major limb amputation in vascular surgery. *Am Surg*. 2018;84:e147–e149.
88. O'Banion LA, Qumsiyeh Y, Matheny H, et al. Lower extremity amputation protocol: a pilot enhanced recovery pathway for vascular amputees. *J Vasc Surg Cases Innov Tech*. 2022;8:740–747.

Submitted Sep 25, 2024; accepted Sep 25, 2024.