Veterans Health Administration
Research & Development
Improving Veterans' Lives — www.research.va.gov

Advancements in Prosthetics Research: VA Studies of the DEKA Arm

Linda Resnik, PT, PhD, OCS
Research Health Scientist
Providence VA Medical Center

Assistant Professor
Department of Community Health
Brown University

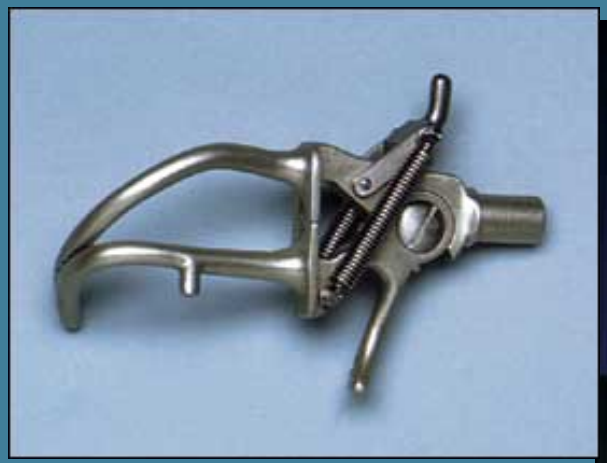
Background

- Upper limb amputees are 3% of amputee population
- Historically, there has been little commercial interest in development of upper limb prosthetics
- Currently available devices aren’t good enough to restore function

Background

- Increasing prevalence of upper limb amputation due to injuries in Iraq and Afghanistan
- Upper limb amputees constitute **22%** of new military amputees
- The majority of these amputees will separate from active duty and enroll in VA healthcare
- The VA will provide lifetime prosthetic care for Veterans with amputations

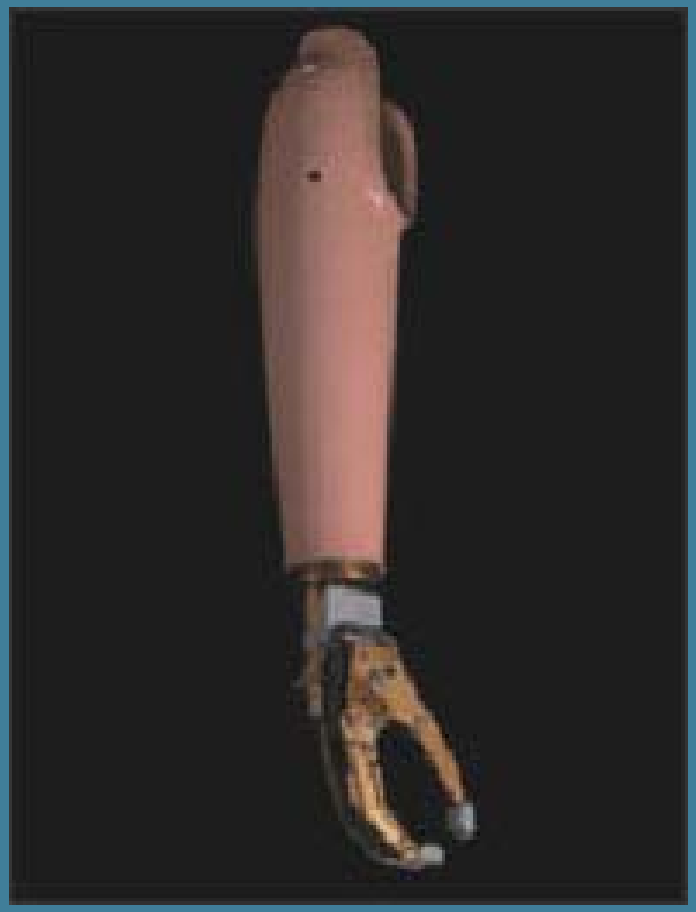
State of the Art: Prosthetic Hands



Current State of the Art of Prosthetic Hands

open and close:
1 grip only

Current State of the Art in Sockets



- Rigid and uncomfortable
- Cannot adjust to changing anatomy
- Hot and sweaty

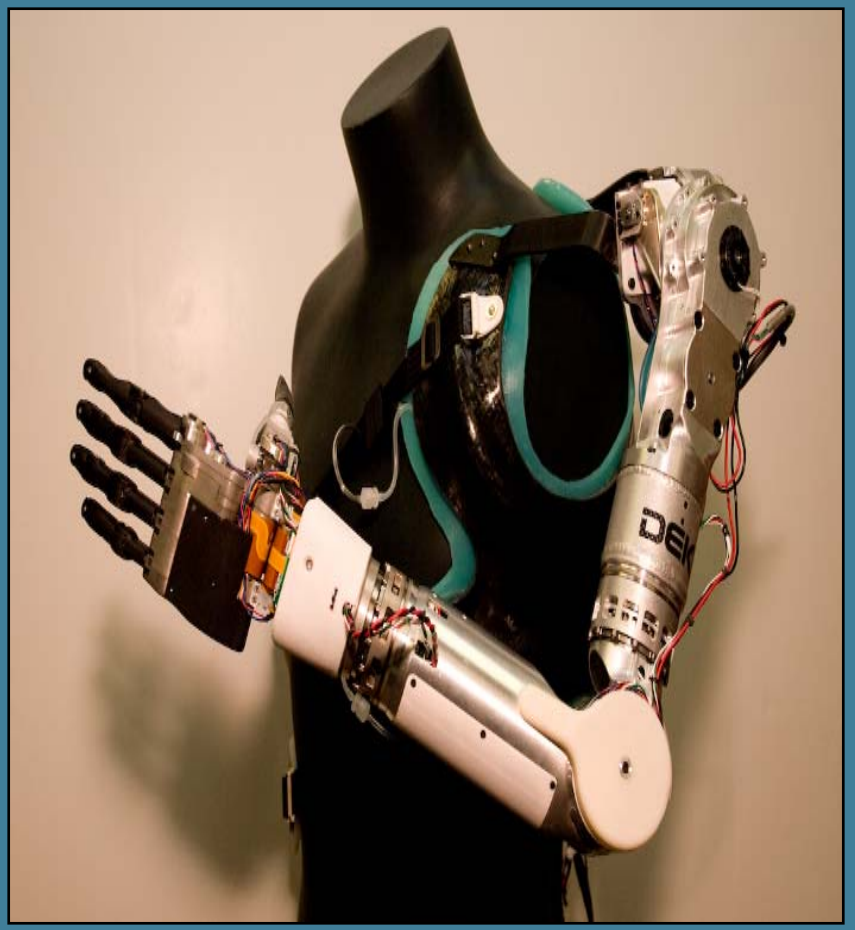
Veterans Health Administration
Research & Development
Improving Veterans' Lives — www.research.va.gov

DARPA's Revolutionizing Prosthetics Program

A major investment in technology development to advance the care of military members with upper limb amputations

The DEKA Gen2 Arm:
2 Years of Research & Development

Veterans Health Administration
Research & Development
Improving Veterans' Lives -- www.research.va.gov



DEKA Arm Features

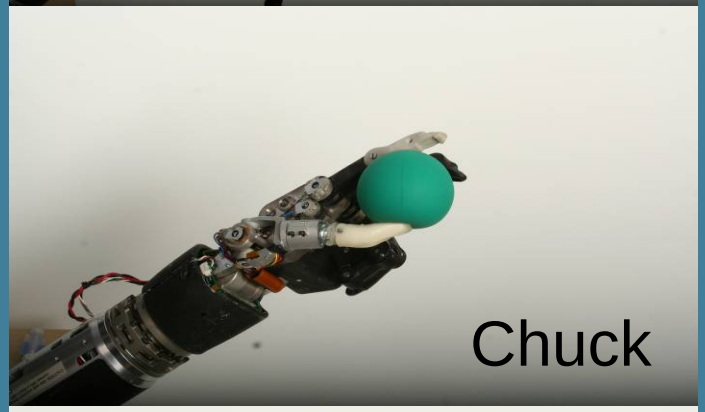
- Multiple hand grips

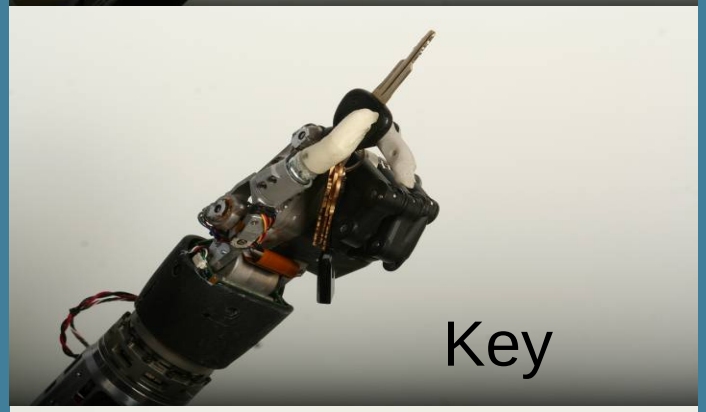
- Enhanced comfort
  - Active socket design

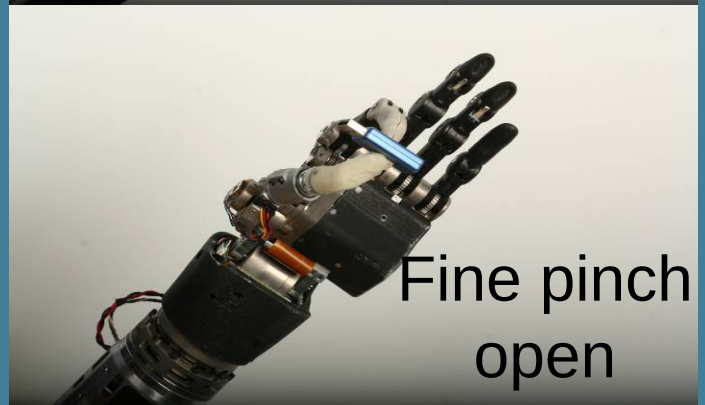
- 18 degrees of freedom
  - 10 powered

- Improved speed and torque
- Elbow lift capacity of up to 20 ft-lbs
  - Currently available between 2.5-4 lbs

Grip Patterns







Active Socket

- **Open frame concept**
- **Air bladders accommodate variability in tissue volumes**
- **Allows a closer, yet cooler, more comfortable fit**

DEKA Tests Pilots

DEKA Gen2 Arm

- **This is a product in development**
- **It is NOT commercially available yet**
  - Further testing is required to inform optimization efforts
- **VA is serving as a transition partner to conduct clinical studies of the DEKA arm**

VA Studies of the DEKA Arm

- **Funded by VA Rehabilitation Research and Development**
- **DEKA arms and support funded by DARPA**
- **Research Partnership**
  - VA and DARPA Memorandum of Agreement
  - VA and DEKA Cooperative Research Agreement
  - Clinical collaboration with VA Prosthetics and Sensory Aids Services, Physical Medicine and Rehabilitation

VA Study Objectives

1) Evaluate the amputee's experience of using the DEKA arm

2) Evaluate clinicians' experience of fitting, setting up and training subjects with the DEKA arm

3) Evaluate improvements in the arm and its software as it is optimized by DEKA

VA Research: Improving Veterans' Lives

Veterans Health Administration
Research Development
Improving Veterans' Lives ~ www.research.va.gov

These VA led studies demonstrate the VA's commitment to advance the field of prosthetics to better serve amputees injured in OEF/OIF and transitioning to the VA from DOD facilities.

Importance of the Study

- Study results will be used to inform design efforts of the Gen 3 arm
- VA's leading role will help to ensure that the DEKA arm is optimized to best suit needs of Veterans with amputations

Importance of the Study

Involvement of VA clinical and research services will help:

- determine the feasibility of deploying the DEKA arm within the VA
- position the VA amputee system of care at the cutting edge of upper limb prosthetics research

Veterans Health Administration
Research & Development
Improving Veterans' Lives — www.research.va.gov

VA Research: Improving Veterans' Lives

Thank You

Veterans Health Administration
Research Development
Improving Veterans' Lives -- www.research.va.gov

DSO

DEFENSE SCIENCES OFFICE

Revolutionizing Prosthetics

Revolutionizing Prosthetics
The Vision

Exploit/advance state of the art technologies: actuation, mechanical power distribution, energy storage, biotic/abiotic interfaces, sensors, computation, and **neural control**

To

Provide fully integrated limb replacements that enable victims of upper body limb loss to perform arm and hand tasks with near-natural strength and dexterity

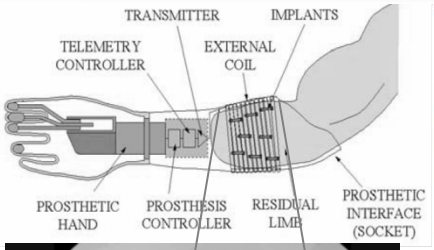
State of the Art: Utah arm

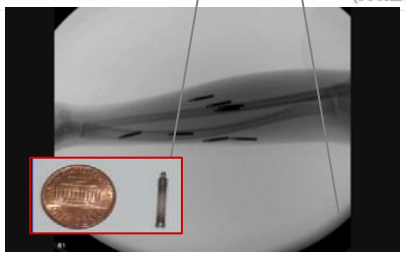
2 pound active lift
Myoelectric or "shrug" control with a standard harness and socket interface

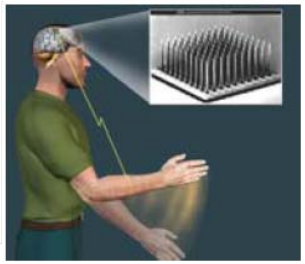
Mechanically Superior

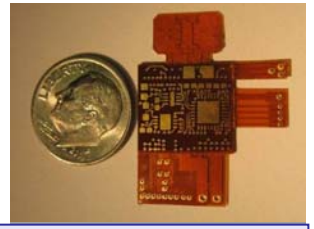
Neurally Integrated

- **Closed loop nervous system integration**
- **Degrees-of-freedom allow natural range-of-motion**
- **Tactile & force receptors provide feedback**
- **Human-like endurance and actuation**









Clinical Development Strap-and-Go

- 6 patients, >500 hours of use to date
- Next steps
  - >10 clinical trials
  - >4 patient home trials
  - Testing
  - Design 3rd Gen Arm
  - 2011- submit to FDA

Clinical Development Neural

- >30 patients with targeted motor reinnervation (TMR) surgery to facilitate arm control; 4 used arm in clinical setting
- Walter Reed and Brooke Army Medical Centers evaluate patients for TMR and have performed 3 surgeries at each facility to date
- Successful wireless cortical and peripheral nerve signal decoding experiments
- 2010 – FDA submission; initiate trials for direct brain controlled device

Continued support to 2-year VA Optimization Study


60
MINUTES

Veterans Health Administration
Research & Development
Improving Veterans' Lives — www.research.va.gov

Research Leading to a Paradigm Shift in VA Amputation Care

Gayle E. Reiber, PhD
VA Senior Career Scientist

Funded by VA Health Services Research & Development

Need For This Research

Little is published on service members with traumatic limb loss from Vietnam, Operation Iraqi Freedom and Operation Enduring Freedom (OIF/OEF). We need to better understand:

- Combat injuries
- Health
- Function
- Quality of life
- Prosthetic use and satisfaction
- Costs

Impact of the DoD Paradigm Shift on VA Amputee Prosthetic Care

Veterans Health Administration
Research Development
Improving Veterans' Lives -- www.research.va.gov

Purpose of the Research

1. To survey 501 eligible Vietnam and 541 OIF/OEF service members with traumatic limb loss

2. To project future prosthetic shifts and costs for 5,10-,20 years and lifetime

Summary of the Project

Over 1,000 Veterans and service members with combat-related limb loss identified

Completed *Survey for Prosthetic Use* (mail, internet and phone)

- Costs determined and projected
- Expert panel met to discuss study issues, clinical recommendations, research recommendations and prepare manuscripts
- Single-topic issue of JRRD in late 2009 includes 10 manuscripts, 4 editorials and clinical and research recommendations

Program Status

- Survey response rate 62%
- Data analysis complete
- Identified key clinical and research topics
- Manuscripts under review
- Some clinical translation efforts underway
- Need support for other clinical and research initiatives

Results

	Vietnam	OIF/OEF
Phantom limb	72	76
Remaining limb	48	63
Wearing prostheses	47	40
Chronic back pain	36	42
Skin problems,%	51	57
PTSD, %	38	59
TBI, %	3	34

Significant Contributions

This research supports a VA Rehabilitation Paradigm shift in Amputation Care to better serve veterans with limb loss through an improved system of care.

- Regional
- VISN and
- Local clinical teams
- Uniform care to service members with limb loss regardless of conflict

Recommendations for Veterans with Limb Loss

Veterans Health Administration
Research Development
Improving Veterans' Lives ~ www.research.va.gov

Clinical topics:

- Paradigm shift in care and organization for veterans with limb loss
- Uniform standard for prosthetic care
- Continue veterans choice for prosthetic provider
- Registry, linked to medical record and prosthetic record

Research topics:

- Physical and psychosocial function, social support, quality of life, prosthetic satisfaction and outcomes
- Neuro-musculoskeletal pain
- Socket design to improve fit and decrease pain
- Decreasing abandonment of prosthetic devices
- Follow-up surveys

Expert Panel

Veterans Health Administration Research Development

Improving Veterans' Lives ~ www.research.va.gov

Advised on Study Issues, Recommendations and Wrote Manuscripts

VA

Lucille Beck, PhD
Kendra Betz, MSPT, ATP
Donna Jo Blake, MD, PT
Rory Cooper, PhD
Joseph Czerniecki, MD
Paul Dougherty, MD
Fred Downs
Robert Gailey, PhD, PT
Sandra L. Hubbard-Winkler, PhD
Charles Maynard, PhD*
Martin McDowell
Lynne McFarland, PhD*
John R. Milani, CPO
Billie Jane Randolph, PhD, PT
Gayle Reiber, PhD*
Barbara Sigford, MD, PhD

Veteran Service Organizations

Juan Arredondo
Ned Foote
Jonathan Pruden, MPS

DOD

CPT Kristin Erickson, MD, MPH*
John Fergason, CPO
COL Jeffrey Gambel, MD, MPH
LTC Paul Pasquina, MD, MC

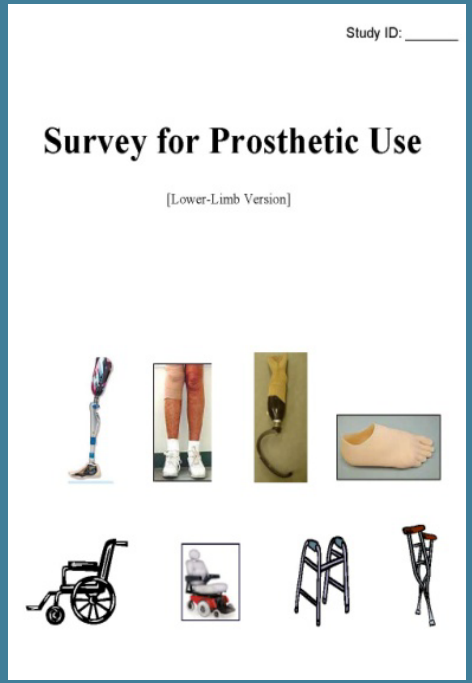
Academic Institutions/Other

Gary Berke, MS, CP, FAAOP
David Blough, PhD*
Tony Choppa, MEd, CRC, CCM, CDMS
Alberto Esquenazi, MD
John Hattingh, LCPO
Allen Heinemann, PhD, ABPP
Sharon Hubbard, MS*
Melissa Jones, PhD, OTR/L, CHT
Douglas Smith, MD*

* Project Team

Acknowledgments

We gratefully acknowledge the Veterans who participated in our study


Study ID: _____

Survey for Prosthetic Use

[Lower-Limb Version]

Veterans Health Administration
Research Development
Improving Veterans' Lives -- www.research.va.gov

Veterans Health Administration
Research & Development
Improving Veterans' Lives — www.research.va.gov

Using VHA Telehealth to Improve Access and Patient Centered Outcomes for Community-Dwelling Veterans

Neale R. Chumbler, PhD

VA HSR&D
Center of Excellence
on Implementing Evidence-Based Practice
affiliated with

VA QUERI Stroke
Quality Enhancement Research Initiative

Aging Veterans with Chronic Care Needs

- Veteran population (age 85+)
  - 124% (2000–2020)
  - VHA treats --- triple ’00-’11
- Live independently at home
- 32% of VHA patients in rural areas

Darkins et al., 2008

Collaborations

- VA RR&D
- VA HSR&D
- VHA Office of Care Coordination
- VISN 8 Community Care Coordination Service

Home Telehealth

- **Patient Centered Care**
  - Delivery of health care services at a distance
  - Veterans timely and convenient care (rural)
- **Home-telehealth (CCHT)**
  - **Self management of chronic conditions in homes**

Darkins, 2008

Research Purpose

1. Compare effectiveness of care coordination/home-telehealth (CCHT) for Veterans with diabetes

2. To determine the effect of a tele-rehabilitation intervention on physical function

CCHT and Diabetes

1. **VHA Service Use:**
   Significant in preventable hospitalizations (18 months)

↓

2. **Health-Related Quality of Life:**
   Significant improvement @ 12 months

↓

3. **Mortality:** Significant in 4-year all-cause mortality

Chumbler et al., 2005; Jia et al., in press; Chumbler et al., 2009

Cost Effectiveness of Home-Telehealth and Diabetes

- Cost effective for 1/3 of participants
- Cost-effectiveness varied by marital status, VAMC location site and co-morbidities

Barnett et al., 2007

Tele-rehabilitation for Stroke Patients

Veterans Health Administration
Research Development
Improving Veterans' Lives -- www.research.va.gov

- **Stroke is a special emphasis population in the VA**
- **Very costly hospitalization for veterans with stroke and follow-up care**
- **Phase II randomized control trial**
  - Patients recruited from 4 VAMCs in 4 VISNs
- **Goal to improve functional mobility using multifaceted rehabilitation intervention via tele-health technology**

Tele-rehabilitation for Stroke Patients

Veterans Health Administration
Research & Development
Improving Veterans' Lives ~ www.research.va.gov

1. Exercise component: strengthening, balance and endurance

2. Adaptive strategies: identify home modifications, assistive devices

3. Screen for unforeseen problems, reinforce adherence to exercise

Enrollment is ongoing.

Research Improving Veterans' Lives

Veterans Health Administration
Research & Development
Improving Veterans' Lives -- www.research.va.gov

Home-telehealth and Diabetes:

- Key VHA non-institutional care service
- Support older veterans with chronic conditions as they age and remain independent
- Improves access to timely care and obviating hospital admissions

Research Improving Veterans' Lives

Veterans Health Administration
Research Development
Improving Veterans' Lives -- www.research.va.gov

Tele-rehabilitation for Veterans with stroke

- Access to post-acute in-patient rehabilitation is limited
- Resources for in-home rehabilitation are limited
- Reinforce exercise adherence and rapid response to new functional problems

Next Steps: Tele-rehabilitation

Veterans Health Administration
Research & Development
Improving Veterans' Lives ~ www.research.va.gov

Improved methods for functional assessment; more effective and efficient rehab strategies

- Interventions applicable to other rehab populations (i.e. polytrauma)
- Utility for older veterans with mobility disability
- May create national partnerships for approaches to transition from hospital to home

Next Steps: Home-telehealth

- Expand to support returning OEF/OIF heroes
- Expanded into the Personal Health Record

Darkins, 2008

Acknowledgment

- Thank you to all of the veterans who participated in the studies

- “Home-based telehealth stroke care: A randomized trial for Veterans” is a Merit Review Grant funded by VA Rehabilitation Research & Development (B4492R)

- HSR&D QUERI (QLP) (STR 04-347)

VA Research:
Improving Veterans' Lives