AWARD NUMBER: W81XWH-19-1-0800

TITLE: Comparative Effectiveness of Upper Limb Prostheses and Component Effects

PRINCIPAL INVESTIGATOR: Dr. Linda Resnik, PhD, PT

CONTRACTING ORGANIZATION: Ocean State Research Institute, Providence, RI

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6. AUTHOR(S)
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14. ABSTRACT

Purpose: This application will provide data to guide prosthesis prescription by comparing effectiveness of upper limb prostheses and components and evaluating heterogeneity of treatment effects for key sub-groups. This proposal focuses on the function, form, and interface of upper limb prostheses. The data we collect will be rich and multi-faceted, enabling us to test a multitude of clinically relevant hypotheses.
Scope: 1) Compare the effectiveness of prosthesis type (body powered, myoelectric/hybrid) by amputation level; 2) Quantify the impact of prosthesis form (e.g., weight and shape) on outcomes; 3) Compare the effectiveness of prosthesis suspension method, controlling for potential confounding by prosthesis level, prosthesis type, and prosthesis weight.
Findings/Progress: This reporting period focused on maintaining regulatory approvals; preparing staff and maintaining study coordination; conducting Study Restart Meetings and restarting participant recruitment and enrollment activities. Data collection is ongoing. Forty study participants were enrolled as of 9/29/2022.

15. SUBJECT TERMS
Upper limb amputation; upper limb amputee; quality of care; Evidence-Based Clinical Practice Guidelines; prosthetic device; care satisfaction; amputation rehabilitation; amputation outcomes.

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1. **INTRODUCTION:**

Many upper limb prosthesis and componentry options are clinically available; however, it is unclear how to best match an individual amputee with a particular device type and configuration. The inconclusive results of recent systematic reviews comparing body powered to myoelectric prostheses underscore the need for studies that address comparative effectiveness of these devices and components as well as comparative effectiveness for specific sub-groups of patients. Without a body of evidence quantifying the relative benefits of specific devices and components for sub-groups of patients, the clinician has only expert opinion and experience and manufacturers' testimonials, but insufficient research evidence, to inform clinical decision-making. This study will provide data to guide prosthesis prescription by comparing effectiveness of upper limb prostheses and components and evaluating heterogeneity of treatment effects for key sub-groups. It focuses on the function, form, and interface of upper limb prostheses. The data we collect will be rich and multi-faceted, enabling us to test a multitude of clinically relevant hypotheses.

2. **KEYWORDS:**

Keyword summary: Upper limb amputation; upper limb amputee; quality of care; Evidence-Based Clinical Practice Guidelines; prosthetic device; care satisfaction; amputation rehabilitation; amputation outcomes.

3. **ACCOMPLISHMENTS:**

- **What were the major goals of the project?**

There are 3 major goals/aims in the approved statement of work (SOW) for this project:

Aim 1: Compare the effectiveness of prosthesis type (body powered, myoelectric/hybrid) by amputation level.

Aim 2: Quantify the impact of prosthesis form (e.g., weight and shape) on outcomes.

Aim 3: Compare the effectiveness of prosthesis suspension method, controlling for potential confounding by prosthesis level, prosthesis type, and prosthesis weight.

The table below shows the major tasks associated with this study, the target completion date, the actual completion date and percent complete.

Task	Target Completion Date	Completion Date	Percent Complete, End of Year 3
Obtained Regulatory Approvals	Month 1	Complete	100%
Maintain regulatory approvals	Ongoing	Ongoing	100%
Prepare Study Staff	Ongoing	Ongoing	100%
Maintain Study Coordination	Ongoing	Ongoing	50%
Begin Participant Recruitment	Month 1	Complete	100%
Continue Participant Recruitment	Month 24	Month 24	100%
Resume data collection which had been paused due to COVID 19	Month 25	Month 27	100%
Complete Participant Recruitment	Original: Month 24 Revised: Month 47		20%
Complete data collection and data entry	Original: Month 25 Revised: Month 48		20%
Begin Data Analysis	Original: Month 25 Revised: Month 45-48	Not started	0%
Begin Dissemination	Original: Month 36 Revised: Month 48	Not started	0%

- **What was accomplished under these goals?**

1 & 2) Specific objectives and major activities

Specific objectives and major activities accomplished during the Year 3 reporting period (30th September 2021 – 29th September 2022) are described below:

Specific Objective 1: Obtain regulatory approvals (fully met)

Specific Objective 2: Maintain regulatory approvals

Major Activities:

- Ensured that all staff maintain research training certification
- Received VA CIRB approval for Tampa LSI Amendment 4 changing the LSI to Dr. Jeffrey Heckman
- Submitted and received approval for PI-SC Amendment 29 which:

- modified the protocol to allow Aim 3 participants, who have had a major change in amputation status, to participate in Aim 5
- requested approval for recruitment documents that would be used by the Amputee Coalition to assist us with study recruitment

- Requested and received VA CIRB permission to close the Seattle VA site
- Obtained continuing review approval from the VA CIRB, USF IRB & ISR IRB
- Submitted and received approval for PI-SC Amendment 30 which:
  - Added VA Box as a method of data transfer
  - Clarified that analyses will only be done while the study is open in the VA CIRB
- Submitted all study modifications and continuing reviews to HRPO

Specific Objective 3: Prepare study staff

Major Activities:

- Held in depth retraining meetings with our Richmond, Seattle, and Tampa study sites in October 2021 to prepare them for relaunching data collection activities
- Reviewed policies and procedures, data collection details, regulatory requirements, and other topics to ensure a successful study restart
- Held Assessors Meetings on February 11, May 2, June 6, and August 1, 2022, to review performance testing protocols, provide feedback from video tape quality control reviews and discuss overall study progress
- Held ISR retraining meetings in May 2022

Specific Objective 4: Maintain Study Coordination

Major Activities:

- Weekly PVAMC team meetings to ensure tracking of study deliverables
- Executed Year 3 subcontract awards for 3 VA sites (Seattle, Richmond, Tampa), Institute for Surgical Research, University of South Florida, and Brown University
- Bi-monthly plus as needed phone meetings with individual Site Coordinators to discuss recruitment, enrollment and regulatory issues and address questions
- Worked with LSI teams to prepare local amendments and continuing review submissions

Specific Objective 5: Begin Participant Recruitment (fully met)

Specific Objective 6: Continue Participant Recruitment

Major Activities:

- Continued to develop study participant referral lists
- Recruitment activities resumed in September 2021 after being paused due to the COVID 19 pandemic
- Screened potential study participants
- Submitted and received approval for a VA Data Access Request (DART) to identify potential study participants
- Submitted and received approval for recruitment assistance from the Amputee Coalition
- Participants scheduled for study activities

Specific Objective 7: Continue Data Collection and Data Entry

Major Activities:

- Data collection resumed in December 2021 and continued throughout Year 3
- Data entry and data quality control also resumed in December 2021 and continued throughout Year 3

3) Significant Results or Key Outcomes

Data collection is ongoing. Forty study participants were enrolled as of 9/29/2022. To date, there are 6 study visits scheduled for the first quarter of NCE Year 4.

4) Other Achievements

- Nothing to report

Infrastructure development

- Executed Year 3 subcontract awards for the 3 VA sites (Seattle, Richmond, Tampa), Institute for Surgical Research, University of South Florida, and Brown University

- Revised Study Policy and Procedure Manual and Testing Manual (containing Data Collection Forms and Instructions) to ensure study fidelity

- Maintained regular communications to facilitate coordination and to ensure study fidelity, including:
  - Bi-monthly - plus as needed - phone meetings with individual Site Coordinators to discuss recruitment, enrollment and regulatory issues and address questions.
  - Held multiple Site Assessors Meetings to review performance testing protocols, provide feedback from video tape quality control reviews and discuss overall study progress.

- Identified 2 potential new data collection sites that are a part of Arm Dynamics, a company offering comprehensive, upper-limb-focused prosthetic rehabilitation
  - Secured funding from our Center for Neurorestoration & Neurotechnology (CfNN), VA Providence Healthcare System, to cover the costs of the additional sites.
  - The Arm Dynamics contracting package was submitted to the VA Contracting Office on 6/17/2021. The contract was fully executed on 8/1/2022 – 13 and half months after submission.
  - Unfortunately, Arm Dynamics withdrew from participation in the study on 8/17/2022. We will provide details below.

Data

- Nothing to report

Stated goals not met

1. Complete data collection and data entry - Goal- Month 25; Revised – Month 48
   We were unable to meet our original goals for data collection and data entry primarily due to the impact of the COVID 19 pandemic and related temporary halt to study activities. Please see Section 5 Changes/Problems for more details.

2. Begin data analysis - Goal – Month 25; Revised – Month 45-48
   Due to the delay in reaching data collection and data entry goals, there was not sufficient data to begin analysis in Month 25.

3. Begin dissemination – Goal – Month 36; Revised – Month 48
   The original goal for dissemination was the last month of Year 3. The revised goal is now the last month of NCE Year 4.

- **What opportunities for training and professional development has the project provided?**

  Nothing to report

- **How were the results disseminated to communities of interest?**

  We are not at a point in the study to disseminate results.

- **What do you plan to do during the next reporting period to accomplish the goals?**

During the next reporting period (NCE Year 4), we anticipate accomplishing the following activities to meet the project goals and objectives:

Project Activity	Goal Completion Date
Maintain regulatory approvals	Ongoing
Maintain communication with local sites • Bimonthly and as needed meetings with each site • Assessors Meetings as needed	Ongoing
Submit regulatory approvals to HRPO	Ongoing
Continue recruitment activities	Ongoing
Complete Participant Recruitment	Month 47
Complete data collection and data entry	Month 48
Begin Data Analysis	Month 45-48
Begin Dissemination	Month 48

4. **IMPACT:**

- **What was the impact on the development of the principal discipline(s) of the project?**

  Nothing to report

- **What was the impact on other disciplines?**

Nothing to report

- **What was the impact on technology transfer?**

  Nothing to report

- **What was the impact on society beyond science and technology?**

  Nothing to report

5. **CHANGES/PROBLEMS:**

- **Changes in approach and reasons for change**

  Nothing to report.

- **Actual problems or delays and actions or plans to resolve them**

  Delayed Enrollment with resulting delays in data collection, date entry, data analysis and dissemination:

  - As reported in last year's Annual Progress Report and in our Year 4 No Cost Extension request, the COVID 19 pandemic, beginning in March 2020 (Month 6) and continuing through the end of Year 2 (Month 24), had a tremendous negative impact. Our study activities were temporarily paused during this prolonged period due concerns for study participant safety and staff safety.

  - During Quarters 1 & 2 of this year, Enrollment Sites took longer than expected to resume data collection due to the Delta and Omicron waves of COVID 19. In the Fall of 2021, potential participants were hesitant to travel long distances and attend a 4-hour study visit. In addition, there were cancellations due to illness. Enrollment activities resumed at the Richmond and Tampa VA sites in Month 27 (December 2021) and have continued at a slow, but steady pace.

  - Staffing issues:
    The Research Coordinator at our Seattle site resigned in March. Given concomitant challenges in engaging the site Principal investigator and obtaining OT assessors time at this site, we decided it was best to close this site.
    - We lost a Research Coordinator in San Antonio when the PI moved from the CFI to the ISR. It took a prolonged amount of time to hire and onboard the new ISR coordinator. In addition, IRB approval to add him to the protocol took much longer than anticipated. Approval was received on 7/2/22. We conducted site restart trainings and recruitment and enrollment at the ISR has resumed.

  - In last year's Annual Progress Report and in Year 3 Quarterly Reports, we reported that we received funding from the VA to add 2 new Arm Dynamics data collection sites.

Unfortunately, it took approximately a year for the VA to issue a contract. Arm Dynamics signed the contract on 8/1/2022. We then held a planning meeting where we discussed necessary logistics and next steps. On 8/17/202, Arm Dynamics notified us that they were no longer interested in participating in the study. Given the challenges in adding new, external study sites, we will not seek new partners, but expect to prolong data collection activities at our 3 engaged sites. We had hoped Arm Dynamics would be able to enroll 50 participants before study completion.

- **Anticipated problems or delays and actions or plans to resolve them**

We requested and received a 12-month No Cost Extension for Year 4 of this study. After many challenging circumstances, our Richmond VA, Tampa VA and ISR sites are steadily recruiting participants. Each site has a very capable, qualified, and reliable team. We are confident they are collecting high quality data and will continue to do so throughout Year 4.

With the loss of Arm Dynamics' participation in Year 4, we are concerned we will be unable to reach our goal of enrolling 200 study participants by the end of Year 4. We have enrolled 40 study participants as of the end of Year 3, leaving 160 participants still needed. Each of our 3 sites is budgeted to enroll 4 participants per month (4 x 12 x 3 sites = 144, which would be 16 less than needed. We expect that we will need to request a 2nd No Cost Extension to complete data collection in the 1st Quarter of Year 5.

- **Changes that had a significant impact on expenditures**

- Closure of the Seattle VA Site at end of March 2022. Budgeted funds that were not expended will be reallocated to the remaining sites in NCE Year 4 to continue study activities.
- Delay in restarting ISR Site resulted in expenditures less than anticipated in Year 3. Remaining funds will be reallocated to continue NCE Year 4 study activities.
- Less money was expended for participant travel and compensation than anticipated. These funds will be reallocated to the NCE Year 4 budget.

- **Significant changes in use or care of human subjects, vertebrate animals, biohazards, and/or select agents**

- **Significant changes in use or care of human subjects**

Nothing to report

- **Significant changes in use or care of vertebrate animals.**

Nothing to report

- **Significant changes in use of biohazards and/or select agents**

Nothing to report

6. **PRODUCTS:**

Nothing to report

- **Website(s) or other Internet site(s)**

Nothing to report

- **Technologies or techniques**

Nothing to report

- **Inventions, patent applications, and/or licenses**

Nothing to report

- **Other Products**

Nothing to report

7. **PARTICIPANTS & OTHER COLLABORATING ORGANIZATIONS**

- **What individuals have worked on the project?**

Name:	Linda Resnik
Project Role:	Principal Investigator
Researcher Identifier (e.g., ORCID ID):	n/a
Nearest person month worked:	1.0
Contribution to Project:	Dr. Resnik has provided overall study oversight and data quality monitory. She is responsible for oversight of the work of Ms. Small, Mr. Borgia and Mr. Davey.
Funding Support:	*n/a*

Name:	Eileen Small
Project Role:	Program Manager

Researcher Identifier (e.g., ORCID ID):	n/a
Nearest person month worked:	6.0
Contribution to Project:	Ms. Small has performed study coordination across all sites, including providing technical support to local site coordinators in regulatory document preparation and submission. In addition, she was responsible for maintaining the overall study budget, reporting requirements, conducting quality control reviews and other administrative tasks as required.
Funding Support:	*n/a*

Name:	Matthew Borgia
Project Role:	Analyst
Researcher Identifier (e.g., ORCID ID):	n/a
Nearest person month worked:	.06
Contribution to Project:	Mr. Borgia was responsible for coordinating VINCI data pulls in preparation for recruitment mailings and updating DART requests as needed.
Funding Support:	*n/a*

Name:	John Davey
Project Role:	Deputy Project Coordinator
Researcher Identifier (e.g., ORCID ID):	n/a

Nearest person month worked:	7.5
Contribution to Project:	Mr. Davey has developed participant referral lists and prepared materials for the Study Restart meetings. He was also responsible for maintenance of study data bases, data cleaning, providing technical support to local site coordinators in data collection and data entry procedures. Mr. Davey also conducted quality control reviews.
Funding Support:	*n/a*

Name:	Jeffrey Heckman
Project Role:	Local Site Investigator (Tampa VA)
Researcher Identifier (e.g., ORCID ID):	n/a
Nearest person month worked:	1.2
Contribution to Project:	Dr. Heckman has provided oversight for the Tampa VA Site and oversight for the work of Ms. Kern and Ms. Delikat.
Funding Support:	n/a

Name:	Meghan Kern
Project Role:	Research Assistant/Coordinator (Tampa)
Researcher Identifier (e.g., ORCID ID):	n/a
Nearest person month worked:	3.6
Contribution to Project:	Ms. Kern has coordinated data collection activities for the Tampa site, including subject recruitment, travel, reimbursement tracking, data collection and data entry. In addition, she has coordinated required regulatory submissions for the Tampa Site.

Funding Support:	*n/a*

Name:	Jemy Delikat
Project Role:	Assessor (Tampa)
Researcher Identifier (e.g., ORCID ID):	n/a
Nearest person month worked:	2.4
Contribution to Project:	Ms. Delikat is the Assessor for the Tampa Site. She has participated in Assessors Meetings and collected functional performance data.
Funding Support:	*n/a*

Name:	Matthew Jerrell
Project Role:	Research Assistant/Coordinator (Seattle)
Researcher Identifier (e.g., ORCID ID):	n/a
Nearest person month worked:	6.0 (Oct 2021 through March 2022)
Contribution to Project:	Mr. Jerrell coordinated required regulatory submissions for this site and restarted recruitment activities. He resigned from the study in March 2022.
Funding Support:	*n/a*

Name:	Joseph Webster
Project Role:	Local Site Investigator (Richmond VA)
Researcher Identifier (e.g., ORCID ID):	n/a
Nearest person month worked:	1.2

Contribution to Project:	Dr. Webster provided study oversight for the Richmond VA Site and oversight for the work of Ms. Singh.
Funding Support:	

Name:	Mandeesha Singh
Project Role:	Research Assistant/Coordinator (Richmond)
Researcher Identifier (e.g., ORCID ID):	n/a
Nearest person month worked:	6.0
Contribution to Project:	Ms. Singh has coordinated data collection activities for the Richmond Site, including subject recruitment, travel, reimbursement tracking, data collection and data entry. In addition, she has coordinated required regulatory submissions for the Richmond Site.
Funding Support:	*n/a*

Name:	Jill Cancio
Project Role:	Local Site Investigator & Assessor (ISR – San Antonio)
Researcher Identifier (e.g., ORCID ID):	n/a
Nearest person month worked:	2.4
Contribution to Project:	Dr. Cancio has provided study oversight for the ISR San Antonio Site and oversight for the work of Mr. Bohanon. She is also the Site Assessor and has participated in Assessors Meetings and collected functional performance data.
Funding Support:	*n/a*

Name:	Markese Bohanon
Project Role:	Research Assistant/Coordinator (ISR – San Antonio)

Researcher Identifier (e.g., ORCID ID):	n/a
Nearest person month worked:	2.5
Contribution to Project:	Mr. Bohanon has coordinated data collection activities for the ISR San Antonio Site, including subject recruitment, travel, reimbursement tracking, and data collection. He joined the study in
Funding Support:	*n/a*

- **Has there been a change in the active other support of the PD/PI(s) or senior/key personnel since the last reporting period?**

There have been two changes to active other support for investigators. These changes are listed below and do not impact levels of effort on this project.

Dr. Linda Resnik: The following change has been made to Dr. Resnik's other support:
Completed
Title: Needs Preferences and Functional Abilities of Veterans and Service Members with Upper Limb Amputation
Role: Principal Investigator (PI)
Time commitments: 1.8 Calendar Months
Supporting agency: DoD W81XWH-16-2-0065 CDMRP
Performance period: 09/30/16 - 09/29/22 (NCE)
Level of funding:
Project goals: The objective of this study is to provide comprehensive cross-sectional and longitudinal data on function, needs, preferences, and satisfaction of Veterans and service members with major upper limb amputation

Dr. Jeffrey Heckman: The following change has been made to Dr. Heckman's other support:
New
Title: Brasthesis™ Prototype for Women Veterans with Upper Limb Amputations
Role: Principal Investigator (PI)
Time commitments: 1.2 Calendar Months
Supporting agency: Rehabilitation Research & Development SPIRE Program, Technology Transfer BRAVE Funding, 1 I21 RX003851-01, A3851-P
Performance period: 4/01/22-3/31/24
Level of funding:
Project goals: The objectives of this study are to (1) Evaluate the satisfaction of and function and comfort with Brasthesis. (2) Use goniometry measures of range of motion and pressure

mapping to compare range of motion and interface pressure of Brasthesis with the traditional harness.

- **What other organizations were involved as partners?** Nothing to report

8. **SPECIAL REPORTING REQUIREMENTS**

- **COLLABORATIVE AWARDS:** Not applicable.

- **QUAD CHART:** See attached.

9. **APPENDICES:** None

Comparative Effectiveness of Upper Limb Prostheses and Component Effects

PI: Linda Resnik, PT, PhD **Org:** Ocean State Research Institute **Award Amount:** $1,493,676

Study/Product Aim(s)

1. Compare the effectiveness of prosthesis type (body powered, myoelectric/hybrid) by amputation level.
2. Quantify the impact of prosthesis form (e.g., weight, shape) on outcomes
3. Compare the effectiveness of prosthesis suspension method, controlling for potential confounding by prosthesis level, prosthesis type, and prosthesis weight

Approach

This is a multi-site comparative effectiveness study with an observational, cross-sectional design. Data collection will be done through in-person assessment and functional performance testing. The study will involve multiple data collection sites and a coordinating site. Each participant will complete one study visit.

Figure 1. A variety of upper limb prostheses.

Timeline and Cost

Activities – Project Year	Year 1	Year 2	Year 3	Year 4
Start up activities: IRB approvals and staff training				
Data Collection				
Data Analysis				
Dissemination				
Actual Expenses – Years 1-3 (Estimated Expenses Year 4)	**$133,931**	**$73,964**	**$301,862**	**$983,919**

Goals/Milestones

PY1 Goals – Project launch and data collection

x Submit and obtain all regulatory approvals for study activities
x Kick off meeting planned and held
x Begin participant recruitment
x Begin data collection - *study was paused due to Covid-19 in Year 1

PY2 Goals – Recruitment, data collection, preliminary data analysis

x Resume recruitment activities in September 2021
x Maintain regulatory approvals

PY3 Goals – Data Collection and preliminary data analysis

x Restart data collection in December 2021
- 40 study participants enrolled as of 9/29/22

❑ Begin preliminary data analysis

PY3 Budget Expenditure to Date

Actual Expenditure: Cumulative Y1 = $133,931 + Y2 = $73,964 + Y3 = $301,862*** Total Expenditure to date: $509,757***

*** As of 10/27/22 – Awaiting final Y3 invoices.**