

EXPLORING THE PERSPECTIVES OF DIFFERENT PROFESSIONS ON TASK-BASED UPPER-LIMB PROSTHESIS ASSESSMENT TECHNIQUES

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ABSTRACT

Upper limb prostheses can significantly enhance independence and functionality for individuals with limb differences, offering them renewed independence, functionality, and quality of life. Task-based evaluation measures, which involve patients directly manipulating objects with their prosthesis, are crucial for accurately assessing performance. However, these measures must meet the needs of various stakeholders, including researchers, clinicians, and insurers, who rely on this data for patient care and technological advancements. Yet, the specific demands of these groups can vary widely and remain underexplored, creating a gap in developing universally applicable evaluation methods. Our study aims to investigate these differences by conducting an online survey targeting a broad spectrum of professionals, including physical and occupational therapists, certified prosthetists/orthotists, medical practitioners, and academic researchers. This approach aims to gather a comprehensive understanding of current evaluation practices and identify areas in need of refinement, ultimately contributing to enhanced precision in prosthetic evaluations and improved patient outcomes.

INTRODUCTION

Task-based metrics, which involve the patient directly manipulating test objects with their prosthesis, offer a myriad of benefits as they provide an immediate assessment of a patient's real-time performance operating their device. Some of these benefits include: the potential to help inform clinical decision making including the selection of appropriate prosthetic solutions for individual patients; enabling precise monitoring of patient progress either as indications of care effectiveness or the need for adjustments; and helping provide an evidence base for decision making in the contexts of insurance coverage and public health systems, collectively helping foster transparency among stakeholders including patients, clinicians, researchers, and regulatory bodies. Additionally, standardized task-based evaluations allow for consistent comparisons across different prosthetic technologies, contributing to innovation by minimizing variability from diverse and often disparate evaluation methodologies. Finally, when paired with patient self-reported data, task-based assessments can also help mitigate common biases, such as response fatigue, social desirability, and central tendency biases, offering an additional objective and supplementary perspective on patient functionality [1], [2], [3]. Collectively, task-based evaluation tools are foundational to progress in upper-limb prosthetics, ensuring advancements are both significant and quantifiable.

Despite their clear importance, there is a notable research gap in this area. While mechatronic technology for upper-limb prosthetics has seen significant advancements, we have found in our recent literature review that only 25 task-based evaluation measures have been reported in literature, and crucially, validated since 1948 [4]. This disparity between the rapid rate of technological advancement and the blunted evolution of standardized measures to assess their performance emphasizes the growing need for more universally accepted and consistently updated assessment frameworks. The challenge of addressing this issue is compounded by the differing priorities of professionals across clinical environments and research laboratories. Clinical settings, which are often under time constraints, may prefer more rapid tests for their efficiency in assessing patient outcomes. However, this may come at the expense of the depth of data collected. On the other hand, research settings may opt for more comprehensive tests which, despite their thoroughness, face challenges in wider spread adoption due to their extensive setups, accessibility of testing materials, significant costs, and more complex protocols.

Our goal was to gather insights on current task-based evaluation methods in the context of the unique needs and expectations across the diversity of practitioners that may interact with individuals prescribed upper limb prostheses. We employed an online survey and contacted a wide array of individuals across the professional spectrum, including physical and occupational therapists, prosthetists, medical practitioners, and academic researchers.

METHODS

Survey Design

Our online survey was strategically designed to gather data on professionals' experiences, preferences, and practices related to upper-limb prostheses and task-based functional measures. Our study was approved by the University of California,

Davis Institutional Review Board. Recruitment was performed through email via our team's professional networks. Once participants agreed to take part in the study, they were provided with a link to an anonymous survey hosted on Qualtrics. This began with an introduction outlining the study's objectives, confidentiality assurances, detailed instructions, and contact information for any follow-up questions. Consent to proceed led participants through a questionnaire that requires no more than 15 minutes to complete. The survey incorporated a variety of question types, including multiple-choice, checkboxes, and questions that allowed respondents to order their preferences. This design facilitated the easy and efficient capture of detailed responses across a range of topics. The questionnaire was structured to progress through a series of questions aimed at anonymously characterizing each participant's profession, experience, training, and exposure to individuals with upper-limb prostheses. Following this initial characterization, the survey focused on identifying which validated task-based measures participants were aware of and actively used in their practice. Finally, participants were asked to prioritize a list of factors they deem most important in a task-based measure for upper-limb prosthetic assessment.

Data Analysis

We employed binning and response counts as our primary analytical methods. Data collected from the survey were first separated (binned) by profession, allowing for a detailed analysis of the perspectives of different professionals. Response counts were utilized to quantify the prevalence of specific views and practices among the participants, providing a straightforward method to identify the most used task-based measures and the factors considered most important in upper-limb prosthetic measures.

RESULTS

In this paper, we present data from N=30 participants, whose professional backgrounds are outlined in Table 1. The distribution of participants by profession was as follows: 5 physical/occupational therapists (PT/OTs), 4 certified prosthetist/orthotists (CPOs), 14 medical doctors (MD/DOs), and 7 who are primarily researchers (PRs). Additionally, we documented the median duration of practice in their respective fields by having them select from a list of time ranges: PT/OTs and CPOs professionals had a median range of experience between 10 to 15 years of experience; MD/DOs participants reported a median range of 12.5 to 17.5 years; and for those primarily involved in research (PRs), the median experience ranged from 15 to 20 years. The survey also required participants to select from a list highlighting the frequency range they interact with upper limb prosthesis users, the median rate of patient interactions revealed a spectrum of engagement frequencies: PT/OTs and PRs typically interacted with patients once every 2 to 5 months; CPOs reported at least one patient interaction per week; and MD/DOs professionals engage with patients at least once per month.

Table 1: Respondent Background

Profession	Respondents	Median Time Practicing	Median Patient Interaction Rate
Physical/Occupational therapist	5	10 – 15 years	Once every 2-5 months
Certified Prosthetist/Orthotist	4	10 – 15 years	At least once per week
Medical Doctor	14	12.5 – 17.5 years	At least once per month
Primarily Researcher	7	15 – 20 years	Once every 2-5 months

Table 2 highlights the results from a survey question that prompted participants to select task-based measures, from a list of 25 (identified in [4]), that they were familiar with and would likely use with patients in their professional practice. The Box and Block Test (BBT) was identified as the most favored test across all professions for patient use. This finding is particularly significant considering the test's brevity and limited scope in assessing functional capabilities. Despite these constraints, the Box and Block Test is valued for its comprehensive validation with numerous patient populations, endorsement through peer review, straightforward administration, affordability, and ease of learning. Conversely, more involved evaluations such as the Southampton Hand Assessment Procedure (SHAP), Activities Measure for Upper-Limb Amputees (AM-ULA), and Gaze and Movement Assessment (GaMA) were primarily chosen for research purposes. It is important to note that a significant portion of the MD/DOs reported a lack of familiarity with many of the tests listed. Several doctors indicated in their responses that they would prefer to delegate the responsibility of administering these tests to PT/OTs.

Table 2: Perspectives on Currently Available Tests

Profession	Top Rated Tests to be used with a Patient – Percentage of Respondents * Indicates tie
Physical/Occupational therapist	1: Box and Block Test (BBT) – 71.43%
	2*: Action Research Arm Test (ARAT) – 50.00% 2*: Jebsen Hand Function Test (JHFT) – 50.00% 2*: Nine-Hole Peg Test – 50.00%
Certified Prosthetist/Orthotist	1: Box and Block Test (BBT) – 50.00%
	2*: Assessment of Capacity for Myoelectric Control (ACMC) – 33.33% 2*: University of New Brunswick Test of Prosthetic Function (UNBT) – 33.33%
Medical Doctor	1*: Box and Block Test (BBT) – 21.42% 1*: Jebsen Hand Function Test (JHFT) – 21.42% 1*: Nine-Hole Peg Test (NHPT) – 21.42%
	2*: Purdue Pegboard Test (PPT) – 14.29% 2*: Unilateral Below Elbow Test (UBET) – 14.29%
Primarily Researcher	1*: Southampton Hand Assessment Procedure (SHAP) – 44.44% 1*: Box and Block Test (BBT) – 44.44%
	2*: Activities Measure for Upper-Limb Amputees (AM-ULA) – 42.86% 2*: Gaze and Movement Assessment (GaMA) – 42.86%

Table 3 shows the results when participants selected from a list of maximum time ranges they felt was acceptable to administer a task-based measure in their practice. Additionally, Table 3 highlights the top three criteria they viewed as important when selecting a task-based measure, underscoring a universal preference for validated and peer-reviewed tools. Clinical practitioners report a significantly shorter maximum testing time compared to their research-focused peers, highlighting a prioritization of efficiency in clinical settings. This emphasis on time efficiency is reflected in the ranking of the total administration time as a key factor for its selection among clinical professionals. Despite these differences, there's a unanimous agreement on the importance of using tests that effectively monitor patient progress, illustrating a common objective to employ assessments that are both practical and beneficial for patient care across diverse professional landscapes.

Table 3: Desired Characteristics for Evaluation Methods

Profession	Median Max Time for Test	Ranking of Most Important Factors
Physical/Occupational therapist	Between 10-20 minutes	1: The test has been validated and peer-reviewed
		2: Efficacy of monitoring patient progress
		3: Total administration time
Certified Prosthetist/Orthotist	Between 15-25 minutes	1: The test has been validated and peer-reviewed
		2: Total administration time
		3: Comprehensive analysis of multi-grasp dexterity and impact of varying control systems
Medical Doctor	Between 5-10 minutes	1: The test has been validated and peer-reviewed
		2: Total administration time
		3: Efficacy of monitoring patient progress
Primarily Researcher	Between 30-60 minutes	1: The test has been validated and peer-reviewed
		2: Efficacy of monitoring patient progress
		3: Comprehensive analysis of multi-grasp dexterity and impact of varying control systems

DISCUSSION

Our study unveiled insightful findings regarding the prevailing views on task-based evaluation methods for upper-limb prosthetics. We observed notable variations in how frequently different professional groups engage with patients equipped with upper-limb prosthetics. It is essential to mention that these interactions ranged from weeks to months, highlighting a considerable variance among professionals. However, a potential limitation of our study was the methodology used to contact respondents—email outreach within our network of researchers and clinicians specializing in upper-limb prosthetics. This approach might have led to an overestimation of interaction frequency, as it may not accurately represent the engagement levels of the average practitioner. Despite this limitation, the importance of addressing the prosthetic needs and managing patient expectations cannot be overstated, especially considering the challenges posed by the advancing technology in upper-limb prosthetics. These challenges are compounded by the mobility requirements of the upper-limb and the vital role that hands and arms play in our daily activities. Our findings also shed light on the "upper extremity dilemma [5]," where prosthetics are becoming more technologically advanced and specialized. However, the relatively infrequent encounters with upper-limb prosthetic users make it difficult for many clinicians to expand their knowledge and expertise [6]. This gap necessitates a high level of specialized care for a group of patients seen less frequently by practitioners, leading to potential challenges in meeting their specific needs [7]. To bridge this gap, validated task-based measures and a more universally applicable analysis framework could play a crucial role. Such tools would provide practitioners with objective data, facilitating more informed decision-making and ultimately enhancing care for patients using upper-limb prosthetics.

Our results revealed many intriguing insights about current perspectives on available task-based evaluation methods used for upper-limb prostheses. Categorizing the data from 30 participants by profession revealed distinct preferences in testing goals and methods. Although all groups emphasized the necessity of validated and peer-reviewed tests, notable differences emerged: clinical settings prioritize quick evaluations next, with the box and block test—likely favoured for its sub-5-minute completion time—ranking high among physical and occupational therapists, prosthetists/orthotists, and medical doctors [4]. Notably, the maximum time reported for testing report in these clinical groups was significantly shorter than that for research-focused professions. Furthermore, professionals across these fields consistently rank the total time required to administer a test as one of the top three criteria for determining its effectiveness. In contrast, research environments valued the comprehensive analysis which likely explains the preference for the more intensive Southampton Hand Assessment Procedure, though the box and block test does remain in use for this group. Nevertheless, professionals unanimously agree on the importance of tests that effectively monitor patient progress. These findings highlight the shared and unique priorities across professions, underscoring the need for a balanced approach in developing and selecting upper-limb prosthetic evaluation methods to accommodate the quick assessment preferences of clinical practitioners and the detailed analytical needs of researchers.

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