



VA/DoD CLINICAL PRACTICE GUIDELINE FOR THE MANAGEMENT OF UPPER EXTREMITY AMPUTATION REHABILITATION

**Department of Veterans Affairs
Department of Defense**

Clinician Guideline Summary

QUALIFYING STATEMENTS

The Department of Veterans Affairs and the Department of Defense guidelines are based upon the best information available at the time of publication. They are designed to provide information and assist decision-making. They are not intended to define a standard of care and should not be construed as one. Neither should they be interpreted as prescribing an exclusive course of management.

This Clinical Practice Guideline is based on a systematic review of both clinical and epidemiological evidence. Developed by a panel of multidisciplinary experts, it provides a clear explanation of the logical relationships between various care options and health outcomes while rating both the quality of the evidence and the strength of the recommendations.

Variations in practice will inevitably and appropriately occur when clinicians take into account the needs of individual patients, available resources, and limitations unique to an institution or type of practice.

Every healthcare professional making use of these guidelines is responsible for evaluating the appropriateness of applying them in the setting of any particular clinical situation.

These guidelines are not intended to represent TRICARE policy. Further, inclusion of recommendations for specific testing and/or therapeutic interventions within these guidelines does not guarantee coverage of civilian sector care. Additional information on current TRICARE benefits may be found at www.tricare.mil or by contacting your regional TRICARE Managed Care Support Contractor.

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Background

Amputation presents a significant disability for the nearly two million Americans living with limb loss. In approximately three percent of this population one or both upper limbs are involved [1] with nearly 70 percent of upper limb amputations resulting from trauma. [2] Traumatic injuries are also the most common cause of upper limb amputations within the Department of Defense (DoD) and Department of Veterans Affairs (VA). Other causes of amputations are from cancer, infections, and dysvascular conditions. From 2001-2014, more than 700 Service Members with some level of upper limb amputation (including partial hand and digits) were cared for in one of three military advanced rehabilitation facilities, comprising approximately 30 percent of the total amputation population treated. More than 32,000 Veterans with some level (including partial hand and digits) of upper limb amputation (18 percent of the total amputation population) were cared for in the Veterans Health Administration (VHA) since 2000. [3]

The successful rehabilitation of patients with upper limb amputations is influenced by a variety of factors that include, but are not limited to, level of amputation, cognitive impairment, conditioning, nutritional status, social support, psychological factors and motivation. To maximize successful outcomes and return patients to independent living in home, work and community environments, these factors must be considered in the development of a rehabilitation program and care plan for the Veteran or Service Member with an upper extremity amputation. Most upper limb amputation patients are candidates for a prosthesis; however, some may not choose to use a prosthesis. For those patients, other approaches need to be considered to allow these patients to be functionally independent.

Long-Term Goals of Upper Extremity Amputation Rehabilitation Care

While the pathophysiology of traumatic amputations may be different than non-traumatic amputations, rehabilitation strategies and prosthetic component prescriptions for both should be centered on realistic patient goals with concentrated efforts directed to maximize function. The overall goal of amputation rehabilitation is to optimize the patient's health status, function, independence, and quality of life. Ongoing medical assessments and therapy interventions to address psychosocial, physical and functional limitations are necessary to achieve these desired end states.

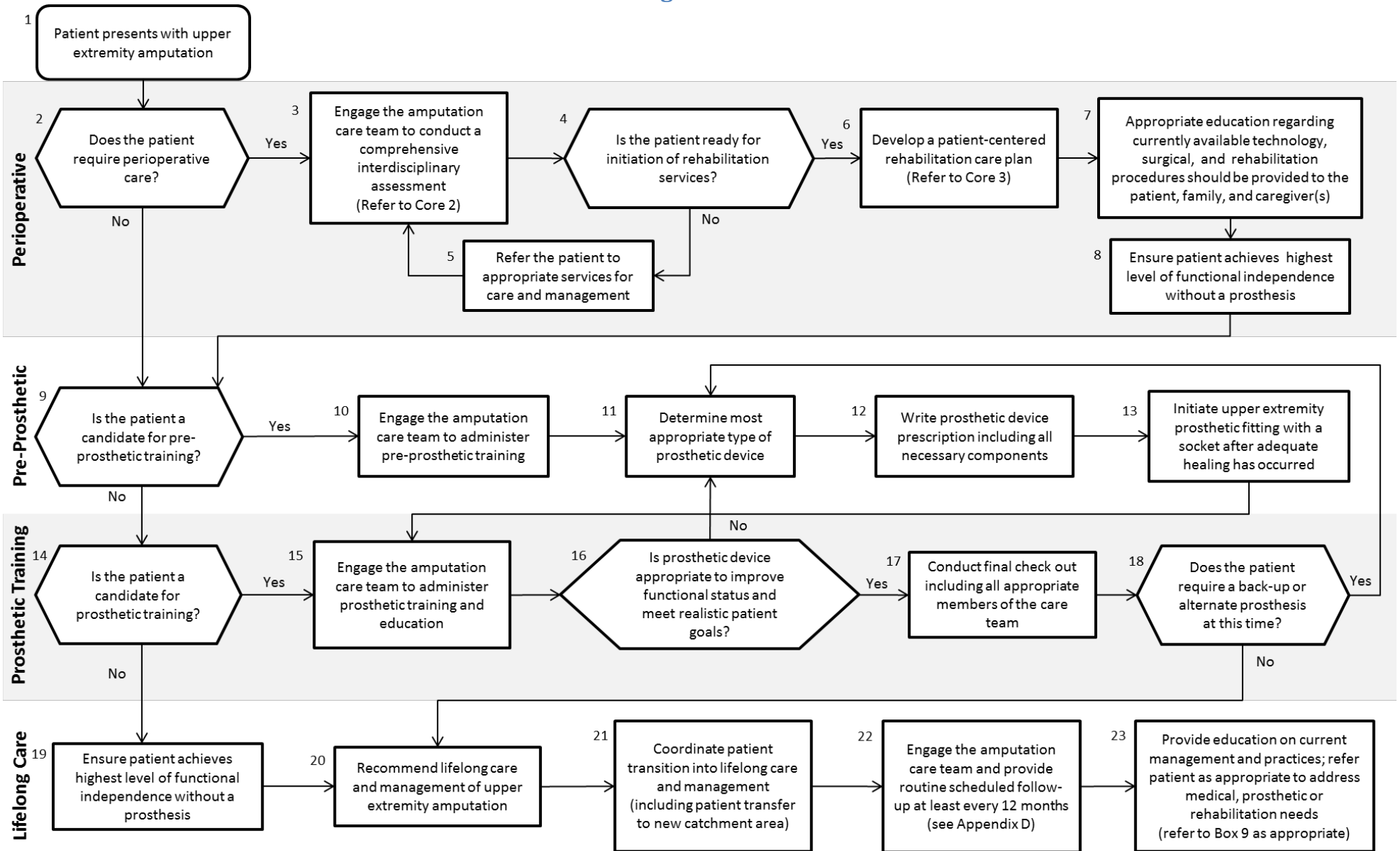
The CPG Working Group defined additional goals of amputation rehabilitation care that the care team should strive to achieve in the key domains of postoperative pain, physical health, function, psychological support and well-being, patient satisfaction, integration, and healthcare utilization. These are described in Table 1.

Table 1. Key Domains of Care and Goals of Amputation Rehabilitation

Domain	Goals
Postoperative pain	<ul style="list-style-type: none">• Reduce residual limb pain, improve effectiveness of coping, and reduce interference with daily function• Reduce phantom limb pain• Minimize complications and side-effects associated with the use of narcotic pain medications

Domain	Goals
Physical health	<ul style="list-style-type: none"> • Reduce the risk of adverse effects due to use or non-use of an artificial limb • Prevent and decrease impact of overuse injuries in remaining extremities and residual limb • Improve and maintain physical health (e.g., residual limb care and tolerance; improve and maintain range of motion proximal to the amputation and throughout the body; core strengthening, postural stability, and balance; cardiovascular health, and increase strength and endurance) to maximize efficient use of a prosthesis
Function	<ul style="list-style-type: none"> • Improve functional independence with and without a prosthesis (e.g., independence and safety in self-care, work, recreational/leisure activities and mobility activities) • Improve quality of life and decrease activity restriction (e.g., optimize self-care, community integration, recreation, return to home and productive work environments)
Psychological support and wellbeing	<ul style="list-style-type: none"> • Reduce psychological comorbidities (e.g., depressive and anxiety disorders) • Improve quality of life • Decrease the mental/emotional disease burden • Enhance adjustment to disability through healthy body image and self-esteem development
Patient satisfaction	<ul style="list-style-type: none"> • Improve satisfaction with the level of skills and independence • For patients receiving prostheses, improve satisfaction with the prosthesis (comfort, functionality, and cosmesis) • Improve satisfaction with healthcare services and care providers
Community Integration	<ul style="list-style-type: none"> • Improve the discharge outcome (discharge to the least restrictive environment) • Improve vocational outcomes • Improve recreational participation • Maximize community participation
Healthcare utilization	<ul style="list-style-type: none"> • Optimize the length of rehabilitation stay • Optimize the time between prosthetic fitting and patient goal attainment • Optimize Lifelong care and minimize the effects of long-term prosthesis use

Algorithm



Evidence Review

The recommendations presented in this CPG are based on a systematic appraisal of the published evidence on the rehabilitation and management of Veterans and Service Members with acquired upper extremity amputation. In areas where the evidence is particularly lacking, expert opinion served as the basis for the recommendations. Published evidence was identified through extensive searches of several research databases. Searches were designed to identify unique reviews, trials, and technology assessments. Searches of the World Wide Web were also performed to capture relevant grey literature that has not been indexed to the databases listed previously. The searches covered an extended time period of January 2002 through February 2013, to ensure relevant studies were captured.

Evidence Assessment

In order for the clinician to be aware of the evidence base behind the recommendations and the weight that should be given to each recommendation, the recommendations are keyed according to the level of confidence with which each recommendation is made. The graded recommendations are based on two main dimensions: 1) net benefit of an intervention and 2) certainty of evidence associated with that net benefit. When evidence is limited, the level of confidence also incorporates clinical consensus with regard to a particular clinical decision. The strength of recommendation is based on the level of the evidence and is graded using the U.S. Preventive Services Task Force (USPSTF) rating system (see Table 2. Strength of Recommendation Rating).

Table 2. Strength of Recommendation Rating (SR) [4]

Grade	Definition	Suggestions for Practice
A	The USPSTF recommends the service. There is high certainty that the net benefit is substantial.	Offer or provide this service.
B	The USPSTF recommends the service. There is high certainty that the net benefit is moderate or there is moderate certainty that the net benefit is moderate to substantial.	Offer or provide this service.
C	The USPSTF recommends selectively offering or providing this service to individual patients based on professional judgment and patient preferences. There is at least moderate certainty that the net benefit is small.	Offer or provide this service for selected patients depending on individual circumstances.
D	The USPSTF recommends against the service. There is moderate or high certainty that the service has no net benefit or that the harms outweigh the benefits.	Discourage the use of this service.
I Statement	The USPSTF concludes that the current evidence is insufficient to assess the balance of benefits and harms of the service. Evidence is lacking, of poor quality, or conflicting, and the balance of benefits and harms cannot be determined.	If the service is offered, patients should understand the uncertainty about the balance of benefits and harms.

Grade of EO for Experts Opinion: To grade the recommendations for the guideline, the CPG Working Group used a variation of the USPSTF grading framework to provide for a grade of EO for “Expert Opinion.” Given that evidence-based clinical practice guidelines have to be used in real practice for Veterans and Service Members, a grade of I for insufficient evidence may not provide useful guidance for supporting clinical decisions in practice. In particular, we considered certain instances in which evidence suggests a Substantial or Moderate net benefit, but the certainty/strength of that evidence is Low. In those instances, rather than concluding that the evidence is insufficient to support a clinical decision, we relied on expert opinion to set forth a recommendation. A grade of EO does not imply that the evidence is strong (it is still Low). However, it does suggest that the magnitude of net benefit (Substantial or Moderate) is of sufficient clinical importance to make a recommendation, even if it is based on low certainty (weak evidence).

Recommendations

Recommendation	GRADE
Core 1: The Care Team Approach	
1. An interdisciplinary amputation care team (care team) approach, including the patient, family and/or caregiver(s), is recommended in the management of all patients with upper extremity amputation.	EO
2. Care teams should communicate on a regular basis to facilitate integration of a comprehensive treatment plan.	EO
Core 2: Comprehensive Interdisciplinary Assessments	
3. Comprehensive interdisciplinary assessments and reassessments should be completed during each of the first three phases of care (perioperative, pre-prosthetic and prosthetic training).	EO
4. Annual comprehensive interdisciplinary screening should be conducted for all patients with an upper extremity amputation throughout lifelong care.	EO
5. Functional status measures should be utilized during assessments and reassessments throughout all phases of care to document outcomes and monitor the efficacy of rehabilitation.	EO
Core 3: Patient-Centered Care	
6. A shared decision making model, incorporating patient goals, should be used throughout all phases of rehabilitation to ensure patient-centered care.	EO
7. A comprehensive, interdisciplinary, patient-centered rehabilitation plan should be developed as early as possible and updated throughout all phases of care based on patient’s progress, changes in functional status, emerging needs, and goals.	EO
8. Patient-centered physical and functional rehabilitation interventions should be initiated based on the rehabilitation plan and the patient’s physical and psychological status.	EO
9. Various types of pain following upper limb loss should be managed appropriately and individually throughout all phases using pharmacological and non-pharmacological treatment options.	EO
10. The care team should provide appropriate education and informational resources to patients, family and caregiver(s) throughout all phases of care.	EO
11. The care team should facilitate early involvement of a trained peer visitor.	C
Perioperative Phase	
12. The decision for amputation should be made based upon accepted surgical and medical	EO

Recommendation	GRADE
standards of care.	
13. Communication must occur between the surgical and non-surgical members of the care team in order to optimize surgical and functional outcomes.	EO
14. The care team should ensure that the patient is optimized for rehabilitation to enhance functional outcomes.	EO
15. Following amputation, the care team should ensure that the patient has achieved his or her highest level of functional independence without a prosthesis.	EO
Pre-Prosthetic Phase	
16. The care team should ensure that patients undergo pre-prosthetic training to help determine the most appropriate type of device to achieve functional goals.	EO
17. Once the appropriate type of prosthesis is identified, the care team should write a prosthetic prescription including all necessary components.	EO
18. Initiate upper extremity prosthetic fitting as soon as the patient can tolerate mild pressure on the residual limb.	EO
Prosthetic Training Phase	
19. Upon delivery of the prescribed prosthesis, or change in the control scheme or componentry, the care team must engage the patient in prosthetic training and education.	EO
20. The care team should frequently reassess the patient's prosthetic fit and function throughout the prosthetic training phase and modify as appropriate.	EO
21. The final check out of the prosthesis should take place with appropriate members of the care team to verify that the prosthesis is acceptable.	EO
22. The care team should offer active prosthesis users at least one back up device to ensure consistency with function.	EO
23. Prescription of activity specific or alternate design prostheses may be considered, dependent upon the patient's demonstration of commitment, motivation, and goals.	EO
Lifelong Care	
24. Upon completion of functional training, and to ensure continuity, the care team should coordinate patient transition into the lifelong care phase.	EO
25. The care team should provide routine, scheduled follow-up contact for patients with upper extremity amputation at a minimum of every 12 months, regardless of prosthetic use or non-use.	EO
26. Upon notification of patient relocation to a new catchment area, the care team should communicate with the receiving care team and coordinate transition of patient care.	EO
27. The care team should provide education to the patient, family, and caregiver(s) regarding advancements in technology, surgical, and rehabilitation procedures related to the management of upper extremity amputation.	EO

Core Modules

The core modules highlight essential elements of care encompassed within all phases of care following upper extremity amputation. The core modules include:

- Core 1: The Care Team Approach
- Core 2: Comprehensive Interdisciplinary Assessments
- Core 3: Patient-Centered Care

Core 1: The Care Team Approach

The care team approach is a physician-led, patient-centered, multidisciplinary approach to provide a comprehensive treatment plan and ensure lifelong management. The care team approach for patients with upper extremity amputation is unique due to varying patient factors and the myriad of medical, surgical, rehabilitation and prosthetic specialists involved, including:

- Rehabilitation physicians
- Anesthesiologists
- Surgeons (hand specialists, orthopedic surgeons, plastic surgeons)
- Mental and behavioral health specialists
- Case managers
- Nurses
- Occupational and physical therapists
- Driver rehabilitation therapists
- Certified prosthetists
- Recreation therapists
- Social workers
- Trained peer visitors
- Others

Patients who sustain upper limb amputation present with complex and diverse issues that require clear and effective communication among care providers and with the patient. All members of the care team, including the patient, are equally important to maximizing the medical, surgical and functional outcome following upper extremity amputation. Members of the care team must work in concert to achieve the patient’s functional goals.

Core 2: Comprehensive Interdisciplinary Assessments

A comprehensive, interdisciplinary, baseline assessment facilitates the optimization of a patient’s condition, guiding the formulation of a customized treatment plan, to promote the best surgical and rehabilitative outcomes. Table 2 outlines the components of the comprehensive interdisciplinary assessment and provides a brief description of each.

Table 2. Components of the Comprehensive Assessment

Component	Description
Present Health Status	<ul style="list-style-type: none"> • May assess for: <ul style="list-style-type: none"> ○ Infection (using laboratory and radiographic studies) ○ Anemia ○ Electrolyte imbalances ○ Nutrition ○ Liver and kidney function ○ Cardiac and pulmonary function ○ Bowel and bladder function ○ Metabolic function ○ Neurologic function ○ Burns, musculoskeletal injuries and bone integrity ○ Prevention of secondary complications such as venous thrombosis, embolism, heterotopic ossification, joint contracture, and pressure ulcers
Level of Function	<ul style="list-style-type: none"> • Assess the patient’s level of function including: <ul style="list-style-type: none"> ○ Hand dominance ○ Range of motion (ROM) and flexibility ○ Gross motor strength and skills

Component	Description
	<ul style="list-style-type: none"> ○ Sensation ○ Fine motor skills ○ Balance ○ Functional mobility ○ Endurance/general conditioning ○ Level of assistance to perform Activities of Daily Living (ADL) and Instrumental Activities of Daily Living (IADL) ○ Home environment/need for modifications ○ Community mobility and driving ○ Community integration (e.g., recreation, leisure and sport interests)
Modifiable/Controllable Health Risk Factors	<ul style="list-style-type: none"> ● Assess patient’s awareness of strategies to reduce the impact on morbidity and mortality
Pain Assessment	<ul style="list-style-type: none"> ● Conduct assessment and monitoring of perioperative pain, phantom limb pain, residual limb pain, and phantom limb sensation ● Assess efficacy of any ongoing pain intervention ● Assess any pain in the non-affected limb(s) and trunk
Behavioral and Cognitive Health	<ul style="list-style-type: none"> ● Complete a Behavioral Health Assessment to include: <ul style="list-style-type: none"> ○ Depression ○ Anxiety ○ Post-traumatic stress symptoms ○ Substance abuse disorders ○ Major life stressors ● Screen the patient to determine ability to participate in rehabilitation ● Assess cognitive function including: <ul style="list-style-type: none"> ○ Intellectual functioning and attention/concentration along with working memory and speed of processing ○ Executive functioning ○ Learning and memory: short- and long-term, auditory and visual, recall, and recognition ○ Self- (and possibly family-) reported cognition and emotional functioning ○ Barriers to learning or communication ● A cognitive assessment should utilize: <ul style="list-style-type: none"> ○ Standardized tests ○ Self-reporting ○ Behavioral descriptions ○ Subjective estimations from family and others ○ Careful history taking ○ Recognition of other possible comorbid factors (e.g., depression, brain injury, dementia or stroke) ○ Acknowledgment of the limitations and sources of variability and error in measuring psychometric performance ● Screen ability to learn, adapt to, and utilize a prosthesis
Patient’s Personal, Social, and Cultural Contexts	<ul style="list-style-type: none"> ● Assess for any personal, social, cultural and financial factors that may influence rehabilitation to include: <ul style="list-style-type: none"> ○ Patient’s beliefs, values and opinions that shape who he or she is

Component	Description
	<ul style="list-style-type: none"> and how he or she may adapt or cope after amputation ○ The level of family or caregiver support available to the patient ○ Cultural factors ○ Spiritual support and/or individual religious beliefs ○ Influences of the patient’s age and gender ○ Accessibility to resources and services ○ Financial limitations or constraints
Learning Assessment	<ul style="list-style-type: none"> ● Language barriers that require a translator ● Education and literacy level ● Patient’s preferred learning style
Residual Limb Assessment	<ul style="list-style-type: none"> ● Acute assessment: <ul style="list-style-type: none"> ○ Edema and shape of residual limb ○ Wound closure (dehiscence) and drainage ○ Excessive redness or induration ○ Temperature of surrounding tissue ○ Protection from external trauma ● Follow-up assessment: <ul style="list-style-type: none"> ○ ROM ○ Strength ○ Skin Integrity/Breakdown ○ Shape ○ Sensitivity/Pressure tolerance
Contralateral Limb and Trunk	<ul style="list-style-type: none"> ● Assess for the presence of: <ul style="list-style-type: none"> ○ Deformity ○ Range of motion limitations ○ Abnormal skin or soft tissues ○ Vascular health issues ● Quantify any motor or any sensory deficit ● Note dominance and functional gross and fine motor skills ● Assess for presence of overuse syndromes
Prosthetic Assessment (if applicable)	<ul style="list-style-type: none"> ● May evaluate and discuss several aspects of prosthesis use including: <ul style="list-style-type: none"> ○ Prosthesis fit to include ability to don and doff the device ○ Prosthesis operational function and ability to use ○ Maintenance of the prosthesis ○ Acceptance/rejection of the prosthesis ○ Appropriateness of the prosthesis prescription (for employment, ADL and leisure)
Vocational Rehabilitation	<ul style="list-style-type: none"> ● A vocational assessment should include: <ul style="list-style-type: none"> ○ Level of education ○ Work history ○ Desired vocation ○ Desire to return to college ○ Desire to begin a business ● May offer a referral to any of the following as appropriate: <ul style="list-style-type: none"> ○ VA Vocational Rehabilitation ○ VA Benefits Administration Program

Component	Description
	<ul style="list-style-type: none"> ○ VA Compensated Work Therapy Program ○ Community or state vocational rehabilitation agencies

Core 3: Patient-Centered Care

Patient-centered care requires clear communication and shared decision making between the patient and care team. The shared decision making model is the collaboration between patients and caregivers to come to an agreement about a healthcare decision. This model requires the cooperation of at least two parties to participate in treatment decision making, information sharing, a treatment decision (which may be to do nothing), and an agreement on the decision by both parties. [5] The medical, surgical and rehabilitative management plan should be presented to the patient and care team prior to, and during, each phase of care with the focus on optimal patient outcomes supported by evidence-based practice. Patient-centered care after upper extremity amputation should include:

- Shared Decision Making
- Rehabilitation and Discharge Plan
- Rehabilitation Interventions
- Pain Management
- Patient Education
- Peer Support

Patient-centered rehabilitation plan

The patient-centered rehabilitation plan should include:

- Evaluations from all members of the care team
- Input from the patient and family/caregiver(s)
- Treatment plan, which must address all identified realistic patient-centered treatment goals, rehabilitation, medical, psychological, and surgical problems
- Indication of the next anticipated phase of rehabilitation care based on discharge criteria
- Identification of and plans for discharge at the initiation and throughout all phases of the rehabilitation process

Discharge plan

The discharge plan should include:

- Evaluation and required modifications of the home, work and community environments
- Determination of needs for home assistance
- Location of rehabilitation
- Social support/financial resources
- Transportation or driver training and vehicle adaptation
- Durable medical equipment (DME)/ specialized equipment needs

Rehabilitation interventions

Patient-centered physical and functional rehabilitation interventions should include:

- ADL retraining and consideration of adaptive equipment, modified or altered strategies, and one handed techniques

- Residual limb management (e.g. volume, pain, sensitivity, skin integrity, and care) (see Table 3)
- Progressive range of motion (ROM) exercises
- Postural exercises and progressive strengthening
- Cardiovascular endurance
- IADL interventions, home and driving modifications, assistive technologies, and community integration

Table 3. Residual Limb Management Through-out Phases of Care

I. Perioperative	<ul style="list-style-type: none"> • Preoperative: <ul style="list-style-type: none"> ○ Desensitization exercises, skin hygiene, and description of types of pain ○ Explain and differentiate between residual limb pain, phantom pain, and phantom sensation • Postoperative: <ul style="list-style-type: none"> ○ Donning/doffing of compressive wrap or shrinker, if appropriate ○ Desensitization exercises, skin hygiene, and description of types of pain
II. Pre-prosthetic	<ul style="list-style-type: none"> • Care of residual limb • Use of shrinker and or silicon liner
III. Prosthetic training	<ul style="list-style-type: none"> • Donning/doffing of prosthetic system • Use of shrinker when out of the prosthesis • Management of sock ply, if appropriate • Skin checks and skin hygiene • Observe pressure points and protect contralateral limb
IV. Lifelong care	<ul style="list-style-type: none"> • Routine residual limb evaluations and skin checks

Pain management

There are several different types of pain that may be experienced after amputation, including:

- **Immediate post-surgical pain** – is experienced after any surgical procedure where skin, muscle, bone, and nerves are cut. Immediate post-surgical pain after amputation should be managed aggressively as part of the post-surgical management plan.
- **Post-amputation pain** – the various factors that contribute to post-amputation pain, such as RLP, PLP, and associated musculoskeletal pain, should be considered and alleviated when developing the treatment plan for pain. Table 4 summarizes the distinction between residual limb pain and phantom limb pain.
 - **Residual limb pain (RLP)** – occurs specifically in the residual tissue and structure of the amputated limb. It is an expected and predictable symptom immediately post-amputation due to the massive tissue disruption of the surgery itself. After immediate post-amputation assessment and treatment, resolution of these symptoms should also occur in a predictable manner with a predictable wean off of all acute treatment interventions. Chronic or emergence of new RLP later in a patient’s care can be due to poor prosthetic socket fit, bruising of the limb, chafing or rubbing of the skin, and numerous other largely mechanical

factors. Other factors for RLP can include inherent vascular, neurologic, or musculoskeletal factors to include ischemia due to poor perfusion, post-amputation neuromas, or heterotopic ossification, respectively, among other considerations.

- **Phantom limb pain (PLP)** – occurs when pain is perceived in the missing limb that has been amputated. It is the most difficult part of post-amputation pain to manage and is treated distinctly compared to RLP. Up to 40 percent may report PLP to be significantly bothersome at one year after amputation. The mechanism for phantom limb pain and sensations is not well understood, although existing theories implicate central nervous system processing as well as peripheral nerve mediation.
- **Phantom limb sensations (PLS)** – are non-painful sensory perceptions of the phantom limb and are likely to be experienced by most patients and may be present throughout their entire life. PLS can be described as paresthesias, normal anatomy, proprioception of the missing body part, temperature gradients, and other non-painful sensations in the missing portion of the limb.
- **Associated musculoskeletal pain** – occurs in body regions other than the amputated limb, such as the back, shoulder or contralateral limb and may be related to overuse/compensatory motions of the intact limbs and trunk, fit and use of the prosthesis, design of the prosthetic socket, residual limb interface, and/or other medical comorbidities. Aggravating factors include abnormal biomechanical stresses to joints and other musculo-tendinous structures, and advancing age.
- **Chronic pain** – may be mediated by neuropathic as well as nociceptive pain mechanisms. Chronic pain symptoms, regardless of mechanism, can be additionally influenced by cognitive, behavioral, and social factors. Chronic pain patients have much higher rates of depressive disorder comorbidities and pain, which often overlap.

Table 4. Residual Limb vs. Phantom Limb Pain

Residual Limb Pain (RLP)	Phantom Limb Pain (PLP)
<ul style="list-style-type: none"> ● Pain occurs in the portion of the amputated limb that is still physically present ● May have allodynic qualities (pain from non-noxious stimuli such as touch), particularly near the skin flap scar or neuromas ● Is expected from the surgical trauma and should be aggressively managed perioperatively ● Later, can be due to <ul style="list-style-type: none"> ○ Mechanical factors including <ul style="list-style-type: none"> ▪ Poor prosthetic socket fit ▪ Bruising of the limb ▪ Chafing or rubbing of the skin ○ Poor perfusion, ischemia ○ Heterotopic ossification ○ Neuromas (common cause) 	<ul style="list-style-type: none"> ● Pain is perceived in the amputated or absent part of the body ● Has been reported to occur in 60 percent to 70 percent of patients and to be significantly bothersome at one year after amputation in up to 40 percent of patients ● Is uncommonly experienced immediately after surgery ● Can be episodic, lasting from seconds to days, or continuous ● Has unclear mechanism(s) that may include: <ul style="list-style-type: none"> ○ Abnormal regeneration of primary afferent neurons ○ Abnormal central somatosensory processing or central sensitization

Residual Limb Pain (RLP)	Phantom Limb Pain (PLP)
<ul style="list-style-type: none"> • Can be managed by addressing the cause(s) and adding multimodal analgesic therapy if necessary 	<ul style="list-style-type: none"> ○ Ectopic peripheral nerve activity ○ May be triggered or exacerbated by various factors including <ul style="list-style-type: none"> ○ Chronic pre-amputation pain ○ Phantom limb sensations • May be related to the intensity and duration of preoperative pain • Is often managed with multimodal pharmacologic and non-pharmacologic therapies • Is more difficult to control than residual limb pain

Due to the complexity of pain syndromes following upper extremity amputation, a multimodal therapeutic approach may yield the best outcome. The following modalities should be considered:

- **Pharmacological:** antiepileptics (e.g., gabapentin), tricyclic antidepressants (TCA), serotonin-norepinephrine reuptake inhibitors (SNRIs), non-steroidal anti-inflammatory drugs (NSAID), dextromethorphan, and long-acting opioids
- **Epidural analgesia:** use of patient controlled analgesia (PCA), or regional analgesia may be considered in the perioperative period, although the benefit is unproven
- **Non-pharmacological:** socket modifications, transcutaneous electrical nerve stimulation (TENS), desensitization, mirror box therapy, scar mobilization, relaxation, and biofeedback.

The etiology of pain in a patient with an upper limb amputation is likely to be multi-factorial and requires coordination of care by a physician led care team throughout all phases of rehabilitation. It is important that the care team provide accurate, verbal and written educational information to patients, caregivers and family members regarding the likelihood of post-amputation pain syndromes. It is essential to identify sources of pain in order to facilitate aggressive treatment and enhance the patient’s participation in rehabilitation, community integration and quality of life. A multidisciplinary approach to pain management is advocated.

There are many pharmacologic options for managing pain following amputation despite the paucity of evidence to support one agent over another. Table 5 lists the pharmacologic therapies to consider for post-amputation pain management. If pharmacologic therapy is offered, providers and patients should understand the uncertainties of the short- and long-term efficacy and safety of treatment, and require the patient to have regular follow-ups to reassess risks and benefits and modify treatment as indicated. These follow-ups could be done in-person or through the use of virtual and connected care.

Table 5. Pharmacologic Therapies to Consider for Post-amputation Pain

Route / Method	Examples
Oral	Antidepressants, Tricyclics; (e.g., amitriptyline) ⁽²⁾ Antiepileptics; (e.g., gabapentin) ⁽²⁾ Opioids, such as tramadol ⁽²⁾ and morphine ⁽¹⁾ Memantine ⁽³⁾

Route / Method	Examples
	Mexiletine ⁽³⁾
Intravenous	Ketamine ⁽¹⁾ Opioids; e.g., morphine ⁽¹⁾
Myofascial Intravenous	Bupivacaine ⁽²⁾
Nerve Block	Anesthetics; e.g., bupivacaine ⁽²⁾ , ropivacaine ⁽²⁾
Neurosclerosis	Phenol ⁽²⁾

(1) Insufficient evidence; results from more than one small trial consistently suggested efficacy

(2) Insufficient evidence; results from one small trial suggest efficacy or results were inconsistent among more than one small trial

(3) Insufficient evidence; results suggest lack of efficacy in one or more small trials

Patient education

The education process can be divided into four stages: assessment, planning, implementation, and documentation. Once the patient’s educational needs are identified, a plan is implemented to assure that the patient receives all of the information needed to achieve the educational goals. Patient education is best provided using multiple means of instruction. Appropriate verbal, written, and physical demonstration methods should be utilized accordingly. All aspects of the patient education process should be documented in the patient’s record in order to monitor efficacy and progress. Appropriate education should include, at a minimum, information relating to:

- Level of amputation
- Role of the care team members
- Pain management
- Procedural/recovery issues
- Potential psychosocial consequences
- Sequence of amputation care
- Postoperative management of wound
- Residual limb management
- Patient safety
- Prevention of complications
- Expectation for functional outcomes
- Overuse syndromes
- Prosthetic types and options
- Peer support groups
- Non-profit resources
- Emerging technology

Peer support

Peer support interventions can be categorized into two types: individual peer support and peer support groups. Support programs, either individual peer support visitors or peer support groups, allow the patient with an extremity loss to interact with others with a similar condition, and who face similar challenges. [6,7] Peer visits work best when the age, gender and type of amputation are considered and matched. [7] A young woman with a shoulder disarticulation amputation will have different needs and concerns in contrast to an elderly man with a transradial amputation. Therefore, the best match would be same-gendered patients with similar levels of amputation.

Potential patient benefits from participation in peer support groups include:

- Improving coping skills and sense of adjustment
- Talking openly and honestly about their feelings
- Reducing distress, depression or anxiety
- Developing an understanding of what to expect from an amputation

- Getting information on various treatment options

Peer visitors should go through a training program such as the one offered by the Amputee Coalition (AC). The training involves visitation strategies, education tasks, emotional support, and other skill sets to ensure a non-biased approach to the patient care discussion. Peer certification programs provide some standardization and consistency to the individual peer support program.

Phases of Rehabilitation Care

There are four phases of care that create a framework for rehabilitation and long term management of patients with an upper limb amputation. The phases are not defined by fixed points in time. Rather, they often overlap to accommodate for the patient's recovery process based on an appreciation of the patient's needs, severity of injury, wound healing, pain tolerance, and psychological readiness. Additionally, progression through the phases of care does not necessarily occur sequentially in a linear direction. Phases are repeated as appropriate based on needs of the patient. The four phases are:

- Perioperative
- Pre-prosthetic
- Prosthetic Training
- Lifelong Care

Perioperative Phase

The Perioperative phase of rehabilitation commences when a patient has been initially evaluated in the clinical setting and has either undergone an upper extremity amputation, or the decision has been made that amputation is necessary. In the vast majority of cases, the mechanism of injury resulting in upper limb amputation will be traumatic in nature. Complete interdisciplinary assessments of the patient's medical, functional, and psychological status should be performed as soon as it is clinically appropriate in order to establish a baseline level of function and prepare the patient for the ensuing rehabilitation plan and, ultimately, lifetime care. The continuum of this phase is to: ensure communication and coordination of care; provide proper medical, surgical, and psychological management; initiate rehabilitation; and facilitate protective healing of the residual limb. The end of the Perioperative phase occurs when residual limb wounds are free of infection and closed, sutures are removed, the patient has been medically cleared, and has maximized independence in self-care ADL using one-handed strategies and adaptive or durable medical equipment.

Pre-prosthetic Phase

The goal of the Pre-prosthetic phase is to prepare the patient and his or her residual limb for initial prosthetic fitting. In this phase, the care team determines if the patient is a candidate for prosthesis and aids the patient in determining which type of prosthesis will be most beneficial. During this phase, wound closure and pain control continue to be monitored, ongoing rehabilitation interventions are performed, and continued psychosocial support is provided. The patient must be medically, surgically and cognitively cleared by the care team for a diagnostic socket fitting to occur. The Pre-prosthetic phase ends with the fitting of the preparatory prosthesis. This phase will typically occur in an outpatient or rehabilitation setting.

Prosthesis options

There are up to six options (or combinations thereof) that a patient can utilize in various settings including:

- No prosthesis
- Semi-prehensile cosmetic prostheses
- Body-powered prostheses
- Externally powered prostheses
- Hybrid prostheses
- Task specific prostheses

Prosthesis prescription

A comprehensive prescription for an upper extremity prosthesis should include:

- Design (e.g., preparatory vs. definitive)
- Control strategy (e.g., passive, externally powered, body powered, task specific)
- The anatomical side and amputation level of the prosthesis
- Type of socket interface (e.g., soft insert, elastomer liner, flexible thermoplastic)
- Type of socket frame (e.g., thermoplastic or laminated)
- Suspension mechanism (e.g., harness, suction, anatomical)
- Terminal device (TD)
- Wrist unit (if applicable)
- Elbow unit (if applicable)
- Shoulder unit (if applicable)

Prosthetic Training Phase

The Prosthetic Training phase marks a turning point in the rehabilitation of the patient who desires a prosthesis. Phases one and two provide a foundation for success in phase three. This phase commences upon delivery of an initial prosthesis and continues until the patient demonstrates a successful functional outcome with proper prosthetic use during desired functional activities. This phase involves continued physical rehabilitation interventions as appropriate, functional prosthetic training, return to vocational and avocational activities, and continued psychological support. Patient's will ebb and flow through this phase after receiving each new or different type of prosthesis. This phase may also begin as a result of a patient receiving a new terminal device programmed with a novel control scheme.

Prosthesis education

Whether preparatory or definitive, once the prosthesis is fabricated, ready for use, and a prescription for training is completed, the prosthetist educates the patient, family/caregiver and rehabilitation providers on:

- The proper terminology related to the prosthesis and its parts
- Proper operation of the prosthesis
- The particular prosthetic control strategy utilized
- Functional and mechanical limitations of the prosthesis
- Any precautions related to the device
- Appropriate care of the prosthesis

Prosthetic training

Prosthetic training should focus on:

- Donning/doffing the prosthesis
- Device wear schedule
- Residual limb management and care of the prosthesis
- Familiarization in components and demonstration of proper and safe use
- Controls training
- Functional training

Patients who use a prosthesis should be advised to report any of the following symptoms as they are signs that the prosthesis needs to be modified:

- Ongoing pain in the residual limb or associated with a prosthetic harness
- Skin breakdown
- Change in the ability to don and doff the prosthesis
- Change in limb volume (weight gain or loss)
- Change in pattern of usage

The care team must monitor the patient's goal progression and function as changes in the patient's physical condition, social status, vocation, and/or technological advancements in prosthetic components, can influence changes in their fitting needs. Different components or types of prostheses should be considered to assist the patient in meeting functional goals. New goals may require changes to the design of an existing prosthesis, consideration of a different terminal device, or warrant the prescription of a completely new prosthesis.

Lifelong Care Phase

The last phase of upper extremity amputation rehabilitation is Lifelong Care. This phase of care begins after the completion of acute rehabilitation or once the initial prosthetic fitting and functional prosthetic training is completed. Typically the patient has reached a desired level of function and stability from both a medical and rehabilitation perspective. This phase of care lasts for the remainder of the patient's life. The importance of this phase cannot be understated. During this phase the patient returns for annual routine patient follow-up assessments with the amputation care team at a minimum of every 12 months. A comprehensive, interdisciplinary approach is used at each follow-up regardless of the patient's use of a prosthesis. The patient's functional independence is maximized through the use of available rehabilitation services and emerging technologies in upper limb amputation rehabilitation. This is the focus of each routine follow up assessment. Table 6 includes the essential elements that should be reviewed during the annual assessment.

Table 6. Essential Elements of the Annual Contact

Elements of the Annual Contact	
Level of functional independence and physical activity level	Social work and case management support
Daily time utilization with functional and leisure	Nutritional status

Elements of the Annual Contact	
activities	
Fit and function of the prosthesis	Amount of prosthesis use and barriers to greater use
Emotional and adjustment issues including attitude toward wearing prosthesis	Vocational, recreational, community resources and support
Residual limb skin condition	Changes in medical comorbidities/ status
Pain issues (residual limb, phantom limb, musculoskeletal pain issues, i.e., neck, shoulder, back)	Changes in the home environment and required adaptations
Environmental modification or assistive technology needs	Changes in functional goals
Family or caregiver support	Driver's training if not previously addressed
Risk factors for secondary amputation	

Additionally, the care team must remain abreast of advancements in upper extremity prosthetic technology and maintain consistent long-term follow-up with the patient in order to provide ongoing assessment of the patient's needs and goals and provide appropriate guidance and treatment to achieve identified goals. [8]

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