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

Department of Veterans Affairs

Department of Defense

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 recommendation.

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 with a patient-centered approach.

These guidelines are not intended to represent Department of Veterans Affairs or 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 by contacting your regional TRICARE Managed Care Support Contractor.

Version 2.0 – 2022

Prepared by:

The Management of Upper Limb Amputation Rehabilitation Work Group

With support from:

Office of Quality and Patient Safety, Veterans Health Administration

&

Clinical Quality Improvement Program, Defense Health Agency

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Based on evidence reviewed through April 2021

[a] VA/DoD Clinical Practice Guideline. (2022). The Management of Upper Limb Amputation Rehabilitation. Washington, DC: U.S. Government Printing Office.

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I. Introduction

The Department of Veterans Affairs (VA) and Department of Defense (DoD) Evidence-Based Practice Work Group (EBPWG) was established and first chartered in 2004, with a mission to advise the Health Executive Committee (HEC) "… on the use of clinical and epidemiological evidence to improve the health of the population …" across the Veterans Health Administration (VHA) and Military Health System (MHS), by facilitating the development of clinical practice guidelines (CPGs) for the VA and DoD populations.(1) Development and update of VA/DoD CPGs is funded by VA Evidence Based Practice, Office of Quality and Patient Safety. The system-wide goal of evidence-based CPGs is to improve patient health and well-being.

In 2014, the VA and DoD published a CPG for the Management of Upper Extremity Amputation Rehabilitation (2014 VA/DoD UEAR CPG), which was based on evidence reviewed through June 2013. Since the release of that CPG, a growing body of research has expanded the evidence base and understanding of upper limb amputation (ULA) rehabilitation. Consequently, the VA/DoD EBPWG initiated the update of the 2014 VA/DoD UEAR CPG in 2020. This updated CPG's use of GRADE reflects a more rigorous application of the methodology than previous iterations. Consequently, the strength of some recommendations may have been modified due to the confidence in the quality of the supporting evidence (see Evidence Quality and Recommendation Strength).

The updated CPG includes recent objective, evidence-based information on the care and rehabilitation of persons with ULA. It is intended to provide guidance to assist healthcare providers in perioperative, pre-prosthetic training, prosthetic training, and life-long phases of patient care. The system-wide goal of this evidence-based guideline is to improve the patient's health and well-being. It guides healthcare providers along evidence supported management pathways to assist patients in rehabilitation following ULA. The expected outcome of successful implementation of this guideline is to:

- Assess the patient's condition and collaborate with the patient, family, and caregivers to determine optimal management of patient care
- Emphasize the use of patient-centered care and shared decision making
- Minimize preventable complications and morbidity
- Optimize individual health outcomes and quality of life (QoL)

II. Background

A. Amputation Level Classification

Various taxonomies are used to describe the different levels of ULA.(2) Table 1 correlates the International Standards amputation terminology with the common terminology used to describe the amputation level in both the clinical setting and research publications. The VA and DoD recommend that the International Standards terminology be used to describe ULA. In addition, ULA can be classified as either major or minor. As shown in Table 1, this taxonomy classifies amputations at the wrist disarticulation level and more proximal as major amputations, and those involving the hand or digits as minor amputations. While this taxonomy is widely used in both the clinical and research settings, the VA and DoD do not specifically endorse use of this terminology because amputation levels classified as

minor can still result in significant functional impairment. Despite most of the rehabilitation and prosthesis fitting research literature focusing on major ULA, this CPG's literature review search strategy included all levels of ULA. Where guideline recommendations pertain to a certain subgroup of persons with ULA, this information is specified in the recommendation language.

Table 1. Upper Limb Amputation Level Terminology

International Standards Terminology	Common Terminology	Major or Minor Amputation
Forequarter	Forequarter	Major
Shoulder disarticulation	Through shoulder	Major
Transhumeral	Above elbow	Major
Elbow disarticulation	Through elbow	Major
Transradial	Below elbow	Major
Wrist disarticulation	Through wrist	Major
Partial hand	Through hand, ray	Minor
Thumb	Thumb	Minor
Digits (upper extremity)	Fingers	Minor

B. Epidemiology

In the United States (U.S.), approximately two million individuals are living with limb loss. Most are lower limb loss with ULA affecting only about 3% of the U.S. limb loss population.(3) The etiologies for limb loss differ with the primary reason for lower limb loss being disease processes, while trauma is the primary reason for loss of the upper limb. Loss of a limb is a life-altering occurrence for an individual and their family. This is especially true in traumatic injuries where individuals are primarily younger, causing significant vocational, functional, and financial consequences.

Traumatic injuries account for nearly 70% of ULA in the U.S. and are also the most common cause of ULA within DoD and VA.(4) Extremity injuries occur from military combat (e.g., blast, shrapnel, and gunshot), motor vehicle accidents, and other training and industrial accidents. While improvements in immediate trauma care, advanced reconstructive surgical techniques, and rehabilitation have reduced the need for some amputations, Veterans and Service Members continue to be at significant risk. Of the total amputation population, including all levels of limb amputation, cared for within DoD and VA healthcare since 2001, approximately 51.2% in DoD and 19% in VA involve one or both upper limbs.(5, 6) Looking more specifically at those with major limb amputation receiving care in the VA, only 7.6% of these individuals have involvement of one or both upper limbs. In the DoD, only 9.5% of the amputation population over age 18 have major limb amputation involving one or both upper limbs. This is secondary to the relatively high number of Veterans with digit amputations involving the upper limb.

While the pathophysiology of traumatic amputations may differ from non-traumatic amputations, rehabilitation strategies and prosthetic prescriptions for both should be centered on realistic patient goals with concentrated efforts directed to maximize function. Level of amputation, cognitive impairment, physical conditioning, nutritional status, social support, psychological factors, and motivation are some challenges that influence the rehabilitation of patients with ULA. To maximize successful outcomes and return Veterans or Service Members with an ULA to independent living in

home, work, and community environments, providers must consider these factors in the development of a rehabilitation program and care plan. The rehabilitation treatment plan should also take into consideration that some individuals may choose to not use a prosthesis. For those patients, care teams need to consider other approaches to maximize functional independence.

Because of the complex rehabilitative needs of persons with ULA, a rehabilitation setting with vocational and psychological counselors, therapists, physicians, and prosthetists with specialized expertise and experience is vital to successful outcomes. The overall goal of amputation rehabilitation is to optimize the patient's health status, function, independence, and QoL. To achieve these desired outcomes, patients should participate in ongoing medical assessments and therapy interventions throughout the life-long continuum of care to address psychosocial, physical, and functional limitations.

III. Scope of this Guideline

This CPG is based on published clinical evidence and related information available through April 30, 2021. It is intended to provide general guidance on best evidence-based practices (see Appendix A for additional information on the evidence review methodology). This CPG is not intended to serve as a standard of care.

A. Guideline Audience

This CPG is intended for use by all healthcare providers caring for patients with ULA. This version of the CPG was specifically tailored to be of greatest value to rehabilitation care providers, including physicians, therapists, and prosthetists, involved in the management of persons with ULA.

B. Guideline Population

The patient population of interest for this CPG is adults (≥18 years) with ULA, including Veterans as well as Service Members, military retirees, and beneficiaries.

IV. Highlighted Features of this Guideline

A. Highlights in this Guideline Update

The current document is an update to the 2014 VA/DoD UEAR CPG. The 2022 VA/DoD ULA Rehabilitation edition is the first update to this CPG and includes recent objective, evidence-based information on the care and rehabilitation of persons with ULA. It is intended to provide guidance to assist healthcare providers in managing the care of persons with ULA across the entire care continuum.

The 2022 VA/DoD ULA CPG developed recommendations using the GRADE methodology. This methodology does not allow for recommendations based on expert opinion alone. This contrasts with the 2014 CPG methodology, which resulted in 26 out of 27 recommendations being based solely on expert opinion. In addition to a more stringent development methodology, the 2022 CPG was strengthened by the utilization of sex-specific patient focus groups to identify priority clinical issues and sex-specific management considerations. Another new aspect of the 2022 VA/DoD ULA CPG is that a different structure was used both for the development of the key questions and for the organization of the guideline recommendations.

Consistent with the 2014 UEAR CPG, this CPG is tailored to be of greatest value to rehabilitation care providers, including physicians, therapists, and prosthetists involved in the management of persons with ULA. However, the 2022 update includes an additional treatment algorithm that is designed specifically for primary care providers to assist in their care of persons with ULA. The treatment algorithm primarily designed for rehabilitation providers remains a strength of this CPG. This algorithm has been updated and continues to address key milestones and decision points across all four phases of rehabilitation care (see Algorithm).

Rather than focus on a narrow aspect of care, the 2022 CPG remains comprehensive in scope. Although this CPG includes only 14 recommendations (13 less than the 2014 CPG), it still provides management recommendations across the life span of the person with ULA and across the spectrum of clinical conditions and management challenges faced following ULA. Although improved in comparison to the 2014 CPG, the quality and quantity of research evidence identified for inclusion in the updated 2021 literature review was still limited, which resulted in no *Strong for* recommendations, four *Weak for* recommendations, and 10 *Neither for nor against* recommendations (see Recommendations). Thus, the 2022 CPG highlights the ongoing need for further high quality research in all fields of ULA rehabilitation and includes a section focused on Research Priorities.

To accompany this CPG, the Work Group also developed toolkit materials for providers and patients, including a provider summary, patient summary, and pocket card. These can be found at https://www.healthquality.va.gov/index.asp.

The 2022 VA/DoD ULA CPG used a more rigorous application of the methodology than previous iterations. For additional information on GRADE or CPG methodology, see Appendix A.

B. Components of the Guideline

The 2022 VA/DoD ULA CPG is the first update to this CPG. It provides clinical practice recommendations for the care of patients with ULA (see Recommendations). In addition, the Algorithm incorporates the recommendations in the context of the flow of patient care. This CPG also includes Research Priorities, which list areas the Work Group identified as needing additional research.

To accompany this CPG, the Work Group also developed toolkit materials for providers and patients, including a provider summary, patient summary, and pocket card. These can be found at https://www.healthquality.va.gov/index.asp.

V. Guideline Development Team

The VA Evidence Based Practice, Office of Quality and Patient Safety, in collaboration with the Clinical Quality Improvement Program, Defense Health Agency (DHA), identified the following four clinicians to serve as Champions (i.e., leaders) of this CPG's Work Group: Billie Randolph, PT, PhD and Joseph Webster, MD from the VA and Andrea Crunkhorn, PT, DPT and MAJ Megan Loftsgaarden, DO from the DoD.

The Work Group comprised individuals with the following areas of expertise: internal medicine, occupational therapy, pain management, pharmacology, physical medicine and rehabilitation

physicians, physical therapy, plastic surgery, polytrauma nursing, prosthetics, and rehabilitation psychology. See Table 2 for a list of Work Group members.

This CPG Work Group, led by the Champions, was tasked with:

- Determining the scope of the CPG
- Crafting clinically relevant key questions (KQs) to guide the systematic evidence review
- Identifying discussion topics for the patient focus group and considering the patient perspective
- Providing direction on inclusion and exclusion criteria for the systematic evidence review and the assessment of the level and quality of evidence
- Developing evidence-based clinical practice recommendations, including determining the strength and category of each recommendation

The Lewin Team, including The Lewin Group, ECRI, Sigma Health Consulting, and Duty First Consulting, was contracted by the VA to help develop this CPG.

Table 2. Guideline Work Group and Guideline Development Team

Organization	Names*
Department of Veterans Affairs	**Billie Randolph, PT, PhD (Champion)**
	Joseph Webster, MD (Champion)
	Irina Agranova-Breyter, MPT
	Erin Andrews, PsyD, ABPP
	Roxanne Disla, OTD, OTR/L
	Selina Doncevic, MSN, RN, CRRN
	Christopher Fantini, MSPT, CP, BOCO
	M. Jason Highsmith, PhD, DPT, CP, FAAOP
	Denise Lester, MD
	William C. Mayes, MSPO, CPO
	Linda Resnik, PT, PhD, FAPTA
	Bradley Tucker, MD
Department of Defense	**Andrea Crunkhorn, PT, DPT (Champion)**
	Maj Megan Loftsgaarden, DO (Champion)
	Shannon Barnicott, MOT, OTR/L
	Josef Butkus, MS, OTR/L
	Rachael Coller, PharmD, BCPS, BCPP
	LCDR Joseph Happel, MD
	Louise Hassinger, CP
	Michelle Nordstrom, MS, OTR/L
	Annemarie Orr, OTD, OTR/L
	Maj Casey Sabbag, MD
Office of Quality and Patient Safety Veterans Health Administration	M. Eric Rodgers, PhD, FNP-BC
	James Sall, PhD, FNP-BC
	Rene Sutton, BS, HCA

Organization	Names*
Clinical Quality Improvement Program Defense Health Agency	Lisa D. Jones, BSN, RN, MHA, CPHQ
	Elaine Stuffel, MHA, BSN, RN
The Lewin Group	Clifford Goodman, PhD
	Erika Beam, MS
	Ben Agatston, JD, MPH
	Shaina Haque, MPH
	Amanda Huben, BA
	Ryan Wilson, BA
ECRI	Kris D'Anci, PhD
	Stacey Uhl, MS
	Aaron Bloschichak, MPH
	Amber Moran, MA
	Emilio Berdiel, MPH
	Jessica T. Gontarek, MSLIS
	Michele Datko, MLS
Sigma Health Consulting	Frances Murphy, MD, MPH
	James Smirniotopoulos, MD
Duty First Consulting	Rachel Piccolino, BA
	Mary Kate Curley, BA
	Richa Ruwala, BS
	Anita Ramanathan, BA

*Additional contributor contact information is available in Appendix L.

VI. Summary of Guideline Development Methodology

The methodology used in developing this CPG follows the *Guideline for Guidelines*, an internal document of the VA/DoD EBPWG updated in January 2019 that outlines procedures for developing and submitting VA/DoD CPGs.(7) The *Guideline for Guidelines* is available at http://www.healthquality.va.gov/policy/index.asp. This CPG also aligns with the National Academy of Medicine's (NAM) principles of trustworthy CPGs (e.g., explanation of evidence quality and strength, the management of potential conflicts of interest [COI], interdisciplinary stakeholder involvement, use of systematic review, and external review).(8) Appendix A provides a detailed description of the CPG development methodology.

A. Evidence Quality and Recommendation Strength

The Work Group used the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach to craft each recommendation and determine its strength. Per GRADE approach, recommendations must be evidence-based and cannot be made based on expert opinion alone. The GRADE approach uses the following four domains to inform the strength of each recommendation (see Determining Recommendation Strength and Direction):(9)

- Confidence in the quality of the evidence
- Balance of desirable and undesirable outcomes

- Patient values and preferences
- Other considerations, as appropriate, e.g.:
    - Resource use
    - Equity
    - Acceptability
    - Feasibility
    - Subgroup considerations

Using these four domains, the Work Group determined the relative strength of each recommendation (*Strong* or *Weak*). The strength of a recommendation is defined as the extent to which one can be confident that the desirable effects of an intervention outweigh its undesirable effects and is based on the framework above, which incorporates the four domains.(10) A *Strong* recommendation generally indicates *High* or *Moderate* confidence in the quality of the available evidence, a clear difference in magnitude between the benefits and harms of an intervention, similar patient values and preferences, and understood influence of other implications (e.g., resource use, feasibility).

In some instances, there is insufficient evidence on which to base a recommendation for or against a particular therapy, preventive measure, or other intervention. For example, the systematic evidence review may have found little or no relevant evidence, inconclusive evidence, or conflicting evidence for the intervention. The manner in which this is expressed in the CPG may vary. In such instances, the Work Group may include among its set of recommendations a statement of insufficient evidence for an intervention that may be in common practice even though it is not supported by clinical evidence, and particularly if there may be other risks of continuing its use (e.g., high opportunity cost, misallocation of resources). In other cases, the Work Group may decide to not include this type of statement about an intervention. For example, the Work Group may remain silent where there is an absence of evidence for a rarely used intervention. In other cases, an intervention may have a favorable balance of benefits and harms but may be a standard of care for which no recent evidence has been generated.

Using these elements, the Work Group determines the strength and direction of each recommendation and formulates the recommendation with the general corresponding text (see Table 3).

Table 3. Strength and Direction of Recommendations and General Corresponding Text

Recommendation Strength and Direction	General Corresponding Text
Strong for	We recommend …
Weak for	We suggest …
Neither for nor against	There is insufficient evidence to recommend for or against …
Weak against	We suggest against …
Strong against	We recommend against …

It is important to note that a recommendation's strength (i.e., *Strong* versus *Weak*) is distinct from its clinical importance (e.g., a *Weak* recommendation is evidence-based and still important to clinical care). The strength of each recommendation is shown in the Recommendations section.

This CPG's use of GRADE reflects a more rigorous application of the methodology than previous iterations. For instance, the determination of the strength of the recommendation is more directly linked to the confidence in the quality of the evidence on outcomes that are critical to clinical decision-making. The confidence in the quality of the evidence is assessed using an objective, systematic approach that is independent of the clinical topic of interest. Therefore, recommendations on topics for which it may be inherently more difficult to design and conduct rigorous studies (e.g., randomized controlled trials [RCTs]) are typically supported by lower quality evidence and, in turn, *Weak* recommendations. Recommendations on topics for which rigorous studies can be designed and conducted may more often be *Strong* recommendations. Per GRADE, if the quality of evidence differs across the relevant critical outcomes, the lowest quality of evidence for any of the critical outcomes determines the overall quality of the evidence for a recommendation.(11, 12) This stricter standard provides a consistent approach to determining recommendation strengths. For additional information on GRADE or CPG methodology, see Appendix A.

B. Categorization of 2014 Clinical Practice Guideline Recommendations

Evidence-based CPGs should be current. Except for an original version of a new CPG, this typically requires revision of a CPG's previous versions based on new evidence or as scheduled subject to time-based expirations.(13) For example, the U.S. Preventive Services Task Force (USPSTF) has a process for monitoring the emergence of new evidence that could prompt an update of its recommendations, and it aims to review each topic at least every five years for either an update or reaffirmation.(14)

Recommendation categories were used to track how the previous CPG's recommendations could be reconciled. These categories and their corresponding definitions are similar to those used by the National Institute for Health and Care Excellence (NICE, England).(15, 16) Table 4 lists these categories, which are based on whether the evidence supporting a recommendation was systematically reviewed, the degree to which the previous CPG's recommendation was modified, and whether a previous CPG's recommendation is relevant in the updated CPG.

Additional information regarding these categories and their definitions can be found in Recommendation Categorization. The 2022 CPG recommendation categories can be found in Recommendations. Appendix K outlines the 2014 VA/DoD UEAR CPG's recommendation categories.

Table 4. Recommendation Categories and Definitions[a]

Evidence Reviewed	Recommendation Category	Definition
Reviewed[b]	New-added	New recommendation
	New-replaced	Recommendation from previous CPG was carried forward and revised
	Not changed	Recommendation from previous CPG was carried forward but not changed
	Amended	Recommendation from previous CPG was carried forward with a nominal change
	Deleted	Recommendation from previous CPG was deleted
Not reviewed[c]	Not changed	Recommendation from previous CPG was carried forward but not changed
	Amended	Recommendation from previous CPG was carried forward with a nominal change
	Deleted	Recommendation from previous CPG was deleted

[a] Adapted from the NICE guideline manual (2012) (15) and Garcia et al. (2014) (16)

[b] The topic of this recommendation was covered in the evidence review carried out as part of the development of the current CPG.

[c] The topic of this recommendation was not covered in the evidence review carried out as part of the development of the current CPG.

Abbreviation: CPG: clinical practice guideline

C. Management of Potential or Actual Conflicts of Interest

Management of COIs for the CPGs is conducted as described in the *Guideline for Guidelines*.(7) Further, the *Guideline for Guidelines* refers to details in the VHA Handbook 1004.07 Financial Relationships between VHA Health Care Professionals and Industry (November 2014, issued by the VHA National Center for Ethics in Health Care),(17) as well as to disclosure statements (i.e., the standard disclosure form that is completed at least twice by CPG Work Group members and the guideline development team).(7) The disclosure form inquires regarding any relevant financial and intellectual interests or other relationships with, e.g., manufacturers of commercial products, providers of commercial services, or other commercial interests. The disclosure form also inquires regarding any other relationships or activities that could be perceived to have influenced, or that give the appearance of potentially influencing, a respondent's contributions to the CPG. In addition, instances of potential or actual COIs among the CPG Work Group and the guideline development team were also subject to random web-based identification via standard electronic means (e.g., Centers for Medicare & Medicaid Services [CMS] Open Payments and/or ProPublica).

No COIs were identified among the CPG Work Group or the guideline development team. If an instance of potential or actual COI had been reported, it would have been referred to the VA and DoD program offices and reviewed with the CPG Work Group Champions. The VA and DoD program offices and the CPG Work Group Champions would have determined whether, and if so, what, further action was appropriate (e.g., excusing Work Group members from selected relevant deliberations or removal from the Work Group). Disclosure forms are on file with the VA Office of Quality and Patient Safety and are available upon request.

D. Patient Perspective

When developing a CPG, consideration should be given to patient perspectives and experiences, which often vary from those of providers.(11, 18) Focus groups can be used to help collect qualitative data on patient perspectives and experiences. VA and DoD Leadership arranged two virtual patient focus groups, one comprised of all men and the other all women, on March 19, 2021. The focus groups explored patients' perspectives on topics related to the management of ULA in the VA and DoD healthcare systems, including information about their history of treatment, experiences with care delivery in various settings, treatments including occupational and physical therapy, prostheses, self-management, and the impact of their ULA and related therapies on their lives.

The patient focus groups comprised a convenience sample of nine people. Six participants were Veterans who received care from the VA health system, and four participants were Service Members who received care from the DoD health system. Two participants indicated receiving care at the Center for the Intrepid, and two participants reported receiving initial rehabilitation care outside of the VA and DoD health systems. The Work Group acknowledges this convenience sample is not representative of all patients with ULA within the VA and DoD healthcare systems and, thus, findings are not generalizable and do not comprise evidence. For more information on the patient focus group methods and findings, see Appendix I. Patient focus group participants were provided the opportunity to review the final draft of the focus group report and provide additional feedback.

E. External Peer Review

The Work Group drafted, reviewed, and edited this CPG using an iterative process. For more information, see Drafting and Finalizing the Guideline. Once the Work Group completed a near-final draft, they identified experts from the VA and DoD healthcare systems and outside organizations generally viewed as experts in the respective field to review that draft. The draft was sent to those experts for a 14-business-day review and comment period. The Work Group considered all feedback from the peer reviewers and modified the CPG where justified, in accordance with the evidence. Detailed information on the external peer review can be provided by the VA Office of Quality and Patient Safety.

F. Implementation

This CPG and algorithm are designed for adaptation by individual healthcare providers with consideration of unique patient considerations and preferences, local needs, and resources. The algorithm serves as a tool to prompt providers to consider key decision points in the care for a patient with ULA. The Work Group submits suggested performance metrics for the VA and DoD to use when assessing the implementation of this CPG. Robust implementation is identified in VA and DoD internal implementation plans and policies. Additionally, implementation would entail wide dissemination through publication in the medical literature, online access, educational programs, and, ideally, electronic medical record (EMR) programming in the form of clinical decision support tools at the point of care.

VII. Approach to Care in Department of Veterans Affairs and Department of Defense

A. Patient-centered Care

Guideline recommendations are intended to consider patient needs and preferences. Guideline recommendations represent a whole/holistic health approach to care that is patient-centered, culturally appropriate, and available to people with limited literacy skills and physical, sensory, or learning disabilities. VA/DoD CPGs encourage providers to use a patient-centered, whole/holistic health approach (i.e., individualized treatment based on patient needs, characteristics, and preferences). This approach aims to treat the particular condition while also optimizing the individual's overall health and well-being.

Regardless of the care setting, all patients should have access to individualized evidence-based care. Patient-centered care can decrease patient anxiety, increase trust in clinicians, and improve treatment adherence.(19, 20) A whole/holistic health approach (https://www.va.gov/wholehealth/) empowers and equips individuals to meet their personal health and well-being goals. Good communication is essential and should be supported by evidence-based information tailored to each patient's needs. An empathetic and non-judgmental approach facilitates discussions sensitive to sex, culture, ethnicity, and other differences.

B. Shared Decision Making

This CPG encourages providers to practice shared decision making, which is a process in which providers and patients consider clinical evidence of benefits and risks as well as patient values and preferences to make decisions regarding the patient's treatment.(21) Shared decision making was emphasized in *Crossing the Quality Chasm,* an Institute of Medicine (IOM) (now NAM) report, in 2001 (22) and is inherent within the whole/holistic health approach. Providers must be adept at presenting information to their patients regarding individual treatments, expected risks, expected outcomes, and levels and/or settings of care, especially where there may be patient heterogeneity in risks and benefits. The VHA and MHS have embraced shared decision making. Providers are encouraged to use shared decision making to individualize treatment goals and plans based on patient capabilities, needs, and preferences.

C. Patients with Co-occurring Conditions

Co-occurring conditions can modify the degree of risk, impact diagnosis, influence patient and provider treatment priorities and clinical decisions, and affect the overall approach to the management of ULA rehabilitation. Many Veterans, Service Members, and their families have one or more co-occurring conditions. Because ULA is sometimes accompanied by co-occurring conditions, it is often best to manage ULA collaboratively with other care providers. Some co-occurring conditions may require early specialist consultation to determine any necessary changes in treatment or to establish a common understanding of how care will be coordinated. This may entail reference to other VA/DoD CPGs (e.g., for posttraumatic stress disorder [PTSD], substance use disorders [SUD], suicide risk, major depressive disorder [MDD], and opioid therapy for chronic pain).[b]

[b] The VA/DoD CPGs are available at: https://www.healthquality.va.gov/index.asp

D. Phases of Rehabilitation Care

The VA and DoD have previously described four phases of care which create a framework for rehabilitation and long-term management of patients with an ULA. 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 the needs of the patient. The four phases are:

- Phase 1: Perioperative
- Phase 2: Pre-prosthetic
- Phase 3: Prosthetic training
- Phase 4: Lifelong care

The perioperative phase of rehabilitation commences when a patient has been initially evaluated in the clinical setting and has either undergone an ULA or the decision has been made that amputation is necessary. In most cases, the underlying cause resulting in the need for an ULA involves a traumatic injury. Complete interdisciplinary assessments of the patient's medical, functional, and psychological status should be performed as soon as it is clinically appropriate to establish a baseline level of function and prepare the patient for the ensuing rehabilitation plan and, ultimately, lifelong 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 incisions are closed and free of infection, sutures are removed, self-care activities of daily living (ADL) using one-handed strategies and adaptive or durable medical equipment are progressing, and the patient has been medically cleared for further rehabilitation.

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 a prosthesis and aids the patient in determining which type of prosthesis(es) 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 initial prosthesis prescription should be developed with input from all members of the care team and individualized for the patient based on the patient's specific needs and goals related to prosthesis use. Table 5 provides the care team with the essential elements that should be included in an upper limb prosthesis prescription. The pre-prosthetic phase ends with the fitting of the initial prosthesis. This phase typically occurs in an outpatient or rehabilitation setting.

Table 5. Components of the Upper Limb Prosthesis Prescription

Comprehensive prescription for an upper limb prosthesis should include:
• Design (e.g., preparatory versus 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)

The prosthetic training phase marks a turning point in the rehabilitation of the patient who is determined to be an appropriate candidate to proceed to prosthesis fitting. 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 desired functional outcomes 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. Patients may ebb and flow through this phase after receiving each new or different type of prosthesis. During this phase of care, the members of the care team must monitor the patient for potential complications that can occur during prosthesis use. Table 6 provides the care team with some common signs and symptoms that the prosthesis may need to be modified. This phase may also begin because a patient receives a new prosthetic component or a novel control scheme.

Table 6. Signs and Symptoms the Prosthesis May Need to Be Modified

Patients who use a prosthesis should be advised to report any of the following symptoms:
• 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 last phase of ULA rehabilitation is lifelong care. This phase begins upon completion of the prosthetic training phase and continues throughout the remainder of the patient's life. The importance of this phase cannot be understated. During this phase, the patient should return for annual routine follow-up assessments and review of the patient's functional goals with the amputation care team. A comprehensive, interdisciplinary approach is used at each follow-up regardless of prosthetic use. Each routine follow-up assessment should focus on maximizing the patient's functional independence using available rehabilitation services and emerging technologies in ULA rehabilitation.

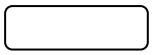
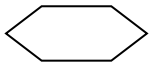
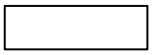
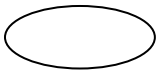
The Algorithm summarizes the activities and milestones achieved in each phase of care.

VIII. Algorithm

This CPG's algorithm is designed to facilitate understanding of the clinical pathway and decision making process used in managing patients with ULA. This algorithm format represents a simplified flow of the management of patients with ULA and helps foster efficient decision making by providers. It includes:

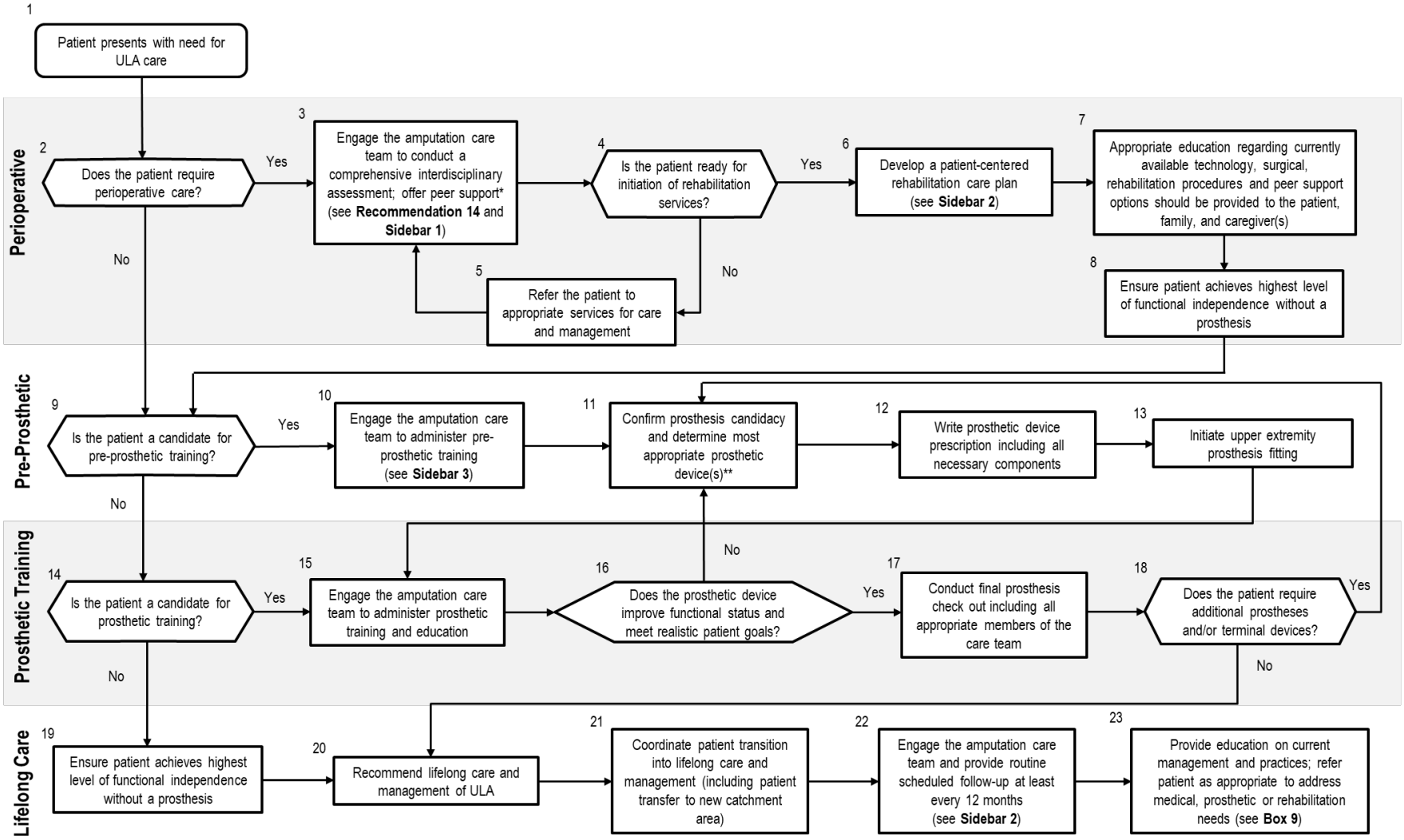
- An ordered sequence of steps of care
- Decisions to be considered
- Recommended decision criteria
- Actions to be taken

The algorithm is a step-by-step decision tree. Standardized symbols are used to display each step, and arrows connect the numbered boxes indicating the order in which the steps should be followed.(23) Sidebars provide more detailed information to assist in defining and interpreting elements in the boxes.

Shape	Description
	Rounded rectangles represent a clinical state or condition
	Hexagons represent a decision point in the process of care, formulated as a question that can be answered "Yes" or "No"
	Rectangles represent an action in the process of care
	Ovals represent a link to another section within the algorithm

Appendix N contains alternative text descriptions of the algorithm.

A. Module A: Upper Limb Amputation Management



*Peer support includes both peer visitors right after surgery and peer support in an outpatient setting

**May involve trials of various device components as appropriate and feasible

Abbreviations: ULA: upper limb amputation

Sidebar 1: Components of the Comprehensive Assessment

- Present health status
- Level of function
- Modifiable/controllable health risk factors
- Pain assessment
- Cognition and behavioral health
- Personal, family, social, and cultural context
- Learning assessment
- Residual limb assessment
- Non-amputated limb and trunk assessment
- Prosthetic assessment (if applicable)
- Vocational assessment

Sidebar 2: The Patient-centered Rehabilitation Plan

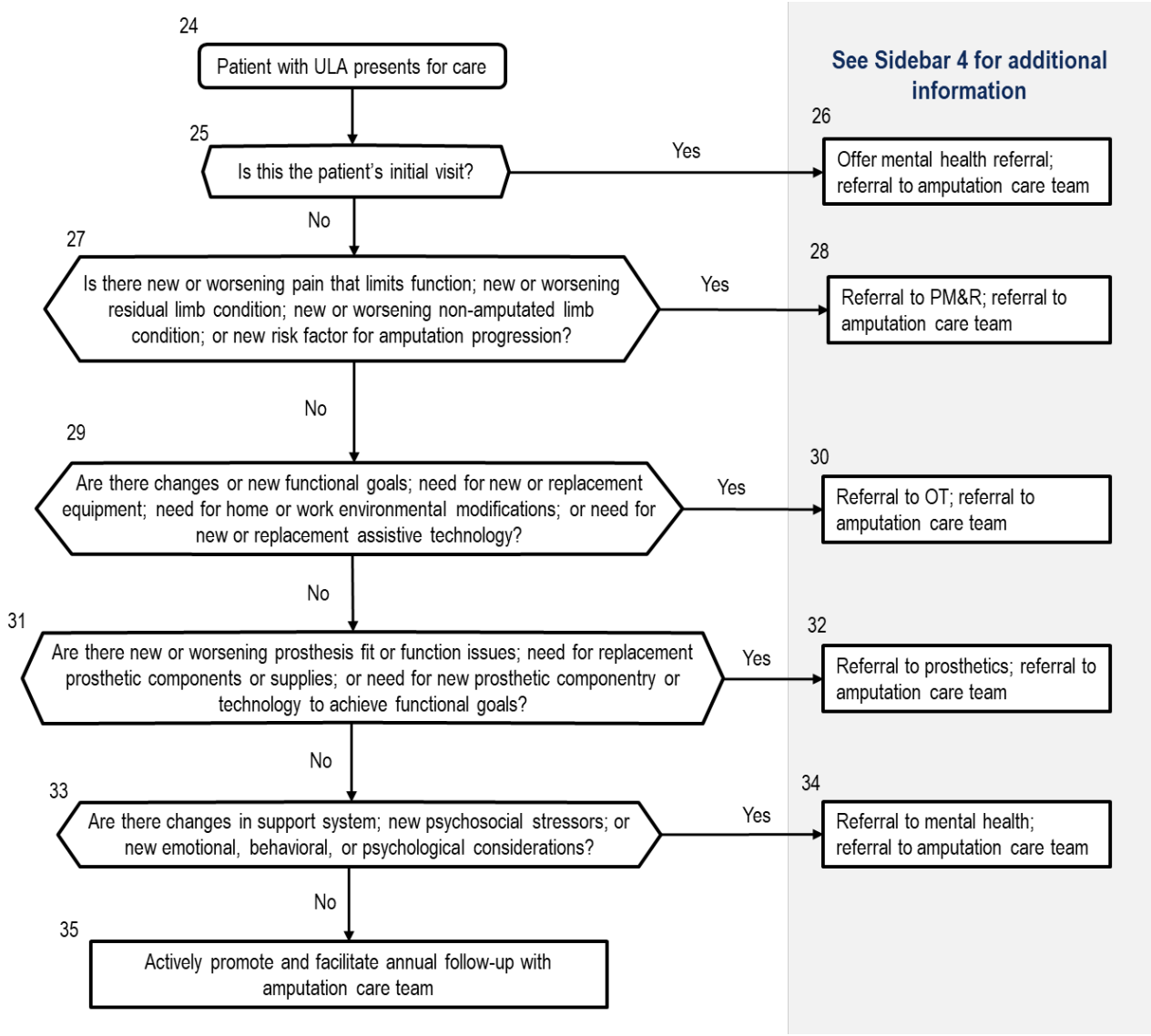
- Evaluations from all members of the care team
- Input from the patient and family/caregiver(s)
- Treatment plan, which must address all identified realistic patient-centered treatment goals, rehabilitation, medical, psychological, and surgical problems
- Indication of the next anticipated phase of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

Sidebar 3: Physical and Functional Rehabilitation Interventions

- 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)
- Progressive ROM exercises
- Postural exercises and progressive strengthening
- Cardiovascular endurance
- IADL interventions, home and driving modifications, assistive technologies, and community integration
- Adaptive sports or leisure activities

Abbreviations: ADL: activities of daily living; IADL: instrumental activities of daily living; ROM: range of motion

B. Module B: Upper Limb Amputation Management for Primary Care



Abbreviations: OT: occupational therapy; PM&R: physical medicine and rehabilitation; ULA: upper limb amputation

Sidebar 4: Amputation Care Team
The amputation care team is an interdisciplinary team consisting of, at a minimum, a physiatrist (or prescribing clinician), occupational and physical therapists, and prosthetist, that provides assessment and treatment for amputation-related needs. Other providers who may be included are mental health, rehabilitation psychology (if available), social work, nursing, wound care, surgery, vocational planning. Members of the team may participate face to face or via telehealth as appropriate.

IX. Recommendations

The following evidence-based clinical practice recommendations were made using a systematic approach considering four domains as per the GRADE approach (see Summary of Guideline Development Methodology). These domains include: confidence in the quality of the evidence, balance of desirable and undesirable outcomes (i.e., benefits and harms), patient values and preferences, and other implications (e.g., resource use, equity, acceptability).

Topic	#	Recommendation	Strength[a]	Category[b]
Surgery/Pre-prosthetic	1.	There is insufficient evidence to assess the impact of the level of amputation or amputation surgical procedure type on functional status and prosthesis-related outcomes.	Neither for nor against	Reviewed, New-added
	2.	For patients undergoing upper limb amputation surgery, there is insufficient evidence to recommend the use of any particular factors to predict the speed and quality of wound healing, successful prosthesis fitting, or need for revision surgery.	Neither for nor against	Reviewed, New-added
	3.	There is insufficient evidence to recommend for or against the use of any particular recent treatment advances including hardware, software, surgical, technology, or supplemental surgical interventions, such as: • targeted muscle reinnervation (TMR) • regenerative peripheral nerve interfaces (RPNI) • vascularized composite allotransplantation (VCA) • agonist-antagonist myoneural interface (AMI) • implantable myoelectric sensor system (IMES) • osseointegration (OI)	Neither for nor against	Reviewed, New-added
Rehabilitation	4.	There is insufficient evidence to recommend for or against any particular training protocol to improve function and outcomes.	Neither for nor against	Reviewed, New-added
	5.	We suggest the use of mirror therapy for the short-term reduction of phantom limb pain.	Weak for	Reviewed, New-replaced
	6.	There is insufficient evidence to recommend for or against any particular treatment setting, intensity, or service delivery model.	Neither for nor against	Reviewed, New-replaced
Prosthetic Restoration	7.	For patients with major unilateral upper limb amputation (i.e., through or proximal to the wrist), we suggest use of a body-powered or externally powered prosthesis to improve independence and reduce disability.	Weak for	Reviewed, New-added
	8.	There is insufficient evidence to recommend for or against any specific control strategy, socket design, suspension method, or component.	Neither for nor against	Reviewed, New-added

Topic	#	Recommendation	Strength[a]	Category[b]
Medical	9.	There is insufficient evidence to recommend for or against a particular intervention for the *prevention* of phantom and/or residual limb pain.	Neither for nor against	Reviewed, New-replaced
	10.	There is insufficient evidence to recommend for or against any particular pharmacologic intervention for the *management* of phantom and/or residual limb pain.	Neither for nor against	Reviewed, New-replaced
	11.	There is insufficient evidence to recommend for or against the use of non-invasive brain stimulation for the management of phantom limb pain.	Neither for nor against	Reviewed, New-added
Outcomes	12.	There is insufficient evidence to recommend for or against the use of any specific assessment tool to guide the determination of prosthetic candidacy, the need for therapy, or for identifying improvement or worsening of function and quality of life.	Neither for nor against	Reviewed, New-added
Psychosocial Considerations	13.	We suggest screening patients for cognition, mental health conditions such as posttraumatic stress disorder and depression, and pain during the initial evaluation and across the continuum of care.	Weak for	Reviewed, New-added
	14.	We suggest offering peer support services.	Weak for	Reviewed, New-replaced

[a] For additional information, see Determining Recommendation Strength and Direction.

[b] For additional information, see Recommendation Categorization and Appendix K.

A. Surgery/Pre-prosthetic

Recommendation

1. There is insufficient evidence to assess the impact of the level of amputation or amputation surgical procedure type on functional status and prosthesis-related outcomes.
   (Neither for nor against | Reviewed, New-added)

Discussion

The effect of surgical technique and level of amputation on functional status in persons with ULA has not been fully determined as there is limited evidence. This CPG's systematic evidence review identified two systematic reviews (SR) and three observational studies; however, the Work Group determined these studies contained evidence that is either inconclusive or limited by indirectness and/or study design.

Yuan et al. (2015) conducted an SR that reviewed 43 studies (63% prospective studies) that focused on traumatic finger amputations, revision surgeries, and functional outcomes.(24) They found that revision amputation promoted improved static two-point discrimination in comparison to traumatic finger amputation without revision. However, they reported no difference in function as it relates to conservative treatment versus revision surgery. Data from this study pertains to finger amputations only and cannot be extrapolated to other amputation levels.(24) This CPG's systematic evidence review identified no other studies addressing the impact of surgical procedure type on functional status and prosthesis-related outcomes.

This CPG's systematic evidence review identified three observational studies and one SR related to amputation levels and functional status.(25-28) None of the studies showed any difference in function

or pain with the exclusion of Resnik & Borgia (2015), which documented that persons with transradial (TR) amputation reported less disability compared to more proximal amputations utilizing the QuickDASH assessment tool.(28) However, the Work Group was unable to draw any objective conclusions from Resnik & Borgia (2015) as the quality of evidence was poor due to selection bias, no description of response rate or responder versus non-responder characteristics, and controlling only for level of amputation.(28)

Otto et al. (2015) analyzed seven observational studies that evaluated functional outcomes in replantation patients (n=301) and prosthetic users (n=172).(27) They reported that persons with below elbow amputations have better functional outcomes in both prosthetic users and replantation compared to persons with above elbow amputations. Although the data suggested that distal amputations fare better functionally than more proximal amputations, all the data was descriptive and the authors noted that the data on the level of amputations was incomplete.(27)

The Work Group also reviewed another study that investigated levels of amputation and functional outcomes that were not included in this CPG's systematic evidence review.(29) Resnik et al. (2020) found that dexterity is best at the TR level followed by transhumeral (TH) amputation and glenohumeral disarticulation/shoulder amputation level.(29) This study was not included in the recommendation because of potential selection bias as patients were selected into studies based primarily on convenience, minimal control for potential confounders, and lack of blinding of outcomes assessors.

The patient focus group indicated a preference for consultation with their surgeons and prosthetists before and after surgery since it may improve outcomes. Furthermore, participants also reported being concerned about the lack of sex-specific customization in prosthetics as they stated that prostheses are not designed for female fit (e.g., too large/heavy, sized for men). In addition, since two of the studies reviewed focused on the DEKA arm, it should be noted that not all patients prefer or are comfortable with the weight of the DEKA arm and the necessity of wearing extra batteries. Advanced prostheses, such as the DEKA arm, are high-cost units that require prosthetist and therapist expertise which may limit access and availability for some patients.

The Work Group systematically reviewed evidence related to this recommendation.(24-28) Therefore, this is a *Reviewed, New-added* recommendation. The Work Group's confidence in the quality of evidence was very low and the balance of desirable and undesirable outcomes was not able to be determined. Patient values and preferences largely vary. Resource use for an advanced prosthesis, such as the DEKA arm, can be high and difficult to achieve, from the high monetary cost to unique prosthetist and therapist expertise to extraordinary patient training requirements. This all may limit access and availability for most patients. Thus, the Work Group decided upon a *Neither for nor against* recommendation.

Recommendation

2. For patients undergoing upper limb amputation surgery, there is insufficient evidence to recommend the use of any particular factors to predict the speed and quality of wound healing, successful prosthesis fitting, or need for revision surgery.
   (Neither for nor against | Reviewed, New-added)

Discussion

This CPG's systematic evidence review did not identify any studies that met inclusion criteria and addressed the use of any particular factors including age, sex, race, co-occurring medical conditions, to predict the speed and quality of wound healing, successful prosthesis fitting, or need for revision surgery in patients with ULA.

There were retrospective chart review data identified in two studies that were not included in this CPG's systematic evidence review due to significant biases in the selection of controls, determination of risk factors, and difficulty in assessing true temporal relationships. Chinta et al. (2018) and Vlot et al. (2018) addressed patient factors (e.g., sex, age, race, comorbid conditions) that predict wound healing outcomes and/or need for revision surgery in patients with ULA.(30, 31) Other studies were identified and excluded because they did not match the population or comparator of interest.(32, 33)

There is variability in patient preferences regarding wound healing, successful prosthesis training and fitting, and whether to pursue amputation revision surgery. The patient focus group noted individualized rehabilitation plans are critical and should include aspects of functional goals, pain management, and patient education. Speed and quality of wound healing, successful prosthesis fitting, and need for revision surgery are associated with important outcomes that impact patient QoL and potential success with ULA. The Work Group also considered the variability in goals and predicted outcomes with varying levels of amputation and patient access to rehabilitation specialists and prosthetists that would allow trials and training with different prosthetic devices. The decision to pursue revision amputation is also individualized and may be based upon multiple factors such as pain, function, and cosmetic appearance.

The Work Group systematically reviewed evidence related to this recommendation; none met the criteria for inclusion in the evidence base. Therefore, this is a *Reviewed, New-added* recommendation. The Work Group could not determine the confidence in the quality of the evidence nor the balance of benefits and harms since this CPG's systematic evidence review did not retrieve any evidence on this topic. Patient values and preferences largely varied due to subgroup considerations such as level of amputation, sex, and accessibility to equipment and therapists. Thus, the Work Group decided upon a *Neither for nor against* recommendation.

Recommendation

3. There is insufficient evidence to recommend for or against the use of any particular recent treatment advances including hardware, software, surgical, technology, or supplemental surgical interventions, such as:
    - targeted muscle reinnervation (TMR)
    - regenerative peripheral nerve interfaces (RPNI)
    - vascularized composite allotransplantation (VCA)
    - agonist-antagonist myoneural interface (AMI)
    - implantable myoelectric sensor system (IMES)
    - osseointegration (OI)

    (Neither for nor against | Reviewed, New-added)

Discussion

Two observational studies and one RCT suggested that surgical advances, such as targeted muscle reinnervation (TMR), may improve pain management and prosthetic control in individuals with ULA.(34-36) However, the evidence was inconclusive. Dumanian et al. (2019) identified TMR as a promising surgical intervention for improving phantom limb pain (PLP) and possibly residual limb pain.(35) Mioton et al. (2020) found TMR helped with amputation-related pain and improved control for their myoelectric prosthetic arms.(36) Salminger et al. (2019) evaluated 30 individuals after TMR and found many of the participants still discontinued the use of their prostheses even though the procedure resulted in successful nerve transfers and reduced neuroma pain.(34) Additional studies, conducted in a variety of patient populations, have reported results consistent with these findings which indicates TMR can help reduce neuroma pain.(37-39)

A variety of potential treatments in addition to TMR were identified as options to help improve outcomes in individuals with ULA. However, many did not meet inclusion criteria for this CPG's systematic evidence review due to potential selection bias, minimal control for potential confounders, and lack of blinding outcomes assessors. As a result, this CPG's systematic evidence review did not find evidence that met the inclusion criteria for regenerative peripheral nerve interfaces (RPNI), vascularized composite allotransplantation (VCA), agonist-antagonist myoneural interface (AMI), implantable myoelectric sensor system (IMES), and osseointegration (OI).

The patient focus group participants reported pain management and prosthetic comfort as critical components when deciding if they were going to continue using their prostheses. While the evidence is still inconclusive, the TMR procedure may address these concerns. Targeted muscle reinnervation has also shown promise in improving PLP but it does not change the socket or lack of sensation. In response to these concerns, additional procedures have been developed and are in the beginning stages of gaining evidence to determine their level of success. Further, there is limited access to many of these treatments, including TMR, since there are few providers with adequate experience and training.

Some of the additional procedures that might be available include OI, IMES, RPNI, AMI, VCA. Osseointegration was created as a way to potentially increase comfort by eliminating the socket resulting in an immediate secure connection.(40) The OI attachment enables preservation of humeral internal and external ROM which is not possible with a socket prosthesis. Implantable myoelectric sensor systems are small devices that can be surgically implanted into the muscles and will amplify the signal to the

myoelectric prostheses, which may help improve myoelectric control. An additional way to improve prosthetic control is the AMI procedure, which includes connecting the agonist and antagonist muscles. For the enhancement of sensation, VCA, upper limb transplant, is currently the only option.(41, 42)

Each of these options addresses distinctly different concerns and requires surgical intervention from providers with specialized training. When considering these treatment advances to improve prosthesis acceptance, clinicians must understand why an individual chooses to minimize or discontinue use of their prostheses and address those issues. As discussed in Salminger et al. (2019), some study participants who experienced reduced PLP continued to experience socket discomfort, which may have contributed to device abandonment.(34)

The Work Group systematically reviewed evidence related to this recommendation focusing on TMR.(34-36) Therefore, this is a *Reviewed, New-added* recommendation. The Work Group's confidence in the quality of the evidence was very low. The body of evidence had limitations including small sample sizes and confounders in the analysis. The evidence supporting potential benefits of the advances, including hardware, software, surgical, technology, or supplemental surgical interventions was limited. While there were three articles to support TMR procedures, there are multiple other options such as RPNI, AMI, OI, VCA, and IMES that do not currently have sufficient evidence to define the balance of benefits with the potential harms or adverse events. Patient values and preferences varied largely because of differences in access to the medical teams with extensive experience. Thus, the Work Group decided upon a *Neither for nor against* recommendation.

B. Rehabilitation

Recommendation

4. There is insufficient evidence to recommend for or against any particular training protocol to improve function and outcomes.
   (Neither for nor against | Reviewed, New-added)

Discussion

Although four studies were identified as potentially addressing this recommendation, none of these studies met the inclusion criteria for this CPG's systematic evidence review due to small sample sizes, limited study participants with ULA, and lack of relevant data to abstract.(43-46)

An SR by Soyer et al. (2016) noted that a variety of broad treatment concepts exist for rehabilitation following ULA, "The studies pointed out the upper limb prosthetic rehabilitation protocols consist of general exercise programme, motor tasks, phantom exercises, Muscle Training System, edema control, functional activities, signal strengthening, prosthetic education exercises, neuromuscular reeducation, virtual image and virtual reality exercises."(46) The SR broadly concluded that "prosthetic rehabilitation seems promising especially for upper extremity amputees." The SR did not meet the inclusion criteria for this CPG but does generally indicate a value to the patient that may need more study.

While not meeting inclusion criteria for this CPG's systematic evidence review, Kwah et al. (2019) surveyed other CPGs for the population of persons with upper and lower extremity amputation.(43) The authors found that the overall evidence was of low to moderate quality and only a handful of the recommendations considered were derived from strong quality evidence. Although there are various

established treatments described in the literature, the evidence is lacking for a protocol that encompasses a variety of treatments as a whole. Established protocols for a battery of treatment techniques have insufficient evidence in the current literature to recommend for or against any particular training protocol.(43)

There is very limited evidence that existing treatment protocols for upper extremity training improve function and outcomes for the limb loss population. This underscores the importance and need for further research. Some articles that professionals may seek out to inform their practice are largely based on expert opinion and were not included in our systematic evidence review. Clinicians seeking further information on prosthetic training should also refer to Appendix H.

Given the relatively small population, the cost and time associated with large scale, high quality research studies in this domain, evidentiary gaps in standard clinical practice will be inevitable. While some protocols may be considered common knowledge and standard of care (e.g., strengthening a residual limb before application of a prosthesis), research in this field has yet to provide high quality evidence to support basic clinical standards for rehabilitation interventions. This is partially due to therapy being a standard of care and withheld blinded treatments would be unethical for this population. Furthermore, the development of overarching, composite protocols that include multiple distinct treatment regimens will need to be studied with rigor. There is a great need to improve the quality of evidence for prosthesis training and establish evidence-based protocols to support and grow the work of expert opinion.

The Work Group systematically reviewed evidence related to this recommendation and found no evidence available for inclusion. Therefore, this is a *Reviewed, New-added* recommendation. The Work Group could not determine the confidence in the quality of the evidence nor the balance of benefits and harms since this CPG's systematic evidence review did not retrieve any evidence on this topic. Patient values and preferences varied somewhat because patients may prefer various forms of therapy. In addition, various forms of therapy may not be uniformly available to patients. Thus, the Work Group decided upon a *Neither for nor against* recommendation.

Recommendation

5. We suggest the use of mirror therapy for the short-term reduction of phantom limb pain. **(Weak for | Reviewed, New-replaced)**

Discussion

The 2022 VA/DoD ULA CPG Work Group identified the need for evidence on the efficacy of non-pharmacologic treatment of PLP. Four studies were identified, and one study addressing this need met the inclusion criteria for this CPG's systematic evidence review. Barbin et al. (2016) found treatment with mirror therapy resulted in improved pain outcomes when compared to the control patients with ULA at 4 days to 6 weeks follow-up.(47)

The Work Group determined there is likely some variability in the effectiveness of mirror therapy given the wide range of PLP symptoms and severity associated with ULA. However, this treatment is well tolerated by patients and is an established element of care for this population. Mirror therapy is inexpensive and readily available in a variety of settings, including in the clinic and at home. This allows for intervention with therapy and carryover to home programs for continued pain management

following discharge. Mirror therapy is often utilized in conjunction with other interventions, such as pain neuroscience education, laterality also known as left/right discrimination, and explicit motor imagery, as part of a multi-modal treatment approach known as graded motor imagery (GMI). Factors such as mirror placement, patient position, exercises and activities utilized, massage techniques of residual and contralateral limbs, and therapist versus patient application of input can all be individualized based on the patient's specific needs and responses to the intervention.

The Work Group considered assessment of the evidence put forth in the 2014 VA/DoD UEAR CPG and systematically reviewed newly identified evidence related to this recommendation.(47-49) Therefore, this is a *Reviewed, New-replaced* recommendation. The Work Group's confidence in the quality of the evidence was very low. The body of evidence had some limitations including the very serious risk of bias, and serious indirectness and imprecision. No statistical analyses were performed and instead, the outcomes relied on descriptive results. The potential benefits of mirror therapy as a non-pharmacologic intervention to reduce PLP in upper extremity amputees outweighed the potential harms. Patient values and preferences varied somewhat because of the variability of symptoms and severity associated with PLP. Thus, the Work Group decided upon a *Weak for* recommendation.

Recommendation

6. There is insufficient evidence to recommend for or against any particular treatment setting, intensity, or service delivery model.
   (Neither for nor against | Reviewed, New-replaced)

Discussion

The 2022 VA/DoD ULA CPG Work Group identified the desire for evidence on the relationship between treatment parameters (e.g., setting, treatment intensity, or service delivery model) and rehabilitation outcomes. However, this CPG's systematic evidence review did not retrieve any relevant studies. Recommendation 1 from the 2014 VA/DoD UEAR CPG states, "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" was based solely on expert opinion. As such, there were no studies identified in the 2014 systematic review that could be used to support a recommendation on any specific treatment setting, intensity, or service delivery model.

This CPG's systematic evidence review identified one potential study addressing the results of a telehealth program for persons with ULA that allowed these individuals to interact with peers and learn about the management of both physical and psychological health conditions.(50) However, the study was excluded from the evidence synthesis report because of its weak design (only pre-post data were reported) and small sample size (n=5).

Although not included in this CPG's systematic evidence review, Resnik et al. (2021) provides some insight into quality and satisfaction with prosthetic limb services and the relationship between the treatment setting (VA, DoD, or private) and treatment recency on satisfaction.(51) This study found an association between service provision within the past year and service quality satisfaction scores. Veterans who received amputation care in the VA or DoD also had better, but not statistically different, mean service satisfaction scores when compared with those who received care outside the VA or DoD.

However, treatment setting and treatment recency were not linked with additional patient outcomes of interest, and the strength of the evidence was rated as very low.(51)

Patient values, expectations, and preferences regarding treatment setting, intensity, quality, and service delivery model varied somewhat because the geographic distance to expertise, facilities, and services may influence preferences for service delivery for some patients. In addition, the Work Group recognized that patient needs may vary and call for different service delivery approaches. For example, patients with more complex rehabilitation needs, such as those with multiple limb involvement or more proximal level amputations, may require more specialized services and/or more intensive treatment settings. For adults with ULA, telemedicine and telerehabilitation services have the potential to improve access to specialized treatment teams; however, the availability of this service delivery model is not uniform across the VA and DoD and evidence supporting the effectiveness of these care delivery models is not yet available.

The Work Group systematically reviewed evidence related to this recommendation. Therefore, this is a *Reviewed, New-replaced* recommendation. The Work Group could not determine the confidence in the quality of the evidence nor the balance of benefits and harms since this CPG's systematic evidence review did not retrieve any evidence on this topic. Patient values and preferences varied somewhat. Thus, the Work Group decided upon a *Neither for nor against* recommendation.

C. Prosthetic Restoration

Recommendation

7. For patients with major unilateral upper limb amputation (i.e., through or proximal to the wrist), we suggest use of a body-powered or externally powered prosthesis to improve independence and reduce disability.
   (Weak for | Reviewed, New-added)

Discussion

This CPG's systematic evidence review found one study suggesting that the use of body-powered or externally powered prosthesis interventions improve independence and reduce disability in patients with major unilateral ULA, referring to those performed through or proximal to the wrist joint.(52) Resnik et al. (2020) performed a telephone survey of 755 persons with unilateral ULA, including those who used either passive, body powered or externally powered prostheses as well as those who were not prosthesis users.(52) The study compared patient-reported outcomes of disability, activity difficulty, and health-related quality of life (HRQoL) by prosthetic device use and configuration and also identified factors associated with these outcomes.(52) The study found that the use of such active prostheses in this population was associated with less difficulty performing activities, less disability, and higher physical function in most patients.(52) However, there was no evidence in the systematic evidence review to recommend one type of prosthetic system over another.

Six other observational studies were identified but excluded from this recommendation as they did not provide relevant data to the development of this recommendation. Of the studies excluded, three focused only on the DEKA arm, two studies examined QoL and satisfaction of general prosthesis use

without specific attention to prosthesis type and/or upper limb loss, and one study involved comparison of cosmetic and body powered devices in Iran.(29, 53-57)

Numerous challenges exist for patients with ULA. VA/DoD best-practice has recognized that prescriptions for upper extremity prostheses should be based on a collaborative decision between the patient and the care team. The patient focus group participants expressed the importance of shared decision making and a team-based approach. There is some variability with patient preferences regarding prosthesis intervention. The patient focus group generally noted that prosthetic functionality is more important than cosmesis. However, the patient focus group participants also valued having a range of prosthetic devices available to meet their unique functional goals, including passive, myoelectric, body-powered, and activity-specific prostheses. Receiving a properly designed and fitting prosthesis can be burdensome because it requires patience, frequent visits, the establishment of realistic expectations based on appropriate patient education, and follow-up training. Further, there may be limited access to providers with adequate experience and training within this field.

The Work Group systematically reviewed evidence related to this recommendation.(29, 52-57) Therefore, this is a *Reviewed, New-added* recommendation. The Work Group's confidence in the quality of the evidence was very low and the body of evidence is limited. The potential benefits of using an active prosthesis, including improved function, less disability, and reduced difficulty with activities, outweighed the potential burdens of potential discomfort, investment of time to achieve and maintain proper fit/function, or the risk of unsuccessful functional outcomes. Patient values and preferences largely varied because of their different needs, amputation levels, goals, and expectations from the utilization of a prosthesis. Thus, the Work Group decided upon a *Weak for* recommendation.

Recommendation

8. There is insufficient evidence to recommend for or against any specific control strategy, socket design, suspension method, or component.
   (Neither for nor against | Reviewed, New-added)

Discussion

This CPG's systematic evidence review did not identify any SRs or RCTs addressing outcome variation by control strategy, prosthesis type, socket design and/or suspension method, and/or prosthesis component selection that met inclusion criteria. Seven observational trials addressing various outcomes by prosthesis type and control strategy for the treatment of persons with ULA were identified.(29, 52-57) Three studies were cross-sectional studies, one study was observational, and three studies were quasi-experimental. All seven of these studies had poor methodological quality, potential selection bias, minimal control for potential confounders, and lack of blinding of outcome assessors.

No clear evidence was identified to support for or against specific control strategies, socket designs, suspension methods, or components. One of the challenges in addressing this topic is that each prosthesis is custom-made for the patient based on their level of amputation, goals, needs, and specific anatomy. In addition to a patient's individual needs for a prosthesis, providers should be mindful of the necessity of lifelong access to care. This lifelong care includes the patient's eligibility for care, device cost, and access to ULA rehabilitation subject matter experts.

Although there was poor quality evidence, factors critical to patient outcomes and prosthetic wear rates have been identified. The patient focus group noted prosthetic fit and appropriate components were critical to prosthesis wear and use. Thus, appropriate considerations of prosthetic components and design are clinically significant.

The Work Group systematically reviewed evidence related to this recommendation.(29, 52-57) Therefore, this is a *Reviewed, New-added* recommendation. The Work Group's confidence in the quality of the evidence was very low. The body of evidence had some limitations including potential selection bias, minimal control for potential confounders, and lack of blinding of outcomes assessors. The potential benefits of choosing the optimal prosthesis for a patient that allows them to meet their individual goals and needs outweighed the potential harms of making the wrong assessment for a patient resulting in an insufficient prosthetic prescription that keeps the patient from obtaining their functional goals. Patient values and preferences largely varied because each patient's needs, ability, and level of amputation are unique. Thus, the Work Group decided upon a *Neither for nor against* recommendation.

D. Medical

Recommendation

9. There is insufficient evidence to recommend for or against a particular intervention for the *prevention* of phantom and/or residual limb pain.
   (Neither for nor against | Reviewed, New-replaced)

Discussion

This CPG's systematic evidence review did not identify any studies that met inclusion criteria and addressed the prevention of PLP or residual limb pain for persons with ULA. In addition, there was no relevant evidence identified from the 2014 VA/DoD UEAR CPG.

A small study by Valerio et al. (2019) concluded that preemptive surgical intervention of amputated nerves with TMR at the time of limb loss should be strongly considered to reduce pathologic PLP and symptomatic neuroma-related residual limb pain.(58) However, the study was not included in this CPG's systematic evidence review because it was a non-comparative study with only five persons with an ULA. Also, it did not report pain outcomes for the ULA subgroup. Thus, this study did not influence this recommendation's strength.(58)

Post-amputation PLP and residual limb pain have a high reported prevalence, experienced in up to 70% and 85% of patients, respectively.(58) Both PLP and residual limb pain can be functionally limiting and disruptive to an individual's daily life, especially when trying to adjust to the new loss of a limb. Optimal management of pain symptoms can vary greatly from one patient to another as symptom severity is broad. Unfortunately, it is unclear at this time what factors or patient subgroups correlate with symptom severity due to the paucity of evidence.

There is likely some variation in treatment preferences, in part due to lack of clear guidance and the potential high risk or cost of surgical and procedural interventions. Also, complex or technically difficult surgical procedures may be of limited access given the variable availability of specialists. Once identified, effective medication options should be more feasible to deliver as most immediate postoperative courses

occur in the hospital setting. It is important to consider that the patient focus group participants indicated pain management as a critical component of their ULA rehabilitation. However, they noted it was often poorly controlled. Coping with the pain was reported as psychologically challenging and difficult to describe. Further, participants expressed frustration with ineffective strategies currently offered.

The Work Group systematically reviewed evidence related to this recommendation. Therefore, this is a *Reviewed, New-replaced* recommendation. The Work Group could not determine the confidence in the quality of the evidence nor the balance of benefits and harms since this CPG's systematic evidence review did not retrieve any evidence on this topic. Patient values and preferences vary somewhat because PLP and residual limb pain severity are variable but effective pain and symptom management are considered to be a critical component of amputation rehabilitation. Also, the risk and/or cost of an intervention, especially if benefits are unclear, may not be justified for the level of symptoms and dysfunction. Thus, the Work Group decided upon a *Neither for nor against* recommendation.

Recommendation

10. There is insufficient evidence to recommend for or against any particular pharmacologic intervention for the *management* of phantom and/or residual limb pain.
(Neither for nor against | Reviewed, New-replaced)

Discussion

There is limited evidence on the effectiveness of pharmacologic treatment for PLP and residual limb pain and inconclusive evidence about specific interventions, despite being recognized as an important and common clinical issue. This CPG's systematic evidence review identified one RCT meeting inclusion criteria and addressing pharmacologic interventions.(59)

An RCT by Ilfeld et al. (2021) with moderate quality evidence suggested that ropivacaine as a 6-day perineural infusion (n=71) compared to a six day perineural infusion of normal saline (n=73) for the management of PLP and residual limb pain provided clinical benefit in the short term for PLP and residual limb pain.(59) Most participants underwent lower limb amputation (LLA) (84%) rather than ULA (16%). Baseline pain scores for eligibility included PLP intensity of at least a 2 or higher on the Numeric Rating Scale (NRS) and PLP frequency of at least three times each week for eight weeks. Patients were discharged home with their portable infusion pump and perineural catheter. At four weeks, the average PLP intensity had an average mean difference of 1.3 (95% confidence interval [CI]: 0.4 to 2.2; p=0.003) and the decrease in PLP severity from baseline was 1.4 (95% CI: 0.5 to 2.4; p=0.002). The initial follow-up period was four weeks, with uncertain benefit after four weeks. Some patients (2%) experienced infection at the catheter implantation site and one patient experienced worsened PLP after initiation of treatment.(59) Thus, it was concluded that although continuous peripheral nerve block (PNB) may have benefits in the short term, the clinical significance of the reduction in pain is not clear. Further, long-term benefits after four weeks are uncertain. Additionally, from a feasibility and acceptability standpoint, PNB may be burdensome as it requires a six day continuous catheter implant in an ambulatory setting.

This CPG's systematic evidence review found no additional studies on pharmacologic treatment for the management of PLP and residual limb pain and no studies from the 2014 VA/DoD UEAR CPG were relevant to this topic. Despite the paucity of evidence to support any particular agent(s) for the

treatment of PLP and residual limb pain, an SR by Alviar et al. (2016) evaluated treatment considerations, although no one agent demonstrated high or moderate quality evidence of benefit in the management of PLP.(60) If pharmacotherapy is offered, providers and patients should understand the uncertainties of the short- and long-term effectiveness and safety of treatment, and require the patient to have regular follow-ups to reassess risks and benefits and modify treatment as needed.

Some patient focus group participants indicated pain management was a critical component of their treatment, and they experienced limited benefit with medications they were prescribed. Although not included in the evidence review findings, the results of a large survey of U.S. Veterans (n=2,694) with upper or lower extremity post-amputation pain highlights the need for improved therapeutic interventions by reporting that, despite the use of a variety of therapies, only 1% of the 512 treated patients had clinically important lasting benefits, and only 8.4% were considered by the authors to have obtained any real benefit.(61) However, there is some variability in patient preferences regarding the use of pharmacologic management for PLP. Medications vary significantly in side effect profiles, and the burden of continuous PNB may be unacceptable to some.(59)

The Work Group systematically reviewed evidence related to this recommendation.(59) Therefore, this is a *Reviewed, New-replaced* recommendation. The Work Group's confidence in the quality of the evidence was moderate. The body of evidence had some limitations including indirectness since most participants had LLA. The evidence was further limited with wide variation around the effect estimate. Additionally, the clinical significance was unclear despite statistical significance in the results. The potential harms of a continuous PNB were considered significant compared with the potential benefits. Patient values and preferences varied somewhat due to the wide range of available pharmacologic modalities, the variation in adverse event profiles, and the variation in burdens associated with an intervention or procedure such as a PNB. Thus, the Work Group decided upon a *Neither for nor against* recommendation.

Recommendation

11. There is insufficient evidence to recommend for or against the use of non-invasive brain stimulation for the management of phantom limb pain.
    (Neither for nor against | Reviewed, New-added)

Discussion

This CPG's systematic evidence review identified two crossover RCTs that evaluated the effectiveness of noninvasive brain stimulation (NIBS) for the management of PLP and residual limb pain in persons with ULA.(48, 49) The intervention in Bocci et al. (2019) involved 20-minute sessions of direct current stimulation to the cerebellum (n=14).(49) The intervention was provided over five days with outcomes assessed at two and four weeks. While this study suggested improvement in paroxysmal pain for NIBS compared to sham treatment at four weeks follow-up, there was no difference in either PLP or residual limb pain intensity between NIBS and sham treatment at either the two- or four-week follow-ups.

Kikkert et al. (2019) evaluated one-week outcomes associated with a single session of NIBS to the involved somatosensory cortex.(48) This investigation indicated some potential improvement in PLP with NIBS compared to sham treatment in patients with ULA at six days follow-up. No long-term follow-up was provided. The methodological quality of the two crossover RCTs was fair.

For persons with ULA, NIB appears to be a novel and emerging technology that may hold promise for the management of PLP and residual limb pain. Although there were some promising findings from these studies, the strength of the evidence was insufficient to make a recommendation for or against this intervention at present. Study limitations were the fair quality design, small sample size, and very short follow-up time (between 1 – 4 weeks). Further, the two studies used different stimulation techniques delivered to different areas of the brain.

The benefits of this intervention are yet to be determined. Although typically well-tolerated, the long-term risks of NIBS have not been studied and the treatment burden varies depending on the protocol. Further, the treatment burden and feasibility of delivering NIBS will be impacted by the limited geographic access to the equipment and specialized expertise required to administer the treatment. Given the unknown risk/benefit ratio of NIBS treatment, the Work Group determined there would be a large variation in patient values and preferences. As an emerging technology, some patients may be hesitant about the intervention due to unfamiliarity and some patients with less severe symptoms may be less willing to accept the treatment burden.

In addition to NIBS, the Work Group acknowledges that there are additional non-pharmacologic interventions that have been used clinically for the management of PLP and residual limb pain in persons with ULA. However, no studies meeting the search criteria were identified that addressed the use of these non-pharmacologic interventions: acceptance and commitment therapy (ACT), biofeedback, cognitive behavioral therapy (CBT), desensitization, GMI, meditation, mindfulness-based stress reduction (MBSR), pain neuroscience education, spinal cord stimulation, peripheral nerve stimulation, psychotherapy, radiofrequency ablation, relaxation therapy, or virtual/augmented reality.

The Work Group systematically reviewed evidence related to this recommendation.(47-49) Therefore, this is a *Reviewed, New-added* recommendation. The Work Group's confidence in the quality of the evidence was low. The body of evidence had significant limitations including small sample sizes, short-term follow-up only, and heterogeneity of intervention protocols. The potential benefits of NIBS are yet to be proven and although typically well-tolerated, the longer-term potential harms are unknown. Patient values and preferences largely vary because some patients may be hesitant about the intervention due to unfamiliarity and variability in symptom severity. The potential need for travel to receive the intervention may also impact the acceptance of treatment burden. Thus, the Work Group decided upon a *Neither for nor against* recommendation.

E. Outcomes

Recommendation

12. There is insufficient evidence to recommend for or against the use of any specific assessment tool to guide the determination of prosthetic candidacy, the need for therapy, or for identifying improvement or worsening of function and quality of life.
    (Neither for nor against | Reviewed, New-added)

Discussion

This CPG's systematic evidence review identified three observational studies supporting this recommendation.(26, 28, 62) In the first small (n=30) observational study, Werner & Alawi (2021),

prospectively considered the association of Hand Bionic Scale (HBS) scores to measure injury severity, disability, function, and QoL and to establish HBS cutoff scores.(62) The cutoff scores could be used to help determine which patients would benefit from elective amputation and provision of a hand prosthesis. Werner & Alawi (2021) studied adult patients with severe hand injuries, predominantly occupational injuries, who received previous reconstructive surgery. Ultimately, higher HBS scores (>10 points) were associated with higher severity of injury and greater impairment in terms of hand strength, function, and QoL. The authors concluded that HBS could differentiate patients based on cutoff scores to guide clinical recommendations. One strength of the study is its ability to inform clinical recommendations in patients with a hand injury. However, it is limited to hand injuries, which limits generalizability to the larger population of patients with upper limb injury, including more proximal amputation. Additionally, the clinical recommendations lack specificity.(62)

Two additional observational studies, Resnik et al. (2016) and Resnik et al. (2015) assessed whether selected outcome measures were responsive to change in terms of function and disability in persons with ULA who received training with the DEKA arm.(26, 28) Function and disability were assessed at baseline, after 10 hours of training, and again following training that lasted an average of 18 hours. Selected outcome measures' responsiveness based on ULA level were also considered, as was their ability to assist in determining the amount of training necessary to optimize outcomes with the use of the DEKA arm. Responsiveness of the outcomes were determined by calculating the change in effect estimates of the measures from baseline to final testing, baseline to 10 hours of training, and from 10 hours of training to final testing.

Findings concluded that the Box and Blocks, Jebsen Taylor Hand function (JTHF; light and heavy can items), University of New Brunswick Skill and Spontaneity scales, Activity Measure for Upper Limb Amputation (AM-ULA), Patient-Specific Functional Scale, and QuickDash all appear responsive to change. Conversely, all remaining JTHF items and the Upper Extremity Functional Scale did not appear responsive to change. Further, responsiveness varied by amputation level. Box and Blocks appeared responsive at all three amputation levels (radial, humeral, and shoulder). Dexterity tests seemed to be more responsive at the shoulder amputation level. The authors concluded the selected outcomes and findings may be useful in guiding clinicians regarding the quantity of training required to optimize outcomes in patients using the DEKA prosthetic system. Limitations to these two studies include smaller samples (n=39 and 44, respectively) and the specific use of the DEKA prosthetic system, which may not be accessible to most users of upper limb prosthetic arm systems. It is unknown if the responsiveness findings are generalizable to other prosthetic systems.(26, 28)

In addition to the lack of generalizability, all three studies were very low quality. The following methodological issues resulted in the further downgrading: convenience sampling resulting in potential selection bias, minimal control for potential confounders, and lack of blinding of study assessors.

The Work Group systematically reviewed evidence related to this recommendation.(26, 28, 62) Therefore, this is a *Reviewed, New-added* recommendation. The Work Group's confidence in the quality of the evidence was very low. The body of evidence had some limitations including small sample sizes and limited generalizability. The potential benefits of using an assessment measure to determine the most appropriate decision for a prosthetic device outweighed the potential harms of a time burden on clinicians and patients. Patient values and preferences varied somewhat because patients may find

repeated testing undesirable. Thus, the Work Group decided upon a *Neither for nor against* recommendation.

F. Psychosocial Considerations

Recommendation

13. We suggest screening patients for cognition, mental health conditions such as posttraumatic stress disorder and depression, and pain during the initial evaluation and across the continuum of care.
(Weak for | Reviewed, New-added)

Discussion

This CPG's systematic evidence review identified nine observational studies in 12 papers that assessed the association between patient-related factors and rehabilitation outcomes. This evidence suggested cognitive, mental health conditions, and pain as factors that may influence patient outcomes following ULA. Other factors (e.g., sex, race) may also influence patient outcomes but require additional study before any recommendation statements can be made.(52, 63-67)

An observational study by Hancock et al. (2017) aimed to identify cognitive domains involved with the use of the DEKA arm.(68) The authors provided a working definition of cognition that included cognitive control functions that may also be termed working memory, supervisory, or executive functions. These include cognitive functions "that organize, regulate, or modify information processing in accordance with current behavioral goals and context (1) encoding of control actions in memory, (2) recall of control actions, (3) organization of control actions, (4) selection of the appropriate hand grip amongst the six options, (5) prediction of choice outcomes, (6) outcome evaluation and (7) the integration of evaluative feedback to initiate corrective actions."(68) While this list is not exhaustive, it does capture a functional definition of cognition that is useful to understand the relationship between mental and physical function and should be considered for use in future studies.

One specific finding from Hancock et al. (2017) was that cognitive domains of attention and processing speed were significantly associated with higher scores on measures of function in patients receiving training on the DEKA arm. These findings are specific to the DEKA arm, an advanced upper limb prosthesis, and the generalizability of evidence to other prosthetic arm systems is limited.(68)

The following studies addressed the association of mental health conditions and pain and rehabilitation outcomes following ULA. An observational study by Armstrong et al. (2019) examined predictors of clinically significant levels of psychological distress among 307 persons with ULA, resulting in a suggested association between greater pain interference, PTSD, and depression.(66) A study of cross-sectional design by Kearns et al. (2018) examined associations between levels of ULA and psychological wellbeing.(69) The study found partial hand loss to be associated with higher pain interference and PTSD compared with higher levels of ULA.

Resnik et al. (2021) also examined pain as a patient factor and used QuickDASH scores to evaluate pain and QoL in persons with ULA.(63) In this study, disability QuickDASH scores were 7.9 points higher (worse) on average for those with ULA and severe back pain, and scores were 4.4 and 12.3 points higher for those with ULA and moderate and severe neck pain respectively, compared to those with no pain.

QuickDASH scores were also significantly higher for those with contralateral limb pain (7.1 points), PLP (7.2 points), and residual limb pain (3.5 points).(63) The final observational study, Walsh et al. (2016), included 202 persons with traumatic ULA and found no significant association between resilience or pain and PTSD or depression.(70)

The overall methodological quality of the included studies was poor due to potential selection bias (patients were selected into studies based primarily on convenience), minimal control for potential confounders, and lack of independent or blinded outcomes assessors.

The evidence was limited in quantity and quality, with only a few variables reflected across this very broad inquiry. The potential harm in not assessing these variables could be quite high, inclusive of self-harm and death. There is some variability in patient preferences regarding this treatment. One patient focus group participant sought out mental health services as part of their amputation rehabilitation. Others noted the stigma associated with seeking mental health treatment and commented on their coping strategies as methods for managing mental health concerns. The focus group participant who sought out mental health services now advocates for seeking this treatment.

The Work Group systematically reviewed evidence related to this recommendation.(52, 63-73) Therefore, this is a *Reviewed, New-added* recommendation. The Work Group's confidence in the quality of the evidence was very low. The body of evidence had several limitations including potential selection bias, minimal control for potential confounders, and lack of independent or blinded outcomes assessors. The potential benefits of screening patients for these factors during the initial evaluation and across the continuum of care outweigh the potential harms. Patient values and preferences varied somewhat because of the stigma associated with seeking mental health. Thus, the Work Group decided upon a *Weak for* recommendation.

Recommendation

14. We suggest offering peer support services.
    (Weak for | Reviewed, New-replaced)

Discussion

The 2022 VA/DoD ULA CPG Work Group suggests offering peer support services to persons with ULA. This differs slightly from the 2014 VA/DoD UEAR CPG, which stated that the care team should facilitate the early involvement of a trained peer visitor. This recommendation has been modified to recognize peer support as all-encompassing: integrating trained peer visitor visits under the umbrella of peer support.

Peer support is widely used in the rehabilitation of persons with amputation and is recognized as beneficial by clinicians and patients alike. Although no new studies were identified in this CPG's systematic evidence review, the Work Group reviewed a peer support study from the 2014 VA/DoD UEAR CPG. An RCT by Wegener et al. (2009) (n=502; 12.2% were upper limb loss) compared existing support group activities to the Promoting Amputee Life Skills (PALS) program activities, a self-management group.(74) Participants engaged in 90-minute group sessions for eight weeks. This self-management group program includes topics such as an overview of self-management, pain management, building positive mood, managing negative mood, interacting with family and friends, working with the health team/community resources, building healthy habits, relapse prevention, and

maintaining progress. The self-management program participants showed an overall improvement in self-efficacy, state-of-mind, and functional limitations. The study also found that the odds of being depressed were 50% lower in persons involved in the self-management program.(74)

While the article was not included in this CPG's systematic evidence review, the Work Group also identified another RCT that supported self-management groups. Turner et al. (2021) (n=147) was a multi-site RCT that found that group-based self-management improved psychosocial functioning and QoL in persons with amputation due to chronic limb-threatening ischemia.(75) However, this study was excluded from this CPG's systematic evidence review since the population was exclusively persons with LLA.

Concern for potential lack of acceptance by friends and family, loss of function, and alteration in body image are some common responses that patients experience before or after having an ULA. Persons with an amputation report that peer support programs are often very helpful and provide a sense of hope in recovery and for a life with a sense of normalcy. Support groups may be social, recreational, or educational. Patient values and preferences varied somewhat. Some patients may be unwilling or unable to commit to the time for peer support. However, many patient focus group participants strongly valued peer support.

The Work Group systematically reviewed evidence related to this recommendation and considered the assessment of the evidence put forth in the 2014 VA/DoD UEAR CPG.(74) Therefore, this is a *Reviewed, New-replaced* recommendation. The Work Group's confidence in the quality of the evidence was very low. The body of evidence had limitations including limited representation of minorities with amputation, study design, and discrepancy of contact time between the control group and the self-management group. However, the potential benefits (e.g., improving self-efficacy and mental health) outweighed the potential harms (e.g., time commitment of sessions). This treatment milieu is considered fairly low risk with potential strong benefits (e.g., increasing the patient's confidence to improve their QoL). Patient values and preferences varied somewhat. Access to resources can vary per patient and by location. While the feasibility of peer support increases with virtual platforms such as telehealth, remote or virtual platforms may not be available or of interest to everyone. The VA and DoD have an established telehealth program, but civilian settings may not. In addition, not all patients are technologically capable or interested so this may be a limiting factor in implementing virtual programs. Thus, the Work Group decided upon a *Weak for* recommendation.

X. Research Priorities

During the development of the 2022 VA/DoD ULA CPG, the Work Group identified numerous areas where future research would be beneficial, including areas requiring stronger evidence to support current recommendations and research exploring new areas to guide future CPGs. These areas are summarized below. Additionally, the Work Group identified research designs/approaches that we believe would contribute the highest quality of evidence for inclusion in future systematic evidence reviews. These designs/approaches were chosen while taking into consideration this CPG's systematic evidence review inclusion criteria and GRADE methodology. While a minimum sample size of 20 persons per treatment arm (in an RCT) will generally be required for inclusion in VA/DoD CPG systematic evidence reviews, each study must be sufficiently powered to detect meaningful clinical differences.

With specific regard to crossover designs, a total sample size of 20 would likely be sufficient, provided that it is adequately powered.

Researchers should carefully consider and review the research priorities outlined herein. These priorities were identified in part by a lack of research found that met inclusion criteria following the development of key questions and associated systematic evidence review.

It is highly recommended that investigators consider research rating tools and checklists in planning studies to assure the highest methodologic quality and rigor and to minimize the risk of bias. Some tools that may be useful include:

- For clinical trials: Physiotherapy Evidence Database (PEDro) https://pedro.org.au/english/resources/pedro-publications/
- For clinical trials and other study designs SIGN50: https://www.sign.ac.uk/what-we-do/methodology/checklists/

A. Prevention and Treatment of Phantom and Residual Limb Pain

Phantom and residual limb pain are highly prevalent in this patient population. Unfortunately, limited evidence is available on pharmacologic or non-pharmacologic interventions for the prevention or treatment of PLP and residual limb pain. Future research should evaluate the immediate (perioperative), short-term (0 – 4 weeks), and long-term (3, 6, and 12 months) periods. In addition to pain, improvement of function and QoL are important outcomes. Of interest are well-designed RCTs, including at least 20 persons per treatment arm assessing (or a total sample of 20 subjects for crossover trials):

- The efficacy of commonly used and promising new or alternative pharmacologic agents and non-pharmacologic interventions for the prevention of PLP and residual limb pain. Non-pharmacologic interventions of particular interest include traditional therapies, complementary and alternative treatments, and advanced surgical techniques such as TMR or RPNI and OI. Studies are needed to evaluate the efficacy of commonly used and promising pharmacologic agents and mode of medication delivery (e.g., oral, injected, inhaled, topical) on reduction of PLP and residual limb pain.
- The efficacy of non-pharmacologic agents in managing PLP and residual limb pain. Potential interventions of interest include NIBS, ACT, biofeedback, CBT, desensitization, GMI, meditation, MBSR, pain neuroscience education, peripheral nerve stimulation, psychotherapy, radiofrequency ablation, relaxation therapy, or virtual/augmented reality.

B. Clinical Assessments and Outcomes Tools

Although a wide variety of outcome measures are available for use in ULA, the field still lacks data to guide the selection of the best tools for specific purposes. Studies of outcome metrics, by necessity, involve different types of study design and should follow appropriate standards.(76)

- More research is needed on the psychometric properties of outcome measures for ULA to assist in selecting the optimal measures. Such studies should evaluate reliability, validity, the responsiveness of measures and identify the minimal detectable change (MDC) and minimally clinically important difference (MCID) of measures.

- Research is needed to identify and validate predictive assessments and prognostic factors that can inform decisions on overall prosthetic candidacy or the appropriate choice of prosthesis type and component. Such research requires well-designed, sufficiently powered prospective cohort studies with measures and assessments administered in the pre-prosthetic phase but may also be possible using retrospective study designs.
- Research is needed to identify factors (e.g., utility, function, cosmesis, prosthetic weight) associated with prosthesis acceptance and adoption. Such research requires well-designed, sufficiently powered prospective cohort studies with measures and assessments administered in the pre-prosthetic phase but may also be possible using retrospective study designs.
- Patient-centered outcomes research to develop and validate outcome measures that are meaningful to patients (e.g., more holistic outcomes like employability, financial health, psychological/spiritual/physical health).

C. Psychosocial Interventions

While psychosocial interventions are commonly provided throughout the phases of amputation rehabilitation, little data is available on the effectiveness or efficacy of specific interventions. Studies of treatment efficacy ideally should be well-designed, adequately powered RCTs. We suggest, based on common inclusion/exclusion criteria used in screening papers for evidence-based guidelines, that researchers recruit a minimum of 20 persons per intervention group. However, observational studies using EHR, or other data may provide evidence (albeit weaker) on this topic. Additionally, the Work Group recognized that further data on long-term psychosocial functioning and outcomes of persons with amputation would clarify the needs of this patient population. Research that could address these evidence gaps include:

- RCTs that evaluate the efficacy of interventions to improve psychosocial functioning and outcomes, as well as the most effective elements of interventions.
- Well-designed, appropriately powered, retrospective cohort studies that identify the optimal dose, timing, and content of behavioral health/psychosocial interventions to improve health and functioning. Such studies would likely describe patterns of care and compare the effectiveness of various treatment approaches and timing.
- Longitudinal studies of psychosocial functioning and outcomes, adverse events, and suicidality in persons with ULA, studies that compare these outcomes by sex, race, and ethnicity. Such studies should be appropriately powered.

D. Surgical Procedures and Medical Interventions

Advances in surgical treatment such as TMR, RPNI, vascularized allotransplantation, AMI, OI, and implantable myoelectric sensors have been introduced in the past decade with little data from well-designed studies on the efficacy or effectiveness of these advances. Despite this paucity of research, some of these advances are increasingly used in clinical care and are often considered standard practice. Research to address this evidence gap includes:

- RCTs or large prospective longitudinal cohort studies evaluating the efficacy of various advanced surgical techniques (e.g., TMR, RPNIs, vascularized allotransplantation, AMI, OI, and implantable

myoelectric sensors) compared to traditional surgical care with follow-up at 6 months and 1 or 2 years.

- Studies to determine optimal surgical and post-amputation medical management addressing speed and quality of wound healing, reducing time to fitting, and using a prosthesis.
- Studies to determine optimal surgical and post-amputation medical management addressing speed and quality of wound healing, reducing time to starting prosthesis fitting, and potential factors associated with a need for revision surgery.

E. Rehabilitation and Prosthetic Outcomes

Additional research is needed to understand key rehabilitation and prosthetic outcomes, factors associated with these outcomes, and the efficacy of non-surgical rehabilitation interventions (e.g., occupational and physical therapy, prosthetic training). Observational, epidemiologic studies would provide valuable evidence on factors associated with rehabilitation outcomes. Such studies would ideally be longitudinal with the potential to follow persons with amputation over their lifetime. Research efforts of this magnitude would benefit from the creation of a national registry of Veterans and Service Members with ULA. In contrast, studies of the efficacy of rehabilitation and prosthetic interventions will likely require experimental or quasi-experimental designs.

a. Epidemiologic Studies

In terms of epidemiologic studies, the following research is needed:

- Research to understand the impact of co-occurring conditions (e.g., PTSD, SUD, depression, pain, and other medical conditions) on amputation rehabilitation outcomes. Such research requires well-designed, sufficiently powered prospective cohort studies with longitudinal follow-up or retrospective cohort studies that evaluate impacts of comorbid conditions over time. Studies should provide short-term (three months) and long-term follow-up (a minimum of one year), with long-term follow-up considered highly desirable.
- Research is needed to identify factors (e.g., utility, function, cosmesis, prosthetic weight) associated with prosthesis acceptance and adoption. Such research requires well-designed, sufficiently powered prospective cohort studies with measures and assessments administered in the pre-prosthetic phase but may also be possible using retrospective study designs.
- Development of a registry for Veterans with ULA, with robust data elements and outcomes, would provide valuable data for future longitudinal studies on rehabilitation outcomes including:
    - Prospective cohort studies to examine the patterns of interventions (type, dose, and frequency) that lead to the best outcomes for the patient; and
    - Prospective cohort studies to track associations between amputation level and surgical procedure type on functional outcomes and QoL over time, adjusted matching for comparators.

b. Efficacy and Effectiveness Studies

The strongest designs for the study of rehabilitation and prosthetic interventions are sufficiently powered RCTs, and follow-up periods of sufficient length to provide clinically meaningful information on effectiveness and/or device adoption. Studies should employ psychometrically sound outcome metrics that are meaningful to patients. However, RCTs are not feasible in many situations, and observational study design may provide quality evidence on effectiveness. The following types of studies on rehabilitation interventions are needed:

- Studies that examine the efficacy and effectiveness of telerehabilitation versus usual care for a variety of outcomes (e.g., self-efficacy, independence, QoL, disability, prosthetic use, and satisfaction)
- Studies comparing the efficacy and effectiveness of usual care to more intensive rehabilitation services post amputation
- Studies comparing outcomes of life skills intensive training for persons with bilateral amputation to usual care
- Well-designed, appropriately powered, observational studies examining the comparative effectiveness of various models of amputation rehabilitation (e.g., comparing team-based care to non-team-based care)

The following types of studies of prosthetic interventions are recommended:

- Efficacy and effectiveness trials of upper limb prosthetic components
- Efficacy and effectiveness trials comparing prosthesis control strategies
- Efficacy and effectiveness trials comparing prosthesis suspension methods and socket/interfaces

Appendix A: Guideline Development Methodology

A. Developing Key Questions to Guide the Systematic Evidence Review

To guide this CPG's systematic evidence review, the Work Group drafted 12 KQs on clinical topics of the highest priority for the VA and DoD populations. The KQs followed the population, intervention, comparison, outcome, timing, and setting (PICOTS) framework, as established by the Agency for Healthcare Research and Quality (AHRQ) (see Table A-1).

Table A-1. PICOTS (77)

PICOTS Element	Description
Population or Patients	Patients of interest. It includes the condition(s), populations or sub-populations, disease severity or stage, co-occurring conditions, and other patient characteristics or demographics.
Intervention or Exposure	Treatment (e.g., drug, surgery, lifestyle changes), approach (e.g., doses, frequency, methods of administering treatments), or diagnostic/screening test used with the patient or population.
Comparator	Treatment(s) (e.g., placebo, different drugs) or approach(es) (e.g., different dose, different frequency, standard of care) that are being compared with the intervention or exposure of interest described above.
Outcomes	Results of interest (e.g., mortality, morbidity, quality of life, complications). Outcomes can include short, intermediate, and long-term outcomes.
Timing, if applicable	Duration or follow-up of interest for the particular patient intervention and outcome to occur (or not occur).
Setting, if applicable	Setting or context of interest. Setting can be a location (e.g., primary, specialty, inpatient care) or type of practice.

Abbreviation: PICOTS: population, intervention, comparison, outcome, timing, and setting

Due to resource constraints, all KQs of interest to the Work Group could not be included in the systematic evidence review. Thus, the Work Group selected the 12 highest priority KQs for inclusion in the systematic evidence review (see Table A-2).

Using the GRADE approach, the Work Group rated each outcome on a 1 – 9 scale (7 – 9, critical for decision making; 4 – 6, important, but not critical, for decision making; and 1 – 3, of limited importance for decision making). Critical and important outcomes were included in the evidence review (see Outcomes); however, only critical outcomes were used to determine the overall quality of evidence (see Determining Recommendation Strength and Direction).

a. Population(s)

- Key Questions 1 – 9, 12
    - Including: Adults (≥18 years, including Veterans as well as deployed and non-deployed active duty Service Members, their beneficiaries, and retirees and their beneficiaries) with ULA
- Key Questions 10, 11
    - Including: Adults who are candidates for UE surgery (surgery and/or pre-prosthetic)

b. Interventions

- Key Question 1:
  - TMR, RPNI, VCA – [hand transplant], AMI – [Ewing procedure], IMES system, OI
- Key Question 2:
  - Education, counseling services, social work services, peer support (Individual Peer Visits and Peer Support Groups), amputee support groups, psychotherapy, ACT, CBT, MBSR, mindfulness/meditation, psychotherapy
- Key Question 3:
  - ULA rehabilitation centers/Upper Limb Focused Center, tele-rehabilitation, telehealth/virtual care, remote gaming/monitoring for rehabilitation, telephone visits, residential rehab program, acute inpatient rehab, inpatient rehab center, outpatient clinic setting, day rehab program
- Key Question 4:
  - Dexterity: Jebsen-Taylor Hand Function (JTHF), Nine-Hole Peg (NHP), Box and Block Test (BBT), Southampton Hand Assessment Procedure (SHAP), Clothespin Relocation Test, Assessment of Capacity for Myoelectric Control (ACMC)
  - Activity/Function: [Brief] Activities Measure for Upper Limb Amputees ([B]AM-ULA), timed measure of activity performance (T-MAP), Disabilities of the Arm, Shoulder and Hand Score (QuickDASH), University of New Brunswick (UNB) Test of Prosthetic Function, Patient-Specific Functional Scale (PSFS), need for help with ADL
  - Psychological: PTSD Checklist for DSM-5 (PCL-5), Patient Health Questionnaire (PHQ)-9, General Anxiety Disorder (GAD)-7, Trinity amputation and prosthesis experience scales (TAPES)
  - Other: Community Reintegration of Injured Service Members-Computer Adapted-Test (CRIS-CAT), Veteran RAND 12 Item Health Survey (VR-12) – Physical Component Score/Mental Component Score (PCS/MCS), Orthotics and Prosthetics User's Survey (OPUS) Satisfaction with Devices (CSD), Orthotics and Prosthetics User's Survey (OPUS) Upper Extremity Functional Status (UEFS), NASA Task Load Index (TLX)
- Key Question 5:
  - Use of device, modifiable patient-related factors, amputation etiology, amputation level, laterality (Uni-Bil), time since amputation, prosthetic training, self-efficacy, age, sex/identity, ethnicity, ROM, strength, vision, cognition, motivation, depression, PTSD, SUD, goals, emotional adjustment, associated injuries including traumatic brain injury or comorbidities, weight, function, cosmesis, sleep disorders, personality disorders, pain
- Key Question 6:
  - Terminal devices (TDs): passive hand, body-powered hook (e.g., Hosmer hook) (voluntary opening, voluntary closing), single-degree-of-freedom (DOF) body-powered

hand, motorized hooks and hands (Single-DOF powered hand, powered hook (Griefer), multiarticulating powered hand (i-Limb), sensor hand)

- Control strategies: On/Off control (i.e., crisp control, finite state machine control, onset analysis), proportional control, pattern recognition control, regression control
- Prosthesis type: passive prostheses (cosmetic), body-powered prostheses, externally-powered prostheses (myoelectric, modular Prosthetic Limb (MPL), DEKA (or Luke arm), Hybrid prostheses
- Socket design and/or suspension method: Harness (active transhumeral harness, 21A35 harness, 21A36 harness), rigid lamination, flexible materials, gel inserts, vacuum suspension

- Key Question 7:
  - Medications: antidepressants, anticonvulsants, opioids, skeletal muscle relaxants, non-steroidal anti-inflammatory drugs, acetaminophen (APAP), ketamine, marinol, vitamin D, benzodiazepines, topical lidocaine, any topical preparations, capsaicin, NMDA receptor antagonist (broader group that includes ketamine)
  - Non-pharmacologic: TENS, mirror therapy, desensitization, peripheral nerve stimulation, spinal cord stimulation, radiofrequency (RF) ablation, GMI, ACT, biofeedback, CBT, MBSR, mindfulness/meditation, pain neuroscience education, psychotherapy, relaxation therapy, complementary and alternative medicine (e.g., acupuncture)
- Key Question 8:
  - Antidepressants, anticonvulsants, opioids, skeletal muscle relaxants, non-steroidal anti-inflammatories, acetaminophen (APAP), ketamine, marinol, vitamin D, benzodiazepines, topical lidocaine, any topical preparations, capsaicin, NMDA receptor antagonist (broader group that includes ketamine), notox/botulinum, other anticonvulsants (Keppra, lacosamide, cannabidiol/Epidiolex), DBS, ECT, TMS, VNS
- Key Question 9:
  - TENS, mirror therapy, biofeedback, desensitization, peripheral nerve stimulation, spinal cord stimulation, RF ablation, GMI, ACT, CBT, MBSR, mindfulness/meditation, pain neuroscience education, psychotherapy, relaxation therapy, complementary and alternative medicine (e.g., acupuncture), virtual/augmented reality (like mirror therapy)
- Key Question 10:
  - Level of amputation: fingers or partial hand (transcarpal), at the wrist (wrist disarticulation), below the elbow (TR), at the elbow (elbow disarticulation), above the elbow (transhumeral), at the shoulder (shoulder disarticulation), above the shoulder (forequarter)
  - Surgical procedure: myodesis, myoplasty, OI, TMR, revision, Ertl procedure, peripheral nerve stimulation implants, spinal cord stimulation

- Key Question 11:
    - Skin condition, infection, pain, palpable pulse, scintigraphic skin perfusion pressure (SPP), angiographic patency score, ischemic features, diabetes, known peripheral vascular disease, other medical conditions, age, sex, race, ethnicity
- Key Question 12:
    - Physical therapy (PT), occupational therapy (OT), specific PT/OT protocols, timing of therapy interventions, provision of durable medical equipment, provision of adaptive equipment, provision of assistive technology, prosthetic training, strengthening, functional training, range of motion, therapeutic exercise, neuromuscular education, mirror therapy, residual limb strengthening, desensitization, scar massage, education, activity analysis, community reintegration, wound care and management, TD education, efficiency training with TD, change of dominance training, adaptive sports training, biofeedback, recreational therapy, preservation techniques

c. Comparators

- Key Question 1: Standard intervention surgery, no comparator, standard of care with no surgical intervention, amputation surgery without any of the six listed interventions
- Key Question 2: Other intervention strategy, usual care, waitlist control
- Key Question 3: Another treatment setting; standard of care, no services
- Key Question 4: Clinical experience, normal values, published values on MDC or MCID
- Key Question 5: Absence of factor
- Key Question 6: Other listed intervention
- Key Questions 7 – 9: Standard/usual care (active treatment), other listed intervention, no treatment, placebo
- Key Question 10: A different level or procedure
- Key Question 11: Absence of condition
- Key Question 12: Standard of care

d. Outcomes

- Key Question 1:
    - Critical outcomes: Functional status, independence, IADLs, ADLs, and/or disability, pain – residual limb pain and phantom pain and compensatory pain in other upper body locations – neck, shoulders, and intact limb (if unilateral amputation)
    - Important outcomes: Adverse events/complications (e.g., skin breakdown, surgical revision), mental health (e.g., depression, mood disorders, suicide), prosthesis related outcomes (e.g., prosthesis satisfaction; prosthesis use; prosthesis use intensity; prosthesis acceptance; prosthetic competence), QoL/HRQoL/satisfaction with life

- Key Question 2:
    - Critical outcomes: Adjustment to disability, mental health (e.g., depression, mood disorders, suicide), QoL/HRQoL/satisfaction with life
    - Important outcomes: Community integration, functional status, independence, IADLs, ADLs, and/or disability, independence/employment, satisfaction with body image/cosmesis/appearance
- Key Question 3:
    - Critical outcomes: Functional status, independence, IADLs, ADLs, and/or disability, prosthesis related outcomes (e.g., prosthesis satisfaction; prosthesis use; prosthesis use intensity; prosthesis acceptance; prosthetic competence)
    - Important outcomes: Community integration, independence/employment, mental health (e.g., depression, mood disorders, suicide), pain – residual limb pain and phantom pain and compensatory pain in other upper body locations – neck, shoulders, and intact limb (if unilateral amputation), QoL/HRQoL/satisfaction with life
- Key Question 4:
    - Critical outcomes: Functional status, independence, IADLs, ADLs, and/or disability, prosthesis related outcomes (e.g., prosthesis satisfaction; prosthesis use; prosthesis use intensity; prosthesis acceptance; prosthetic competence)
    - Important outcomes: Adjustment to disability, independence/employment, pain – residual limb pain and phantom pain and compensatory pain in other upper body locations – neck, shoulders, and intact limb (if unilateral amputation), QoL/HRQoL/satisfaction with life, satisfaction with body image/cosmesis/appearance
- Key Question 5:
    - Critical outcomes: Functional status, independence, IADLs, ADLs, and/or disability, QoL/HRQoL/satisfaction with life
    - Important outcomes: Adoption of device, independence/employment, mental health (e.g., depression, mood disorders, suicide), pain – residual limb pain and phantom pain and compensatory pain in other upper body locations – neck, shoulders, and intact limb (if unilateral amputation), prosthesis related outcomes (e.g., prosthesis satisfaction; prosthesis use; prosthesis use intensity; prosthesis acceptance; prosthetic competence)
- Key Question 6:
    - Critical outcomes: Prosthesis satisfaction measures
    - Important outcomes: Functional status, independence, IADLs, ADLs, and/or disability, QoL/HRQoL/satisfaction with life
- Key Questions 7, 8:
    - Critical outcomes: Functional status, independence, IADLs, ADLs, and/or disability, pain – residual limb pain and phantom pain and compensatory pain in other upper body locations – neck, shoulders, and intact limb (if unilateral amputation)

- Important outcomes: Adverse events/complications (e.g., skin breakdown), duration of use and dosage of pain medication, mental health (e.g., depression, mood disorders, suicide), prosthesis related outcomes (e.g., prosthesis satisfaction; prosthesis use; prosthesis use intensity; prosthesis acceptance; prosthetic competence), QoL/HRQoL/satisfaction with life

- Key Question 9:
  - Critical outcomes: Functional status, independence, IADLs, ADLs, and/or disability
  - Important outcomes: Duration of use and dosage of pain medication, independence/employment, mental health (e.g., depression, mood disorders, suicide), pain – residual limb pain and phantom pain and compensatory pain in other upper body locations – neck, shoulders, and intact limb (if unilateral amputation), prosthesis related outcomes (e.g., prosthesis satisfaction; prosthesis use; prosthesis use intensity; prosthesis acceptance; prosthetic competence), QoL/HRQoL/satisfaction with life
- Key Question 10:
  - Critical outcomes: Functional status, independence, IADLs, ADLs, and/or disability, prosthesis related outcomes (e.g., prosthesis satisfaction; prosthesis use; prosthesis use intensity; prosthesis acceptance; prosthetic competence)
  - Important outcomes: Adverse events/complications (e.g., skin breakdown), independence/employment, mental health (e.g., depression, mood disorders, suicide), pain – residual limb pain and phantom pain and compensatory pain in other upper body locations – neck, shoulders, and intact limb (if unilateral amputation), QoL/HRQoL/satisfaction with life
- Key Question 11:
  - Critical outcomes: Prosthesis fitting/timing of prosthesis fitting, wound-related outcomes (e.g., quality, speed of healing)
  - Important outcomes: Surgical revisions
- Key Question 12:
  - Critical outcomes: Functional status, independence, IADLs, ADLs, and/or disability
  - Important outcomes: Prosthesis satisfaction measures, QoL/HRQoL/satisfaction with life

e. Timing

- Key Questions 1 – 12: Any

f. Settings

- Key Questions 1 – 12: Inpatient or outpatient. Can pertain to stay at comprehensive inpatient rehabilitative unit/program.

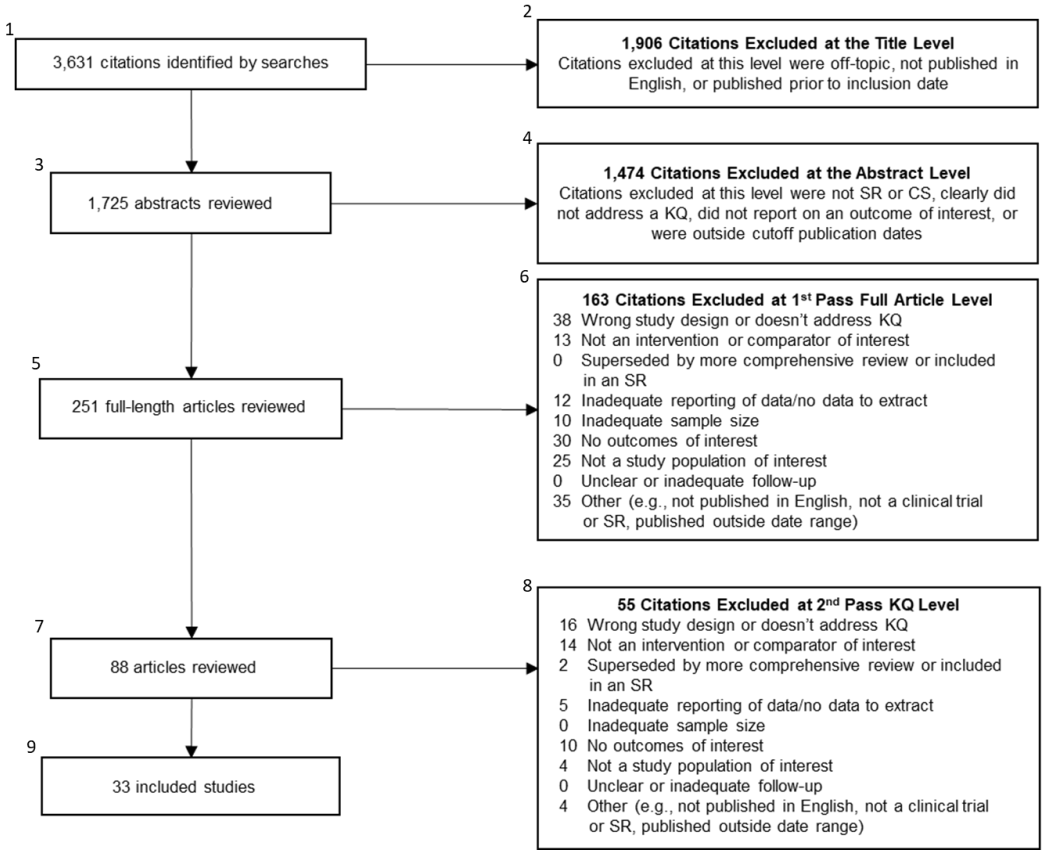
B. Conducting the Systematic Review

Based on the Work Group's decisions regarding the CPG's scope, KQs, and PICOTS statements, the Lewin Team produced a systematic evidence review protocol before conducting the review. The protocol

detailed the KQs, PICOTS criteria, methodology to be used during the systematic evidence review, and the inclusion and exclusion criteria to be applied to each potential study, including study type and sample size. The Work Group reviewed and approved the protocol.

Figure A-1 below outlines the systematic evidence review's screening process (see also the General Criteria for Inclusion in Systematic Review and Key Question Specific Criteria). In addition, Table A-2 indicates the number of studies that addressed each of the questions.

Figure A-1. Study Flow Diagram



Abbreviations: CS: clinical study; KQ: key question; SR: systematic review

Alternative Text Description of Study Flow Diagram

Figure A-1. Study Flow Diagram is a flow chart with nine labeled boxes linked by arrows that describe the literature review inclusion/exclusion process. Arrows point down to boxes that describe the next literature review step and arrows point right to boxes that describe the excluded citations at each step (including the reasons for exclusion and the numbers of excluded citations).

1. Box 1: 3,631 citations identified by searches
    a. Right to Box 2: 1,906 citations excluded at the title level
        i. Citations excluded at this level were off-topic, not published in English, or published prior to inclusion date
    b. Down to Box 3

2. Box 3: 1,725 abstracts reviewed
    a. Right to Box 4: 1,474 citations excluded at the abstract level
        i. Citations excluded at this level were not an SR or CS, clearly did not address a KQ, did not report on or an outcome of interest, or were outside cutoff publication dates
    b. Down to Box 5
3. Box 5: 251 full-length articles reviewed
    a. Right to Box 6: 163 citations excluded at 1st pass full article level
        i. 38 citations excluded at this level had the wrong study design or did not address a KQ
        ii. 13 citations excluded at this level did not have an intervention or comparator of interest
        iii. 0 citations excluded at this level were superseded by more comprehensive review or included in an SR
        iv. 12 citations excluded at this level had relevant reviews with no data to extract
        v. 10 citations excluded at this level had inadequate sample size
        vi. 30 citations excluded at this level had no outcomes of interest
        vii. 25 citations excluded at this level did not study a population of interest
        viii. 0 citations excluded at this level had inadequate follow-up for the KQ
        ix. 35 citations excluded at this level were excluded for another reason (e.g., not published in English, not a CS or SR, published outside date range)
    b. Down to Box 7
4. Box 7: 88 articles reviewed
    a. Right to Box 8: 55 citations excluded at 2nd pass KQ level
        i. 16 citations excluded at this level had the wrong study design or did not address a KQ
        ii. 14 citations excluded at this level did not have an intervention or comparator of interest
        iii. 2 citations excluded at this level were superseded by more comprehensive review or included in an SR
        iv. 5 citations excluded at this level had inadequate reporting of data or no data to extract
        v. 0 citations excluded at this level had an inadequate sample size
        vi. 10 citations excluded at this level had no outcomes of interest
        vii. 4 citations excluded at this level did not study a population of interest

viii. 0 citations excluded at this level had unclear or inadequate follow-up

ix. 4 citations excluded at this level were excluded for another reason (e.g., abstract, published outside date range, or data wholly covered in a previous review)

b. Down to Box 9

5. Box 9: 33 included studies

Table A-2. Evidence Base for KQs

KQ Number	KQ	Number and Study Type
1	In adults with ULA, what is the impact of treatment advances, including hardware, software, surgical, technology, or supplemental surgical interventions on outcomes?	1 RCT, 2 observational
2	In adults with ULA, do psychosocial interventions affect outcomes?	No studies identified
3	In adults with ULA, what treatment parameters (e.g., setting, treatment intensity, or service delivery model) are most effective in improving outcomes?	No studies identified
4	In adults with ULA, what assessment measures are effective in guiding prosthesis candidacy determination, determining the need for therapy, or identifying improvement or worsening of function and quality of life?	3 observational
5	In patients with ULA, with and/or without prostheses, what patient-related factors and/or co-occurring conditions are associated with rehabilitation outcomes?	12 observational
6	How do outcomes vary by control strategy, prosthesis type, socket design and/or suspension method, and/or prosthesis component selection?	7 observational
7	In patients with ULA, what is the effectiveness of pharmacologic and non-pharmacologic interventions for the prevention of phantom and residual limb pain?	No studies identified
8	In patients with ULA, what is the effectiveness of pharmacologic interventions for the management of phantom and residual limb pain?	1 RCT
9	In patients with ULA, what is the effectiveness of non-pharmacologic interventions for the management of phantom and residual limb pain?	1 SR, 2 randomized crossover trials
10	In patients with ULA, does level of amputation and/or amputation surgical procedure type impact patient outcomes?	2 SRs, 3 observational
11	In patients undergoing ULA surgery (initial or revision), what factors predict speed and quality of wound healing, prosthesis fitting, or need for revision surgery?	No studies identified
12	In patients with ULA, what therapy interventions (e.g., PT/OT), therapy intervention timing, or therapy protocols are associated with better function and health outcomes?	No studies identified
	Total Evidence Base	**33 studies**

* One SR was included in both KQ 1 and KQ 2; one paper was used in both KQ 5 and KQ 6

** One study in KQ 11 was published in two papers

Abbreviations: RCT: randomized controlled trial; SR: systematic review

a. General Criteria for Inclusion in Systematic Evidence Review

- Systematic reviews or clinical studies published on or after February 1, 2013, to April 30, 2021. If multiple SRs addressed a KQ, we selected the most recent and/or comprehensive review. Systematic reviews serve as the first line of evidence for all key questions. In the absence of a systematic review for an intervention, RCTs or prospective clinical studies were considered for inclusion, according to a best-evidence approach.
- Studies must be published in English.
- Publication must be a full clinical study or systematic review; abstracts alone were not included. Similarly, letters, editorials, and other publications that are not full-length clinical studies were not accepted as evidence.
- Systematic reviews must have searched MEDLINE or EMBASE for eligible publications, performed a risk of bias assessment of included studies, and assessed the quality of evidence using a recognizable rating system, such as GRADE or something compatible (e.g., the Strength of Evidence grading used by the Evidence-based Practice Centers of the AHRQ). If an existing review did not assess the overall quality of the evidence, evidence from the review must be reported in a manner that allows us to judge the overall risk of bias, consistency, directness, and precision of evidence. We did not use an existing review as evidence if we were not able to assess the overall quality of the evidence in the review.
- Study must have enrolled at least 20 patients (10 per study group).
    - ECRI typically applies a downgrade in precision for small sample sizes for conditions that affect a large number of patients (e.g., hypertension, MDD, or sleep disorders). However, given the relative rarity of upper extremity amputation (UEA) patients, ECRI did not downgrade for sample size.
- Study must have reported on at least one outcome of interest.

b. Key Question Specific Criteria for Inclusion in Systematic Evidence Review

- For all KQs, except KQs 4, 5, and 11 studies included in the SRs or as independent papers must be prospective, RCTs with an independent control group.
    - KQs 4, 5, and 11 also include observational trials, including cohort trials and case series.
- For KQs focusing on a solely ULA population, the study must have enrolled at least 80% of patients who meet the study population criteria: adults aged 18 years or older with ULA rehabilitation. For studies examining mixed patient populations (UEA and LEA), studies must have enrolled at least 80% of patients with the relevant condition (unless otherwise specified). If the studies have presented data in a manner that ECRI can isolate the population of interest, studies with less than 80% of patients with the target condition would be included.
    - KQs 1, 2, 8, and 9 potentially include mixed ULA and LEA populations, the 80% cutoff was not be applied.

c. Literature Search Strategy

Information regarding the bibliographic databases, date limits, and platform/provider can be found in Table A-3. See Appendix M for additional information on the search strategies, including topic-specific search terms and search strategies.

Table A-3. Bibliographic Database Information

Name	Date Limits	Platform/Provider
CINAHL	February 1, 2013, through April 30, 2021	EBSCO
EMBASE (Excerpta Medica) and MEDLINE	February 1, 2013, through April 30, 2021	Elsevier
PsycINFO	February 1, 2013, through April 30, 2021	Ovid
PubMed (In-process, Publisher, and PubMedNotMedline records)	February 1, 2013, through April 30, 2021	National Library of Medicine
Agency for Healthcare Research and Quality (AHRQ)	February 1, 2013, through April 30, 2021	AHRQ
U.S. Department of Veterans Affairs (VA) Evidence Synthesis Program	February 1, 2013, through April 30, 2021	VA

d. Rating the Quality of Individual Studies and the Body of Evidence

The Lewin Team assessed the methodological risk of bias of individual diagnostic, observational, and interventional studies using the USPSTF method. Each study is assigned a rating of *Good*, *Fair*, or *Poor* based on a set of criteria that vary depending on study design. Detailed lists of criteria and definitions appear in Appendix VI of the USPSTF procedure manual.

Following this, the Lewin Team assessed the overall quality of the body of evidence for each critical and important outcome using the GRADE approach. This approach considers the following factors: overall study quality (or overall risk of bias or study limitations), consistency of evidence, directness of evidence, and precision of evidence. The overall quality of the body of evidence is rated as *High*, *Moderate*, *Low*, and *Very low*.

C. Developing Evidence-based Recommendations

In consultation with the VA Office of Quality and Patient Safety and the Clinical Quality Improvement Program, DHA, the Lewin Team convened a four-day virtual recommendation development meeting on August 2 – 5, 2021, to develop this CPG's evidence-based recommendations. Two weeks before the meeting, the Lewin Team finalized the systematic evidence review and distributed the report to the Work Group; findings were also presented during the recommendation development meeting.

Led by the Champions, the Work Group interpreted the systematic evidence review's findings and developed this CPG's recommendations. The Work Group also considered carrying forward and modifying recommendations from the 2014 VA/DoD UEAR CPG (see Categorization of 2014 Clinical Practice Guideline Recommendations). The Work Group also developed new recommendations not included in the 2014 VA/DoD UEAR CPG based on the 2021 evidence review.

The strength and direction of each recommendation were determined by assessing the quality of the overall evidence base, the associated benefits and harms, patient values and preferences, and other implications (see Determining Recommendation Strength and Direction).

a. Determining Recommendation Strength and Direction

Per GRADE, each recommendation's strength and direction is determined by the following four domains:(9)

1. Confidence in the Quality of the Evidence

Confidence in the quality of the evidence reflects the quality of the body of evidence supporting a recommendation (see Rating the Quality of Individual Studies and the Body of Evidence). The options for this domain include: *High*, *Moderate*, *Low*, or *Very low*. This is a direct reflection of the GRADE ratings for each relevant critical outcome in the evidence review (see Outcomes). Per GRADE, if the quality of evidence differs across the relevant critical outcomes, the lowest quality of evidence for any of the critical outcomes determines the overall quality of the evidence for a recommendation.(11, 12)

The recommendation strength generally aligns with the confidence in the quality of evidence. For example, *Strong* recommendations are typically supported by *High* or *Moderate* quality evidence. However, GRADE permits *Low* or *Very low* quality evidence to support a *Strong* recommendation in certain instances (e.g., life-threatening situation).(9)

2. Balance of Desirable and Undesirable Outcomes

The balance of desirable and undesirable outcomes (i.e., benefits and harms) refers to the relative magnitudes or tradeoffs of anticipated benefits (e.g., increased longevity, reduced morbidity, improved QoL, decreased resource use) and harms (e.g., decreased longevity, increased complications, impaired QoL). The options for this domain include: *benefits outweigh harms/burden*, *benefits slightly outweigh harms/burden*, *benefits and harms/burdens are balanced*, *harms/burdens slightly outweigh benefits*, and *harms/burdens outweigh benefits*. This domain assumes most clinicians will offer patients an intervention if its advantages exceed the harms. The Work Group's understanding of the benefits and harms associated with the recommendation influenced the recommendation's strength and direction.

3. Patient Values and Preferences

Patient values and preferences is an overarching term that includes patients' perspectives, beliefs, expectations, and goals for health and life as they may apply to the intervention's potential benefits, harms, costs, limitations, and inconvenience. The options for this domain include: *similar values*, *some variation*, or *large variation*. For instance, there may be *some variation* in patient values and preferences for a recommendation on the use of acupuncture, as some patients may dislike needles. When patient values seem homogeneous, this domain may increase the recommendation's strength. Alternatively, when patient values seem heterogeneous, this domain may decrease a recommendation's strength. As part of this domain, the Work Group considered the findings from the patient focus group carried out as part of this CPG update (see Appendix I).

4. Other Implications

Other implications encompass the potential consequences or other impacts that might affect the strength or direction of the recommendation. The options for this domain include, e.g.: resource use, equity, acceptability, feasibility, and subgroup considerations. The following are example implications related to equity and subgroup considerations, respectively: some of the indicated population may be geographically remote from an intervention (e.g., complex radiological equipment); a drug may be contraindicated in a subgroup of patients.

Table A-4. GRADE Evidence to Recommendation Framework

Decision Domain	Questions to Consider	Judgment
Confidence in the quality of the evidence	Among the designated critical outcomes, what is the lowest quality of relevant evidence? How likely is further research to change the confidence in the estimate of effect?	High Moderate Low Very low
Balance of desirable and undesirable outcomes	What is the magnitude of the anticipated desirable outcomes? What is the magnitude of the anticipated undesirable outcomes? Given the best estimate of typical values and preferences, are you confident that benefits outweigh harms/burdens or vice versa?	Benefits outweigh harms/burdens Benefits slightly outweigh harm/burden Benefits and harms/burdens are balanced Harms/burdens slightly outweigh benefits Harms/burdens outweigh benefits
Patient values and preferences	What are the patients' values and preferences? Are values and preferences similar across the target population? Are you confident about typical values and preferences?	Similar values Some variation Large variation
Other implications (e.g., resource use, equity, acceptability, feasibility, subgroup considerations)	What are the costs per resource unit? Is this intervention generally available? What is the variability in resource requirements across the target population and settings? Are the resources worth the expected net benefit from the recommendation? Is this intervention and its effects worth withdrawing or not allocating resources from other interventions?	Various considerations

b. Recommendation Categorization

A summary of the recommendation categories and definitions is available in Table 4.

1. Categorizing Recommendations with an Updated Review of the Evidence

Reviewed refers to recommendations on topics included in this CPG's systematic evidence review. *Reviewed*, *New-added* recommendations are original, new recommendations (i.e., not included in the previous CPG). These recommendations are based entirely on evidence included in the current CPG's systematic evidence review.

Reviewed, *New-replaced* recommendations were in the previous CPG but revised based on the updated evidence review. These recommendations may have clinically relevant edits. *Reviewed*, *Not changed* recommendations were carried forward from the previous CPG unchanged. *Reviewed*, *Amended*

recommendations were carried forward from the previous CPG with a nominal change. This allowed for the recommendation language to reflect GRADE approach and any other not clinically meaningful edits deemed necessary. These recommendations can be based on a combination of evidence included in the current CPG's systematic evidence review and the evidence base that supported the recommendation in the previous CPG.

Reviewed, *Deleted* refers to recommendations from the previous CPG that were deleted after a review of the evidence. This may occur if the evidence supporting the recommendation is outdated (e.g., there is no longer a basis to recommend use of an intervention and/or new evidence suggests a shift in care), rendering the recommendation obsolete.

2. Categorizing Recommendations without an Updated Review of the Evidence

There were also cases in which it was necessary to carry forward recommendations from the previous CPG without an updated review of the evidence. Given time and resource constraints, the systematic evidence review carried out for this CPG update could not cover all available evidence on ULA; therefore, its KQs focused on new or updated research or areas not covered in the previous CPG.

For areas in which the relevant evidence was not changed and for which recommendations made in the previous CPG were still relevant, recommendations could have been carried forward to the updated CPG without an updated review of the evidence. The evidence supporting these recommendations was thus also carried forward from the previous CPG. These recommendations were categorized as *Not reviewed*. If evidence had not been reviewed, recommendations could have been categorized as *Not changed*, *Amended*, or *Deleted*. *Not reviewed*, *Not changed* recommendations were carried forward from the previous CPG unchanged. *Not reviewed*, *Amended* recommendations were carried forward from the previous CPG with a nominal change. *Not reviewed*, *Deleted* recommendations were determined by the Work Group to not be relevant. A recommendation may not be relevant if it, for example, pertained to a topic (e.g., population, care setting, treatment) outside of the updated CPG's scope or if it was determined to be common practice.

The recommendation categories for the current CPG are noted in the Recommendations. The recommendation categories from the 2014 VA/DoD UEAR CPG are noted in Appendix K.

D. Drafting and Finalizing the Guideline

The Work Group wrote, reviewed, and edited three drafts of the CPG using an iterative review process to solicit feedback on and make revisions to the CPG. The first and second drafts were posted online for 20 and 14 business days, respectively, for the Work Group to provide feedback. Draft 2 was made available for a 14-day peer review and comment (see External Peer Review). The Work Group reviewed all feedback submitted during each review period and made appropriate revisions to the CPG. Following the Draft 2 review and comment period, the Work Group reviewed external feedback and created a final draft of the CPG. The Champions then presented the CPG to the VA/DoD EBPWG for approval. The Work Group considered the VA/DoD EBPWG's feedback and revised the CPG as appropriate to create the final version. To accompany the CPG, the Work Group produced toolkit products, including a provider summary, pocket card, and patient summary. The VA/DoD EBPWG approved the final CPG and toolkit products in March 2022.

Appendix B: Summary of Assessments and Interventions in Rehabilitation Phases

Table B-1. Summary of Assessments and Interventions in Rehabilitation Phases

	Perioperative	Pre-prosthetic	Prosthetic Training	Lifelong Care
1. Physical Health Status (nutritional, CV, endocrine, neurologic, bowel & bladder, skin, MSK)	• Complete initial assessment of medical comorbidities and provide consultation as appropriate, especially if not addressed preoperatively • Initiate medical interventions and education as needed	• Continue medical interventions and provide referrals and education as needed	• Assess changes in medical comorbidities, and perform interventions and education as needed	• Assess changes in medical comorbidities and perform interventions and education as needed • Address strategies for prevention of secondary complications • Specialty referrals as indicated
2. Discharge Planning	• Initiate discharge planning during the initial assessment • Develop discharge plan • Communicate discharge plan with family and/or caregiver	• Determine new needs and update discharge plan as appropriate	• Determine new needs and update discharge plan as appropriate • Arrange appropriate follow-up plans	• Implement appropriate follow-up plans • Assist with care transitions including relocation or major life changes
3. Level of Function **3.1- Range of Motion**	• Assess current ROM in proximal joints of residual limb and on contralateral side • Preoperatively, treat identified contractures • Initiate passive ROM of residual and contralateral limb in all available planes of motion • Educate on importance of proper positioning to prevent contracture • Progress to active-assistive ROM in all planes of motion for residual and contralateral limb	• Maximize ROM of scapula, shoulder girdle, elbow, wrist, and hand as applicable • Advance to active ROM of residual and contralateral limbs	• Continue contracture prevention with stretching program • Maximize ROM for prosthetic fit and use	• Reassess ROM and review home stretching program if needed • Initiate therapy services if needed
3.2 Gross Motor Strength and Skills	• Assess for strength deficits of upper and lower limbs and treat as appropriate • Initiate strengthening program for major muscle groups in the arms and legs	• Continue therapeutic exercise program for strengthening upper extremity to include periscapular muscles	• Progress therapeutic exercise program for all extremities	• Reassess general strength and educate on maintenance of strength for long-term activity

	Perioperative	Pre-prosthetic	Prosthetic Training	Lifelong Care

3.3 Core Stabilization and Balance	• Initiate trunk and core stabilization exercises
	• Assess and initiate a balance progression:
	  ○ Static sitting balance
	  ○ Sitting weight shifts
	• Assess and initiate core stabilization:
	• Pelvic tilts
	• Bridges
		• Advance trunk and core stabilization exercises
		• Progress dynamic balance
			• Advance balance activities and challenge upper limb functional reach	• Reassess core strength and balance as it relates to functional activities using the prosthesis

3.4 Home Exercise Program (HEP)	• Determine and provide HEP addressing deficiencies and maximize above ROM strength, balance, etc.	• Give patient supplies and instruction in exercise program for home	• Advance HEP to focus on full ROM, strength, and endurance	• Address new physical requirements as patient goals change
3.5 Cardiovascular (CV)	• Assess current CV fitness and incorporate a CV component into the therapy program • Educate regarding energy demand with active prosthesis use • Establish cardiac precautions for rehabilitation (heart rate, blood pressure, perceived exertion scales) as indicated	• Advance CV aspect of rehabilitation program to meet needs of patient • Maintain cardiac precautions as indicated • Encourage reducing risk factors	• Establish maintenance program for endurance and fitness • Maintain cardiac precautions as indicated • Encourage reduction of CV risk factors	• Establish maintenance program for endurance and fitness • Maintain cardiac precautions if indicated • Encourage reduction of CV risk factors
3.6 ADL and IADL	• Assess activity level and independence in ADL and IADL to help establish goals and expectations • Initiate ADL training such as eating, dressing, grooming, bathing, toileting • Provide training for any strategies to perform basic ADL with one hand • Ensure patient safety • Initiate change of dominance training as appropriate	• Teach adaptive techniques for dressing, bathing, grooming, and toileting without a prosthesis • Continue change of dominance training as appropriate • Begin IADL training • Progress independence with more complex IADL training	• Instruct in proper care and maintenance of prosthesis • Instruct and train in prosthetic donning and doffing strategies • Practice ADL and IADL with prosthesis as appropriate	• Reassess functional needs and provide any necessary training to maximize independence • Teach energy conservation principles • Teach injury prevention techniques

	Perioperative	Pre-prosthetic	Prosthetic Training	Lifelong Care
3.7 Community Integration	• Obtain recreational interests • Offer and promote trained peer visitation	• Initiate outings into the community without a prosthesis • Complete recreational training activities without the prosthesis(es) • Offer and maintain individual and group peer support	• Initiate recreational training activities with a prosthesis • Practice use of a prosthesis during recreational training activities • Offer and maintain individual and group peer support	• Reassess community integration needs and refer to recreation therapy as necessary • Provide education on opportunities and precautions for long-term sport specific, recreation skills or resources, and prosthesis or assistive devices available • Provide counseling and contact information regarding opportunities in sports and recreation
3.8 Home Evaluation	• Assess patient's home for accessibility and safety and provide information on home modifications	• Assess patient's home for accessibility and safety if not already completed		• Reassess home modification needs with any significant changes to medical condition
3.9 Equipment	• Provide education about available assistive devices or adaptive equipment • Educate regarding available home modifications, ramps, etc.	• Assess for personal equipment and assistive devices to perform ADL • Provide training for personal equipment and assistive devices to perform ADL • Assess for home adaptation needs, environmental modifications, and equipment	• Assess for personal equipment and any necessary accommodations to perform IADL (i.e., voice recognition, one handed keyboard, Bluetooth devices) and provide training	• Reassess for any personal equipment or necessary accommodations to perform ADL, vocation, and avocational IADL as needs and goals evolve • Provide necessary training for identified personal equipment and assistive device needs

	Perioperative	Pre-prosthetic	Prosthetic Training	Lifelong Care
3.10 Driving Evaluation and Training	–	• Assess for driving evaluation needs or need for vehicle modifications or adaptive driving equipment	• Consult Certified Driving Specialist to complete driving evaluation • Complete driver's training with recommended adaptive equipment as needed • Educate patient, family, and/or caregiver to comply with local state driving laws and individual insurance company policies	• Reassess driving modification needs with any significant changes to medical condition or amputation status
4. Pain Management	• Assess for existing pain before surgery and treat aggressively • Following amputation, assess and aggressively treat residual limb pain and PLP (liberal narcotic use, regional anesthesia, and non-narcotic medications especially for neuropathic pain)	• Assess and treat residual limb pain and PLP (transition to non-narcotic modalities including pharmacologic, physical, psychological, and mechanical)	• Assess and treat residual limb pain and PLP (transition to non-narcotic modalities including pharmacologic, physical, psychological, and mechanical)	• Reassess and adjust treatment for residual limb pain and PLP (transition to non-narcotic modalities including pharmacologic, physical, psychological, and mechanical) • Assess and treat associated MSK pain and overuse syndromes
5. Behavioral and Cognitive Health	• Complete psychological assessment • Evaluate and address psychosocial symptoms/issues • Complete cognitive assessment	• Evaluate and address psychosocial symptoms/issues • Evaluate and address cognitive issues • Offer or maintain individual and group peer support activities	• Evaluate and address psychosocial symptoms/issues • Evaluate and address cognitive issues • Offer or maintain individual and group peer support activities	• Evaluate and address psychosocial symptoms/issues • Assess changes in psychosocial support • Assess changes in cognitive issues

	Perioperative	Pre-prosthetic	Prosthetic Training	Lifelong Care
6. Patient Education	• Pain control • Patient safety • Prevention of complications • Procedural/recovery issues: • Level of amputation • Prosthetic options • Postoperative dressing • Sequence of amputation care • Equipment • Role of the care team members • Psychosocial anticipatory guidance • Expected functional outcomes • Positioning • Rehabilitation process • Pain control • Residual limb care • Edema control • Compression wrapping • Wound care • Prosthetic timeline • Coping methods • Contracture prevention	• Positioning • Rehabilitation progress • Pain control • Residual limb care • Edema control • Application of shrinker • Prosthetic timeline • Equipment needs • Coping methods • Prevention of complications • Contracture prevention • Safety	• Positioning • Rehabilitation process • Pain control • Residual limb care • Energy expenditure • Prosthetic education • Donning & doffing • Care of prosthesis • Skin integrity • Sock management • Equipment needs • Coping methods • Prevention of complications • Weight management • Contracture prevention • Injury prevention techniques • Safety	• Positioning • Rehabilitation process • Pain control • Residual limb care • Equipment needs • Coping methods • Prevention of complications • Weight management • Contracture prevention • Injury prevention techniques • Safety • Technological advances in the field that may benefit patient to achieve individual needs and desired goals

	Perioperative	Pre-prosthetic	Prosthetic Training	Lifelong Care
7. Residual Limb Management	• Manage postoperative dressings • Monitor the surgical wound for signs and symptoms of ischemia or infection • Control edema and shape residual limb with the use of postoperative dressing and compression wrap; progress to shrinker once cleared by surgeon • Teach compression wrap application or shrinker application • Promote skin and tissue integrity with the use of a residual limb dressing • Promote ROM and strengthening of proximal joints and muscles	• Continue to monitor wound healing • Continue shaping and shrinkage of residual limb • Teach compression wrap application or shrinker application • Teach patient care of residual limb • Promote ROM and strengthening of proximal joints and muscles • Instruct in desensitization exercises	• Optimize limb shaping and shrinkage before prosthetic fitting • Teach donning/doffing of prosthetic system • Instruct in use of shrinker or compression wrap when out of prosthesis • Teach skin checks and skin hygiene • Teach management of sock ply (if appropriate) • Progress wear schedule • Optimize pain management to promote ROM and restoration of function • Instruct patient to observe pressure points • Monitor skin and tissue integrity with progressive wearing time and frequent skin checks in the newly fitted socket	• Reinforce education regarding skin care • Educate regarding signs and symptoms of ill-fitting socket • Monitor effectiveness of pain management • Continue limb volume management
8. Prosthetic Management	• Determine optimal residual limb length per patient goals • Residual limb care • Postoperative dressing if appropriate	• Initial prosthetic prescription generation	• Prosthetic fabrication, fitting, alignment, and modification as applicable • Test various prosthesis components • Consider activity-specific prosthesis to meet goals	• Prosthetic fabrication, fitting, alignment, and modification as applicable • Prosthetic device repairs as indicated • Schedule routine maintenance (components, upgrades, socket changes, and specialty use devices) • Consider activity-specific prosthesis to meet newly established goals

	Perioperative	Pre-prosthetic	Prosthetic Training	Lifelong Care
9. Vocational Rehabilitation	• Obtain vocation interests	• Complete vocational rehabilitation evaluation if indicated	• Conduct worksite evaluation if indicated • Identify worksite modifications to enhance function • Initiate vocational training activities with a prosthesis • Practice use of a prosthesis during vocational training activities	• Reassess vocational needs and refer as needed to achieve new or ongoing vocational goals • With any significant changes to medical condition, reassess for any additional workplace modification needs

Abbreviations: ADL: activities of daily living; CV: cardiovascular; HEP: Home Exercise Program; IADL: instrumental activities of daily living; MSK: musculoskeletal; ROM: range of motion; PLP: phantom limb pain

Appendix C: Outcome Measures

The International Classification of Functioning, Disability, and Health (ICF) model was endorsed by the World Health Organization (WHO) in 2001 to create a common language to describe health and health-related status. It classifies human functioning into four multi-dimensional domains: body functions and structures, activities and participation, environmental factors, and personal factors, and includes elaborate classification taxonomy.(78) The ICF model is increasingly utilized in clinical settings as a way to conceptualize functional status, identify goals, plan and monitor treatment, and as a framework for outcome measurement. The use of the ICF allows clinicians and researchers from different fields and locations to use a common language to understand health and disability.

Appropriate selection and administration of outcome measures, linked to the ICF taxonomy, can be used to identify the impact of a health or health-related condition, evaluate needs, and track health and function over time.(79, 80) Many authors have attempted to link specific outcome measures to ICF taxonomy across a variety of disciplines, including ULA rehabilitation.(81-83) Most outcome measures were not developed based upon the ICF conceptual model, and as such, may not cover all the aspects of human functioning that are pertinent to specific clinical conditions. Therefore, clinicians may need to employ a "toolkit" of outcome measures when seeking a comprehensive view of the patient's status and progress.(82-85)

In 2014, the UEAR CPG Work Group performed a systematic evidence review to ensure the most current information was included for recommendation development. The 2014 CPG's systematic evidence review intended to identify outcome measures to assess function in persons with ULA and evaluate each measure's focus, content, clinimetric, and psychometric properties. This 2014 CPG systematic evidence review was, in part, an update of one completed in 2012 by the Measurement Group for the VA Amputation System of Care Repository. In 2022, the tables from the 2014 CPG systematic evidence review were updated using the same inclusion and exclusion criteria.

A. Inclusion Criteria

- The manuscript employed a standardized outcome measure developed or used with adult amputee patients/subjects to measure the specified domain for evaluating or predicting outcome
- The research used the measure with a sample of at least 10 persons with ULA
- The paper was written in English (or translated)
- An abstract was available for review

B. Exclusion Criteria

- Dissertation, thesis, book chapter, or conference proceedings
- The full text publication was unavailable for review
- Exclude if used only with a pediatric population
- Exclude if sample was only non-disabled persons using a prosthetic simulator

Based on findings from the literature search, data on outcome measure psychometric properties were updated where indicated. The new literature search update also yielded five additional pertinent outcome measures: The Brief Activity Measure for Upper Limb Amputation (BAM-ULA), the Timed Measure of Activities Performance (T-MAP), the PROMIS-9 UE, the Capacity Assessment of Prosthetic Performance for the Upper Limb (CAPPFUL) and the Nine Hold Peg Test.(82, 83, 86-91) This review is not an exhaustive list of all outcome measures available for use with the ULA population or those that have been used in small studies or studies of prosthetic simulators. The 2014 VA/DoD UEAR CPG tables included the SHAP because of its popularity, evidence of content validity, and use in multiple small studies of TR amputees (1 – 6 subjects), plus several studies of prosthetic simulation.(92-101) Data on the psychometric properties of the SHAP was updated given a recent publication and led to inclusion of the performance measure Prosthesis Index of Functionality (P-IOF).(91)

All measures and their subscales are summarized in Table C-1. Some of the listed measures also include the MDC. These numbers can be very useful in interpreting MDC scores, however, scores vary by population, and may or may not be clinically significant. This table provides a rating of the evidence supporting important measurement properties of the identified outcome measures as documented in the literature. Table C-2 lists the same outcome measures categorized according to broad ICF categories, utility, and functional element assessed to facilitate clinical judgment. The review focuses on physical function and does not include measures designed to assess important domains such as social participation or satisfaction with the prosthesis. The intent is to supply clinicians with information to help them choose the best measures of physical function appropriate for their patients and their facility.

Both the VA and the DoD have developed systems for collecting amputation-related outcome measures. The VA is using embedded outcome measures available within the EMR; the DoD is using a SharePoint based system to collect outcome measures. The VA and DoD Champions for this CPG update can assist anyone with questions about the respective agency systems. This updated literature also highlights that additional research is needed to evaluate the psychometric properties of outcome measures in persons with ULA to evaluate those measures that are most responsive to change and would be most suited for tracking patient outcomes over time.

Table C-1. Review of Evidence in Support of Measurement Properties of Functional Status Measures for Upper Extremity Amputation

Measure	Reliability Evidence				Validity			Overall Rating
	Inter-rater	Test-retest	IRT/Rasch	Internal consistency	Construct Validity	No Floor/Ceiling	Sensitivity to change/ Responsiveness (MDC)	
ABILHAND-ULA	UK	UK	+	N/A	+	?	UK	UK
Activities Measure for Upper Limb Amputees (AM-ULA)	+	+	N/A	+	+	UK	+ (MDC 90 3.7)	+
Actual Use Index (AUI)	N/A	UK	N/A	UK	+	UK	UK	UK
Assessment of Capacity for Myoelectric Control (ACMC)	+	UK	+	N/A	+	+	UK	+
Assessment of Capacity for Myoelectric Control (ACMC) V2	+	+	+	N/A	+	+	+ MDC 950.55-0.69 logits	++
Box and Block Test of Manual Dexterity (BBT)	+	+	N/A	N/A	+	+	+ (MDC 90 6.5)	++
Brief Activity Measure Upper Limb (BAM-ULA)	*	*	UK	*	+	UK	UK	+
Carroll test (Upper Extremity Function Test)	UK	UK	N/A	UK	UK	UK	UK	UK
Carroll test (modified)	UK	UK	N/A	UK	UK	UK	UK	UK
Capacity Assessment of Prosthetic Performance for the Upper Limb (CAPPFUL)	*	?	UK	*	UK	UK	UK	UK
Disability of the Arm, Shoulder and Hand (DASH)	N/A	UK	N/A	UK	+	UK	?	UK
Jebsen-Taylor Hand Function Test – modified (mJTHFT)	+	+	N/A	N/A	+	0	(MDC 90 0.09-0.18 items/second)	?
PROMIS-9 Upper Extremity (UE)	UK	+	+	+	+	UK	UK	UK
Orthotics and Prosthetics Users Survey (OPUS) Upper Extremity Functional Scale (UEFS)	UK	UK	0	UK	UK	UK	UK	0

Measure	Reliability Evidence				Validity			Overall Rating
	Inter-rater	Test-retest	IRT/Rasch	Internal consistency	Construct Validity	No Floor/Ceiling	Sensitivity to change/ Responsiveness (MDC)	
OPUS UEFS modified (Burger)	UK	UK	+	UK	+	UK	UK	UK
OPUS UEFS modified rating scale (Jarl)	N/A	+	UK	N/A	UK	UK	+ (MDC 95 14.8)	UK
OPUS UEFS modified 27 item scale (Jarl)	N/A	UK	+	N/A	+	0	UK	UK
OPUS UEFS modified 22 item scale (Resnik)	N/A	+	UK	N/A	0	+	0 (MDC 90 12)	0
OPUS UEFS Use	N/A	?	N/A	UK	0	+	0 (MDC 90.39)	0
Patient-Specific Function Scale (PSFS)	N/A	UK	N/A	UK	+	+	+	UK
Prosthesis Index of Functionality (P-IOF)	N/A	UK	UK	+	+	+	UK	+
Purdue Pegboard	N/A	UK	N/A	UK	?	UK	UK	
Southampton Hand Assessment Procedure (SHAP)	UK	UK	N/A	*	*	Floor effects +	UK	0
Timed Based Measure of Activity Performance (T-MAP)	UK	+	N/A	+	+	UK	UK	+
Total Skill Score	UK	UK	N/A	UK	+	UK	UK	UK
University of New Brunswick (UNB) Skill	+	+	N/A	UK	+	UK	+ (MDC 90 0.8)	+
University of New Brunswick Spontaneity	+	+	N/A	UK	+	UK	+ (MDC 90 0.7)	+
QuickDASH	N/A	+	N/A	+	+	UK	(MDC 90 13.9) (MDC 95 17.4)(28)	+

Measurement property rating scheme

(++) Excellent = evidence from 2 or more separate studies with strong methodology supporting the property

(+) Good = evidence from 1 study with strong methodology supporting the property

(?) Fair = evidence from 1 or more studies with fair methodology supporting the property, more research needed

(0) Poor = evidence from poor quality study/studies, and/or results from well-constructed studies did not strongly support the property or indicated serious issues

(UK) Unknown = to date no research has been conducted on the measurement property. MDC 90 = Minimal Detectable Change at 90% confidence interval

Overall rating scheme

(++) Excellent = evidence from 2 or more separate studies with strong methodology supporting both reliability and validity

(+) Good = evidence from 1 study with strong methodology supporting both reliability and validity

(?) Fair = evidence from 1 or more studies with fair methodology supporting both reliability and or validity, more research needed

(0) Poor = evidence from poor quality study/studies, and/or results from well-constructed studies did not strongly support both reliability and validity or indicated serious issues

(UK) Unknown = to date insufficient research has been conducted on measurement properties

Table C-2. Utility, Elements Assessed, Content, and Evidence Rating of Upper Extremity Functional Outcome Measures

		Utility				Elements Assessed								ICF Content Areas											
														Body Functions				Activities and Participation							
		Phase of rehabilitation	Easy to score	Easy to interpret score	Burden (minutes to complete)	Speed	Difficulty/skill	Special equipment (prosthesis use)	Task completion	Spontaneity of prosthetic use	Movement quality	Assistance	Skillfulness of prosthetic device use	Pain/tingling/stiffness	Sleep	Hand grips/grasping	Use of visual feedback	Carry and handle objects	Household activities	Eating/drinking	Food preparation	Bathing/grooming	Dressing	Other daily activities	Sexual activities	Recreation	Social activities
Self-Report Measures	ABILHAND	All	Y		15		Y											Y	Y	Y	Y	Y	Y	Y			
	ABILHAND-ULA	All	Y	N	10		Y											Y	Y	Y	Y	Y	Y	Y			
	AUI	Pros	Y	Y	?			Y										Y	Y	Y	Y	Y	Y	Y			
	DASH	All	Y	Y	10-15		Y							Y	Y			Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	QuickDASH	All	Y	Y	5		Y								Y	Y		Y	Y	Y		Y				Y	Y
	OPUS UEFS	All	Y	N	5-10		Y		Y									Y	Y	Y	Y	Y	Y	Y			
	OPUS UEFS (Burger)	All	Y	N	5-10		Y		Y									Y	Y	Y	Y	Y	Y	Y			
	OPUS UEFS modified rating scale (Jarl)	All	Y	N	5-10		Y		Y									Y	Y	Y	Y	Y	Y	Y			
	OPUS UEFS modified 27 item scale (Jarl)	All	Y	N	5-10		Y		Y									Y	Y	Y	Y	Y	Y	Y			
	OPUS UEFS modified 22 item scale (Resnik)	All	Y	N	5-10				Y									Y	Y	Y	Y	Y	Y	Y			
	OPUS UEFS Use	All	Y	Y	5-10			Y										Y	Y	Y	Y	Y	Y	Y			
	PROMIS-9 UE																										
	PSFS	All	Y	Y	5-10		Y											Patient lists tasks of importance									
	QuickDASH	All	Y	Y	5		Y							Y	Y			Y	Y		Y					Y	Y

		Utility				Elements Assessed								ICF Content Areas												
														Body Functions				Activities and Participation								
		Phase of rehabilitation	Easy to score	Easy to interpret score	Burden (minutes to complete)	Speed	Difficulty/skill	Special equipment (prosthesis use)	Task completion	Spontaneity of prosthetic use	Movement quality	Assistance	Skillfulness of prosthetic device use	Pain/tingling/stiffness	Sleep	Hand grips/grasping	Use of visual feedback	Carry and handle objects	Household activities	Eating/drinking	Food preparation	Bathing/grooming	Dressing	Other daily activities	Sexual activities	Recreation	Social activities
Performance Measures	ACMC	Pros	N	Y	10-15		Y			Y	Y		Y			Y	Y	Y									
	ACMC v 2	Pros	N	Y	10-15		Y			Y	Y		Y			Y	Y	Y									
	AM-ULA	Pros	Y	Y	30	Y	Y		Y		Y	Y							Y	Y	Y		Y	Y			
	BAM-ULA	Pros	Y	Y	10-20				Y									Y	Y		Y		Y				
	BBT	Pros	Y	Y	2	Y												Y									
	CAPPFUL	Pros	Y	Y	25-35	Y	Y	Y	Y	Y	Y	Y	Y			Y		Y	Y		Y		Y	Y		Y	Y
	Carroll test	Pros	N	Y	25 ?	Y	Y		Y									Y	Y								
	Carroll test (modified)	Pros	N	Y	20 ?	Y	Y											Y	Y								
	JTHF - modified	Pros	Y	Y	15+	Y													Y		Y						
	P-IOF	Pros	N	N	?	Y			Y							Y		Y	Y		Y			Y			
	Purdue Pegboard	Pros	Y	Y	5	Y												Y									
	SHAP	Pros	N	N	?	Y			Y							Y		Y	Y		Y			Y			
	T-Map	All	Y	Y	10-20	Y			Y											Y	Y	Y	Y				
	Total Skill Score	Pros	Y	Y	?	Y					Y							Y	Y	Y	Y	Y	Y	Y	Y		
	UNB Skill (1 subtest)	Pros	Y	Y	20-40								Y			Y											
	UNB Spontaneity (1 subtest)	Pros	Y	Y	20-40					Y						Y											

Appendix D: Essential Elements of the Annual Contact

Persons with ULA should be contacted annually at a minimum. Contact can occur via telephone, telehealth visits, in-person visits, or secure messaging as clinically appropriate. Assessment of the following elements should be completed at the time of the annual contact.

A. Medical Considerations

- Changes in medical status and new medical conditions
- Medication changes including the use of non-prescription supplements
- Tobacco, alcohol, or illegal substance use
- Physical activity level and exercise program
- Nutritional status and changes in weight (increase or decrease)

B. Functional Status

- Current level of functional independence and changes in functional status (mobility, ADL function)
- Changes or new functional goals
- Need for new or replacement durable medical equipment
- Need for home or work environmental modifications
- Need for assistive technology for ADL and/or vocational support
- Need for occupational and physical therapy services to address a change in functional status, new functional goals, or address equipment needs

C. Prosthesis-related Considerations

- Fit and function of the prosthesis
- Prosthesis utilization and barriers to greater use
- Need for replacement prosthetic components or supplies
- Need for new prosthetic componentry or technology to achieve functional goals
- Need for activity-specific prosthesis to better perform recreational or vocational activity

D. Pain and Residual Limb Considerations

- Residual limb skin condition and complications
- Pain issues (residual limb, PLP, musculoskeletal pain issues [i.e., neck, shoulder, back])
- Overuse symptoms in the proximal amputated limb or contralateral limb

E. Psychosocial Considerations

- Family and caregiver support or changes in support system

- New psychosocial stressors
- New emotional, behavioral, or psychological considerations
- Recreational or community resources and support
- Vocational issues or concerns
- Leisure activity participation
- Engagement in peer support activities

F. Secondary Amputation Prevention

- Risk factors for more proximal or additional amputation

Appendix E: Advantages and Disadvantages of Prostheses

Table E-1. Advantages and Disadvantages of Prostheses by Type

	Advantages	Disadvantages
No Prosthesis	+ Comfort (no device/harness/suspension) + Tactile sensation through the residual limb + Proprioceptive feedback available through the residual limb	– No active prehension or mechanical grasp – Limited ability to do bimanual tasks – Increased potential for overuse injuries in the sound limb – Increased risk of asymmetry and back pain
Passive Prosthesis	+ Lightweight + Good cosmetic appearance + Minimal harnessing + Low maintenance + No control cables + Silicone products resist staining	– No functional grasp – Can be very expensive – Latex and PVC glove or prosthetic skin products stain easily
Body-powered Prosthesis	+ Durable and can be used in tasks or environments that could damage externally powered prosthesis (i.e., conditions involving excessive water, dust, or vibration) + Secondary proprioceptive feedback + Lower maintenance costs than electric options + Preferred for heavy duty jobs or activities + Less training required + Can be used with an activity specific TD	– Harnessing over shoulder is required – Less grip force with VO TD compared with electric options – Appearance of hook and cables
Hybrid Prosthesis	+ Simultaneous control of elbow and TD or wrist + Lighter than fully electric elbow prosthesis + Increased grip force compared with VO body-powered options + Advantage of electric TD and wrist operation	– Requires a harness for elbow – Susceptible to damage from moisture or excessive vibration – Requires battery maintenance
Externally Powered Prosthesis	+ Proportional or variable speed grip/rotation + Advantage of electric TD and wrist operation + Potential for a more natural/ cosmetic appearance + Potential for pattern recognition and simultaneous control + Less shoulder motion required for TD operation	– Increased training time – More complicated to control; inadvertent motions are common – Harness is required for TH level amputations – Requires battery maintenance – Typically heavier than body-powered – Repairs are more complex – Susceptible to damage from moisture or excessive vibration – More expensive
Task-specific Prosthesis	+ TD and arm allow the capability to perform specific activities + May have minimal harnessing + Often has limited or no control cables + Durable, low maintenance + Protects primary prosthesis from damage	– No functional grip – Not appropriate for a broad range of functions – May need multiple TDs to perform different activities

Abbreviations: PVC: polyvinyl chloride; TD: terminal device; TH: transhumeral; VO: voluntary opening

Appendix F: Surgical Considerations

A. Surgical Considerations

a. Partial Hand Amputation

The mangled or mutilated hand is a common traumatic injury, most commonly occurring from agricultural, industrial, household, and motor vehicle mishaps, as well as combat-related injuries. The surgical goal is to retain or reestablish an acceptable hand, defined as "one which has three fingers of near normal length with near normal PIP joint motion and good sensibility along with a functioning thumb."(102) Because of the thumb's functional importance, special consideration should be taken to preserve it.(103, 104) The ring and small finger are also critical for grip strength and power grasp, essential in ADL.(105) More proximal amputation levels should be discouraged if preservation of basic prehensile function with two sensate digits able to oppose one another may be accomplished. However, a more stable terminal pinch can be expected with preservation of the thumb and at least two additional digits.(106) While outside the scope of this CPG, the decision to perform digital salvage versus amputation can be difficult, and there is currently no specific algorithm or extremity scoring system to guide the surgeon. Consultation with an upper limb specialist is highly recommended, if available. Surgeon experience, a patient-centered approach to treatment, and multi-specialty consultation all help guide decision-making.

Amputations through the carpal bones require special consideration. Reconstruction to allow pinching and grasping are not possible at this level. Consideration can be made to revise the amputation to a wrist disarticulation or TR level. However, if the radiocarpal joint is preserved, consideration can be made to salvage a transcarpal level when soft tissue coverage is available. The advantage of this level is the long limb that may allow functional use for rudimentary tasks, or to assist a contralateral normal extremity, without the need for a prosthesis. The perceived disadvantage is the same as that for wrist disarticulation; historically, this level has been difficult to fit with a highly functional prosthesis when compared to the TR level. However, this may be changing with advanced prosthesis technology and the emergence of hand transplantation procedures.

b. Wrist Disarticulation Amputation

The advantages of wrist disarticulation level amputation include:

- Full forearm rotation is preserved when the distal radioulnar joint (DRUJ) is preserved
- There is no risk of impingement of the distal radius and ulna as seen in TR amputations
- The large surface of the distal radius can allow weight-bearing through the terminal end
- The long sensate residual limb increases functional length
- It is a better platform for the self-suspension of the prosthesis

The main disadvantage, historically, has been limited prosthesis options due to the very short working length between the end of the residual limb and the TD, while attempting to achieve an acceptable limb length and cosmetic result. A survey of U.S. surgeons by Tooms (1972), before the introduction of modern wrist components, indicated a preference for distal TR amputations over wrist

disarticulations.(107) However, advances in prosthesis design and materials have greatly improved function for the wrist disarticulation patient.(108)

c. Transradial Amputation

The TR level amputation is the most common major ULA.(109) This level of amputation also has the highest prosthesis acceptance rates in the upper limb. In distal TR amputations, the long lever arm, available forearm rotation, and preserved shoulder and elbow function allow the patient to easily position the TD and prosthesis in space. The TR amputation level is also cosmetically appealing due to the ability to fit body-powered or myoelectric prostheses with quick-disconnecting components, while still maintaining equal limb lengths. When practical, at least two-thirds of the forearm should be maintained. Removal of 6 – 8 centimeters (cm) of bone is recommended to offer a robust soft-tissue envelope and permit a wide variety of prosthetic options. At least 5 cm of the residual ulna is required to allow for prosthetic fitting and elbow motion.(110, 111) At this level, consideration should be made to transfer the distal biceps tendon to the proximal ulna.(112) The obvious prosthesis and mechanical advantages of the TR level coupled with the superior prosthetic acceptance rates should prompt the surgeon to consider all reconstruction options, including free tissue transfer, to preserve an amputation at this level.

d. Elbow Disarticulation Amputation

Elbow disarticulation and distal TH amputations are functionally quite similar, with both maintaining a flare to the distal humerus allowing improved suspension and improved rotational control of a prosthesis when compared to more proximal amputation levels. The major disadvantage of this level is the cosmetic appearance of length inequality with the prosthetic elbow joint distal compared to the contralateral normal elbow, or with the center of rotation placed lateral to the axis of the humerus to minimize the length inequality.(110, 113) However, the improved suspension and rotational control usually outweigh any cosmetic considerations for most patients. Shortening osteotomy of the humerus to improve the cosmetic result may be considered, but this is rarely indicated or performed.

e. Transhumeral Amputation

If the condyles of the distal humerus are not preserved, the ideal level for TH amputation is approximately 3 – 5 cm proximal to the elbow joint. Adequately suspended and standard prosthetic components are expected at this level, but rotational control is decreased compared to elbow disarticulation. Anterior angulation osteotomy, described by Neusel et al. (1997), can be performed to the distal humerus to improve the rotational stability of the prosthesis while still allowing a free-moving shoulder.(114) The osteotomy is generally angulated 70 degrees anterior, and fixation with either inter-fragmentary screw fixation, or a compression plate and screw construct is performed.

With a proximal TH amputation level, maintenance of length is critical, with most sources recommending the preservation of at least 5 – 7 cm of length from the glenohumeral joint to preserve maximum function. As in the TR amputation level, the use of dermal substitutes, skin grafting, and local and free flaps are strongly considered to preserve adequate length.(115) Preservation of the deltoid, pectoralis major, and latissimus dorsi insertions to the humerus will allow for body-powered or myoelectric prosthesis control.

f. Shoulder Disarticulation Amputation

Amputation proximal to these named tendon insertions will functionally result in a shoulder disarticulation level amputation. In such instances, preservation of the humeral head will improve body contour and the cosmetic result of the amputation as well as possibly aid in force transmission during prosthesis use. Unless stabilizing myodesis can be performed with available muscles, the unopposed pull of the rotator cuff muscles may result in painful or disfiguring abduction contracture or subluxation. As a result, glenohumeral arthrodesis, often as a planned, staged procedure, is strongly recommended.(108, 111, 113)

g. Forequarter Amputation

Forequarter amputation consists of removal of the entire upper limb plus the scapula, part or all of the clavicle, and potentially part of the chest wall, typically as treatment for solid tumors. Free flaps, harvested from the amputated limb, are a reliable method for wound closure.(116) Preservation of as much of the shoulder as possible will enhance cosmesis and fitting for any prostheses. The primary purpose of a prosthesis in this group is to protect the chest wall; rehabilitation and prosthesis fit is challenging.(117) While rare, traumatic forequarter amputations do occur. The majority of those are traction injuries although other etiologies can include direct trauma to the upper quarter.(118) These cases present greater management difficulties as there may not be an amputated limb or viable tissue available to harvest for wound closure.

h. Surgical Muscle Balancing Strategies and Wound Closure Techniques

Myodesis, the process of attaching muscle tendon units directly to the bone, is the surgical technique that provides the most stable construct over the distal bone end. This is typically achieved by suturing the muscle and/or tendon to the bone end, usually through drill tunnels, or less commonly, to the periosteum. Myoplasty, attaching agonist muscles to antagonist muscles over the bone end to create physiologic tension, and myofascial closure, or suturing of muscle and fascia together, are less stable constructs that may be indicated when myodesis cannot be achieved for secondary muscles once primary myodesis is performed, or to contour remaining muscles before closure. While there is no data to support the superiority of myodesis over myoplasty, the expert consensus is myodesis in ULA provides the most stable residual extremity and best isolates muscle signals for use in myoelectric prosthetic control.

Stabilizing the muscle-tendon units of the residual extremity near physiologic tension at the time of amputation closure serves two main purposes. First, it provides robust coverage over the distal bone end, providing comfortable padding for the prosthetic socket while preventing the formation of painful bursa from mobile muscle units. Second, optimal contractility characteristics of the muscle are preserved, improving muscle signal quality, and maximizing myoelectric prosthetic control.

Local tissue flaps or free tissue transfer should be considered in the following cases to preserve:

- A functional shoulder joint and a TH amputation level
- A functional elbow joint and a TR amputation level
- A partial carpal or hand amputation level for future reconstructive efforts

When residual tissue flaps are inadequate to provide distal amputation coverage, and shortening will diminish prosthetic fitting and functional outcomes, additional soft tissue coverage options, including skin grafts and flaps, should be strongly considered. This is perhaps most important in shoulder and elbow joint preservation and when optimizing the length of the TH and TR amputation.

Studies have demonstrated that residual extremities can still have excellent function with a terminal skin graft, provided otherwise robust soft tissue coverage is present. The use of dermal substitutes as an adjunct to skin grafting has proven successful in ULA, providing a more durable skin graft prosthetic interface, and allowing direct surgical approaches for future reconstructive procedures.(119, 120)

The use of microvascular free tissue transfer in well-selected patients to maximize length and provide durable soft tissue coverage has been successful in ULA.(115, 121, 122) Indications for free tissue transfer include:

- Shoulder joint preservation by preserving a TH amputation level
- Elbow joint preservation
- Preservation of bone greater than 7 cm below the shoulder or elbow
- Preservation of a partial hand or carpal level amputation to allow for future reconstructive surgery

Relative indications include wrist joint preservation and skeletal preservation between 5 – 7 cm below the shoulder or elbow. While ULA requiring skin grafts or flaps will take longer to heal, the functional benefits of joint and/or length preservation will usually outweigh any delays in rehabilitation and prosthetic fitting.

B. Emerging Surgical Techniques

At this time, some emerging surgical techniques may support greater patient function, reduce pain, and integrate with evolving technological advances in prosthetic devices. These techniques show promise in early studies but may not yet be considered standard of care. Providers need to be aware that such procedures exist and understand that there are implications for length and type of rehabilitation, types of prostheses, and other considerations over the continuum of care.

a. Targeted Muscle Reinnervation

Targeted muscle reinnervation involves “transferring distally innervating peripheral nerves from muscles that are no longer present or functional to more proximal available or functional musculature.”(123) This technique allows the creation of up to six sites for myoelectric control of the prosthesis.(36) Emerging research shows additional potential for reduced PLP and residual limb pain, although some of the risks involved in TMR include neuromas of the dissected nerve, local wound problems, and compromised limb/socket interface due to scarring or hypersensitivity.(123, 124)

b. Regenerative Peripheral Nerve Interface

The RPNI is another form of neural interface that may decrease neuroma formation, post-amputation pain, PLP, and sensation.(125) The described procedure involves implanting the free end of a transected peripheral nerve into a segment of free autologous muscle. This surgical procedure can be performed

prophylactically at the time of the index amputation or as a staged procedure for symptomatic neuromas.

c. Agonist Antagonist Myoneural Interface

The AMI is another emerging technology in limb amputation surgical management that has shown promise to improve patient outcomes by providing bidirectional neural feedback and proprioceptive feedback in the residual limb.(126) This theory was developed using a rat animal model to connect agonist and antagonist muscles in the healthy tissues of the distal residual limb following amputation.(126, 127) The first description of AMIs being used in the human extremity was a case series of three below the knee amputations (BKA) with encouraging results for increased proprioception of the distal residual limb and decreased PLP.(128) Although trialed in persons with ULA, there is currently no published literature supporting the safety or outcomes of the AMI procedure in this population.(129)

d. Osseointegration

For the attachment of the prosthesis to the residual limb, OI has been used in Europe for more than 20 years for both lower and upper extremities and in the U.S. for over a decade. This includes emerging work with osseointegrated digits.(123, 129-131) It involves inserting a titanium implant into the distal bone of the residual limb. A percutaneous implant component allows the prosthesis to attach directly to the skeleton without the use of a socket. As a result, the residual limb is free of skin complications commonly associated with the use of a socket suspension system and is available for tactile feedback. The inclusion criteria for this procedure include skeletal maturity, sufficient bone stock to support the fixture, and the ability to complete rehabilitation.(132) Minor complications are most common, such as soft tissue infections, and may be mitigated in the future by improvements in surgical technique and implant design.(133)

Appendix G: Control Strategies for Body-Powered and Externally Powered Prostheses

A. Control of a Body-Powered Prosthesis

A body-powered or cable driven prosthesis is controlled by one's own body motions. Depending on the level of amputation, gross muscle movements are captured by a cable traversing from a harness to the TD.(134, 135) Specific combinations of proximal motions produce tension through the cable that results in prosthetic function.

For a TR amputation patient, glenohumeral flexion and scapular protraction will produce TD function. It is important to train the patient to minimize motions of the contralateral shoulder and scapula to allow for optimal control of a unilateral prosthesis.(134)

For a TH amputation patient, the cable from the harness to TD will pass through an anchor(s) near the elbow joint. Glenohumeral flexion and scapular protraction will produce elbow flexion when the elbow is unlocked and TD open or closed, depending on the type of TD used (voluntary open or voluntary close).(134, 135) Locking and unlocking of the elbow unit is captured through a strap attached to the harness and routed to the anterior aspect of the shoulder into the elbow unit. The application of tension through the locking strap locks the elbow and unlocks the elbow. Locking the elbow unit in various positions is achieved with oblique glenohumeral extension of the residual limb and scapular depression.(136) To unlock the elbow, the locking strap must recoil first and then the same motion for locking is used to unlock.(135) The elbow will not lock if tension has not been removed from the locking strap which is achieved through scapular elevation with the shoulder in neutral or slightly flexed. For new users, glenohumeral abduction may be exaggerated during glenohumeral extension and scapular depression to lock or unlock the elbow however as proficiency improves abduction will be used less frequently.(134)

B. Control of an Externally Powered Prosthesis

An externally powered prosthesis is one characterized by at least one motorized joint, powered through a battery, and actuated by the user through one or more control inputs.

The most common control inputs for externally powered prostheses are electromyography (EMG) surface electrodes embedded into the socket. Externally powered prostheses that utilize EMG electrodes are commonly referred to as "myoelectric" prostheses. The EMG electrodes can be thought of as antennae that pick up the electrical signal given off by muscle tissue as it contracts. These signals are then amplified and converted into commands used to control the movement of a given motorized joint. Adjustments and programming are possible using various software packages, specific to the prosthesis product being used.

It is important to understand that EMG sites are not required to consider externally powered components. Other control inputs, such as force sensitive resistors (FSRs), linear transducers, toggle and rocker switches, and inertial measurement units (IMUs) are available to increase the potential for using externally powered joints.

Depending on the level of amputation, types of components, and number of available "joints" that make up the myoelectric prosthesis, various control strategies may be utilized. The control strategy is the method used to translate the user's intent, with regards to operating the prosthesis, by converting that intention into an electric signal and using that electric signal to actuate a particular motion of a powered joint. Various control configurations can be programmed into the prosthesis by the prosthetist with input from the patient and therapist. They include sequential, and/or simultaneous, control strategies.

Sequential control refers to a system where each joint is controlled by the same input signals and the user must cycle through each "mode" (e.g., "hand mode," "wrist mode," or "elbow mode") to get to the joint motion they wish to control. To switch from one mode to another, the control configuration may involve strategies such as co-contraction of two myosites, use of a hard/fast versus a soft/slow contraction, use of a separate input. Alternatively, it may be set to automatically switch to a specific mode after a predetermined time delay.

Simultaneous control refers to the use of additional control inputs that can be designated for specific movements. The most common example is that of a powered TH prosthesis that uses a linear transducer to control a powered elbow and two antagonistic myosites that are programmed to control the powered TD and/or wrist. This setup allows the user to simultaneously activate the elbow with the TD or wrist since the elbow is always active. Control of the wrist and TD would be navigated using a sequential strategy as described above.

Electromyography pattern recognition systems designed for use with prostheses may improve the ability of a patient with ULA to obtain more intuitive control of externally powered prostheses. Pattern recognition systems utilize an array of numerous surface EMG electrodes and are capable of discerning more diverse muscle contraction patterns, as compared to the traditional single-site or dual-site set ups. The patterns can be differentiated and assigned to specific motor commands of the externally powered prosthesis using computer software. Pattern recognition may benefit patients with higher amputation levels and those who have undergone TMR.(137-139)

Another developing control strategy option is that of "end-point control." This strategy allows the user to actuate multiple powered joints, in simultaneous coordinated movement, to bring the TD to a desired point in space. Inertial measurement units or EMG pattern recognition inputs are more suited for this control. As an example, an externally powered upper limb prosthesis which includes a powered shoulder, elbow wrist, and hand has a large number of powered degrees of freedom. Rather than plan the motion of each powered joint to get the prosthetic TD into a desired position, the control commands, using endpoint control, may be simplified as "hand up/down," hand left/right," "hand forward/back," etc. Endpoint control reduces the number of required control inputs in the system and can enable coordinated movement of the shoulder, elbow, wrist, and hand. This control strategy provides an alternative reference point for prosthetic control and provides the potential to improve anthropomorphic movements in prostheses for more proximal levels of limb loss.(140)

Appendix H: Training for Body-Powered and Externally Powered Prostheses

A. Overview of Training

Quality training in the use of a prosthesis is essential to ensure the best outcomes for the limb loss population. Occupational and physical therapists train the limb loss patient from basic operation of the device up to seamless incorporation of the device in complex tasks without having to think about movement. Coaching and practice assists the patient in motor relearning, normal quality of motion, anticipatory skills, and carry over of learned techniques to a variety of tasks. Among other goals, therapy aims to teach the patient how best to operate a prosthetic device and how to analyze tasks to incorporate the device into daily activities. The real skill of prosthesis training comes in the patient looking at the environment with a critical eye of anticipating how the prosthesis will best assist them and or how to adapt to the environment. Having another efficient functional grasp helps the patient be more functional as well as gives them a sense of fulfillment. If a patient has learned the following essential skills with a trained professional, then they have achieved a level of competence and are encouraged to use or not use a prosthesis at their discretion. The following is a general guideline for clinicians to follow to ensure general concepts are covered in training.

B. Residual Limb Management

- Scar massage and desensitization: Important for reducing scarring and preparing to tolerate weight and pressure of a socket. This also serves to make them aware of any sensitive areas of their residual limb.
- Therapeutic exercise for residual limb: Use of cuff weights, theraband, or strap with metal D-ring for use with cable machine.
    - Important to initiate in preparation for a prosthesis. Promotes tolerance of the weight of the prosthesis, pressure, and muscular endurance for long-term wearing.
- ROM:
    - Prevent loss of ROM in the proximal joints of the residual limb initiate early in rehabilitation.
    - Myosite deep pressure massage to stretch muscle site.
    - Stretching of residual musculature is important long-term to ensure symmetry due to compensatory movements, loss of weight of the limb, and less use of the distal extremity.
- Strengthening:
    - Increase strength to tolerate weight of a prosthesis with use of cuff weights or cable machine to strengthen and desensitize the residual limb.
    - Strengthening proximal joints will promote symmetry and may decrease atrophy to the affected limb.
    - Postural training, exercise, and yoga/pilates may prevent pain and deformity due to asymmetry.

- Skin checks and wearing schedule:
    - Limit prosthesis wear time to 1 to 2 hours initially, then increasing an hour or so every few days.
    - Monitor skin for signs of excessive pressure, blister, or wound formation. This is especially important if there is impaired sensation or skin grafts.
    - Use a mirror to self-monitor daily.

C. Prosthesis Training Concepts

Prosthesis training provides the opportunity for a patient to become familiar with the device and progress to a level of expertise. Patients should be encouraged to experiment through this process with how tasks are performed and be assisted with determining how the device may best assist the individual. The ability to accurately control a device may vary from person to person and from body powered to myoelectric, but the therapist's role is to help each individual identify appropriate challenges and have realistic expectations in task performance. Expectation management and appropriate sub-task selection is key to success. Therapists are encouraged to review these concepts with their patients to ensure covering the necessary skills (see below).

- Control of prosthesis: operating all joints individually and combined.
    - Body powered: teach the patient to operate all device motions by gross body movements. Challenge patient to operate the device at various heights and distances away from the body
    - Myoelectric: begin by using software programs to maximize control accuracy, especially for patients with more complicated muscle activation controls like quick/slow, double/triple impulse, linear potentiometer, and pattern recognition.
        - Perform accuracy testing: have the patient perform four motions of wrist and TD outlined below. Repeat three times for open, rotate clockwise, close, and rotate counterclockwise. Then record if they were a) correct, b) performed the wrong motion/stalls with number of attempts, or c) were unable. The individual 1) opens the TD ¾ of the full finger extension, 2) supinates 180 degrees, 3) closes TD to ¼ extension, and 4) pronates 180 degrees. This is repeated three times and the therapist should cue the patient to the next motion, so they don't have to guess the next motion. The clinician can make a list of 1 to 12, mark when there is an error or delay and get a percentage of accuracy by dividing the correct motions from the 12 motions to track progress over time.
        - Make sure to involve the prosthetist as they may have more adjustments available to improve myoelectric signal and control.
- Quality of movement: teach the patient to maintain supporting joints in the appropriate positions to prevent strain and awkward movements. Use mirrors and therapist cues to help patients be aware of compensatory movements such as shoulder hiking, extreme shoulder flexion, elbow abduction, or excessive internal humeral rotation. Therapist cues, mirrors, and video feedback (with patient permission) may be used so patients learn to maintain thoracic

spine extension, ensure scapular retraction/depression, keep the elbow adducted, and avoid aberrant compensatory movements listed above.

- Prepositioning: educate the patient to anticipate the appropriate position that the prosthetic devices need to be in for optimal engagement in a selected task. For example, make sure when preparing to grasp that the tines or fingers face the appropriate direction to optimize grasp. Or more explicitly, having the prosthetic hand open and rotated to face the intact hand prior to receiving an object from the other hand.
- Rote tasks:
    - Pass objects to and from prosthesis to contralateral hand in different positions. Do this without vision, behind the back, between the legs, and in all positions of elbow and shoulder movement.
    - Grasp and release objects in various planes of movement to optimize use of the prosthesis for all tasks.
        - Body powered difficulties: operating with full elbow flexion, shoulder at 90 degrees of flexion, overhead, or behind back. Patients should be educated about the 3-dimensional functional envelope for using the prosthesis (the area around the body where the prosthesis can be operated most easily) in front of them.
        - Myoelectric power difficulties: overhead, reaching, holding heavy items, and maintaining grasp to prevent dropping items.
- Experiment with use of the TD with bilateral tasks: have the patient try to perform bilateral tasks (see below task list) in a few different methods/strategies and see what works best for them. Discuss advantages and disadvantages of performance, focus on efficiency of movements.
    - Tying shoe or lacing board: have the patient identify how many pinches are the most efficient and how fast they can perform once they find the best method.
    - Try performing other tasks three different ways and discuss what works best.
- Adjustments to the arm: patients should learn, when appropriate, how to adjust the prosthesis or prosthetic control system and master the subtleties of control.
    - Body powered: how to adjust control cable length. How to tighten or lock TD in place. Pad or prevent chafing from prosthesis. How to repair a broken control cable or strap.
    - Myoelectric: how to alter gain of the electrodes. When to turn the device off or disable features, such as turning off the hand/wrist or locking a joint.
    - Sockets: how to relieve or change pressure from the socket or strapping and how to make various socket suspension adjustments.
- Holding objects while performing tasks. Developing trust and learning where and when tasks can be performed consistently. Three points of control on the object is optimal.
    - Holding coffee while operating keys and open door.
    - Holding stabilizing utensil while cutting.

    - Leather lacing tasks.
    - Beading strings.
    - Cutting fruit and placing on a wooden skewer.
- Dexterity: encourage performing things rapidly to increase efficiency and improve function.
    - Timing simple tasks with a stopwatch such as stacking cones or moving blocks.
    - Asking the patient to anticipate how long it will take to perform a particular task and see if they were correct.
    - Challenge the patient to find a way to perform faster or compete for fun against another patient.
- Light touch: practice performing light touch to prevent deforming or breaking certain objects. Can be performed with foam blocks or thin disposable plastic cups.
- Performing tasks without vision, such as in the dark or with vision excluded to facilitate proprioceptive knowledge and skill with TD in space. For example, tasks such as: don/doff glove, pants, shirt, jacket, and tie shoes.
- Rote complete task performance: more practice with repetitive tasks to increase automatic performance and increase dexterity
    - Folding laundry/towels, washing dishes, cleaning tasks, vacuum, or sweeping.
    - Wallet management tasks, filing files, lacing, or sewing tasks.
- Bimanual task list: therapist reviews the list of activities in Table H-1, identifies meaningful activities to the patient, and then coaches and discusses what approaches are efficient and what works best for the patient. Therapist discusses strategies for adapting tasks or objects to be adapting tasks or objects to be adapted to perform tasks more easily.

Table H-1. Prosthetic Training: Bimanual Task List

Bimanual Task List	
• Feed self with utensils	• Clean prosthesis
• Cut food with knife	• Don/doff prosthesis
• Open variety of food packages	• Re-charge batteries
• Eat finger foods	• Change TD
• Drink from cup or bottle	• Remove/apply harness
• Don/doff bra	• Turn prosthesis on/off
• Don/doff pull-over shirt	• Apply compression garment or sleeve
• Dress button-down shirt: cuffs and front	• Skin care management – visual inspection
• Manage zippers and snaps	• Wash clothes
• Don/doff pants	• Hang clothes
• Don/doff belt	• Fold clothes
• Don/doff socks	• Set up ironing board
• Don/doff shoes, boots	• Iron clothes
• Lace and tie shoes	• Hand wash dishes
• Screw/unscrew cap of toothpaste tube	• Dry dishes with a towel
• Squeeze toothpaste	• Load and unload dishwasher

Bimanual Task List

- Use toothbrush to brush teeth
- Floss teeth
- Open/close bottle of pills or pillbox
- Manipulate pills
- Shave
- Perform residual limb care
- Wash back
- Apply deodorant
- Wash/dry hand
- Bathe/dry upper body
- Bathe/dry lower body
- Wash/blow dry hair
- Blow nose
- Toilet paper management
- Feminine hygiene
- Flushing toilet
- Wipe self
- Apply lotion
- Apply make-up
- Clean fingernails
- Cut and file fingernails
- Polish fingernails
- Use/remove contacts
- Place and remove glasses
- Patient specific tasks
- Open/close safety pin
- Change diapers
- Brush/arrange child's hair
- Use phone and take notes simultaneously
- Operate door knob
- Place chain on chain lock
- Plug/unplug cord into wall outlet
- Set time on watch
- Receive change/ count coins
- Remove keys or wallet from pocket
- Take dollar bill from wallet
- Write signature
- Answer phone
- Text message on cell phone
- Open mail
- Hold/turn pages of paperback, magazine, newspaper
- Operate lamp
- Use an umbrella
- Change a light bulb
- Hang a picture
- Use scissors
- Use ruler
- Remove and replace ink pen cap
- Use broom and dustpan
- Operate vacuum cleaner
- Use wet and dry mop
- Sweep/mop the floor
- Dust the furniture
- Clean countertops
- Clean the toilet/sink/tub
- Make bed/change sheets
- Change garbage/trash bag
- Open/close jar – tight or new
- Open lid of can
- Cut vegetables
- Peel vegetables
- Peel banana
- Crack an egg
- Stir food in bowl
- Manipulate hot pots
- Turn an egg or pancake with spatula
- Use measuring cups
- Use measuring spoons
- Scoop ice cream
- Use toaster
- Open pop-top
- Wrap/unwrap food in foil and or plastic wrap
- Put dishes in overhead cabinet
- Pour milk from carton
- Use mixer
- Use lock-type plastic bags
- Light a match
- Sew a button
- Turn key in lock
- Carry a suitcase
- Operate window blinds
- Open pet food container
- Attach and hold dog leash
- Change litter box
- Fill water dish
- Play cards or board game
- Operate TV remote control
- Manipulate radio
- Use computer: typing, mouse
- Use CD/DVD player
- Grocery shopping – push a cart, load, unload
- Carry grocery bags
- Use vending machine
- Make change/receive change
- Use ATM
- Use public transportation

Bimanual Task List	
• Sharpen pencil	• Open and close car doors, trunk, and hood
• Fold and seal letter	• Perform steps required to operate vehicle
• Use paper clip	• Open/close gas cap and door
• Use stapler	• Operate gas pump
• Thread a needle	• Fill windshield wiper fluid
• Wrap package	• Test level and add oil
• Carry a tray	• Wash windows
• Don/doff pantyhose	• Scrape ice/snow from car
• Tie a tie or scarf	• Fasten/unfasten seat belt
• Don/doff glove	• Start ignition
• Assembling a tent	• Making a fire in a fire pit
• Rowing a boat	• Cooking on a grill
• Mowing lawn	• Weed whacking/hedge trimming
• Painting a room	• Setting up and climbing a ladder
• Construct a moving box	• Operate controls

Abbreviations: TD: terminal device

- Compare and contrast different TDs and advantages/disadvantages with a variety of tasks.
- Unilateral performance with prosthesis: increases proficiency with control and creative use of the prosthesis with more complex challenges.
    - Eat a snack and drink with only the prosthesis.
    - Using a key to unlock a door.
    - Build a construction task only with the TD like Lincoln Logs or large LEGO bricks.
    - Make a sandwich or cook an egg with only the prosthesis.
- Adaptive sports/fitness/recreation/leisure tasks:
    - Complex, multi-step tasks such as setting up a campsite and tent.
    - Activity specific devices for specific sports or activities. How to find a way to make other devices work if needed.
    - Educate patient on how to incorporate prosthesis into high level fitness tasks.
    - Select whole tasks to be performed and how to perform them, such as going camping, going to the beach, packing for a picnic, taking photographs, and planning to go on vacation with devices needed.
    - Practice return to meaningful recreational or leisure tasks that the patient may want to resume performing.
- Multitasking with prosthesis: increase cognitive load to increase difficulty to process prosthesis use.
    - Make a three-course meal simultaneously.
    - Perform a construction task quickly while listening to a podcast. Attempt to remember all details of the podcast to be questioned after task completion.

- Adapting tasks or objects for success with prosthesis.
    - Increase or reduce friction of some objects with use of self-adherent wrap (e.g., Coban™), Dycem™ non-slip, or moisturizer.
    - Prevent scratching from metal hooks by adding rubber tubing to prosthesis tines.
    - Adding built up foam handles or making custom interface to allow grasp to be performed easier with prosthesis and prevent rotation of the object in the device.
- Work tasks: practice set up and performance.
    - Ergonomics assessment and look at how to incorporate prosthesis into office tasks while ensuring good body mechanics.

D. Education Topics

Medical providers should take every opportunity to educate patients early and often throughout the rehabilitation process. The patient can make informed decisions when educated about prostheses and various prosthetic limb options for control and function. However, the information presented must not be overwhelming for the patient. These topics serve to stimulate awareness about the field of prosthetics to encourage the patient to advocate for their needs and seek out answers to the many new physical challenges they face daily.

- Scar massage
- Adaptive equipment
- How prosthetics realistically assist function
- How to protect and decrease stress on an intact limb
- The importance of humor in recovery
- The importance of peer support and success stories
- Casting and prosthesis fitting process
- Prosthesis suspension types
- How to best exercise, stretch, and strengthen
- Educate about the muscles involved in operation of devices
- How myoelectric prostheses operate
- How myoelectric software can identify a switch between prostheses actions (quick/slow, co-contraction, double/triple impulse)
- Pattern recognition systems such as CoApt and Myo Plus from Otto Bock
- Clarify that although there are more devices and control systems available, using microvolts traveling in muscles to act as switches is not a perfect system. Errors happen and precise control is not guaranteed.
- Review safety and situations that would be dangerous, such as holding on to heavy machinery without a way to automatically release/open TD

- Types of TDs for body powered or myoelectric prostheses
- Advantages and disadvantages of different TDs

Appendix I: Patient Focus Group Methods and Findings

A. Methods

VA and DoD Leadership recruited nine participants for the focus group, with support from the Champions and other Work Group members as needed. While participant recruitment focused on eliciting a range of perspectives likely to be relevant and informative in the CPG development process, patient focus group participants were not intended to be a representative sample of VA and DoD patients. Participants were not incentivized for their participation or reimbursed for travel expenses.

The Work Group, with support from the Lewin Team, identified topics on which patient input was important to consider in developing the CPG. The Lewin Team developed, and the Work Group approved and patient focus group guide covering these topics. The focus group facilitator led the discussion used the guide to elicit the patients' perspectives about their treatment and overall care. Given the limited time and the range of interests of the focus group participants, not all questions were addressed.

B. Patient Focus Group Findings

a. Participants believed that an individualized rehabilitation plan is critical, including goals, prescribing prostheses to achieve functional goals, patient education, and pain management. Patient-provider communication is extremely important in identifying an optimal set of physical/occupational therapies and prostheses.

- Participants reported difficulty seeking and finding information related to ULAs, including information on prosthetic devices.
- Participants emphasized the importance of communicating their functional goals with their providers and having these goals supported and achieved throughout their ULA rehabilitation.
- Two participants expressed disfavor for testing and assessments (e.g., box and blocks) during rehabilitation as these diagnostic tools did not parallel their ADLs.
- Two participants noted that pain management is an important component of rehabilitation.

b. Participants strongly valued peer support and emphasized the importance of connecting with peers who have similar experiences, amputations, and functional goals. Informal peer networks also provide a useful forum for sharing information about real-world adaptation to upper extremity amputations, accomplishing ADLs/functional goals, coping with limitations, and as a source of information on devices and prosthetic choices.

- Participants reported that it is important to feel understood and connected following ULAL.
- Participants reported relying on peer support networks for advice and information.
- Participants reported it is important to be matched with peers who have similar experiences, amputations, and functional goals.

c. While participants valued having a range of prosthetic devices available to meet their varied functional needs, they noted fitting was often challenging, leading some to discontinue prosthetic use.

- Participants valued having a range of prosthetic devices available to meet their unique functional goals.
- Participants shared struggling with prosthetic fit and function and noted this is an ongoing topic of discussion with their providers.
- Generally, participants reported prosthetic functionality is more important than cosmesis.
- Several participants reported discontinuing use of one or all of their prosthetic devices.

d. Participants stated that they did not wear their prostheses all day since they found some activities easier to do without a device by adapting to their amputation. Generally, participants reported prosthetic functionality was more important than cosmesis. Women reported finding prostheses to be too large/sized for men and too heavy for their body habitus. Women asked for prostheses to be designed for a woman's body size and muscle strength.

- Some participants reported discontinuing use of one or all of their prosthetic devices.
- Generally, participants reported prosthetic functionality is more important than cosmesis.
- Female participants requested prostheses to be designed for their body sizes and muscle strength.

e. Participants reported that a team-based approach to care is important, including pre-surgical coordination between surgeons, prosthetists, nurse case managers, and occupational and physical therapists. Participants also reported valuing regular, private, in-person consultation with their prosthetists.

- Participants emphasized the importance of pre-surgical prosthetic consultations when possible.
- Participants also emphasized the importance of defined clinical care coordinators, such as nurse case managers.
- Participants also reported valuing regular, private, in-person communication with their providers.

f. Participants reported that adaptive sports programs and behavioral health interventions were valuable additions to routine occupational and physical therapy.

- Participants valued adaptive sports programs and other physical activities.
- Although participants valued the opportunity to participate in behavioral health interventions, few did.
- Except for children and in some cross-cultural contexts, participants reported facing minimal stigma regarding their amputation.

Appendix J: Evidence Table

Table J-1. Evidence Table[a,b,c,d]

#	Recommendation	2014 Strength of Recommendation	Evidence	2022 Strength of Recommendation	Recommendation Category
1.	There is insufficient evidence to assess the impact of the level of amputation or amputation surgical procedure type on functional status and prosthesis-related outcomes.	Not applicable	(24-28) **Additional references**: (29)	Neither for nor against	Reviewed, New-added
2.	For patients undergoing upper limb amputation surgery, there is insufficient evidence to recommend the use of any particular factors to predict the speed and quality of wound healing, successful prosthesis fitting, or need for revision surgery.	Not applicable	**Additional references**: (30-33)	Neither for nor against	Reviewed, New-added
3.	There is insufficient evidence to recommend for or against the use of any particular recent treatment advances including hardware, software, surgical, technology, or supplemental surgical interventions, such as: • targeted muscle reinnervation (TMR) • regenerative peripheral nerve interfaces (RPNI) • vascularized composite allotransplantation (VCA) • agonist-antagonist myoneural interface (AMI) • implantable myoelectric sensor system (IMES) • osseointegration (OI)	Not applicable	(34-36) **Additional references**: (37-42)	Neither for nor against	Reviewed, New-added
4.	There is insufficient evidence to recommend for or against any particular training protocol to improve function and outcomes.	Not applicable	**Additional references**: (43-46)	Neither for nor against	Reviewed, New-added

[a] 2014 Strength of Recommendation column: "Not applicable" indicates that the 2022 VA/DoD ULA CPG recommendation was a new recommendation, and therefore does not have an associated 2014 strength of recommendation.

[b] Evidence column: The first set of references listed in each row in the evidence column constitutes the evidence base for the recommendation. To be included in the evidence base for a recommendation, a reference needed to be identified through a systematic evidence review carried out as part of the initial development or update of this CPG. The second set of references in the evidence column (called "Additional References") includes references that provide additional information related to the recommendation, but which were not identified through a systematic evidence review. These references were, therefore, not included in the evidence base for the recommendation and did not influence the strength and direction of the recommendation.

[c] 2022 Strength of Recommendation column: The 2022 VA/DoD ULA CPG was developed using the GRADE approach to determine the strength of each recommendation. Refer to the Grading Recommendations section for more information.

[d] Recommendation Category column: Refer to the Recommendation Categorization section for more information on the description of the categorization process and the definition of each category.

#	Recommendation	2014 Strength of Recommendation	Evidence	2022 Strength of Recommendation	Recommendation Category
5.	We suggest the use of mirror therapy for the short-term reduction of phantom limb pain.	Not applicable	(47-49)	Weak for	Reviewed, New-replaced
6.	There is insufficient evidence to recommend for or against any particular treatment setting, intensity, or service delivery model.	Not applicable	**Additional references**: (50, 51)	Neither for nor against	Reviewed, New-replaced
7.	For patients with major unilateral upper limb amputation (i.e., through or proximal to the wrist), we suggest use of a body-powered or externally powered prosthesis to improve independence and reduce disability.	Not applicable	(29, 52-57)	Weak for	Reviewed, New-added
8.	There is insufficient evidence to recommend for or against any specific control strategy, socket design, suspension method, or component.	Not applicable	(29, 52-57)	Neither for nor against	Reviewed, New-added
9.	There is insufficient evidence to recommend for or against a particular intervention for the *prevention* of phantom and/or residual limb pain.	Not applicable	**Additional references**: (58)	Neither for nor against	Reviewed, New-replaced
10.	There is insufficient evidence to recommend for or against any particular pharmacologic intervention for the *management* of phantom and/or residual limb pain.	Not applicable	(59) **Additional references**: (60, 61)	Neither for nor against	Reviewed, New-replaced
11.	There is insufficient evidence to recommend for or against the use of non-invasive brain stimulation for the management of phantom limb pain.	Not applicable	(47-49)	Neither for nor against	Reviewed, New-added
12.	There is insufficient evidence to recommend for or against the use of any specific assessment tool to guide the determination of prosthetic candidacy, the need for therapy, or for identifying improvement or worsening of function and quality of life.	Not applicable	(26, 28, 62)	Neither for nor against	Reviewed, New-added
13.	We suggest screening patients for cognition, mental health conditions such as posttraumatic stress disorder and depression, and pain during the initial evaluation and across the continuum of care.	Not applicable	(52, 63-73)	Weak for	Reviewed, New-added
14.	We suggest offering peer support services.	Not applicable	(74) **Additional references**: (75)	Weak for	Reviewed, New-replaced

Appendix K: 2014 Recommendation Categorization Table

Table K-1. 2014 UEAR CPG Recommendation Categorization Table[a,b,c,d,e,f]

2014 CPG Recommendation #	2014 CPG Recommendation Text	2014 CPG Strength of Recommendation	2014 CPG Recommendation Category	2022 CPG Recommendation Category	2022 CPG Recommendation #
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.	Expert Opinion	-	Not reviewed, Deleted	-
2.	Care teams should communicate on a regular basis to facilitate integration of a comprehensive treatment plan.	Expert Opinion	-	Not reviewed, Deleted	-
3.	Comprehensive interdisciplinary assessments and reassessments should be completed during each of the first three phases of care (perioperative, pre-prosthetic and prosthetic training).	Expert Opinion	-	Not reviewed, Deleted	-
4.	Annual comprehensive interdisciplinary screening should be conducted for all patients with an upper extremity amputation throughout lifelong care.	Expert Opinion	-	Not reviewed, Deleted	-
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.	Expert Opinion	-	Not reviewed, Deleted	-
6.	A shared decision making model, incorporating patient goals, should be used throughout all phases of rehabilitation to ensure patient-centered care.	Expert Opinion	-	Reviewed, New-replaced	6

[a] 2014 CPG Recommendation # column: This indicates the recommendation number of the recommendation in the 2014 VA/DoD UEAR CPG.
[b] 2014 CPG Recommendation Text column: This contains the wording of each recommendation from the 2014 VA/DoD UEAR CPG.
[c] 2014 CPG Strength of Recommendation column: The 2014 VA/DoD UEAR CPG used a variation of the USPSTF grading framework to provide for a rating of EO for "Expert Opinion."
[d] 2014 CPG Recommendation Category column: Recommendation categories were not assigned during the development of the 2014 VA/DoD UEAR CPG. Refer to the Recommendation Categorization section for more information on the description of the categorization process and the definition of each category.
[e] 2022 CPG Recommendation Category column: This is the recommendation category assigned during the development of the 2022 VA/DoD ULA CPG. Refer to the Recommendation Categorization section for more information on the description of the categorization process and the definition of each category.
[f] 2022 CPG Recommendation # column: For recommendations that were carried forward to the 2014 VA/DoD UEAR CPG, this column indicates the new recommendation(s) to which they correspond.

2014 CPG Recommendation #	2014 CPG Recommendation Text	2014 CPG Strength of Recommendation	2014 CPG Recommendation Category	2022 CPG Recommendation Category	2022 CPG Recommendation #
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.	Expert Opinion	-	Not reviewed, Deleted	-
8.	Patient-centered physical and functional rehabilitation interventions should be initiated based on the rehabilitation plan and the patient's physical and psychological status.	Expert Opinion	-	Not reviewed, Deleted	-
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.	Expert Opinion	-	Reviewed, New-replaced	5, 9, 10
10.	The care team should provide appropriate education and informational resources to patients, family and caregiver(s) throughout all phases of care.	Expert Opinion	-	Not reviewed, Deleted	-
11.	The care team should facilitate early involvement of a trained peer visitor.	C	-	Reviewed, New-replaced	14
12.	The decision for amputation should be made based upon accepted surgical and medical standards of care.	Expert Opinion	-	Not reviewed, Deleted	-
13.	Communication must occur between the surgical and non-surgical members of the care team in order to optimize surgical and functional outcomes.	Expert Opinion	-	Not reviewed, Deleted	-
14.	The care team should ensure that the patient is optimized for rehabilitation to enhance functional outcomes.	Expert Opinion	-	Not reviewed, Deleted	-
15.	Following amputation, the care team should ensure that the patient has achieved his or her highest level of functional independence without a prosthesis.	Expert Opinion	-	Not reviewed, Deleted	-
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.	Expert Opinion	-	Not reviewed, Deleted	-
17.	Once the appropriate type of prosthesis is identified, the care team should write a prosthetic prescription including all necessary components.	Expert Opinion	-	Not reviewed, Deleted	-
18.	Initiate upper extremity prosthetic fitting as soon as the patient can tolerate mild pressure on the residual limb.	Expert Opinion	-	Not reviewed, Deleted	-

2014 CPG Recommendation #	2014 CPG Recommendation Text	2014 CPG Strength of Recommendation	2014 CPG Recommendation Category	2022 CPG Recommendation Category	2022 CPG Recommendation #
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.	Expert Opinion	-	Not reviewed, Deleted	-
20.	The care team should frequently reassess the patient's prosthetic fit and function throughout the prosthetic training phase and modify as appropriate.	Expert Opinion	-	Not reviewed, Deleted	-
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.	Expert Opinion	-	Not reviewed, Deleted	-
22.	The care team should offer active prosthesis users at least one back up device to ensure consistency with function.	Expert Opinion	-	Not reviewed, Deleted	-
23.	Prescription of activity specific or alternate design prostheses may be considered, dependent upon the patient's demonstration of commitment, motivation, and goals.	Expert Opinion	-	Not reviewed, Deleted	-
24.	Upon completion of functional training, and to ensure continuity, the care team should coordinate patient transition into the lifelong care phase.	Expert Opinion	-	Not reviewed, Deleted	-
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.	Expert Opinion	-	Not reviewed, Deleted	-
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.	Expert Opinion	-	Not reviewed, Deleted	-
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.	Expert Opinion	-	Not reviewed, Deleted	-

Appendix L: Participant List

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Appendix M: Literature Review Search Terms and Strategy

A. EMBASE and MEDLINE with EMBASE.com syntax (all questions)

Question*	Set #	Concept	Strategy
KQ 1	#1	Adults with UE amputation	('arm injury'/exp OR 'upper limb'/exp OR (arm OR arms OR carpal OR digit OR digits OR digital OR elbow* OR finger* OR forearm* OR forequarter OR hand OR hands OR humeral OR humerus OR interscapulothoracic OR metacarp* OR palm OR palms OR ((phalang* OR phalanx*) AND (digit OR digits OR finger* OR hand OR hands OR thumb*)) OR radial OR radius OR shoulder* OR thumb* OR transcarpal OR transhumeral OR transradial OR ulnar OR 'upper extremit*' OR 'upper limb*' OR wrist*):ti,ab,kw) AND ('amputation'/de OR 'amputation stump'/de OR 'amputee'/de OR 'disarticulation'/de OR 'traumatic amputation'/de OR (amputat* OR amputee* OR disarticulat* OR exarticulat* OR 'limb loss*' OR 'loss of limb*' OR postamputation* OR reamputat* OR 'remaining limb*' OR 'residual limb*' OR stump*):ti,ab,kw) OR 'arm amputation'/de OR 'finger amputation'/de OR 'forearm amputation'/de OR 'forequarter amputation'/de OR 'hand amputation'/de OR 'shoulder amputation'/de OR 'thumb amputation'/de OR 'transhumeral amputation'/de OR (loss* NEAR/2 ('upper limb*' OR 'upper extremit*')):ti,ab,kw
	#2	UE prostheses population	(('arm prosthesis'/exp OR 'finger implant'/exp OR (('bionics'/de OR 'electric limb prosthesis'/exp OR 'limb prosthesis'/de OR 'myoelectric control'/de OR 'orthopedic prosthesis'/de OR 'prosthesis fixation'/de) AND 'upper limb'/exp)) OR 'artificial hand*':ti,ab OR ('artificial limb*' AND (arm OR arms OR hand OR hands OR upper)):ti,ab OR (((bionic* OR 'man-machine' OR myoelectric* OR 'myo electric*' OR neuroprosth* OR prosthes* OR prosthet* OR 'robot* manipulat*') NEAR/2 (arm OR arms OR carpal OR digit OR digits OR elbow* OR finger* OR forearm* OR forequarter OR hand OR hands OR humeral OR humerus OR metacarp* OR palm OR palms OR phalang* OR phalanx* OR radial OR radius OR shoulder* OR thumb* OR transcarpal OR transhumeral OR transradial OR ulnar OR 'upper extremit*' OR 'upper limb*')):ti,ab) OR ((neuroprosth* OR prosthes* OR prosthet*) NEAR/4 (arm OR arms OR hand OR hands OR 'upper extremit*' OR 'upper limb*')):ti,ab,kw OR ((((artificial* OR 'body power*' OR bionic* OR electric* OR electronic OR 'external* power*' OR 'man-machine' OR myoelectric* OR neuroprosth* OR prosthes* OR prosthet* OR robot*) NEAR/3 (extremit* OR limb*)):ti,ab OR ('body power*' OR bionic* OR 'external* power*' OR 'man-machine' OR myoelectric* OR neuroprosth* OR prosthes* OR prosthet*):ti) AND (arm OR arms OR carpal OR digit OR digits OR elbow* OR finger* OR forearm* OR forequarter OR hand OR hands OR humeral OR humerus OR metacarp* OR shoulder* OR thumb* OR transcarpal OR transhumeral OR transradial OR 'trans radial' OR ulnar OR 'upper arm*' OR 'upper limb*' OR 'upper extremit*' OR 'upper or lower'):ti,ab))
	#3	General terms	(((advance* OR new OR update* OR novel) NEAR/2 (device* OR hardware OR implant* OR intervention* OR prosthes* OR prosthet* OR reconstruct* OR software OR surger* OR surgical OR technolog* OR treatment*)):ti,ab) OR (((arm OR arms OR hand OR hands OR extremit* OR finger* OR forearm* OR limb* OR 'upper extremit*' OR 'upper limb*') NEAR/2 transplant*):ti,ab,kw) OR (advances OR advancement* OR emerging OR future OR innovat* OR 'state of the art' OR trend* OR novel):ti

Question*	Set #	Concept	Strategy
KQ 1 (cont.)	#4	Specific terms	'composite graft'/de OR 'hand transplantation'/de OR 'limb transplantation'/de OR 'muscle innervation'/de OR 'muscle reinnervation'/de OR 'neuromuscular junction'/de OR 'osseointegration'/de OR 'osseointegrated implant'/de OR 'reinnervation'/exp OR 'targeted muscle reinnervation'/de OR 'vascularized composite allograft'/de OR 'vascularized composite allotransplantation'/de OR 'antagonist interface*' OR AMI:ti,ab OR 'composite allotransplant*' OR 'composite allograft*' OR 'composite graft*' OR 'ewing amputation*' OR 'ewing procedure*' OR 'implant* sensor*' OR (implant* NEAR/2 myoelectric*) OR IMES:ti,ab OR reinnervat* OR 'myoelectric* interface*' OR 'myoelectric* sensor*' OR 'myoneural interface*' OR (neuromuscular NEAR/6 (interface* OR myoelectric* OR myoneural OR osseo* OR sensor*)) OR 'nerve interface*' OR osseointegrat* OR 'osseo integrat*' OR OI:ti OR (regenerat* AND 'peripheral nerve*') OR (regenerat* NEAR/3 interface*) OR RPNI:ti,ab OR 'targeted muscle' OR TMR:ti,ab OR 'vascularised composite' OR 'vascularized composite' OR VCA:ti,ab
	#5	Combine population sets	#1 OR #2
	#6	Combine intervention sets	#3 OR #4
	#7	Combine population and intervention sets	#5 AND #6
	#8	Apply limits, remove unwanted publication types	See limits and hedges at the end of this table
KQ 2	#1	Adults with UE amputation	('arm injury'/exp OR 'upper limb'/exp OR (arm OR arms OR carpal OR digit OR digits OR digital OR elbow* OR finger* OR forearm* OR forequarter OR hand OR hands OR humeral OR humerus OR interscapulothoracic OR metacarp* OR palm OR palms OR ((phalang* OR phalanx*) AND (digit OR digits OR finger* OR hand OR hands OR thumb*)) OR radial OR radius OR shoulder* OR thumb* OR transcarpal OR transhumeral OR transradial OR ulnar OR 'upper extremit*' OR 'upper limb*' OR wrist*):ti,ab,kw) AND ('amputation'/de OR 'amputation stump'/de OR 'amputee'/de OR 'disarticulation'/de OR 'traumatic amputation'/de OR (amputat* OR amputee* OR disarticulat* OR exarticulat* OR 'limb loss*' OR 'loss of limb*' OR postamputation* OR reamputat* OR 'remaining limb*' OR 'residual limb*' OR stump*):ti,ab,kw) OR 'arm amputation'/de OR 'finger amputation'/de OR 'forearm amputation'/de OR 'forequarter amputation'/de OR 'hand amputation'/de OR 'shoulder amputation'/de OR 'thumb amputation'/de OR 'transhumeral amputation'/de OR (loss* NEAR/2 ('upper limb*' OR 'upper extremit*')):ti,ab,kw
	#2	General terms	'behavioral health'/de OR 'motivation'/exp/mj OR 'psychosocial'/de OR 'social adaptation'/de OR 'social behavior'/de OR 'social competence'/de OR 'behavioral health':ti,ab,kw OR communit*:ti OR (communit* AND (assist* OR integrat* OR interact* OR live OR living OR particip* OR reintegrat* OR relation* OR support*)) OR 'general communit*' OR happiness:ti,ab,kw OR 'patient engagement*' OR psychosocial* OR 'psycho social*' OR (social* NEAR/3 (adapt* OR adjust* OR behavior* OR competent* OR integrat* OR interact* OR particip* OR rehab* OR reintegrat* OR skill*))

Question*	Set #	Concept	Strategy
KQ 2 (cont.)	#3	Peer/group/mentor /community	'community'/de OR 'community based rehabilitation'/de OR 'community care'/exp OR 'community reintegration'/de OR 'group therapy'/de OR 'mentor'/de OR 'mentoring'/de OR 'peer acceptance'/de OR 'peer counseling'/de OR 'peer guidance'/de OR 'social support'/de OR 'support group'/exp OR '1 on 1':ti,ab,kw OR 'amputee support*' OR 'emotional* support*' OR 'group therap*' OR ((group* OR peer*) NEXT/2 (counsel* OR therap* OR support*)) OR interpersonal:ti,ab,kw OR mentor*:ti,ab,kw OR (mutual NEXT/2 (group* OR help* OR support*)) OR ((mutual OR communit* OR peer*) NEAR/3 (help* OR group* OR support* OR aid OR led OR assist*)) OR 'one on one':ti,ab,kw OR peer*:ti,ab OR (support* NEAR/2 group*) OR 'wounded warrior'
	#4	Additional counseling and therapy	'acceptance and commitment therapy'/exp OR 'behavioral counseling'/de OR 'behavior therapy'/exp OR 'case manager'/de OR 'case management'/de OR 'cognitive behavioral therapy'/exp OR 'counseling'/exp OR 'mental health care'/exp OR 'mindfulness based cognitive therapy'/exp OR 'mindfulness based therapy'/exp OR 'motivational enhancement therapy'/de OR 'motivational intervention'/de OR 'motivational interviewing'/de OR 'motivational therapy'/de OR 'patient counseling'/de OR 'patient guidance'/de OR 'psychological counseling'/de OR 'psychosocial care'/de OR 'psychotherapy'/exp OR 'social medicine'/de OR 'social work'/de OR 'social psychiatry'/de OR ((acceptance OR commitment) NEAR/3 therap*) OR ACT:ti OR ((behavior* OR cognitiv* OR famil* OR motivation* OR psychological OR social*) NEAR/2 (counsel* OR intervent* OR management OR service* OR support* OR therap*)) OR 'case manage*':ti,ab,kw OR CBT:ti OR counseling:ti,ab,kw OR 'mental health care':ti,ab,kw OR (mindful* NEXT/2 therap*) OR motivational:ti,ab,kw OR (motivation* NEAR/2 (enhancement* OR intervention* OR interview* OR support*)) OR (psychodynamic NEAR/2 therap*) OR psychotherap*:ti,ab,kw OR ((social OR interpersonal) NEAR/2 (support* OR train*)) OR 'social work*':ti,ab,kw OR 'social service*':ti,ab,kw
	#5	Education and techniques	'education program'/de OR 'meditation'/exp OR 'mindfulness'/exp OR 'mindfulness based stress reduction'/de OR 'pain education'/de OR 'patient education'/de OR 'psychoeducation'/de OR (breathing NEAR/2 (deep OR exercise*)) OR 'client education':ti,ab,kw OR hakomi:ti,ab OR MBSR:ti,ab OR meditat*:ti,ab,kw OR mindfulness:ti,ab,kw OR (mindful* NEAR/2 'stress reduc*') OR morita:ti,ab OR 'neuroscience education' OR 'neuroscience therap*' OR 'pain education' OR 'patient discharge education' OR 'patient education':ti,ab,kw OR PNE:ti,ab OR psychoeducation* OR 'self help':ti,ab OR TNE:ti,ab
	#6	Combine intervention sets	#2 OR #3 OR #4 OR #5
	#7	Combine population and intervention sets	#1 AND #6
	#8	Apply limits, remove unwanted publication types, limit to SRs, meta-analyses (MAs), RCTs, nonrandomized controlled trials (non-RCTs), and comparative studies	See limits and hedges at the end of this table

Question*	Set #	Concept	Strategy
KQ 3	#1	Adults with UE amputation	('arm injury'/exp OR 'upper limb'/exp OR (arm OR arms OR carpal OR digit OR digits OR digital OR elbow* OR finger* OR forearm* OR forequarter OR hand OR hands OR humeral OR humerus OR interscapulothoracic OR metacarp* OR palm OR palms OR ((phalang* OR phalanx*) AND (digit OR digits OR finger* OR hand OR hands OR thumb*)) OR radial OR radius OR shoulder* OR thumb* OR transcarpal OR transhumeral OR transradial OR ulnar OR 'upper extremit*' OR 'upper limb*' OR wrist*):ti,ab,kw) AND ('amputation'/de OR 'amputation stump'/de OR 'amputee'/de OR 'disarticulation'/de OR 'traumatic amputation'/de OR (amputat* OR amputee* OR disarticulat* OR exarticulat* OR 'limb loss*' OR 'loss of limb*' OR postamputation* OR reamputat* OR 'remaining limb*' OR 'residual limb*' OR stump*):ti,ab,kw) OR 'arm amputation'/de OR 'finger amputation'/de OR 'forearm amputation'/de OR 'forequarter amputation'/de OR 'hand amputation'/de OR 'shoulder amputation'/de OR 'thumb amputation'/de OR 'transhumeral amputation'/de OR (loss* NEAR/2 ('upper limb*' OR 'upper extremit*')):ti,ab,kw
	#2	General terms	'health care delivery'/exp/mj OR 'health care facility'/exp OR 'postoperative care'/mj OR 'rehabilitation'/mj OR 'rehabilitation care'/de OR 'rehabilitation nursing'/de OR 'kinesiotherapy'/exp OR (amput* NEAR/2 rehab*):ti,ab,kw OR ((care NEAR/2 deliver*):ti,ab,kw) OR ((duration* OR frequenc* OR intensity) NEAR/5 outcome*) OR (frequenc* NEAR/5 (duration* OR intensit*)) OR (intensit* NEAR/5 (duration* OR frequenc*)) OR (outcome* NEAR/2 improv*):ti OR (postoperative OR 'post operative' OR postsurgical OR 'post surgical' OR 'post surgery' OR posttreatment OR 'post treatment'):ti OR ((rehab* NEAR/3 (nursing OR program* OR setting*)):ti,ab) OR (service* NEAR/3 deliver*) OR (((appointment* OR treatment* OR visit*) NEAR/2 (deliver* OR duration* OR frequen* OR intensit* OR length* OR service* OR setting* OR time OR timing)):ti,ab,kw) OR (day* AND month* AND week*):ti,ab
	#3	Settings/ locations	'ambulatory care'/exp OR 'hospital patient'/de OR 'inpatient care'/de OR 'inpatient rehabilitation'/de OR 'inpatient rehabilitation facility'/de OR 'outpatient'/de OR 'outpatient care'/de OR 'outpatient department'/de OR 'rehabilitation center'/de OR 'residential care'/de OR 'residential home'/de OR 'acute care':ti,ab,kw OR 'acute rehab*':ti,ab,kw OR (ambulatory NEXT/2 (care OR center* OR facilit* OR rehab*)):ti,ab,kw OR 'care facilit*':ti,ab,kw OR clinic:ti OR clinics:ti OR 'day* rehab*':ti,ab,kw OR hospitalis*:ti OR hospitaliz*:ti OR 'in hospital':ti,ab OR ((inpatient* OR outpatient*) NEAR/3 (care OR clinic* OR department* OR facilit* OR hospital* OR rehab* OR therap* OR treat*)) OR (rehab* NEAR/2 (center* OR hospital*)):ti,ab,kw OR 'residential rehab*':ti,ab,kw OR 'skilled nursing' OR 'UEAcenter*' OR ('upper limb' NEAR/2 center*)

Question*	Set #	Concept	Strategy
KQ 3 (cont.)	#4	Telehealth/virtual/ digital	'computer simulation'/exp OR 'digital health'/de OR 'digital health intervention'/de OR 'digital health technology'/de OR 'digital technology'/de OR 'mhealth'/de OR 'mobile application'/de OR 'mobile health'/de OR 'mobile health application'/de OR 'mobile health technology'/de OR 'mobile phone'/exp OR 'online monitoring'/de OR 'technology based intervention'/de OR 'telecommunication'/exp OR 'teleconference'/de OR 'teleconsultation'/de OR 'telehealth'/exp OR 'telemedicine'/exp OR 'telemonitoring'/de OR 'telephone'/de OR 'telephone interview'/exp OR 'telepsychiatry'/de OR 'telepsychotherapy'/de OR 'videoconferencing'/de OR 'video game'/de OR 'virtual care'/de OR 'virtual reality'/de OR (android OR camera* OR cellphone OR 'cell phone' OR computer* OR distan* OR electronic OR email OR 'e-mail' OR game OR gaming OR facetime OR 'face time' OR ipad OR 'i pad' OR iphone OR 'i phone' OR internet OR laptop OR mobile OR online OR phone* OR remote* OR smart* OR tablet* OR telephone* OR video* OR virtual OR 'web based' OR wireless OR zoom):ti OR ((android OR camera* OR cellphone OR 'cell phone' OR computer* OR digital OR distan* OR electronic OR email OR 'e-mail' OR facetime OR 'face time' OR ipad OR 'i pad' OR iphone OR 'i phone' OR internet OR laptop OR mobile OR online OR remote* OR tablet* OR telephone OR video* OR virtual OR 'web based' OR zoom) NEAR/2 (care OR conference* OR consult* OR monitor* OR health* OR medicine OR psychiatr* OR psycholog* OR psychotherap* OR therap* OR treatment* OR visit*)) OR 'augmented reality' OR bluetooth OR 'blue tooth' OR 'digital technolog*' OR 'e care' OR 'e consult*' OR ehealth OR 'e health' OR emedicine OR 'e medicine' OR etherapy OR 'e therapy' OR ((game OR gaming) NEAR/5 (rehab* OR treatment*)) OR 'game based' OR 'gaming based' OR mhealth OR 'm health' OR ((mobile OR wireless OR smart) NEAR/5 (health* OR device* OR application* OR app OR apps)) OR ((phone* OR telephone*) NEAR/3 (consult* OR interview* OR visit*)) OR (('real time' OR realtime OR real-time) AND (care OR communicat* OR consult* OR mentor* OR rehab* OR therap* OR treatment*)) OR ((remote OR remotely) NEAR/5 (consult* OR game* OR gaming OR health* OR visit*)) OR smartphone* OR 'smart technolog*' OR 'technology based' OR telecare OR 'tele care' OR teleconsult* OR 'tele consult*' OR telehealth OR 'tele health' OR telemanagement OR 'tele management' OR telemedicine OR 'tele medicine' OR telemonitor* OR 'tele monitor*' OR telenursing OR 'tele nursing' OR telerehab* OR 'tele rehab*' OR teletreatment* OR 'tele treatment*' OR televideo OR 'tele video' OR videoconferenc* OR 'virtual reality'
	#5	Combine intervention sets	#2 OR #3 OR #4
	#6	Combine population and intervention sets	#1 AND #5
	#7	Apply limits, remove unwanted publication types, limit to SRs, MAs, RCTs, non-RCTs, and comparative studies	See limits and hedges at the end of this table

Question*	Set #	Concept	Strategy
KQ 4	#1	Adults with UE amputation	(‘arm injury’/exp OR ‘upper limb’/exp OR (arm OR arms OR carpal OR digit OR digits OR digital OR elbow* OR finger* OR forearm* OR forequarter OR hand OR hands OR humeral OR humerus OR interscapulothoracic OR metacarp* OR palm OR palms OR ((phalang* OR phalanx*) AND (digit OR digits OR finger* OR hand OR hands OR thumb*)) OR radial OR radius OR shoulder* OR thumb* OR transcarpal OR transhumeral OR transradial OR ulnar OR ‘upper extremit*’ OR ‘upper limb*’ OR wrist*):ti,ab,kw) AND (‘amputation’/de OR ‘amputation stump’/de OR ‘amputee’/de OR ‘disarticulation’/de OR ‘traumatic amputation’/de OR (amputat* OR amputee* OR disarticulat* OR exarticulat* OR ‘limb loss*’ OR ‘loss of limb*’ OR postamputation* OR reamputat* OR ‘remaining limb*’ OR ‘residual limb*’ OR stump*):ti,ab,kw) OR ‘arm amputation’/de OR ‘finger amputation’/de OR ‘forearm amputation’/de OR ‘forequarter amputation'/de OR ‘hand amputation’/de OR ‘shoulder amputation’/de OR ‘thumb amputation’/de OR ‘transhumeral amputation’/de OR (loss* NEAR/2 ('upper limb*' OR 'upper extremit*')):ti,ab,kw
	#2	UE prostheses population	((‘arm prosthesis’/exp OR ‘finger implant’/exp OR ((‘bionics’/de OR ‘electric limb prosthesis’/exp OR ‘limb prosthesis’/de OR ‘myoelectric control'/de OR ‘orthopedic prosthesis’/de OR ‘prosthesis fixation’/de) AND 'upper limb'/exp)) OR ‘artificial hand*’:ti,ab OR ('artificial limb*' AND (arm OR arms OR hand OR hands OR upper)):ti,ab OR (((bionic* OR ‘man-machine’ OR myoelectric* OR ‘myo electric*’ OR neuroprosth* OR prosthes* OR prosthet* OR ‘robot* manipulat*’) NEAR/2 (arm OR arms OR carpal OR digit OR digits OR elbow* OR finger* OR forearm* OR forequarter OR hand OR hands OR humeral OR humerus OR metacarp* OR palm OR palms OR phalang* OR phalanx* OR radial OR radius OR shoulder* OR thumb* OR transcarpal OR transhumeral OR transradial OR ulnar OR ‘upper extremit*’ OR ‘upper limb*’)):ti,ab) OR ((neuroprosth* OR prosthes* OR prosthet*) NEAR/4 (arm OR arms OR hand OR hands OR ‘upper extremit*’ OR ‘upper limb*’)):ti,ab,kw OR ((((artificial* OR ‘body power*’ OR bionic* OR electric* OR electronic OR ‘external* power*’ OR ‘man-machine’ OR myoelectric* OR neuroprosth* OR prosthes* OR prosthet* OR robot*) NEAR/3 (extremit* OR limb*)):ti,ab OR ('body power*' OR bionic* OR 'external* power*' OR ‘man-machine’ OR myoelectric* OR neuroprosth* OR prosthes* OR prosthet*):ti) AND (arm OR arms OR carpal OR digit OR digits OR elbow* OR finger* OR forearm* OR forequarter OR hand OR hands OR humeral OR humerus OR metacarp* OR shoulder* OR thumb* OR transcarpal OR transhumeral OR transradial OR ‘trans radial’ OR ulnar OR ‘upper arm*’ OR ‘upper limb*’ OR ‘upper extremit*’ OR ‘upper or lower’):ti,ab))
	#3	Dexterity tests	‘box and block test’/exp OR ‘jebsen taylor hand function test’/exp OR ‘nine hole peg test’/exp OR ‘southampton hand assessment procedure’/exp OR ‘9 hole peg’ OR (assess* NEAR/5 myoelectric*):ti,ab,kw OR ‘assessment of capacity’ OR ACMC:ti,ab OR ‘box & block*’ OR ‘box AND block*’ OR BBT:ti OR ((clothespin* OR ‘clothes pin’) NEAR/2 relocat*) OR ((dexterity OR dexterous*) NEAR/4 (assess* OR evaluat* OR measur* OR test*)):ti,ab,kw OR ‘hand assessment*’:ti,ab OR (‘hand function*’ AND (assess* OR evaluat* OR measur* OR score* OR scoring OR test*)):ti,ab OR jebsentaylor OR ‘jebsen taylor’ OR (jebsen NEAR/4 test*) OR JTHF:ti,ab,kw OR ‘nine hole peg’ OR NHP:ti OR ‘relocation test*’ OR ‘southampton hand’ OR SHAP:ti
	#4	Activity/function tests	‘patient specific functional scale’/exp OR ‘quickdash’/exp OR ‘quickdash score’/exp OR ‘quickdash questionnaire’/exp OR (‘physical activity, capacity and performance’/exp AND (assess* OR evaluat* OR measure* OR rate OR rating OR test*):ti) OR (activit* NEAR/5 (assess* OR evaluat* OR measure* OR test*)):ti,ab OR (activit* NEAR/5 ('daily life' OR 'daily living')):ti OR ‘activit* perform*’:ti,ab OR AMULA:ti,ab,kw OR ‘AM ULA’:ti,ab OR ((assist* OR help*) NEAR/3 (activit* OR adl OR daily OR life OR living)):ti,ab OR ‘BAM ULA’:ti,ab OR DASH:ti,ab,kw OR (function* NEAR/2 (assess* OR evaluat* OR measur* OR test*)):ti OR ‘functional scale*’:ti,ab OR (hand NEAR/2 score*) OR PSFS:ti,ab,kw OR ((perform* OR skill*) NEAR/2 (activit* OR assess* OR measur* OR test*)):ti OR (‘prosthetic function*’ AND (asses* OR evaluat* OR test*)):ti,ab OR quickdash OR ‘quick dash’ OR ‘test of prosthetic*’:ti,ab OR ‘timed activit*’:ti,ab,kw OR ‘T MAP’:ti OR (‘university of new brunswick’ NEAR/3 test*) OR ‘UNB test*’

Question*	Set #	Concept	Strategy
KQ 4 (cont.)	#5	Psychological tests	'checklist'/de OR 'cognitive test'/de OR 'general anxiety disorder 7'/de OR 'general anxiety disorder scale'/de OR 'general anxiety disorder scale 7'/de OR 'patient health questionnaire'/exp OR 'psychologic test'/exp OR 'psychometry'/exp OR 'questionnaire'/mj OR ('questionnaire'/exp/mj AND (activit* OR adjustment* OR anxiety OR behavior* OR cognition OR cognitive OR mental OR neuropsych* OR performance OR psych* OR satisfaction)) OR ((anxiety OR 'anxiety disorder*' OR behavior* OR cognitive* OR cognition OR mental OR psych* OR psychophysical* OR neuropsych*) NEAR/4 (checklist* OR evaluat* OR measur* OR scale* OR questionnaire* OR scale* OR score* OR test*)):ti,ab OR 'GAD 7':ti,ab OR 'experience scale*' OR 'patient health questionnaire*' OR 'PHQ 9':ti,ab OR 'PCL 5':ti,ab OR ((ptsd OR posttraumatic OR 'post traumatic') NEAR/3 checklist*) OR psychometric* OR psychoprosthetic* OR TAPES OR ('prosthesis experience*' NEAR/3 scale*) OR 'trinity activity' OR 'trinity amputation'
	#6	Other tests	'community reintegration'/exp OR 'mental component summary'/exp OR 'nasa task load index'/exp OR 'physical component summary'/exp OR 'upper extremity function'/exp OR 'upper extremity functional index'/exp OR 'upper extremity functional scale'/exp OR 'veterans rand 12 item health survey'/de OR 'client satisfaction' OR ((reintegrat* OR 're integrat*') AND ('active duty' OR army OR combat OR deployed OR deployment OR marine* OR military OR navy OR 'service member*' OR servicemen OR servicewomen OR soldier* OR veteran*)) OR 'CRIS CAT':ti,ab,kw OR CRISCAT:ti,ab,kw OR 'health survey*':ti,ab OR ('mental component*' NEAR/3 summar*) OR MCS:ti,ab,kw OR 'nasa task load' OR 'OPUS CSD':ti,ab,kw OR 'OPUS UE':ti,ab,kw OR ((orthotic* OR prosthes* OR prosthetic*) AND 'user* survey*') OR 'patient satisfaction':ti OR ((prosthes* OR prosthetic*) AND survey*):ti,ab OR ('physical component*' NEAR/3 summar*) OR ((physical OR mental) AND 'component score*') OR PCS:ti,ab,kw OR 'prosthetic* perform*':ti,ab OR 'RAND 12 item' OR 'RAND twelve item' OR 'scoring guide*' OR 'task load index*' OR TLX:ti,ab,kw OR ('upper extremit*' AND 'functional status'):ti,ab OR ((use OR user*) NEAR/10 (questionnaire* OR survey*)):ti,ab OR 'veteran* RAND*' OR VR12:ti,ab,kw OR 'VR 12':ti,ab,kw
	#7	General terms	((assess* OR outcome*) NEAR/2 measur*):ti OR ((independen* OR 'quality of life' OR 'quality of living') NEAR/2 (evaluat* OR measur* OR score OR scoring OR test*)):ti,ab OR (identif* NEAR/3 (difficult* OR improv* OR worse*)):ti,ab OR ((evaluat* OR improv* OR worse*) AND function*):ti OR 'national survey' OR ((prosthes* OR prosthet*) AND (candidate* OR candidac* OR prescription*)):ti,ab OR ((prosthes* OR prosthet*) NEAR/2 (experience* OR need OR needs OR required OR requirement*)):ti,ab OR ((prosthes* OR prosthet*):ti,ab AND (determin* OR need OR needs OR required OR requirement*):ti) OR ((prosthe* NEAR/2 (accept* OR satisf*)):ti,ab AND (checklist* OR questionnaire* OR survey OR test*):ti,ab) OR (prosthe* AND (use OR usage) AND (assess* OR evaluat* OR questionnaire* OR survey* OR test*)):ti OR (therap* NEAR/3 (evaluat* OR need OR needs OR required OR requirement*)):ti,ab
	#8	Combine population sets	#1 OR #2
	#9	Combine intervention sets	#3 OR #4 OR #5 OR #6 OR #7
	#10	Combine population and intervention sets	#8 AND #9
	#11	Apply limits, remove unwanted publication types	See limits and hedges at the end of this table

Question*	Set #	Concept	Strategy
KQ 5	#1	Adults with UE amputation	(‘arm injury’/exp OR ‘upper limb’/exp OR (arm OR arms OR carpal OR digit OR digits OR digital OR elbow* OR finger* OR forearm* OR forequarter OR hand OR hands OR humeral OR humerus OR interscapulothoracic OR metacarp* OR palm OR palms OR ((phalang* OR phalanx*) AND (digit OR digits OR finger* OR hand OR hands OR thumb*)) OR radial OR radius OR shoulder* OR thumb* OR transcarpal OR transhumeral OR transradial OR ulnar OR ‘upper extremit*’ OR ‘upper limb*’ OR wrist*):ti,ab,kw) AND (‘amputation’/de OR ‘amputation stump’/de OR ‘amputee’/de OR ‘disarticulation’/de OR ‘traumatic amputation’/de OR (amputat* OR amputee* OR disarticulat* OR exarticulat* OR ‘limb loss*’ OR ‘loss of limb*’ OR postamputation* OR reamputat* OR ‘remaining limb*’ OR ‘residual limb*’ OR stump*):ti,ab,kw) OR ‘arm amputation’/de OR ‘finger amputation’/de OR ‘forearm amputation’/de OR ‘forequarter amputation'/de OR ‘hand amputation’/de OR ‘shoulder amputation’/de OR ‘thumb amputation’/de OR ‘transhumeral amputation’/de OR (loss* NEAR/2 ('upper limb*' OR 'upper extremit*')):ti,ab,kw
	#2	UE prostheses population	((‘arm prosthesis’/exp OR ‘finger implant’/exp OR ((‘bionics’/de OR ‘electric limb prosthesis’/exp OR ‘limb prosthesis’/de OR ‘myoelectric control'/de OR ‘orthopedic prosthesis’/de OR ‘prosthesis fixation’/de) AND 'upper limb'/exp)) OR ‘artificial hand*’:ti,ab OR ('artificial limb*' AND (arm OR arms OR hand OR hands OR upper)):ti,ab OR (((bionic* OR ‘man-machine’ OR myoelectric* OR ‘myo electric*’ OR neuroprosth* OR prosthes* OR prosthet* OR ‘robot* manipulat*’) NEAR/2 (arm OR arms OR carpal OR digit OR digits OR elbow* OR finger* OR forearm* OR forequarter OR hand OR hands OR humeral OR humerus OR metacarp* OR palm OR palms OR phalang* OR phalanx* OR radial OR radius OR shoulder* OR thumb* OR transcarpal OR transhumeral OR transradial OR ulnar OR ‘upper extremit*’ OR ‘upper limb*’)):ti,ab) OR ((neuroprosth* OR prosthes* OR prosthet*) NEAR/4 (arm OR arms OR hand OR hands OR ‘upper extremit*’ OR ‘upper limb*’)):ti,ab,kw OR ((((artificial* OR ‘body power*’ OR bionic* OR electric* OR electronic OR ‘external* power*’ OR ‘man-machine’ OR myoelectric* OR neuroprosth* OR prosthes* OR prosthet* OR robot*) NEAR/3 (extremit* OR limb*)):ti,ab OR ('body power*' OR bionic* OR 'external* power*' OR ‘man-machine’ OR myoelectric* OR neuroprosth* OR prosthes* OR prosthet*):ti) AND (arm OR arms OR carpal OR digit OR digits OR elbow* OR finger* OR forearm* OR forequarter OR hand OR hands OR humeral OR humerus OR metacarp* OR shoulder* OR thumb* OR transcarpal OR transhumeral OR transradial OR ‘trans radial’ OR ulnar OR ‘upper arm*’ OR ‘upper limb*’ OR ‘upper extremit*’ OR ‘upper or lower’):ti,ab))
	#3	Targeted/narrow UEA population (to be paired with broad amputation, patient-related etc interventions)	((arm OR arms OR carpal OR digit OR digits OR digital OR elbow* OR finger* OR forearm* OR forequarter OR hand OR hands OR humeral OR humerus OR interscapulothoracic OR metacarp* OR palm OR palms OR radial OR radius OR shoulder* OR thumb* OR transcarpal OR transhumeral OR transradial OR ulnar OR ‘upper or lower’ OR ‘upper extremit*’ OR ‘upper limb*’ OR wrist*) NEAR/4 (amputat* OR amputee* OR postamputation* OR reamputat*)):ti,ab,kw OR (‘upper limb’/exp/mj AND (‘amputation’/mj OR ‘amputation stump’/mj OR ‘amputee’/de OR ‘disarticulation’/de OR ‘traumatic amputation’/de))
	#4	Targeted/narrow UE prostheses population (to be paired with broad prostheses-related interventions)	(('bionics'/mj OR 'electric limb prosthesis'/mj OR 'limb prosthesis'/mj OR 'myoelectric control'/mj OR 'orthopedic prosthesis'/mj) AND 'upper limb'/exp/mj) OR ‘artificial hand*’:ti,ab OR ('artificial limb*' AND (arm OR arms OR hand OR hands OR upper)):ti,ab OR ((neuroprosth* OR prosthes* OR prosthet*) NEAR/4 (arm OR arms OR hand OR hands OR ‘upper extremit*’ OR ‘upper limb*’)):ti,ab
	#5	Amputation factors	‘amputation level’/de OR ‘hemispheric dominance’/de OR ‘injury severity’/de OR bilateral*:ti,ab OR ‘bi lateral*’:ti,ab OR ((cause* OR delay* OR etiolog* OR factor* OR level* OR reason* OR severity OR time) NEAR/3 amput*) OR ((cause* OR etiolog* OR factor* OR level* OR reason* OR severity OR time) AND amput*):ti OR laterality:ti,ab OR unilateral*:ti,ab

Question*	Set #	Concept	Strategy
KQ 5 (cont.)	#6	Personal factors	'age'/exp/mj OR attitude/exp/mj OR 'caregiver support'/de OR 'cognition'/exp/mj OR 'ethnicity'/exp/mj OR 'economic status'/de OR 'sex'/exp/mj OR 'sex identity'/exp/mj OR 'identity'/exp/mj OR 'motivation'/exp/mj OR 'sensory dysfunction'/de OR 'social support'/de OR 'self concept'/exp/mj OR 'psychological adjustment'/exp/mj OR 'range of motion'/mj OR 'strength'/exp/mj OR ((amputee* OR client* OR patient*) NEAR/3 (age* OR attitude* OR characteristic* OR factor* OR related OR satisfaction*)):ti,ab,kw OR 'body image*':ti,ab,kw OR (caregiver* NEAR/2 status*):ti,ab,kw OR coping:ti,ab,kw OR cognition:ti,ab OR cognitive:ti,ab OR demograph*:ti,ab,kw OR 'economic status*' OR ethnicit*:ti,ab,kw OR 'emotional adjust*':ti,ab,kw OR sex*:ti,ab,kw OR goals:ti,ab,kw OR identit*:ti,ab,kw OR 'low* income*' OR 'marital status*':ti,ab,kw OR 'mental health':ti,ab,kw OR motivation*:ti,ab,kw OR 'psychological* adjust*':ti,ab,kw OR race:ti,ab OR 'range* of motion':ti,ab OR resilience:ti,ab,kw OR (self NEXT/2 (care OR competenc* OR concept* OR efficac*)) OR 'sensory deficit*' OR 'sensory dysfunction*' OR 'social class*' OR (social* NEAR/2 support*) OR (strength NEAR/3 (arm OR determin* OR hand OR limb* OR muscle* OR patient* OR measure*)):ti,ab OR transgender*:ti,ab,kw OR vision*:ti,ab OR 'well being':ti,ab
	#7	Psychological issues, disorders, pain, injuries	'acute stress disorder'/de OR 'battle injury'/de OR 'blast injury'/de OR 'comorbidity'/de OR 'depression'/exp/mj OR 'missile wound'/de OR 'pain'/de OR 'personality disorder'/exp/mj OR 'posttraumatic stress disorder'/exp/mj OR 'psychotrauma'/exp/mj OR 'sleep disorder'/exp/mj OR 'stump pain'/de OR 'substance abuse'/de OR 'traumatic brain injury'/exp/mj OR alcohol*:ti,ab OR 'associated injur*':ti,ab,kw OR 'brain damage*':ti,ab OR 'brain injur*':ti,ab,kw OR 'combat disorder*':ti,ab,kw OR 'combat stress':ti,ab,kw OR comorbid*:ti,ab,kw OR 'co morbid*':ti,ab,kw OR cooccur*:ti,ab,kw OR 'co occur*':ti,ab,kw OR (depression OR depressive):ti,ab OR ((drug* OR substance*) NEAR/2 (abuse OR addict* OR use*)):ti,ab,kw OR ((mood* OR personality OR stress) NEAR/3 disorder*):ti,ab,kw OR mTBI:ti,ab OR 'operational stress*':ti,ab,kw OR 'neurologic* disease*':ti,ab,kw OR pain:ti,ab OR posttrauma*:ti,ab,kw OR 'post trauma*':ti,ab,kw OR (psychologic* NEXT/2 (disorder* OR stress* OR trauma*)):ti,ab,kw OR PTSD:ti,ab OR (sleep* NEAR/3 (disorder* OR issue* OR problem*)):ti,ab,kw OR 'trauma* disorder*':ti,ab,kw OR 'trauma* syndrome*':ti,ab,kw OR TBI:ti,ab OR 'traumatic stress*':ti,ab,kw
	#8	Prostheses factors	(('comfort'/exp OR 'cosmesis'/de OR 'cosmetic'/de OR 'function'/de OR 'usability'/de) AND ('artificial limb*' OR device* OR prosthes* OR prosthet*):ti,ab) OR ((artificial OR device* OR prosthes* OR prosthet*) NEAR/3 (aesthetic* OR comfort* OR cosmetic* OR ease OR mobility OR train* OR usage OR usability OR satisf*)):ti,ab,kw OR cosmesis OR 'device use':ti,ab,kw OR 'ease of use' OR 'prosthetic* function*' OR 'prosthe* use':ti,ab,kw OR 'use of device*':ti,ab,kw OR weight:ti,ab
	#9	Rehabilitation outcomes	'outcome'/de OR 'outcome assessment'/exp OR 'outcomes'/de OR 'patient outcomes'/de OR 'treatment outcome'/exp OR (amputee* NEAR/5 outcome*) OR effectiveness*:ti OR function*:ti OR improved:ti OR improvement:ti OR independence:ti,ab OR 'long term':ti OR outcome*:ti OR 'patient outcome*' OR 'patient rehab*' OR 'quality of life':ti,ab,kw OR ((recover* OR rehab*) NEAR/3 (effectiveness OR outcome*)):ti,ab,kw OR reintegration*:ti,ab,kw OR (treatment* NEXT/2 (effective* OR outcome*)):ti,ab,kw OR ((client* OR patient* OR rehab* OR 'service member*' OR treatment* OR veteran*) AND (associated OR association* OR efficac* OR effective* OR factor* OR outcome* OR perform* OR predict* OR prognos* OR recover* OR symptom*)):ti

Question*	Set #	Concept	Strategy
KQ 5 (cont.)	#10	Focused amputation, patient, co-occurring and prostheses factors search	((amputat* AND (cause* OR delay* OR etiolog* OR level* OR reason* OR severity OR time)) OR alcohol* OR adjustment* OR bilateral OR (injur* AND severity) OR laterality OR unilateral* OR age OR attitude* OR ((amputee* OR client* OR personal OR patient*) AND (characteristic* OR factor* OR related)) OR 'body image*' OR 'caregiver status*' OR coping OR cognition OR cognitive OR demograph* OR 'economic status' OR ethnicit* OR sex* OR goals OR identit* OR income OR 'marital status*' OR men OR 'mental health' OR motivation* OR race OR 'range* of motion' OR resilience OR satisfaction OR (self AND (care OR competenc* OR concept* OR efficac*)) OR 'sensory deficit*' OR 'sensory dysfunction' OR sex OR 'social class*' OR 'social support*' OR 'sensory deficit*' OR 'sensory dysfunction*' OR strength OR transgender* OR vision* OR 'well being' OR women OR ((associat* OR brain) AND (injur* OR trauma*)) OR (brain AND damage*) OR (combat AND (disorder* OR stress*)) OR comorbid* OR 'co morbid*' OR cooccur* OR 'co occur*' OR depression OR depressive OR ((drug OR substance*) AND (abuse OR addict* OR use)) OR ((mood* OR personality OR stress) AND disorder*) OR mTBI OR 'operational stress*' OR ((neurologic* OR psychologic*) AND (disease* OR disorder* OR stress* OR trauma*)) OR pain OR posttrauma* OR 'post trauma*' OR PTSD OR (sleep* AND (disorder* OR issue* OR problem*)) OR (trauma* AND (disorder* OR syndrome* OR stress*)) OR TBI OR ((aesthetic* OR comfort* OR cosmesis OR cosmetic OR ease OR mobility OR train* OR use OR usability OR satisfaction OR weight) AND (artificial OR bionic OR device* OR prosthes* OR prosthet*)) OR (function* NEAR/3 (artificial OR prosthes* OR prosthet*))):ti
	#11	Combine broad population sets	#1 OR #2
	#12	Combine amputation, patient factors and rehabilitation outcomes	(#5 OR #6 OR #7 OR #8) AND #9
	#13	Combine broad population with factors and outcomes	#11 AND #12
	#14	Combine broad population with focused amputation, patient etc search	#10 AND #11
	#15	Combine narrow populations with broad amputation, patient etc searches	(#3 AND (#5 OR #6 OR #7 OR #8)) OR (#4 AND #8)
	#16	Combine sets	#13 OR #14 OR #15
	#17	Apply limits, remove unwanted publication types	See limits and hedges at the end of this table

Question*	Set #	Concept	Strategy
KQ 6	#1	Adults with UE amputation	(‘arm injury’/exp OR ‘upper limb’/exp OR (arm OR arms OR carpal OR digit OR digits OR digital OR elbow* OR finger* OR forearm* OR forequarter OR hand OR hands OR humeral OR humerus OR interscapulothoracic OR metacarp* OR palm OR palms OR ((phalang* OR phalanx*) AND (digit OR digits OR finger* OR hand OR hands OR thumb*)) OR radial OR radius OR shoulder* OR thumb* OR transcarpal OR transhumeral OR transradial OR ulnar OR ‘upper extremit*’ OR ‘upper limb*’ OR wrist*):ti,ab,kw) AND (‘amputation’/de OR ‘amputation stump’/de OR ‘amputee’/de OR ‘disarticulation’/de OR ‘traumatic amputation’/de OR (amputat* OR amputee* OR disarticulat* OR exarticulat* OR ‘limb loss*’ OR ‘loss of limb*’ OR postamputation* OR reamputat* OR ‘remaining limb*’ OR ‘residual limb*’ OR stump*):ti,ab,kw) OR ‘arm amputation’/de OR ‘finger amputation’/de OR ‘forearm amputation’/de OR ‘forequarter amputation'/de OR ‘hand amputation’/de OR ‘shoulder amputation’/de OR ‘thumb amputation’/de OR ‘transhumeral amputation’/de OR (loss* NEAR/2 ('upper limb*' OR 'upper extremit*')):ti,ab,kw
	#2	UE prostheses population	((‘arm prosthesis’/exp OR ‘finger implant’/exp OR ((‘bionics’/de OR ‘electric limb prosthesis’/exp OR ‘limb prosthesis’/de OR ‘myoelectric control'/de OR ‘orthopedic prosthesis’/de OR ‘prosthesis fixation’/de) AND 'upper limb'/exp)) OR ‘artificial hand*’:ti,ab OR ('artificial limb*' AND (arm OR arms OR hand OR hands OR upper)):ti,ab OR (((bionic* OR ‘man-machine’ OR myoelectric* OR ‘myo electric*’ OR neuroprosth* OR prosthes* OR prosthet* OR ‘robot* manipulat*’) NEAR/2 (arm OR arms OR carpal OR digit OR digits OR elbow* OR finger* OR forearm* OR forequarter OR hand OR hands OR humeral OR humerus OR metacarp* OR palm OR palms OR phalang* OR phalanx* OR radial OR radius OR shoulder* OR thumb* OR transcarpal OR transhumeral OR transradial OR ulnar OR ‘upper extremit*’ OR ‘upper limb*’)):ti,ab) OR ((neuroprosth* OR prosthes* OR prosthet*) NEAR/4 (arm OR arms OR hand OR hands OR ‘upper extremit*’ OR ‘upper limb*’)):ti,ab,kw OR ((((artificial* OR ‘body power*’ OR bionic* OR electric* OR electronic OR ‘external* power*’ OR ‘man-machine’ OR myoelectric* OR neuroprosth* OR prosthes* OR prosthet* OR robot*) NEAR/3 (extremit* OR limb*)):ti,ab OR ('body power*' OR bionic* OR 'external* power*' OR ‘man-machine’ OR myoelectric* OR neuroprosth* OR prosthes* OR prosthet*):ti) AND (arm OR arms OR carpal OR digit OR digits OR elbow* OR finger* OR forearm* OR forequarter OR hand OR hands OR humeral OR humerus OR metacarp* OR shoulder* OR thumb* OR transcarpal OR transhumeral OR transradial OR ‘trans radial’ OR ulnar OR ‘upper arm*’ OR ‘upper limb*’ OR ‘upper extremit*’ OR ‘upper or lower’):ti,ab))
	#3	Terminal devices	‘degree of freedom’/de OR ‘hand prosthesis’/exp/mj OR ‘hook’/exp OR ‘voluntary movement’/de OR ((‘body power*’ OR motor* OR passive OR sensor*) NEAR/3 (hand* OR prosthe*)) OR ‘degree* of freedom’:ti,ab,kw OR DOF:ti,ab,kw OR ‘DOF hand*’ OR greifer* OR hook* OR hosmer:ti,ab,kw OR ‘hosmer hook*’ OR ‘ilimb*’ OR ‘i limb*’ OR motorized OR motorised OR multiarticulating OR ‘multi articulat*’ OR terminal* OR (voluntar* NEAR/5 (close OR closing OR movement* OR open*))
	#4	Control strategies	‘automated pattern recognition’/de OR ‘brain computer interface’/exp OR ‘computer interface’/de OR ‘control strategy’/de OR ‘control system’/de OR ‘pattern recognition’/exp OR ‘body power*’:ti,ab OR ‘bodily power*’:ti,ab OR (control* NEAR/3 (crisp* OR device* OR flexible OR machine* OR strateg* OR system*)) OR ‘finite state*’ OR interface*:ti,ab,kw OR microcontrol* OR ((movement* OR motion*) NEAR/3 (detect* OR onset)) OR ‘on-off’ OR ((on OR off) NEAR/2 control*) OR ‘onset analysis’ OR (pattern* NEAR/3 recogn*) OR ((proportion* OR recognition* OR regression*) NEAR/5 control*) OR ‘prosthes* control*’ OR ‘prosthet* control*’

Question*	Set #	Concept	Strategy
KQ 6 (cont.)	#5	Prosthesis type	'myoelectrically controlled prosthesis'/exp OR (('artificial intelligence'/exp OR 'artificial neural network'/exp OR 'computer system'/de OR 'cosmetic'/de OR 'electromyogram'/de OR 'electrotactile stimulation'/de OR 'functional electrical stimulation'/de OR 'myoelectric control'/de OR 'sensory feedback'/exp OR 'signal processing'/exp OR 'signal processor'/exp) AND ('artificial hand*' OR 'artificial limb*' OR device* OR prosthes* OR prosthet*)) OR 'body powered' OR (component* NEAR/5 select*) OR ((cosmetic* OR hybrid) AND (artificial OR device* OR prosthes* OR prosthet* OR robotic*)) OR DEKA OR 'electric* power*' OR ('electric* stimulat*' AND prosthe*) OR ((electrode* OR electromyogram* OR EMG OR 'functional electric*' OR intraneural OR 'intra neural' OR microelectrode* OR 'nerve stimulat*' OR 'neural network*' OR sEMG) AND (prosthes* OR prosthet*)):ti,ab,kw OR electrotactile OR 'electro tactile' OR eOPRA OR 'e-OPRA' OR 'external* power*' OR 'LUKE arm*' OR (modular NEAR/3 (limb* OR prosthe*)) OR MPL:ti,ab,kw OR ((myoelectric* OR 'myo electric*') AND (artificial OR device* OR prosthes* OR prosthet*)) OR neurointegrat* OR 'neuro integrat*' OR neuroprosth* OR 'neuro prosth*' OR ((prosthes OR prosthet*) NEAR/3 (component* OR electric* OR electronic* OR feedback OR outcome* OR passive* OR power* OR pressure OR select* OR type*)):ti,ab,kw OR ((sensor* OR signal*) NEAR/3 (feedback OR integrat* OR process*)):ti,ab OR 'wrist rotator*'
	#6	Socket design and/or suspension method	'biomechanics'/mj OR 'harness'/de OR 'lamination'/de OR 'mechanics'/exp/mj OR 'pressure'/exp OR 'prosthesis fixation'/de OR 'prosthetic socket'/de OR 'suspension'/de OR 'torque'/de OR 21A35 OR 21A36 OR 'active transhumeral' OR (anatomical NEAR/3 socket*) OR flexible:ti,ab,kw OR 'compression release*' OR flexibilit*:ti,ab,kw OR gel:ti,ab,kw OR (gel* NEAR/2 insert*) OR harness* OR 'high fidelity' OR laminat* OR monolithic OR muenster:ti,ab,kw OR osseointegrat*:ti,ab,kw OR ((pin OR sleeve) NEAR/3 (artificial* OR device* OR limb* OR prosthe*)) OR ((pressure* OR vacuum*) NEAR/5 suspen*) OR rigid*:ti,ab OR sauter:ti,ab,kw OR 'self suspen*' OR 'shuttle lock*' OR socket*:ti,ab OR 'supra condylar' OR supracondylar OR (suction* NEAR/5 (socket OR suspension)) OR suspension*:ti,ab OR torque:ti,ab OR vacuum:ti,ab
	#7	Combine population sets	#1 OR #2
	#8	Combine intervention sets	#3 OR #4 OR #5 OR #6
	#9	Combine population and intervention sets	#7 AND #8
	#10	Apply limits, remove unwanted publication types, limit to SRs, MAs, RCTs, non-RCTs, and comparative studies	See limits and hedges at the end of this table

Question*	Set #	Concept	Strategy
KQ 7	#1	Adults with UE amputation	('arm injury'/exp OR 'upper limb'/exp OR (arm OR arms OR carpal OR digit OR digits OR digital OR elbow* OR finger* OR forearm* OR forequarter OR hand OR hands OR humeral OR humerus OR interscapulothoracic OR metacarp* OR palm OR palms OR ((phalang* OR phalanx*) AND (digit OR digits OR finger* OR hand OR hands OR thumb*)) OR radial OR radius OR shoulder* OR thumb* OR transcarpal OR transhumeral OR transradial OR ulnar OR 'upper extremit*' OR 'upper limb*' OR wrist*):ti,ab,kw) AND ('amputation'/de OR 'amputation stump'/de OR 'amputee'/de OR 'disarticulation'/de OR 'traumatic amputation'/de OR (amputat* OR amputee* OR disarticulat* OR exarticulat* OR 'limb loss*' OR 'loss of limb*' OR postamputation* OR reamputat* OR 'remaining limb*' OR 'residual limb*' OR stump*):ti,ab,kw) OR 'arm amputation'/de OR 'finger amputation'/de OR 'forearm amputation'/de OR 'forequarter amputation'/de OR 'hand amputation'/de OR 'shoulder amputation'/de OR 'thumb amputation'/de OR 'transhumeral amputation'/de OR (loss* NEAR/2 ('upper limb*' OR 'upper extremit*')):ti,ab,kw
	#2	Phantom/residual limb pain	'phantom limb'/exp OR 'phantom pain'/de OR 'residual limb pain'/de OR 'stump pain'/de OR (('arm pain'/de OR 'battle injury'/de OR 'blast injury'/de OR 'chronic pain'/de OR 'intractable pain'/de OR 'limb pain'/de OR 'missile wound'/de OR 'neuropathic pain'/de OR 'pain'/de OR 'postoperative pain'/de OR 'posttraumatic pain'/de OR pain OR pains OR painful) AND (((missing NEAR/4 (perception* OR perceive*)):ti,ab OR phantom* OR 'remaining limb*' OR 'residual limb*')) OR 'pain perceived':ti,ab OR 'perceived pain':ti,ab OR (pain* NEAR/3 stump*))
	#3	Narrower upper extremity terms paired with phantom and residual limb pain terms	('arm injury'/exp OR 'upper limb'/exp OR (arm OR arms OR carpal OR digit OR digits OR digital OR elbow* OR finger* OR forearm* OR forequarter OR hand OR hands OR humeral OR humerus OR interscapulothoracic OR metacarp* OR palm OR palms OR ((phalang* OR phalanx*) AND (digit OR digits OR finger* OR hand OR hands OR thumb*)) OR radial OR radius OR shoulder* OR thumb* OR transcarpal OR transhumeral OR transradial OR ulnar OR 'upper extremit*' OR 'upper limb*' OR wrist*):ti,ab,kw) AND ('phantom limb'/exp OR 'phantom pain'/de OR 'residual limb pain'/de OR 'stump pain'/de OR (('arm pain'/de OR 'battle injury'/de OR 'blast injury'/de OR 'chronic pain'/de OR 'intractable pain'/de OR 'limb pain'/de OR 'missile wound'/de OR 'neuropathic pain'/de OR 'pain'/de OR 'postoperative pain'/de OR 'posttraumatic pain'/de OR pain OR pains OR painful) AND ((pain* NEAR/3 stump*) OR (phantom* OR 'remaining limb*' OR 'residual limb*'))))

Question*	Set #	Concept	Strategy
KQ 7 (cont.)	#4	Pharmacologic	'analgesia'/exp OR 'analgesic agent'/exp OR 'anticonvulsive agent'/exp OR 'antidepressant agent'/exp OR 'benzodiazepine derivative'/exp OR 'benzatropine'/exp OR 'beta adrenergic receptor blocking agent'/exp OR 'bupivacaine'/de OR 'calcitonin'/de OR 'capsaicin'/de OR 'carbamazepine'/de OR 'codeine'/de OR 'dronabinol'/de OR 'drug therapy'/exp OR 'fentanyl'/de OR 'dronabinol'/de OR 'gabapentin'/de OR 'ketamine'/de OR 'lidocaine'/de OR 'menthol'/de OR 'muscle relaxant agent'/exp OR 'muscle relaxants'/exp OR 'muscle relaxants therapeutic use'/de OR 'morphine'/de OR 'narcotic analgesic agent'/exp OR 'n methyl dextro aspartic acid receptor stimulating agent'/exp OR 'nonsteroid antiinflammatory agent'/exp OR 'opiate'/de OR 'opiate agonist'/exp OR 'opiate receptor affecting agent'/exp OR 'paracetamol'/de OR 'tramadol'/de OR 'vitamin D'/exp OR ('acetylsalicylic acid' OR advil* OR aleve* OR anacin* OR aspirin OR diclofenac OR ibuprofen OR motrin* OR naproxen OR salicylate*):ti,ab,kw OR (((arnica OR aspercreme* OR bengay* OR biofreeze* OR camphor* OR capsicum OR 'deep relief*' OR diclofenac) NEAR/3 (gel OR patch OR topical)):ti,ab,kw) OR amitriptyline OR antidepressant* OR 'anti depressant*' OR anticonvulsant* OR anticonvulsive* OR antiepileptic* OR APAP:ti,ab,kw OR benzodiaz* OR benztropine OR 'beta adrenergic' OR 'beta blocker*' OR bupivacaine OR buprenorphine OR calcitonin OR capsaicin* OR carbamazepine OR codeine OR (drug* OR medication* OR medicine* OR pharmac*):ti,ab OR ((drug* OR medication* OR medicine* OR pharmac*) NEAR/5 (pain OR prevent*)) OR dronabinol OR gabapentin OR (ibuleve* OR 'icy hot*' OR lidocaine OR 'methyl salicylate' OR 'methylsalicylate' OR pennsaid* OR powergel* OR voltarol):ti,ab,kw OR ketamine OR lidocaine OR marinol OR mirtazapine OR 'muscl* relaxant*' OR 'muscular relax*' OR 'muscle relax*' OR morphine OR (('non steroid*' OR nonsteroid*) NEXT/2 (anti-inflammator* OR antiinflammator*)) OR NMDA:ti,ab,kw OR 'n methyl d' OR nsaid*:ti,ab,kw OR n-said*:ti,ab,kw OR nortriptyline OR opioid* OR paracetamol OR pregabalin OR 'serotonin nonepinephrine' OR SNRI*:ti,ab OR tapentadol OR TCA*:ti,ab OR (topical NEAR/2 pain*) OR tramadol OR 'vitamin d'
	#5	Non-pharmacologic	'acceptance and commitment therapy'/de OR 'acupuncture'/exp OR 'behavior therapy'/exp OR 'biofeedback'/exp OR 'biofeedback training'/de OR 'biofeedback therapy'/de OR 'cognitive behavioral therapy'/exp OR 'desensitization'/de OR 'graded motor imagery'/de OR 'meditation'/exp OR 'mindfulness'/exp OR 'mindfulness based cognitive therapy'/de OR 'mindfulness based stress reduction'/de OR 'mindfulness based stress reduction program'/de OR 'mindfulness based therapy'/de OR 'mirror therapy'/de OR 'motor imagery'/de OR 'motor imagery training'/de OR 'nerve stimulation'/exp OR 'nerve stimulator'/exp OR 'nonpharmaceutical intervention'/de OR 'neurofeedback training'/de OR 'neurofeedback therapy'/de OR 'neuromodulation'/de OR 'pain neuroscience education'/de OR 'psychotherapy'/exp OR 'radiofrequency ablation'/exp OR 'radiofrequency therapy'/de OR 'reinnervation'/exp OR 'rehabilitation'/exp OR 'relaxation training'/de OR 'spinal cord stimulation'/de OR 'spinal cord stimulator'/de OR 'transcutaneous electrical nerve stimulation'/de OR (accept* NEAR/4 (commitment OR therap*)) OR ACT:ti,ab OR acupuncture OR biofeedback* OR 'bio feedback' OR ((behavior* OR cognit*) NEAR/5 therap*) OR 'cognitive behavioral' OR CBT:ti,ab OR desensitiz* OR desensitis* OR ((dorsal OR spine OR spinal) NEAR/6 stimulat*) OR 'electric* stimulat*' OR 'electric* nerve stimulat*' OR feedback OR (implant* NEAR/5 stimulat*) OR MBSR:ti,ab OR meditat* OR 'mental health' OR 'mental therap*' OR mindful* OR 'mirror box' OR 'mirror therap*' OR 'mirror visual' OR MVF:ti,ab OR 'motor imag*' OR 'motor execution' OR 'motor sequenc*' OR myobiofeedback* OR myofeedback* OR 'nerve stimulat*' OR neurofeedback* OR neuromodulat* OR 'neuro* modulat*' OR nonpharma* OR 'non pharma*' OR 'pain neuroscience' OR PNE:ti,ab OR ('peripheral nerve*' NEAR/4 stimulat*) OR PNS:ti,ab OR prevent*:ti,ab OR 'neuroscience educat*' OR psychotherap* OR radiofrequenc* OR 'radio frequenc*' OR reinnervat* OR (relax* NEXT/4 (technique* OR therap* OR treatment*)) OR 'RF ablation' OR SCS:ti,ab OR 'self care' OR 'stress reduc*' OR 'transcutaneous electric*' OR TENS

Question*	Set #	Concept	Strategy
KQ 7 (cont.)	#6	Combine main population with phantom/residual limb pain terms	#1 AND #2
	#7	Combine population sets	#3 OR #6
	#8	Combine intervention sets	#4 OR #5
	#9	Combine population and intervention sets	#7 AND #8
	#10	Apply limits, remove unwanted publication types, limit to SRs, MAs, and RCTs	See limits and hedges at the end of this table
KQ 8	#1	Adults with UE amputation	(‘arm injury’/exp OR ‘upper limb’/exp OR (arm OR arms OR carpal OR digit OR digits OR digital OR elbow* OR finger* OR forearm* OR forequarter OR hand OR hands OR humeral OR humerus OR interscapulothoracic OR metacarp* OR palm OR palms OR ((phalang* OR phalanx*) AND (digit OR digits OR finger* OR hand OR hands OR thumb*)) OR radial OR radius OR shoulder* OR thumb* OR transcarpal OR transhumeral OR transradial OR ulnar OR ‘upper extremit*’ OR ‘upper limb*’ OR wrist*):ti,ab,kw) AND (‘amputation’/de OR ‘amputation stump’/de OR ‘amputee’/de OR ‘disarticulation’/de OR ‘traumatic amputation’/de OR (amputat* OR amputee* OR disarticulat* OR exarticulat* OR ‘limb loss*’ OR ‘loss of limb*’ OR postamputation* OR reamputat* OR ‘remaining limb*’ OR ‘residual limb*’ OR stump*):ti,ab,kw) OR ‘arm amputation’/de OR ‘finger amputation’/de OR ‘forearm amputation’/de OR ‘forequarter amputation'/de OR ‘hand amputation’/de OR ‘shoulder amputation’/de OR ‘thumb amputation’/de OR ‘transhumeral amputation’/de OR (loss* NEAR/2 ('upper limb*' OR 'upper extremit*')):ti,ab,kw
	#2	Phantom/residual limb pain	‘phantom limb’/exp OR ‘phantom pain’/de OR ‘residual limb pain’/de OR ‘stump pain’/de OR ((‘arm pain’/de OR ‘battle injury’/de OR ‘blast injury’/de OR ‘chronic pain’/de OR ‘intractable pain’/de OR ‘limb pain’/de OR ‘missile wound’/de OR ‘neuropathic pain’/de OR ‘pain’/de OR ‘postoperative pain’/de OR ‘posttraumatic pain’/de OR pain OR pains OR painful) AND (((missing NEAR/4 (perception* OR perceive*)):ti,ab OR phantom* OR ‘remaining limb*’ OR ‘residual limb*’)) OR ‘pain perceived’:ti,ab OR ‘perceived pain’:ti,ab OR (pain* NEAR/3 stump*))
	#3	Narrower upper extremity terms paired with phantom and residual limb pain terms	(‘arm injury’/exp OR ‘upper limb’/exp OR (arm OR arms OR carpal OR digit OR digits OR digital OR elbow* OR finger* OR forearm* OR forequarter OR hand OR hands OR humeral OR humerus OR interscapulothoracic OR metacarp* OR palm OR palms OR ((phalang* OR phalanx*) AND (digit OR digits OR finger* OR hand OR hands OR thumb*)) OR radial OR radius OR shoulder* OR thumb* OR transcarpal OR transhumeral OR transradial OR ulnar OR ‘upper extremit*’ OR ‘upper limb*’ OR wrist*):ti,ab,kw) AND (‘phantom limb’/exp OR ‘phantom pain’/de OR ‘residual limb pain’/de OR ‘stump pain’/de OR ((‘arm pain’/de OR ‘battle injury’/de OR ‘blast injury’/de OR ‘chronic pain’/de OR ‘intractable pain’/de OR ‘limb pain’/de OR ‘missile wound’/de OR ‘neuropathic pain’/de OR ‘pain’/de OR ‘postoperative pain’/de OR ‘posttraumatic pain’/de OR pain OR pains OR painful) AND ((pain* NEAR/3 stump*) OR (phantom* OR ‘remaining limb*’ OR ‘residual limb*’))))

Question*	Set #	Concept	Strategy
KQ 8 (cont.)	#4	Pharmacologic	'analgesia'/exp OR 'analgesic agent'/exp OR 'anticonvulsive agent'/exp OR 'antidepressant agent'/exp OR 'benzodiazepine derivative'/exp OR 'benzatropine'/exp OR 'botulinum toxin A'/de OR 'bupivacaine'/de OR 'cannabis'/de OR 'capsaicin'/de OR 'carbamazepine'/de OR 'codeine'/de OR 'dronabinol'/de OR 'drug therapy'/exp OR 'fentanyl'/de OR 'dronabinol'/de OR 'gabapentin'/de OR 'ketamine'/de OR 'lidocaine'/de OR 'medical cannabis'/de OR 'menthol'/de OR 'muscle relaxant agent'/exp OR 'muscle relaxants'/exp OR 'muscle relaxants therapeutic use'/de OR 'morphine'/de OR 'narcotic analgesic agent'/exp OR 'n methyl dextro aspartic acid receptor stimulating agent'/exp OR 'nonsteroid antiinflammatory agent'/exp OR 'opiate'/de OR 'opiate agonist'/exp OR 'opiate receptor affecting agent'/exp OR 'paracetamol'/de OR 'tramadol'/de OR 'vitamin D'/exp OR ('acetylsalicylic acid' OR advil* OR aleve* OR anacin* OR aspirin OR diclofenac OR ibuprofen OR motrin* OR naproxen OR salicylate*):ti,ab,kw OR (((arnica OR aspercreme* OR bengay* OR biofreeze* OR camphor* OR capsicum OR 'deep relief*' OR diclofenac) NEAR/3 (gel OR patch OR topical)):ti,ab,kw) OR amitriptyline OR antidepressant* OR 'anti depressant*' OR anticonvulsant* OR anticonvulsive* OR antiepileptic* OR APAP:ti,ab,kw OR benzodiaz* OR benztropine OR botox OR botulinum OR bupivacaine OR cannabis OR cannabidiol OR capsaicin* OR carbamazepine OR codeine OR (drug* OR medication* OR medicin* OR pharmac*):ti,ab OR ((drug* OR medication* OR medicin* OR pharmac*) NEAR/5 (pain OR manag*)) OR dronabinol OR epidiolex OR gabapentin OR (ibuleve* OR 'icy hot*' OR lidocaine OR 'methyl salicylate' OR 'methylsalicylate' OR pennsaid* OR powergel* OR voltarol):ti,ab,kw OR keppra OR ketamine OR lacosamide OR lidocaine OR marinol OR (medic* NEAR/4 marijuana) OR mirtazapine OR 'muscl* relaxant*' OR 'muscular relax*' OR 'muscle relax*' OR morphine OR (('non steroid*' OR nonsteroid*) NEXT/2 (anti-inflammator* OR antiinflammator*)) OR NMDA:ti,ab,kw OR 'n methyl d' OR nsaid* OR n-said*:ti,ab,kw OR nortriptyline OR opioid* OR paracetamol OR pregabalin OR 'serotonin nonepinephrine' OR SNRI*:ti,ab OR TCA*:ti,ab OR (topical NEAR/2 pain*) OR tramadol OR 'vitamin d'
	#5	Combine main population with phantom/residual limb pain terms	#1 AND #2
	#6	Combine population sets	#3 OR #5
	#7	Combine population and intervention sets	#4 AND #6
	#8	Apply limits, remove unwanted publication types, limit to SRs, MAs, and RCTs	See limits and hedges at the end of this table

Question*	Set #	Concept	Strategy
KQ 9	#1	Adults with UE amputation	('arm injury'/exp OR 'upper limb'/exp OR (arm OR arms OR carpal OR digit OR digits OR digital OR elbow* OR finger* OR forearm* OR forequarter OR hand OR hands OR humeral OR humerus OR interscapulothoracic OR metacarp* OR palm OR palms OR ((phalang* OR phalanx*) AND (digit OR digits OR finger* OR hand OR hands OR thumb*)) OR radial OR radius OR shoulder* OR thumb* OR transcarpal OR transhumeral OR transradial OR ulnar OR 'upper extremit*' OR 'upper limb*' OR wrist*):ti,ab,kw) AND ('amputation'/de OR 'amputation stump'/de OR 'amputee'/de OR 'disarticulation'/de OR 'traumatic amputation'/de OR (amputat* OR amputee* OR disarticulat* OR exarticulat* OR 'limb loss*' OR 'loss of limb*' OR postamputation* OR reamputat* OR 'remaining limb*' OR 'residual limb*' OR stump*):ti,ab,kw) OR 'arm amputation'/de OR 'finger amputation'/de OR 'forearm amputation'/de OR 'forequarter amputation'/de OR 'hand amputation'/de OR 'shoulder amputation'/de OR 'thumb amputation'/de OR 'transhumeral amputation'/de OR (loss* NEAR/2 ('upper limb*' OR 'upper extremit*')):ti,ab,kw
	#2	Phantom/residual limb pain	'phantom limb'/exp OR 'phantom pain'/de OR 'residual limb pain'/de OR 'stump pain'/de OR (('arm pain'/de OR 'battle injury'/de OR 'blast injury'/de OR 'chronic pain'/de OR 'intractable pain'/de OR 'limb pain'/de OR 'missile wound'/de OR 'neuropathic pain'/de OR 'pain'/de OR 'postoperative pain'/de OR 'posttraumatic pain'/de OR pain OR pains OR painful) AND (((missing NEAR/4 (perception* OR perceive*)):ti,ab OR phantom* OR 'remaining limb*' OR 'residual limb*')) OR 'pain perceived':ti,ab OR 'perceived pain':ti,ab OR (pain* NEAR/3 stump*))
	#3	Narrower upper extremity terms paired with phantom and residual limb pain terms	('arm injury'/exp OR 'upper limb'/exp OR (arm OR arms OR carpal OR digit OR digits OR digital OR elbow* OR finger* OR forearm* OR forequarter OR hand OR hands OR humeral OR humerus OR interscapulothoracic OR metacarp* OR palm OR palms OR ((phalang* OR phalanx*) AND (digit OR digits OR finger* OR hand OR hands OR thumb*)) OR radial OR radius OR shoulder* OR thumb* OR transcarpal OR transhumeral OR transradial OR ulnar OR 'upper extremit*' OR 'upper limb*' OR wrist*):ti,ab,kw) AND ('phantom limb'/exp OR 'phantom pain'/de OR 'residual limb pain'/de OR 'stump pain'/de OR (('arm pain'/de OR 'battle injury'/de OR 'blast injury'/de OR 'chronic pain'/de OR 'intractable pain'/de OR 'limb pain'/de OR 'missile wound'/de OR 'neuropathic pain'/de OR 'pain'/de OR 'postoperative pain'/de OR 'posttraumatic pain'/de OR pain OR pains OR painful) AND ((pain* NEAR/3 stump*) OR (phantom* OR 'remaining limb*' OR 'residual limb*'))))

Question*	Set #	Concept	Strategy
KQ 9 (cont.)	#4	Non-pharmacologic interventions	'acceptance and commitment therapy'/de OR 'acupuncture'/exp OR 'augmented reality'/de OR 'augmented reality system'/de OR 'behavior therapy'/exp OR 'biofeedback'/exp OR 'biofeedback training'/de OR 'biofeedback therapy'/de OR 'cognitive behavioral therapy'/exp OR 'desensitization'/de OR 'graded motor imagery'/de OR 'meditation'/exp OR 'mindfulness'/exp OR 'mindfulness based cognitive therapy'/de OR 'mindfulness based stress reduction'/de OR 'mindfulness based stress reduction program'/de OR 'mindfulness based therapy'/de OR 'mirror therapy'/de OR 'motor imagery'/de OR 'motor imagery training'/de OR 'nerve stimulation'/exp OR 'nerve stimulator'/exp OR 'nonpharmaceutical intervention'/de OR 'neurofeedback training'/de OR 'neurofeedback therapy'/de OR 'neuromodulation'/de OR 'pain neuroscience education'/de OR 'psychotherapy'/exp OR 'radiofrequency ablation'/exp OR 'radiofrequency therapy'/de OR 'reinnervation'/exp OR 'rehabilitation'/exp OR 'relaxation training'/de OR 'spinal cord stimulation'/de OR 'spinal cord stimulator'/de OR 'transcutaneous electrical nerve stimulation'/de OR 'virtual reality'/de OR 'virtual reality system'/de OR 'virtual reality simulator'/exp OR 'virtual reality exposure therapy'/de OR (ameliorat* OR manag* OR reduc* OR eliminat* OR treat* OR treatment*):ti OR (accept* NEAR/4 (commitment OR therap*)) OR ACT:ti,ab OR acupuncture OR 'augmented reality' OR biofeedback* OR 'bio feedback' OR ((behavior* OR cognit*) NEAR/5 therap*) OR 'cognitive behavioral' OR CBT:ti,ab OR desensitiz* OR desensitis* OR ((dorsal OR spine OR spinal) NEAR/6 stimulat*) OR 'electric* stimulat*' OR feedback OR (implant* NEAR/5 stimulat*) OR managing:ti,ab,kw OR management:ti,ab,kw OR MBSR:ti,ab OR meditat* OR 'mental health*' OR 'mental therap*' OR mindful* OR 'mirror box' OR 'mirror therap*' OR 'mirror visual' OR MVF:ti,ab OR 'motor imag*' OR 'motor execution' OR 'motor sequenc*' OR myobiofeedback* OR myofeedback* OR 'nerve stimulat*' OR neurofeedback* OR neuromodulat* OR 'neuro* modulat*' OR nonpharma* OR 'non pharma*' OR 'pain neuroscience' OR PNE:ti,ab OR ('peripheral nerve*' NEAR/4 stimulat*) OR PNS:ti,ab OR 'neuroscience educat*' OR psychotherap* OR radiofrequenc* OR 'radio frequenc*' OR reinnervat* OR (relax* NEAR/4 (technique* OR therap* OR treatment*)) OR 'RF ablation' OR SCS:ti,ab OR 'self care' OR 'stress reduc*' OR 'transcutaneous electric*' OR TENS OR 'virtual reality'
	#5	Combine main population with phantom/ residual limb pain terms	#1 AND #2
	#6	Combine population sets	#3 OR #5
	#7	Combine population and intervention sets	#4 AND #6
	#8	Apply limits, remove unwanted publication types, limit to SRs, MAs, RCTs, non-RCTs, and comparative studies	See limits and hedges at the end of this table

Question*	Set #	Concept	Strategy
KQ 10	#1	Adults who are candidates for UE surgery	(‘arm injury’/exp OR ‘upper limb’/exp OR (arm OR arms OR carpal OR digit OR digits OR digital OR elbow* OR finger* OR forearm* OR forequarter OR hand OR hands OR humeral OR humerus OR interscapulothoracic OR metacarp* OR palm OR palms OR ((phalang* OR phalanx*) AND (digit OR digits OR finger* OR hand OR hands OR thumb*)) OR radial OR radius OR shoulder* OR thumb* OR transcarpal OR transhumeral OR transradial OR ulnar OR ‘upper extremit*’ OR ‘upper limb*’ OR wrist*):ti,ab,kw) AND (‘amputation’/de OR ‘amputation stump’/de OR ‘amputee’/de OR ‘disarticulation’/de OR ‘traumatic amputation’/de OR (amputat* OR amputee* OR disarticulat* OR exarticulat* OR ‘limb loss*’ OR ‘loss of limb*’ OR postamputation* OR preamputat* OR preprosthe* OR ‘pre prosthe*’ OR reamputat* OR ‘remaining limb*’ OR ‘residual limb*’ OR stump*):ti,ab,kw) OR ‘arm amputation’/de OR ‘finger amputation’/de OR ‘forearm amputation’/de OR ‘forequarter amputation'/de OR ‘hand amputation’/de OR ‘shoulder amputation’/de OR ‘thumb amputation’/de OR ‘transhumeral amputation’/de OR (loss* NEAR/2 ('upper limb*' OR 'upper extremit*')):ti,ab,kw
	#2	Level of amputations	'amputation level'/de OR (amputat* NEAR/3 level*):ti,ab,kw OR ‘amputation method’ OR ((above OR at OR below) NEXT/3 (elbow* OR shoulder* OR wrist*)):ti,ab OR ‘method* of amputation*’ OR ‘partial digit*’:ti,ab,kw OR ‘partial finger’:ti,ab,kw OR ‘partial hand’:ti,ab,kw OR ‘partial thumb’:ti,ab,kw OR ((elbow* OR shoulder* OR wrist*) NEAR/2 disarticulat*):ti,ab OR ((level* OR method* OR technique*) AND (forequarter OR transcarpal OR transhumeral OR transradial)):ti,ab
	#3	Surgical procedure	‘myoplasty’/de OR ‘peripheral nerve stimulator’/de OR ‘osseointegration’/de OR ‘revision surgery’/de OR ‘spinal cord stimulation’/de OR ‘targeted muscle reinnervation’/de OR ((amputation/exp/mj OR ‘surgical approach’/de OR ‘surgical technique’/exp OR ‘surgical approach*’ OR ‘surgical technique*’) AND (approach* OR level* OR method* OR procedure* OR technique):ti) OR ((operative OR surgery OR surgical) NEXT/2 (approach* OR method* OR procedure* OR technique*)):ti,ab OR (amputation* NEAR/3 (approach* OR method* OR procedure* OR technique*)):ti,ab OR (myodesis OR myoplast* OR osseointegrat* OR ‘osseo integrat*’ OR ‘targeted muscle reinnervation’ OR ‘revision surger*’ OR ertl OR ‘peripheral nerve stimulat*’ OR ‘spinal cord stimulation’):ti,ab,kw
	#4	Patient outcomes with amputation level/surgical procedure	(('amputation level'/de OR ‘surgical approach’/de OR ‘surgical technique’/exp OR ‘amputation level*’ OR ‘amputation method*’ OR ‘operative technique*’ OR ‘surgical approach*’ OR ‘surgical technique*’) AND ‘patient outcome*’) OR ((‘amputation level*’ OR ‘amputation method*’ OR ‘operative technique*’ OR ‘surgical approach*’ OR ‘surgical technique*’) AND outcome*:ti) OR ((‘surgical outcome’/de OR (amputation* NEAR/2 outcome*)) AND (approach* OR level* OR method* OR procedure* OR technique*):ti) OR (amputat*:ti,ab AND ((operative OR surgery OR surgical OR ‘surgical procedure*’) NEAR/2 outcome*))
	#5	Combine intervention sets	#2 OR #3 OR #4
	#6	Combine population and intervention sets	#1 AND #5
	#7	Apply limits, remove unwanted publication types, limit to SRs, MAs, RCTs, non-RCTs, and comparative studies	See limits and hedges at the end of this table

Question*	Set #	Concept	Strategy
KQ 11	#1	Adults who are candidates for UE surgery	('arm injury'/exp OR 'upper limb'/exp OR (arm OR arms OR carpal OR digit OR digits OR digital OR elbow* OR finger* OR forearm* OR forequarter OR hand OR hands OR humeral OR humerus OR interscapulothoracic OR metacarp* OR palm OR palms OR ((phalang* OR phalanx*) AND (digit OR digits OR finger* OR hand OR hands OR thumb*)) OR radial OR radius OR shoulder* OR thumb* OR transcarpal OR transhumeral OR transradial OR ulnar OR 'upper extremit*' OR 'upper limb*' OR wrist*):ti,ab,kw) AND ('amputation'/de OR 'amputation stump'/de OR 'amputee'/de OR 'disarticulation'/de OR 'traumatic amputation'/de OR (amputat* OR amputee* OR disarticulat* OR exarticulat* OR 'limb loss*' OR 'loss of limb*' OR postamputation* OR preamputat* OR preprosthe* OR 'pre prosthe*' OR reamputat* OR 'remaining limb*' OR 'residual limb*' OR stump*):ti,ab,kw) OR 'arm amputation'/de OR 'finger amputation'/de OR 'forearm amputation'/de OR 'forequarter amputation'/de OR 'hand amputation'/de OR 'shoulder amputation'/de OR 'thumb amputation'/de OR 'transhumeral amputation'/de OR (loss* NEAR/2 ('upper limb*' OR 'upper extremit*')):ti,ab,kw
	#2	Skin condition, infection, pain, etc.	'blood flow'/exp OR 'circulation'/exp OR 'heterotopic ossification'/de OR 'infection'/exp/mj OR 'limb ischemia'/exp/mj OR 'muscle ischemia'/de OR 'neuroma'/exp/mj OR 'pain'/exp/mj OR 'palpation'/exp OR 'skin infection'/exp OR 'skin ischemia'/exp/mj OR 'skin perfusion pressure'/exp OR (angiograph* NEAR/3 score*) OR (blood NEAR/2 (flow* OR supply)) OR circulation:ti,ab,kw OR dermatitis:ti,ab,kw OR edema*:ti,ab,kw OR 'heterotopic ossification' OR infected:ti,ab OR infection*:ti,ab OR ischemic:ti,ab,kw OR (amput* AND (muscle* NEAR/3 (condition* OR strength OR weak*)):ti,ab,kw) OR pain*:ti,ab OR neuroma*:ti,ab OR oedema*:ti,ab,kw OR 'patency score*' OR 'palpable pulse*' OR palpitation*:ti,ab,kw OR scintigraphic OR (skin NEAR/3 (breakdown* OR care OR cleaning OR condition* OR disease* OR infection* OR integrity)):ti,ab,kw OR 'skin perfusion pressure' OR SPP:ti,ab,kw OR 'vascular insufficienc*':ti,ab,kw
	#3	Wound healing, prostheses fitting, need for revision surgery	'outcome'/de OR 'outcome assessment'/exp/mj OR 'outcomes'/de OR 'patient outcomes'/de OR 'postoperative complication'/exp/mj OR 'prosthesis fixation'/de OR 'prosthetic fitting'/de OR 'reoperation'/de OR 'revision surgery'/de OR 'treatment outcome'/exp/mj OR 'wound healing'/exp OR ((postsurg* OR 'post surg*') AND ('adverse event*' OR complicat*)) OR ((adverse OR complicat* OR qualit* OR speed*) AND wound* AND (heal OR healing)) OR (wound* NEAR/3 (complicat* OR heal OR healing)) OR (prosthe* NEAR/3 fit*) OR 'revision surger*' OR 're amputat*':ti,ab,kw OR reoperat*:ti,ab,kw OR (revision* NEAR/4 amputat*)
	#4	Targeted terms	(amput* AND ('adverse event*' OR complicat* OR outcome* OR readmit* OR 're admit*' OR readmission* OR 're admission*' OR revision*)):ti OR (amput* AND complicat* AND 'prosthe* fiting'):ti,ab OR (amput* NEAR/3 outcome*):ti,ab OR ((amput* OR skin OR surger* OR surgical OR wound*) AND (factor* OR complicat* OR predict*)):ti OR (complicat* NEAR/4 (factor* OR healing OR wound*)):ti,ab OR ((factor* OR predict* OR need* OR requir*) AND (revision* NEAR/4 (amputat* OR surger*))):ti,ab OR ('prosthe* fit*' OR reoperat* OR 'revision amput*' OR 'revision surger*' OR 'wound healing'):ti OR ((preamputat* OR 'pre amputat*' OR preprosthe* OR 'pre prosthe*' OR presurgical OR 'pre surgical' OR 'prosthe* fit*' OR 'wound healing') NEAR/5 (factor* OR predict* OR outcome*)) OR ((amput* NEAR/3 infect*) OR (angiograph* NEAR/3 score*) OR (blood NEAR/2 (flow* OR supply)) OR circulation OR dermatitis OR edema* OR 'heterotopic ossification' OR (amput* AND (muscle* NEAR/3 (condition* OR strength OR weak*))) OR oedema* OR 'patency score*' OR 'palpable pulse*' OR palpitation* OR scintigraphic OR (skin NEAR/3 (breakdown* OR care OR cleaning OR condition* OR disease* OR infection* OR integrity)) OR 'skin perfusion pressure' OR SPP OR 'vascular insufficienc*' OR ((ischemic OR infected OR infection* OR neuroma* OR pain) NEAR/3 (effect* OR factor* OR fitting* OR healing OR outcome*))):ti,ab OR ((ischemic OR infected OR infection* OR neuroma* OR pain) AND (effect* OR factor* OR fitting* OR healing OR outcome* OR revision)):ti
	#5	Combine intervention sets	(#2 AND #3) OR #4

Question*	Set #	Concept	Strategy
KQ 11 (cont.)	#6	Combine population and intervention sets	#1 AND #5
	#7	Apply limits, remove unwanted publication types	See limits and hedges at the end of this table
KQ 12	#1	Adults with UE amputation	(‘arm injury’/exp OR ‘upper limb’/exp OR (arm OR arms OR carpal OR digit OR digits OR digital OR elbow* OR finger* OR forearm* OR forequarter OR hand OR hands OR humeral OR humerus OR interscapulothoracic OR metacarp* OR palm OR palms OR ((phalang* OR phalanx*) AND (digit OR digits OR finger* OR hand OR hands OR thumb*)) OR radial OR radius OR shoulder* OR thumb* OR transcarpal OR transhumeral OR transradial OR ulnar OR ‘upper extremit*’ OR ‘upper limb*’ OR wrist*):ti,ab,kw) AND (‘amputation’/de OR ‘amputation stump’/de OR ‘amputee’/de OR ‘disarticulation’/de OR ‘traumatic amputation’/de OR (amputat* OR amputee* OR disarticulat* OR exarticulat* OR ‘limb loss*’ OR ‘loss of limb*’ OR postamputation* OR reamputat* OR ‘remaining limb*’ OR ‘residual limb*’ OR stump*):ti,ab,kw) OR ‘arm amputation’/de OR ‘finger amputation’/de OR ‘forearm amputation’/de OR ‘forequarter amputation'/de OR ‘hand amputation’/de OR ‘shoulder amputation’/de OR ‘thumb amputation’/de OR ‘transhumeral amputation’/de OR (loss* NEAR/2 ('upper limb*' OR 'upper extremit*')):ti,ab,kw
	#2	UE prostheses population	((‘arm prosthesis’/exp OR ‘finger implant’/exp OR ((‘bionics’/de OR ‘electric limb prosthesis’/exp OR ‘limb prosthesis’/de OR ‘myoelectric control'/de OR ‘orthopedic prosthesis’/de OR ‘prosthesis fixation’/de) AND 'upper limb'/exp)) OR ‘artificial hand*’:ti,ab OR ('artificial limb*' AND (arm OR arms OR hand OR hands OR upper)):ti,ab OR (((bionic* OR ‘man-machine’ OR myoelectric* OR ‘myo electric*’ OR neuroprosth* OR prosthes* OR prosthet* OR ‘robot* manipulat*’) NEAR/2 (arm OR arms OR carpal OR digit OR digits OR elbow* OR finger* OR forearm* OR forequarter OR hand OR hands OR humeral OR humerus OR metacarp* OR palm OR palms OR phalang* OR phalanx* OR radial OR radius OR shoulder* OR thumb* OR transcarpal OR transhumeral OR transradial OR ulnar OR ‘upper extremit*’ OR ‘upper limb*’)):ti,ab) OR ((neuroprosth* OR prosthes* OR prosthet*) NEAR/4 (arm OR arms OR hand OR hands OR ‘upper extremit*’ OR ‘upper limb*’)):ti,ab,kw OR ((((artificial* OR ‘body power*’ OR bionic* OR electric* OR electronic OR ‘external* power*’ OR ‘man-machine’ OR myoelectric* OR neuroprosth* OR prosthes* OR prosthet* OR robot*) NEAR/3 (extremit* OR limb*)):ti,ab OR ('body power*' OR bionic* OR 'external* power*' OR ‘man-machine’ OR myoelectric* OR neuroprosth* OR prosthes* OR prosthet*):ti) AND (arm OR arms OR carpal OR digit OR digits OR elbow* OR finger* OR forearm* OR forequarter OR hand OR hands OR humeral OR humerus OR metacarp* OR shoulder* OR thumb* OR transcarpal OR transhumeral OR transradial OR ‘trans radial’ OR ulnar OR ‘upper arm*’ OR ‘upper limb*’ OR ‘upper extremit*’ OR ‘upper or lower’):ti,ab))

Question*	Set #	Concept	Strategy
KQ 12 (cont.)	#3	Physical and occupational therapies	'athletic rehabilitation'/de OR 'core stability exercise'/de OR 'exercise'/exp/mj OR 'functional training'/de OR 'kinesiotherapy'/exp OR 'occupational therapy'/de OR 'physiotherapy'/exp OR 'manipulative medicine'/exp OR 'manual therapist'/exp OR 'muscle training'/de OR 'occupational therapist'/de OR 'physical medicine'/de OR 'physical rehabilitation'/de OR 'physiotherapist'/de OR 'range of motion'/exp/mj OR 'range of motion exercise'/de OR 'rehabilitation medicine'/de OR 'resistance training'/de OR 'return to sport'/de OR 'return to work'/de OR 'strengthening exercise'/de OR 'vocational rehabilitation'/de OR (('amputee'/de OR 'amputation'/de OR 'arm amputation'/exp) AND 'range of motion'/exp) OR 'adaptive sport*':ti,ab,kw OR (chang* NEAR/5 dominan*) OR exercise*:ti OR ((exercise* OR recreation* OR physical OR occupation* OR vocation*) NEAR/4 (rehab* OR therap*)):ti,ab,kw OR 'functional training' OR kinesiotherap*:ti,ab,kw OR 'manual therap*':ti,ab,kw OR 'manipulative medicine':ti,ab OR physiatrist*:ti,ab,kw OR 'physical medicine':ti,ab,kw OR ((physical OR occupation* OR vocation*) AND protocol*):ti,ab OR physiotherap*:ti,ab,kw OR 'physio therap*':ti,ab,kw OR ((exercise* OR rehab* OR therap* OR train*) NEAR/5 'range* of motion*'):ti,ab OR 'rehab* therap*':ti,ab,kw OR relearn*:ti,ab OR 'resistance training':ti,ab,kw OR retrain*:ti,ab,kw OR (return* NEXT/2 (duty OR play OR sport* OR work)):ti,ab OR (scar* NEAR/2 massage*) OR strengthen*:ti,ab OR 'sport* train*':ti,ab,kw OR (strengthen* AND ('residual limb*' OR 'intact limb*')) OR (core NEAR/3 strength*) OR (preserv* NEAR/5 (contralateral OR intact))
	#4	Prostheses/equipment specific	'assistive technology'/de OR 'assistive technology device'/de OR 'physical therapy device'/de OR 'rehabilitation equipment'/de OR ((adaptive OR assistive OR rehab*) NEXT/4 (technolog* OR equipment)):ti,ab,kw OR ((device* OR prosthes* OR prosthet*) NEAR/4 (educat* OR provision* OR rehab* OR teach* OR train*)) OR 'durable medical equipment':ti,ab,kw OR DME:ti OR (efficien* NEAR/5 train*)
	#5	Intervention timing, additional therapies, and interventions	'biofeedback'/exp OR 'biofeedback training'/de OR 'biofeedback therapy'/de OR 'community reintegration'/de OR 'desensitization'/de OR 'mirror box therapy'/de OR 'mirror therapy'/de OR 'patient education'/de OR 'psychosocial rehabilitation'/de OR 'wound care'/exp/mj OR 'wound management'/de OR (activit* NEAR/4 analy*) OR biofeedback* OR 'bio feedback*' OR (communit* NEAR/2 reintegrat*) OR desensitiz* OR desensitis* OR ((frequency OR number*) NEAR/4 (course OR exercise* OR intervention* OR practice* OR rehab* OR session* OR therap* OR train* OR treatment* OR visit*)) OR 'mirror box*' OR 'mirror therap*' OR 'mirror visual' OR MVF:ti OR 'neuromuscular educat*' OR 'neuro muscular educat*' OR 'patient discharge education':ti,ab,kw OR 'patient education':ti,ab,kw OR ((course OR exercise* OR intervention* OR practice* OR rehab* OR session* OR timing OR therap* OR train* OR treatment* OR visit*) AND (per NEAR/2 (day* OR hour* OR minute* OR month* OR week*))) OR ((physician* OR therap*) AND ('patient reported' NEAR/3 (information OR outcome* OR symptom*))):ti,ab OR 'practice pattern*' OR ((schedule* OR stage* OR time OR visit*) NEAR/5 (course OR intervention* OR rehab* OR therap* OR training*)) OR 'stage* of care' OR (timing AND (intervention* OR rehab* OR therap*)) OR 'therap* protocol*' OR 'wound care':ti,ab OR 'wound management*':ti,ab
	#6	Combine population sets	#1 OR #2
	#7	Combine intervention sets	#3 OR #4 OR #5
	#8	Combine population and intervention sets	#6 AND #7

Question*	Set #	Concept	Strategy
KQ 12 (cont.)	#9	Apply limits, remove unwanted publication types, limit to SRs, MAs, RCTs, non-RCTs, and comparative studies	See limits and hedges at the end of this table
Limits and hedges applied to each search strategy		Hedge to identify RCTs	'random sample'/de OR 'randomized controlled trial'/de OR randomization/de OR (random* OR RCT):ti,ab
		Hedge to identify meta-analyses and systematic reviews	'meta analysis'/exp OR 'systematic review'/de OR [cochrane review]/lim OR systematic*:ti OR (cochrane OR metaanaly* OR "meta analy*" OR (search* AND (databases OR electronic OR methodolog* OR embase* OR ebsco* OR medline* OR ovid* OR sciencedirect* OR scopus* OR systematic OR web)) OR (systematic* NEAR/2 review*)):ti,ab
		Hedge to identify nonrandomized controlled and comparative studies	'case control study'/exp OR 'clinical trial'/exp OR 'cohort analysis'/de OR 'comparative study'/exp OR 'control group'/de OR 'controlled study'/exp OR 'longitudinal study'/de OR 'major clinical study'/de OR 'prospective study'/de OR 'retrospective study'/de OR ('between groups' OR 'case control*' OR cohort OR compar* OR 'control group*' OR 'controlled study' OR 'controlled trial' OR 'cross over' OR crossover OR 'double blind' OR 'double blinded' OR longitudinal OR 'matched controls' OR placebo* OR prospective OR retrospective OR sham):ti,ab OR (versus OR vs):ti
		Limit to English language publications	AND [english]/lim
		Exclude animal and experimental studies	NOT (([animals]/lim NOT [humans]/lim) OR (animal* OR cadaver* OR experimental OR (vitro NOT vivo) OR canine OR dog OR dogs OR mouse OR mice OR murine OR pig OR pigs OR piglet* OR porcine OR rabbit* OR rat OR rats OR rodent* OR sheep OR swine):ti)
		Exclude studies focusing on children	NOT ((adolescen* OR boys OR child* OR girls OR juvenile* OR paediatric* OR pediatric* OR preschool* OR teen* OR toddler* OR youth*) NOT (adult* OR men OR women)):ti
		Remove unwanted publication and study types (e.g., case reports, conferences, editorials)	NOT ('conference paper'/exp OR [conference abstract]/lim OR [conference paper]/lim OR [conference review]/lim OR ('case report' OR book OR editorial OR erratum OR letter OR note OR 'short survey')/de OR (book OR conference OR editorial OR erratum OR letter OR note OR 'short survey'):it OR 'a case':ti,ab OR 'year old':ti OR (book OR 'conference proceeding'):pt OR ('case report' OR comment OR ((rationale OR study) NEAR/3 protocol)):ti)
		Remove unrelated studies	NOT ((((elbow OR hip OR joint OR knee OR shoulder) NEXT/1 (arthroscop* OR arthroplast* OR replacement*)):ti) OR (arthroplast*:ti,ab,kw NOT amput*) OR dental:ti OR denture*:ti OR laparoscopic*:ti OR maxillofacial:ti OR orthodontic*:ti OR palmoplantar:ti OR parkinson*:ti OR poststroke*:ti OR prosthodontic*:ti OR stroke:ti OR 'robotic assisted surg*':ti,ab OR 'robotic surg*':ti,ab OR 'surgical robot*':ti,ab OR teeth:ti OR tooth:ti OR ((robot* NEAR/2 surg*):ti))
		Limit to items published 2013-2021	AND [2013-2021]/py
		Limit to results added to the database between February 1, 2013, and April 30, 2021	AND [1-2-2013]/sd NOT [30-04-2021]/sd

*For more information about the key question (KQ), see Table A-2.

B. CINAHL in EBSCO Syntax (KQs 2, 3, 7, 8, 9, 12)

Question*	Set #	Concept	Strategy
KQ 2	S1	Adults with UE amputation	(DE "arm injuries" OR DE "upper extremity" OR TX (arm OR arms OR carpal OR digit OR digits OR digital OR elbow* OR finger* OR forearm* OR forequarter OR hand OR hands OR humeral OR humerus OR interscapulothoracic OR metacarp* OR palm OR palms OR ((phalang* OR phalanx*) AND (digit OR digits OR finger* OR hand OR hands OR thumb*)) OR radial OR radius OR shoulder* OR thumb* OR transcarpal OR transhumeral OR transradial OR ulnar OR "upper extremit*" OR "upper limb*" OR wrist*)) AND (DE "amputation" OR DE "amputation stumps" OR DE "amputees" OR DE "disarticulation" OR DE "amputation, traumatic" OR TX (amputat* OR amputee* OR disarticulat* OR exarticulat* OR "limb loss*" OR "loss of limb*" OR postamputation* OR reamputat* OR "remaining limb*" OR "residual limb*" OR stump*)) OR TX (loss* N2 ("upper limb*" OR "upper extremit*"))
	S2	General terms	DE “behavioral medicine” OR DE “motivation” OR DE “psychosocial intervention” OR DE “psychosocial functioning” OR DE “psychosocial support systems” OR DE "social adjustment” OR DE “social behavior” OR DE “social skills” OR TX “behavioral health OR TI communit* OR TX (communit* AND (assist* OR integrat* OR interact* OR live OR living OR particip* OR reintegrat* OR relation* OR support*)) OR TX (“general communit*” OR happiness OR “patient engagement*” OR psychosocial* OR “psycho social*”) OR TX (social* N3 (adapt* OR adjust* OR behavior* OR competent* OR integrat* OR interact* OR particip* OR rehab* OR reintegrat* OR skill*))
	S3	Peer/group/mentor/ community	DE “community integration” OR DE “therapeutic community” OR DE “community participation” OR DE “community psychiatry” OR DE “psychotherapy, group” OR DE “mentors” OR DE “peer group” OR DE “peer influence” OR DE “social support” OR DE “self-help groups” OR TX (“1 on 1” OR “amputee support*” OR “emotional* support*” OR “group therap*”) OR TX ((group* OR peer*) W2 (counsel* OR therap* OR support*)) OR TX interpersonal OR TX mentor* OR TX (mutual W2 (group* OR help* OR support*)) OR TX ((mutual OR communit* OR peer*) N3 (help* OR group* OR support* OR aid OR led OR assist*)) OR TX “one on one” OR TI peer* OR AB peer* OR TX (support* N2 group*) OR TX “wounded warrior”
	S4	Additional counseling and therapy	DE “acceptance and commitment therapy” OR DE “behavior therapy” OR DE “cognitive behavioral therapy” OR DE “case managers” OR DE “counseling” OR DE “mental health services” OR DE “mindfulness” OR DE “psychotherapy” OR DE “social medicine” OR TX ((acceptance OR commitment) N3 therap*) OR TI ACT OR TX ((behavior* OR cognitiv* OR famil* OR motivation* OR psychological OR social*) N2 (counsel* OR intervent* OR management OR service* OR support* OR therap*)) OR TX “case manage*” OR TI CBT OR TX counseling OR TX “mental health care” OR TX (mindful* W2 therap*) OR TX motivational OR TX (motivation* N2 (enhancement* OR intervention* OR interview* OR support*)) OR TX (psychodynamic N2 therap*) OR TX psychotherap* OR TX ((social OR interpersonal) N2 (support* OR train*)) OR TX “social work*” OR TX “social service*”
	S5	Education and techniques	DE “education” OR DE “meditation” OR DE “mindfulness” OR DE “patient education as topic” OR TX (breathing N2 (deep* OR exercise*)) OR TX (“client education” OR hakomi OR MBSR OR meditat* OR mindfulness) OR TX (mindful* N2 “stress reduc*”) OR TX (morita OR “neuroscience education” OR “neuroscience therap*” OR “pain education” OR “patient discharge education” OR “patient education”) OR TI PNE OR TX psychoeducation* OR TX “self help” OR TI TNE
	S6	Combine intervention sets	S2 OR S3 OR S4 OR S5
	S7	Combine population and intervention sets	S1 AND S6

Question*	Set #	Concept	Strategy
KQ 2 (cont.)	S8	Apply limits, remove unwanted publication types, limit to SRs, MAs, RCTs, non-RCTs, and comparative studies	See limits and hedges at the end of this table
KQ 3	S1	Adults with UE amputation	(DE "arm injuries" OR DE "upper extremity" OR TX (arm OR arms OR carpal OR digit OR digits OR digital OR elbow* OR finger* OR forearm* OR forequarter OR hand OR hands OR humeral OR humerus OR interscapulothoracic OR metacarp* OR palm OR palms OR ((phalang* OR phalanx*) AND (digit OR digits OR finger* OR hand OR hands OR thumb*)) OR radial OR radius OR shoulder* OR thumb* OR transcarpal OR transhumeral OR transradial OR ulnar OR "upper extremit*" OR "upper limb*" OR wrist*)) AND (DE "amputation" OR DE "amputation stumps" OR DE "amputees" OR DE "disarticulation" OR DE "amputation, traumatic" OR TX (amputat* OR amputee* OR disarticulat* OR exarticulat* OR "limb loss*" OR "loss of limb*" OR postamputation* OR reamputat* OR "remaining limb*" OR "residual limb*" OR stump*)) OR TX (loss* N2 ("upper limb*" OR "upper extremit*"))
	S2	General terms	DE “delivery of health care” OR DE “health facilities” OR TI (amput* N2 rehab*) OR AB (amput* N2 rehab*) OR TI (care N2 deliver*) OR AB (care N2 deliver*) OR TX ((duration* OR frequenc* OR intensity) N5 outcome*) OR TX (frequenc* N5 (duration* OR intensit*)) OR TX (intensit* N5 (duration* OR frequenc*)) OR TI (outcome* N2 improv*) OR TI (postoperative OR “post operative” OR postsurgical OR “post surgical” OR “post surgery” OR posttreatment OR “post treatment”) OR TX ((rehab* N3 (nursing OR program* OR setting*)) OR TX (service* N3 deliver*) OR TX (((appointment* OR treatment* OR visit*) N2 (deliver* OR duration* OR frequen* OR intensit* OR length* OR service* OR setting* OR time OR timing)) OR AB (day* AND month* AND week*)
	S3	Settings/locations	DE “ambulatory care facilities” OR DE “inpatients” OR DE “hospitalization” OR DE “outpatients” OR DE “outpatient clinics, hospital” OR DE “rehabilitation centers” OR DE “residential facilities” OR TX “acute care” OR TX “acute rehab*” OR TX (ambulatory N2 (care OR center* OR facilit* OR rehab*)) OR TX “care facilit*” OR TI clinic OR TI clinics OR TX “day* rehab*” OR TI hospitalis* OR TI hospitaliz* OR TI “in hospital” OR AB “in hospital” OR TX ((inpatient* OR outpatient*) N3 (care OR clinic* OR department* OR facilit* OR hospital* OR rehab* OR therap* OR treat*)) OR TX (rehab* N2 (center* OR hospital*)) OR TX “residential rehab*” OR TX “skilled nursing” OR TX “UEAcenter*” OR TX (“upper limb” N2 center*)

Question*	Set #	Concept	Strategy
KQ 3 (cont.)	S4	Telehealth/virtual/ digital	DE “computer simulation” OR DE “digital technology” OR DE “telemedicine” OR DE “telephone” OR DE “video games” OR DE “virtual reality” OR TI (android OR camera* OR cellphone OR “cell phone” OR computer* OR distan* OR electronic OR email OR “e-mail” OR game OR gaming OR facetime OR “face time” OR ipad OR “i pad” OR iphone OR “i phone” OR internet OR laptop OR mobile OR online OR phone* OR remote* OR smart* OR tablet* OR telephone* OR video* OR virtual OR “web based” OR wireless OR zoom) OR TX ((android OR camera* OR cellphone OR “cell phone” OR computer* OR digital OR distan* OR electronic OR email OR “e-mail” OR facetime OR “face time” OR ipad OR “i pad” OR iphone OR “i phone” OR internet OR laptop OR mobile OR online OR remote* OR tablet* OR telephone OR video* OR virtual OR “web based” OR zoom) N2 (care OR conference* OR consult* OR monitor* OR health* OR medicine OR psychiatr* OR psycholog* OR psychotherap* OR therap* OR treatment* OR visit*)) OR TX (“augmented reality” OR bluetooth OR “blue tooth” OR “digital technolog*” OR “e care” OR “e consult*” OR ehealth OR “e health” OR emedicine OR “e medicine” OR etherapy OR “e therapy”) OR TX ((game OR gaming) N5 (rehab* OR treatment*)) OR “game based” OR “gaming based” OR mhealth OR “m health” OR TX ((mobile OR wireless OR smart) N5 (health* OR device* OR application* OR app OR apps)) OR TX ((phone* OR telephone*) N3 (consult* OR interview* OR visit*)) OR TX ((“real time” OR realtime OR real-time) AND (care OR communicat* OR consult* OR mentor* OR rehab* OR therap* OR treatment*)) OR TX ((remote OR remotely) N5 (consult* OR game* OR gaming OR health* OR visit*)) OR TX (smartphone* OR “smart technolog*” OR “technology based” OR telecare OR “tele care” OR teleconsult* OR “tele consult*” OR telehealth OR “tele health” OR telemanagement OR “tele management” OR telemedicine OR “tele medicine” OR telemonitor* OR “tele monitor*” OR telenursing OR “tele nursing” OR telerehab* OR “tele rehab*” OR teletreatment* OR “tele treatment*” OR televideo OR “tele video” OR videoconferenc* OR “virtual reality”)
	S5	Combine intervention sets	S2 OR S3 OR S4
	S6	Combine population and intervention sets	S1 AND S5
	S7	Apply limits, remove unwanted publication types, limit to SRs, MAs, RCTs, non-RCTs, and comparative studies	See limits and hedges at the end of this table
KQ 7 KQ 8 KQ 9	S1	Adults with UE amputation	(DE "arm injuries" OR DE "upper extremity" OR TX (arm OR arms OR carpal OR digit OR digits OR digital OR elbow* OR finger* OR forearm* OR forequarter OR hand OR hands OR humeral OR humerus OR interscapulothoracic OR metacarp* OR palm OR palms OR ((phalang* OR phalanx*) AND (digit OR digits OR finger* OR hand OR hands OR thumb*)) OR radial OR radius OR shoulder* OR thumb* OR transcarpal OR transhumeral OR transradial OR ulnar OR "upper extremit*" OR "upper limb*" OR wrist*)) AND (DE "amputation" OR DE "amputation stumps" OR DE "amputees" OR DE "disarticulation" OR DE "amputation, traumatic" OR TX (amputat* OR amputee* OR disarticulat* OR exarticulat* OR "limb loss*" OR "loss of limb*" OR postamputation* OR reamputat* OR "remaining limb*" OR "residual limb*" OR stump*)) OR TX (loss* N2 ("upper limb*" OR "upper extremit*"))
	S2	Phantom/residual limb pain	((DE “chronic pain” OR DE “pain” OR DE “pain, postoperative” OR pain*) AND (((missing N4 (perception* OR perceive*)) OR DE “phantom limb” OR phantom* OR “remaining limb*” OR “residual limb*”)) OR “pain perceived” OR “perceived pain” OR (pain* N3 stump*)

Question*	Set #	Concept	Strategy
KQ 7 KQ 8 KQ 9 (cont.)	S3	Narrower upper extremity terms paired with phantom and residual limb pain terms (to capture studies not containing amputation terms in searchable fields)	((DE "arm injuries" OR DE "upper extremity" OR TX (arm OR arms OR carpal OR digit OR digits OR digital OR elbow* OR finger* OR forearm* OR forequarter OR hand OR hands OR humeral OR humerus OR interscapulothoracic OR metacarp* OR palm OR palms OR ((phalang* OR phalanx*) AND (digit OR digits OR finger* OR hand OR hands OR thumb*)) OR radial OR radius OR shoulder* OR thumb* OR transcarpal OR transhumeral OR transradial OR ulnar OR "upper extremit*" OR "upper limb*" OR wrist*)) AND (DE “chronic pain” OR DE “pain” OR DE “pain, postoperative” OR pain*) AND (DE “phantom limb” OR phantom* OR “remaining limb*” OR “residual limb*” OR (pain* N3 stump*)))
	S4	Combine population and phantom limb sets	S1 AND S2
	S5	Combine sets	S3 OR S4
	S6	Apply limits, remove unwanted publication types, limit to SRs, MAs, RCTs, non-RCTs, and comparative studies	See limits and hedges at the end of this table
KQ 12	S1	Adults with UE amputation	(DE "arm injuries" OR DE "upper extremity" OR TX (arm OR arms OR carpal OR digit OR digits OR digital OR elbow* OR finger* OR forearm* OR forequarter OR hand OR hands OR humeral OR humerus OR interscapulothoracic OR metacarp* OR palm OR palms OR ((phalang* OR phalanx*) AND (digit OR digits OR finger* OR hand OR hands OR thumb*)) OR radial OR radius OR shoulder* OR thumb* OR transcarpal OR transhumeral OR transradial OR ulnar OR "upper extremit*" OR "upper limb*" OR wrist*)) AND (DE "amputation" OR DE "amputation stumps" OR DE "amputees" OR DE "disarticulation" OR DE "amputation, traumatic" OR TX (amputat* OR amputee* OR disarticulat* OR exarticulat* OR "limb loss*" OR "loss of limb*" OR postamputation* OR reamputat* OR "remaining limb*" OR "residual limb*" OR stump*)) OR TX (loss* N2 ("upper limb*" OR "upper extremit*"))
	S2	UE prosthesis population	((DE “bionics” OR DE ”artificial limbs”) AND DE “upper extremity”) OR TX “artificial hand*” OR (TX (“artificial limb*” AND (arm OR arms OR hand OR hands OR upper)) OR (TX ((bionic* OR “man-machine” OR myoelectric* OR “myo electric*” OR neuroprosth* OR prosthes* OR prosthet* OR “robot* manipulat*”) N2 (arm OR arms OR carpal OR digit OR digits OR elbow* OR finger* OR forearm* OR forequarter OR hand OR hands OR humeral OR humerus OR metacarp* OR palm OR palms OR phalang* OR phalanx* OR radial OR radius OR shoulder* OR thumb* OR transcarpal OR transhumeral OR transradial OR ulnar OR ‘upper extremit*’ OR ‘upper limb*’))) OR (TX ((neuroprosth* OR prosthes* OR prosthet*) N4 (arm OR arms OR hand OR hands OR “upper extremit*” OR “upper limb*”))) OR (((TX ((artificial* OR “body power*” OR bionic* OR electric* OR electronic OR “external* power*” OR “man-machine” OR myoelectric* OR myo-electric* OR neuroprosth* OR prosthes* OR prosthet* OR robot*) N3 (extremit* OR limb*))) OR (TI (bionic OR “body power*” OR "electric* powered" OR “external* power*” OR “man-machine” OR myoelectric* OR neuroprosth* OR prosthes* OR prosthet* OR robotic*))) AND (TX (arm OR arms OR carpal OR digit OR digits OR elbow* OR finger* OR forearm* OR forequarter OR hand OR hands OR humeral OR humerus OR metacarp* OR shoulder* OR thumb* OR transcarpal OR transhumeral OR transradial OR “trans radial” OR ulnar OR “upper arm*” OR “upper limb*” OR “upper extremit*”)))

Question*	Set #	Concept	Strategy
KQ 12 (cont.)	S3	Physical and occupational therapies	DE "exercise" OR DE "occupational therapy" OR DE "physical therapy modalities" OR DE "Osteopathic Medicine" OR DE "Range of Motion, Articular" OR DE "Physical and Rehabilitation Medicine" OR DE "Resistance Training" OR DE "Return to sport" OR DE "Return to Work" OR DE "Rehabilitation, Vocational" OR TX "adaptive sport*" OR TX (chang* N5 dominan*) OR TI exercise* OR TX ((exercise* OR recreation* OR physical OR occupation* OR vocation*) N4 (rehab* OR therap*)) OR TX ("functional training" OR kinesiotherap* OR "manual therap*" OR "manipulative medicine" OR physiatrist* OR "physical medicine") OR TX ((physical OR occupation* OR vocation*) AND protocol*) OR TX physiotherap* OR TX "physio therap*" OR TX ((exercise* OR rehab* OR therap* OR train*) N5 "range* of motion*") OR TX "rehab* therap*" OR TI relearn* OR AB relearn* OR TX "resistance training" OR TI retrain* OR AB retrain* OR TX (return* W2 (duty OR play OR sport* OR work)) OR TX (scar* N2 massage*) OR TI strengthen* OR AB strengthen* OR TI "sport* train*"OR AB "sport* train*" OR (strengthen* AND ("intact limb" OR "residual limb")) OR (core N3 strength) OR (preserv* N5 (contralateral OR intact))
	S4	Prostheses/equipment specific	DE "self-help devices" OR TX ((adaptive OR assistive OR rehab*) W4 (technolog* OR equipment)) OR TX ((device* OR prosthes* OR prosthet*) N4 (educat* OR provision* OR rehab* OR teach* OR train*)) OR TI "durable medical equipment" OR AB "durable medical equipment" OR TI DME OR TX (efficien* N5 train*)
	S5	Intervention timing, additional therapies and interventions	DE "biofeedback, psychology" OR DE "community integration" OR DE "desensitization, psychologic" OR DE "neurofeedback" OR DE "patient education as topic" OR TX (activit* N4 analy*) OR TX biofeedback* OR TX "bio feedback*" OR TX (communit* N2 reintegrat*) OR TX desensitiz* OR TX desensitis* OR TX ((frequency OR number*) N4 (course OR exercise* OR intervention* OR practice* OR rehab* OR session* OR therap* OR train* OR treatment* OR visit*)) OR TX ("mirror box*" OR "mirror therap*" OR "mirror visual") OR TI MVF OR TX ("neuromuscular educat*" OR "neuro muscular educat*" OR "patient discharge education" OR "patient education") OR TX ((course OR exercise* OR intervention* OR practice* OR rehab* OR session* OR timing OR therap* OR train* OR treatment* OR visit*) AND (per N2 (day* OR hour* OR minute* OR month* OR week*))) OR TX ((physician* OR therap*) AND ("patient reported" N3 (information OR outcome* OR symptom*))) OR TX "practice pattern*" OR TX ((schedule* OR stage* OR time OR visit*) N5 (course OR intervention* OR rehab* OR therap* OR training*)) OR TX "stage* of care" OR TX (timing AND (intervention* OR rehab* OR therap*)) OR TX "therap* protocol*" OR TI ("wound care" OR "wound management*") OR AB ("wound care" OR "wound management*")
	S6	Combine populations	S1 OR S2
	S7	Combine intervention sets	S3 OR S4 OR S5
	S8	Combine population and intervention sets	S6 AND S7
	S9	Apply limits, remove unwanted publication types, limit to SRs, MAs, RCTs, non-RCTs, and comparative studies	See limits and hedges at the end of this table

Question*	Set #	Concept	Strategy
Limits and hedges applied to each search strategy		Hedge to identify RCTs	PT "randomized controlled trial" OR TI (random* OR RCT) OR AB (random* OR RCT)
		Hedge to identify meta-analyses and systematic reviews	PT "meta-analysis" OR PT "systematic review" OR "cochrane database syst rev" OR TI systematic* OR TI "meta-analysis" OR AB (cochrane OR metaanaly* OR "meta analy*" OR (search* AND (databases OR electronic OR methodolog* OR embase* OR ebsco* OR medline* OR ovid* OR sciencedirect* OR scopus* OR systematic OR web)) OR AB (systematic* N2 review*))
		Hedge to identify nonrandomized controlled and comparative studies	AB ("case control study" OR "clinical trial" OR "cohort analysis" OR "comparative study" OR "control group" OR "controlled study" OR "longitudinal study" OR "major clinical study" OR "prospective study" OR "retrospective study" OR "between groups" OR "case control*" OR cohort OR compar* OR "control group*" OR "controlled study" OR "controlled trial" OR "cross over" OR crossover OR "double blind" OR "double blinded" OR longitudinal OR "matched controls" OR placebo* OR prospective OR retrospective OR sham) OR TI (versus OR vs)
		Exclude animal and experimental studies	NOT (TI (animal* OR cadaver* OR experimental OR (vitro NOT vivo) OR canine OR dog OR dogs OR mouse OR mice OR murine OR pig OR pigs OR piglet* OR rabbit* OR rat OR rats OR rodent* OR sheep OR swine))
		Exclude studies focusing on children	NOT (TI (adolescen* OR baby OR babies OR boys OR child* OR girls OR infancy OR infant* OR juvenile* OR neonat* OR newborn* OR NICU OR nurser* OR paediatric* OR pediatric* OR preschool* OR school OR schools OR teen* OR toddler* OR youth*) NOT TI (adult* OR women OR men))
		Remove unwanted publication and study types (e.g., case reports, conferences, editorials)	NOT (TI ((elbow OR hip OR joint OR knee OR shoulder) N1 (arthroscop* OR arthroplast* OR replacement*)) OR (arthroplast* NOT amput*) OR dental OR denture* OR "foot ulcer*" OR laparoscopic* OR maxillofacial OR orthodontic* OR palmoplantar OR parkinson* OR poststroke OR prosthodontic* OR stroke OR "robotic assisted surg*" OR "robotic surg*" OR "surgical robot*" OR teeth OR tooth OR (robot* N2 surg*))
		Limit to English language publications	AND LA English
		Limit to results with abstracts	AND AA Y
		Limit to results published 2013-2021	AND PY 2013-2021
		Date – ensure results entered into databases since 2014 review (February 1, 2013)	AND EM 201302-
		Remove MEDLINE results	limited by Menu option under Advanced Search

*For more information about the key question (KQ), see Table A-2.

C. PsycINFO with OVID syntax (KQs 2, 4, 5, 7, 8, 9, 12)

Question*	Set #	Concept	Strategy
KQ 2, KQ 4, KQ 5, KQ 7, KQ 8, KQ 9, KQ 12	1	Adults with UE amputation	(("arm (anatomy)"/ OR "elbow (anatomy)"/ OR exp "fingers (anatomy)"/ OR "palm (anatomy)"/ OR "shoulder (anatomy)"/ OR wrist/ OR (arm OR arms OR carpal OR digit OR digits OR digital OR elbow* OR finger* OR forearm* OR forequarter OR hand OR hands OR humeral OR humerus OR interscapulothoracic OR metacarp* OR palm OR palms OR ((phalang* OR phalanx*) AND (digit OR digits OR finger* OR hand OR hands OR thumb*)) OR radial OR radius OR shoulder* OR thumb* OR transcarpal OR transhumeral OR transradial OR ulnar OR "upper extremit*" OR "upper limb*" OR wrist*).ti,ab,id.) AND (amputation/ OR (amputat* OR amputee* OR disarticulat* OR exarticulat* OR "limb loss*" OR "loss of limb*" OR postamputation* OR reamputat* OR "remaining limb*" OR "residual limb*" OR stump*).ti,ab,id.)) OR (loss* ADJ2 ("upper limb*" OR "upper extremit*")).ti,ab,id.
	2	Phantom/residual limb pain	"phantom limbs"/ OR "phantom limb*" OR (("remaining limb*" OR "residual limb*" OR stump) ADJ3 pain)
	3	UE prostheses population	"artificial hand*".ti,ab. OR ("artificial limb*" AND (arm OR arms OR hand OR hands OR upper)).ti,ab. OR ((bionic* OR "man-machine" OR myoelectric* OR "myo electric*" OR neuroprosth* OR prosthes* OR prosthet* OR "robot* manipulat*") ADJ2 (arm OR arms OR carpal OR digit OR digits OR elbow* OR finger* OR forearm* OR forequarter OR hand OR hands OR humeral OR humerus OR metacarp* OR palm OR palms OR phalang* OR phalanx* OR radial OR radius OR shoulder* OR thumb* OR transcarpal OR transhumeral OR transradial OR ulnar OR "upper extremit*" OR "upper limb*")).ti,ab. OR ((neuroprosth* OR prosthes* OR prosthet*) ADJ4 (arm OR arms OR hand OR hands OR "upper extremit*" OR "upper limb*")).ti,ab,id. OR ((artificial* OR "body power*" OR bionic* OR electric* OR electronic OR "external* power*" OR "man-machine" OR myoelectric* OR neuroprosth* OR prosthes* OR prosthet* OR robot*) ADJ3 (extremit* OR limb*)).ti,ab. OR ((prostheses/ OR ("body power*" OR bionic* OR "external* power*" OR "man-machine" OR myoelectric* OR neuroprosth* OR prosthes* OR prosthet*).ti.) AND (arm OR arms OR carpal OR digit OR digits OR elbow* OR finger* OR forearm* OR forequarter OR hand OR hands OR humeral OR humerus OR metacarp* OR shoulder* OR thumb* OR transcarpal OR transhumeral OR transradial OR "trans radial" OR ulnar OR "upper arm*" OR "upper limb*" OR "upper extremit*" OR "upper or lower").ti,ab.)
	4	Combine population sets	1 OR 2 OR 3
	5	Apply limits, remove unwanted publication types and off-topic results	See limits and hedges at the end of this table *(Note that intervention search terms and study hedges were not included in this PsycINFO strategy because the retrieval was very low)*

Question*	Set #	Concept	Strategy
Limits and hedges applied to each search strategy		Limit to English language publications	limit to english language
		Exclude animal and experimental studies	NOT (animal* OR experimental OR (vitro NOT vivo) OR canine OR dog OR dogs OR mouse OR mice OR murine OR pig OR pigs OR piglet* OR porcine OR rabbit* OR rat OR rats OR rodent* OR sheep OR swine).ti.
		Exclude studies focusing on children	NOT ((adolescen* OR baby OR babies OR boys OR child* OR girls OR infancy OR infant* OR juvenile* OR neonat* OR newborn* OR NICU OR nurser* OR paediatric* OR pediatric* OR preschool* OR school OR schools OR teen* OR toddler* OR youth*) NOT (adult* OR women OR woman OR pregnan*)).ti.
		Remove unwanted publication and study types (e.g., case reports, conferences, editorials)	NOT ((chapter OR "column/opinion" OR "comment/reply" OR dissertation OR editorial OR letter OR review-book).dt. OR (book or encyclopedia OR "dissertation abstract").pt. OR ("case report" OR "a case" OR "year old").ti,ab. OR ((rationale OR study) ADJ3 protocol).ti.)
		Limit to results published 2013-2021	limit to yr="2013 - 2021"
		Limit to results added to the database between February 1, 2013, and April 30, 2021	limit to up=20130201-20210430
		Remove MEDLINE results (already captured by EMBASE search)	NOT (1* OR 2* OR 3* OR 4* OR 5* OR 6* OR 7* OR 8* OR 9*).pm.

*For more information about the key question (KQ), see Table A-2.

Appendix N: Alternative Text Descriptions of Algorithm

The following outline narratively describes the ULA algorithm. An explanation of the purpose of the algorithm and description of the various shapes used within the algorithm can be found in the Algorithm section. The sidebars referenced within this outline can also be found in the Algorithm section.

Module A: Upper Limb Amputation Management

1. Module A starts with Box 1, in the shape of a rounded rectangle: "Patient presents with need for ULA care"
2. Box 1 connects to Box 2, in the shape of a hexagon, asks the question: "Does the patient require perioperative care?"
    a. If the answer is "Yes" to Box 2, then Box 3, in the shape of a rectangle: "Engage the amputation care team to conduct a comprehensive interdisciplinary assessment; offer peer support* (see Recommendation 14 and Sidebar 1)"
        i. Box 3 has a footnote: "Peer support includes both peer visitors right after surgery and peer support in an outpatient setting"
    b. If the answer is "No" to Box 3, then Box 9, in the shape of a hexagon, asks the question: "Is the patient a candidate for pre-prosthetic training?"
3. Box 3 connects to Box 4, in the shape of a hexagon, asks the question: "Is the patient ready for initiation of rehabilitation services?"
    a. If the answer is "Yes" to Box 4, then Box 6, in the shape of a square: "Develop a patient-centered rehabilitation care plan (see Sidebar 2)"
    b. If the answer is "No" to Box 4, then Box 5, in the shape of a square: "Refer the patient to appropriate services for care and management"
4. Box 6 connects to Box 7, in the shape of a square: "Appropriate education regarding currently available technology, surgical, rehabilitation procedures and peer support options should be provided to the patient, family, and caregiver(s)"
5. Box 7 connects to Box 8, in the shape of a square: "Ensure patient achieves highest level of functional independence without a prosthesis"
6. Box 8 connects to Box 9, in the shape of a hexagon, asks the question: "Is the patient a candidate for pre-prosthetic training?"
    a. If the answer is "Yes" to Box 9, then Box 10, in the shape of a square: "Engage the amputation care team to administer pre-prosthetic training (see Sidebar 3)"
    b. If the answer is "No" to Box 9, then Box 14, in the shape of a hexagon, asks the question: "Is the patient a candidate for prosthetic training?"
        i. If the answer is "Yes" to Box 14, then Box 15, in the shape of a square: "Engage the amputation care team to administer prosthetic training and education"
        ii. If the answer is "No" to Box 14, then Box 19, in the shape of a square: "Ensure patient achieves highest level of functional independence without a prosthesis"

1. Box 19 connects to Box 20, in the shape of a square: "Recommend lifelong care and management of ULA"

7. Box 10 connects to Box 11, in the shape of a square: "Confirm prosthesis candidacy and determine most appropriate prosthetic device(s)"
    a. Box 11 has a footnote: "May involve trials of various device components as appropriate and feasible"
8. Box 11 connects to Box 12, in the shape of a square: "Write prosthetic device prescription including all necessary components"
9. Box 12 connects to Box 13, in the shape of a square: "Initiate upper extremity prosthesis fitting"
10. Box 13 connects to Box 15, in the shape of a square: "Engage the amputation care team to administer prosthetic training and education"
11. Box 15 connects to Box 16, in the shape of a hexagon, asks the question: "Does the prosthetic device improve functional status and meet realistic patient goals?"
    a. If the answer is "Yes" to Box 16, then Box 17, in the shape of a square: "Conduct final prosthesis check out including all appropriate members of the care team"
    b. If the answer is "No" to Box 16, then Box 11, in the shape of a square: "Confirm prosthesis candidacy and determine most appropriate prosthetic device(s)"
12. Box 17 connects to Box 18, in the shape of a hexagon, asks the question: "Does the patient require additional prostheses and/or terminal devices?
    a. If the answer is "Yes" to Box 18, then Box 11, in the shape of a square: "Confirm prosthesis candidacy and determine most appropriate prosthetic device(s)"
    b. If the answer is "No" to Box 18, then Box 20, in the shape of a square: "Recommend lifelong care and management of ULA"
13. Box 20 connects to Box 21, in the shape of a square: "Coordinate patient transition into lifelong care and management (including patient transfer to new catchment area)"
14. Box 21 connects to Box 22, in the shape of a square: "Engage the amputation care team and provide routine scheduled follow-up at least every 12 months (see Sidebar 2)"
15. Box 22 connects to Box 23, in the shape of a square: "Provide education on current management and practices; refer patient as appropriate to address medical, prosthetic or rehabilitation needs (see Box 9)"

Module B: Upper Limb Amputation Management for Primary Care

1. Module B begins with Box 24, in the shape of a rounded rectangle: "Patient presents with need for ULA care"
2. Above boxes 26, 28, 30, 32, and 34 says: "See Sidebar 4 for additional information"
3. Box 24 connects to Box 25, in the shape of a hexagon, asks the question: "Is this the patient's initial visit?

a. If the answer is “Yes” to Box 25, then Box 26, in the shape of a square: “Offer mental health referral; referral to amputation care team”

b. If the answer is “No” to Box 25, then Box 27, in the shape of a hexagon, asks the question: “Is there new or worsening pain that limits function; new or worsening residual limb condition; new or worsening non-amputated limb condition; or new risk factor for amputation progression?”

    i. If the answer is “Yes” to Box 27, then Box 28, in the shape of a square: “Referral to PM&R; referral to amputation care team”

    ii. If the answer is “No” to Box 27, then Box 29, in the shape of a hexagon, asks the question: “Are there changes or new functional goals; need for new or replacement equipment; need for home or work environmental modifications; or need for new or replacement assistive technology?

    iii. If the answer is “Yes” to Box 29, then Box 30, in the shape of a square: “Referral to OT; referral to amputation care team”

        1. If the answer is “No” to Box 30, then Box 31, in the shape of a hexagon, asks the question: “Are there new or worsening prosthesis fit or function issues; need for replacement prosthetic components or supplies; or need for new prosthetic componentry or technology to achieve functional goals?”

            a. If the answer is “Yes” to Box 31, then Box 32, in the shape of a square: “Referral to prosthetics; referral to amputation care team”

            b. If the answer is “No” to Box 31, then Box 33, in the shape of a hexagon, asks the question: “Are there changes in support system; new psychosocial stressors; or new emotional, behavioral, or psychological considerations?”

                i. If the answer is “Yes” to Box 33, then Box 34, in the shape of a square: “Referral to mental health; referral to amputation care team”

                ii. If the answer is “No” to Box 33, then Box 35, in the shape of a square: “Actively promote and facilitate annual follow-up with amputation care team”

Appendix O: Abbreviations

Abbreviation	Definition
ACT	acceptance and commitment therapy
AHRQ	Agency for Healthcare Research and Quality
AMI	agonist-antagonist myoneural interface
BMI	body mass index
CBT	cognitive behavioral therapy
CI	confidence interval
COI	conflict of interest
COR	contracting officer's representative
CPG	clinical practice guideline
DHA	Defense Health Agency
DoD	Department of Defense
EBPWG	Evidence-Based Practice Work Group
GRADE	Grading of Recommendations Assessment, Development and Evaluation
HBS	Hand Bionic Scale
HEC	Health Executive Committee
IMES	implantable myoelectric sensor system
KQ	key question
mAb	monoclonal antibodies
MBSR	mindfulness-based stress reduction
MHS	Military Health System
NAM	National Academy of Medicine
NIBS	noninvasive brain stimulation
NICE	National Institute for Health and Care Excellence
NRS	numeric rating scale
OI	osseointegration
OT	occupational therapy
PCP	primary care providers
PCS	Pain Catastrophizing Scale
PHP	personal health plan
PHQ	Patient Health Questionnaire
PICOTS	population, intervention, comparison, outcome, timing and setting
PLP	phantom limb pain
PM&R	physical medicine and rehabilitation
PNB	peripheral nerve block
PT	physical therapy
PTSD	post-traumatic stress disorder
QoL	quality of life
RCT	randomized controlled trial
RPNI	regenerative peripheral nerve interface
SR	systematic review

Abbreviation	Definition
SUD	substance use disorder
TD	terminal device
TENS	transcutaneous electrical nerve stimulation
TMR	target nerve reinnervation
U.S.	United States
UEA	upper extremity amputation
ULA	upper limb amputation
USPSTF	United States Preventive Services Task Force
VA	Department of Veterans Affairs
VAS	visual analog scale
VCA	vascularized composite allotransplantation
VHA	Veterans Health Administration

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