U.S. Department of Veterans Affairs

# *Upper Extremity Amputation: New Research Findings from the Department of Veterans Affairs*

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# Overview

- **Research studies and findings from the Department of Veterans Affairs**
- Unique differences between loss of the upper limb compared to lower limb loss
- Types of prostheses used by persons with upper limb loss / limb difference
- Advantages and challenges associated with newer prosthesis technology

# Disclosures

**Joseph B. Webster, MD**
**Linda Resnik, PT, PhD, FAPTA**

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**Disclaimer**

Views expressed in this presentation do not represent the views of the Federal Government or the Department of Veterans Affairs

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- VA RR&D, A67801
- VA RR&D  A9226-R
- DoD, Orthotics and Prosthetics Outcomes Research Program W81XWH-16-0794

# Importance of the Upper Limb

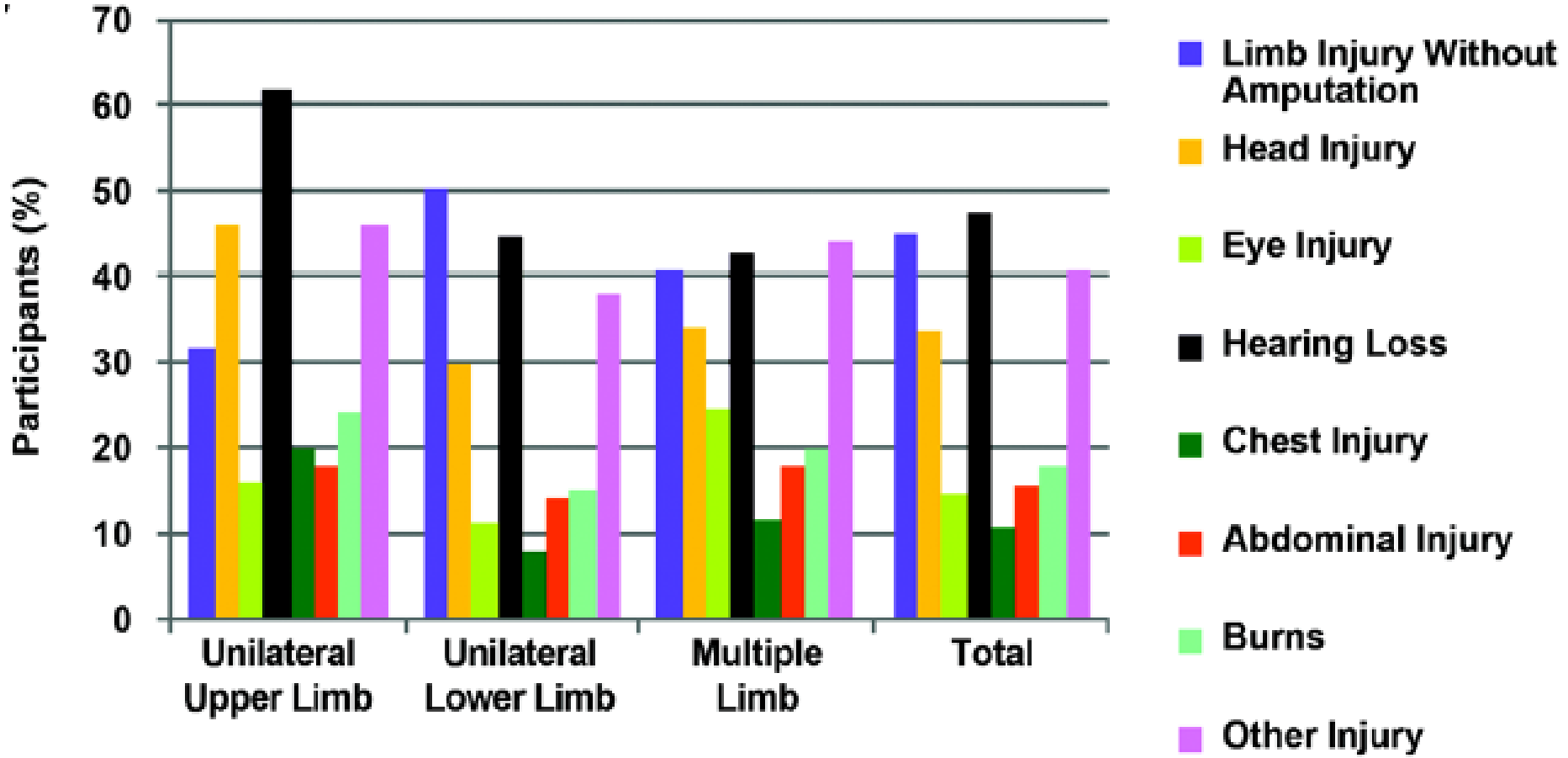
- Interaction with the environment (Active and Receptive)
- High visibility
- Body image component
- Means of communication
- Balance and Coordination

# Management Challenges

## Most upper limb loss related to traumatic injuries

- Unique individual presentations
- Complex function of the UE
- Loss of fine motor skills
- Loss of sensation
- Hand dominance
- Pain more severe and impairing
- Associated extremity trauma
- Other traumatic injuries

# Management Challenges




*Military Medicine 175, 3:147-154, 2010.*
*Reiber et al. JRRD, Volume 47, Number 4, 2010.*

# Management Challenges

## Mental Health Considerations

- PTSD 66%
- Depression / Adjustment Disorders 46%
- Anxiety Disorders 38%
- Substance Abuse 16%

- Some association with co-morbid injuries and injury severity

- **Psychological adjustment to UEA unique: High visibility of the upper extremity**

- Longitudinal care is essential

*JRRD. 2010;47(4):373-86.*
*OIG Report. Prosthetic Limb Care. May 2012.*

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# Take Home Points:

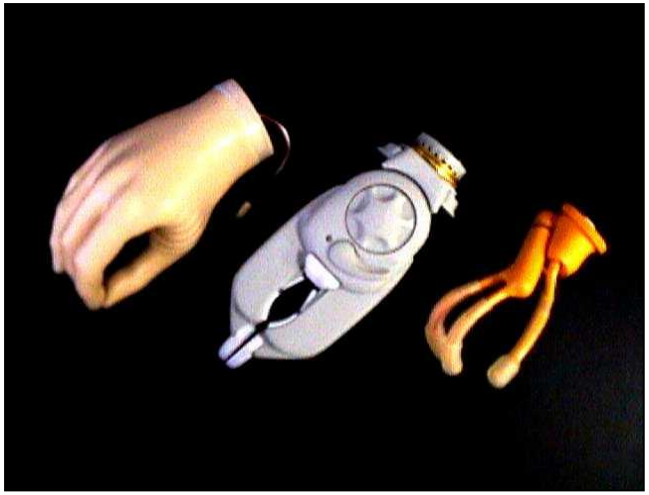
*Absence or loss of the arm is very different than loss or absence of the leg*

*These differences create challenges with prosthetic restoration of the upper limb*

# Upper Limb Amputation
# Prosthesis Restoration Considerations

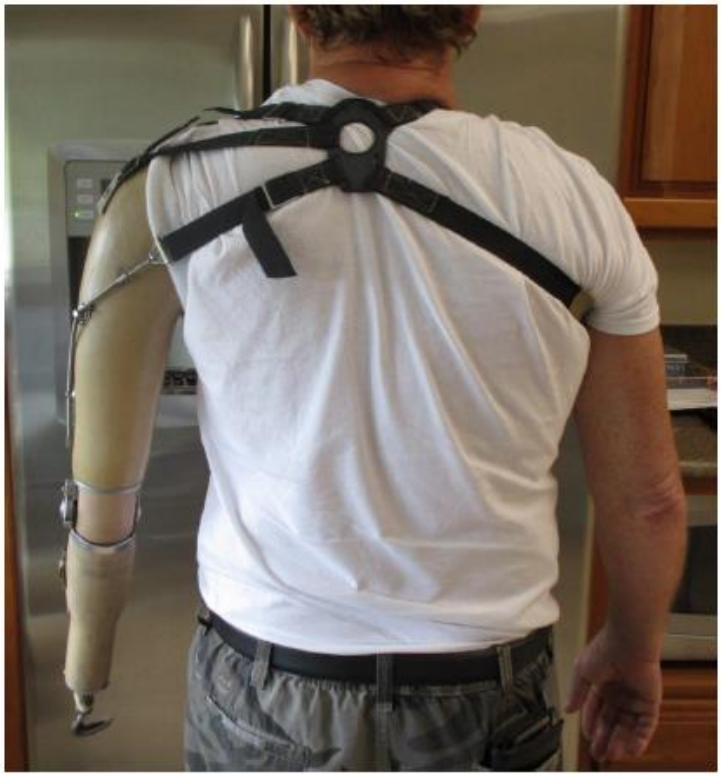
# Prosthesis Options

- No Prosthesis
- Passive Prosthesis
- Cable-Operated (Body-Powered)
- Electric/Myoelectric (Externally-Powered)
- Hybrid System
  (Combination of Body-Power and Electric)
- Activity Specific



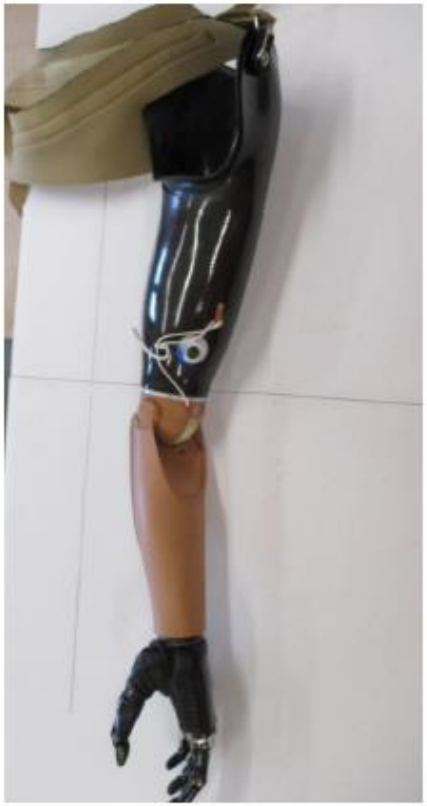
# Body-Powered Transradial Prosthesis

# Body-Powered Transhumeral Prosthesis



# Myoelectric (External Powered)


# Myoelectric Transhumeral Prosthesis



# Multi-Articulating Hands


Ottobock
(Bebionic)

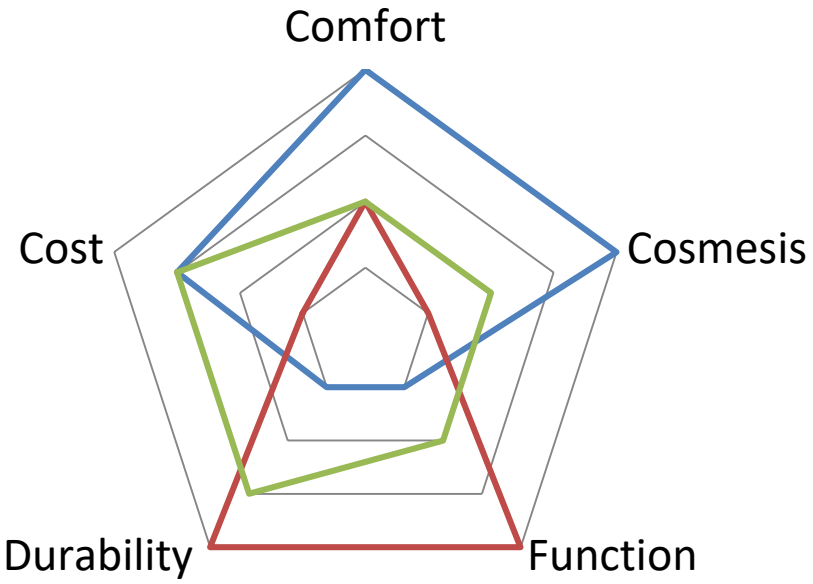
Fillauer
(Taska)

Ottobock
(Michelangelo)


Ossur
(iLimb)

# Prosthesis Prescription Considerations

**Comfort**
**Cosmesis**
**Function**
**Durability / Reliability**
**Cost**




## CONSIDERATION POINTS

Prescription must be based on the **Patient** not the available technology

**Prosthetic education and training** essential to successful outcomes

Greater need for **highly specialized teams** with advanced technology

*Arch Phys Med Rehabil 2012;93:710-7.*

# Prosthesis Prescription Considerations

**Comfort**
**Cosmesis**
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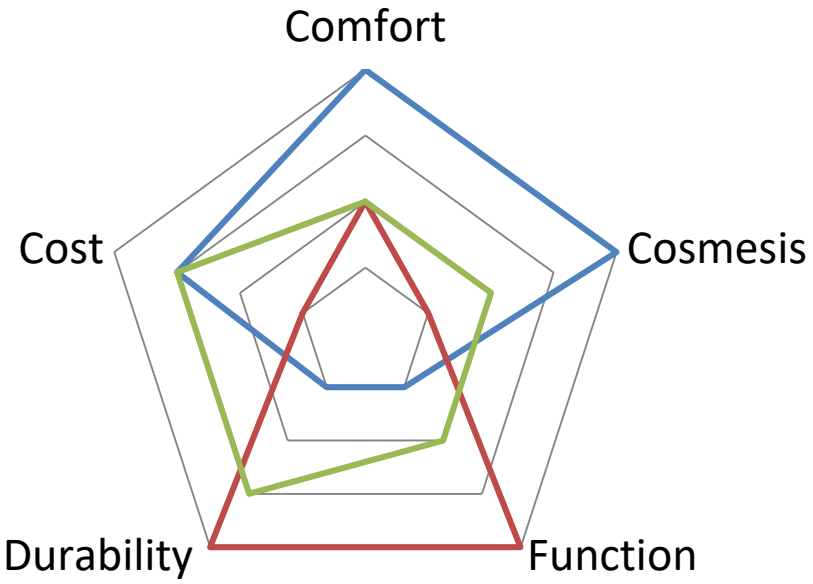


**CONSIDERATION POINTS**

**Patient preference and goals for prosthesis use need to drive recommendations from the rehabilitation provider / team**

**Clinical decision-making challenging because limited research evidence available comparing advantages and disadvantages of prosthesis type or specific types of components**

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# Take Home Point:

*Although a wide variety of prostheses and prosthetic components are available, there is limited research to help you decide which device type is best for you.*

# VA Research

# Upper Extremity Amputation Rehabilitation Clinical Practice Guideline 2014

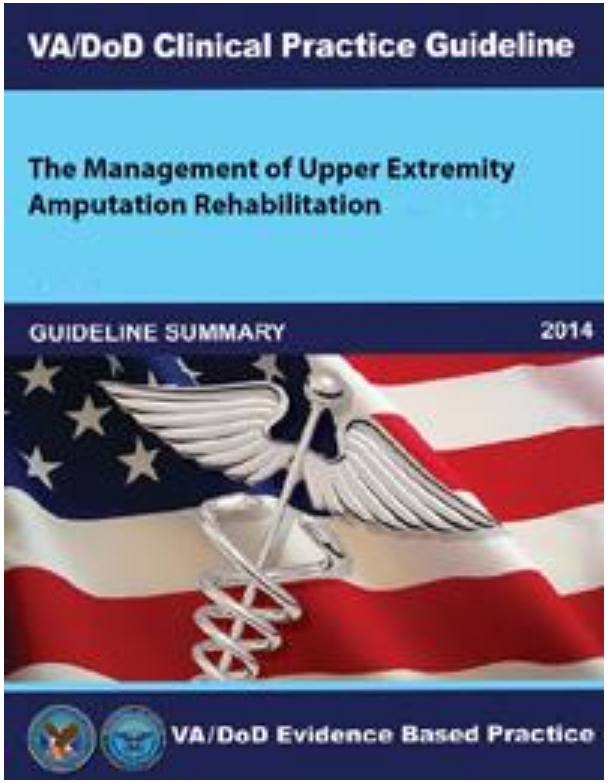
- UEAR CPG and other resources can be located at:

http://www.healthquality.va.gov/guidelines/rehab/uear/index.asp

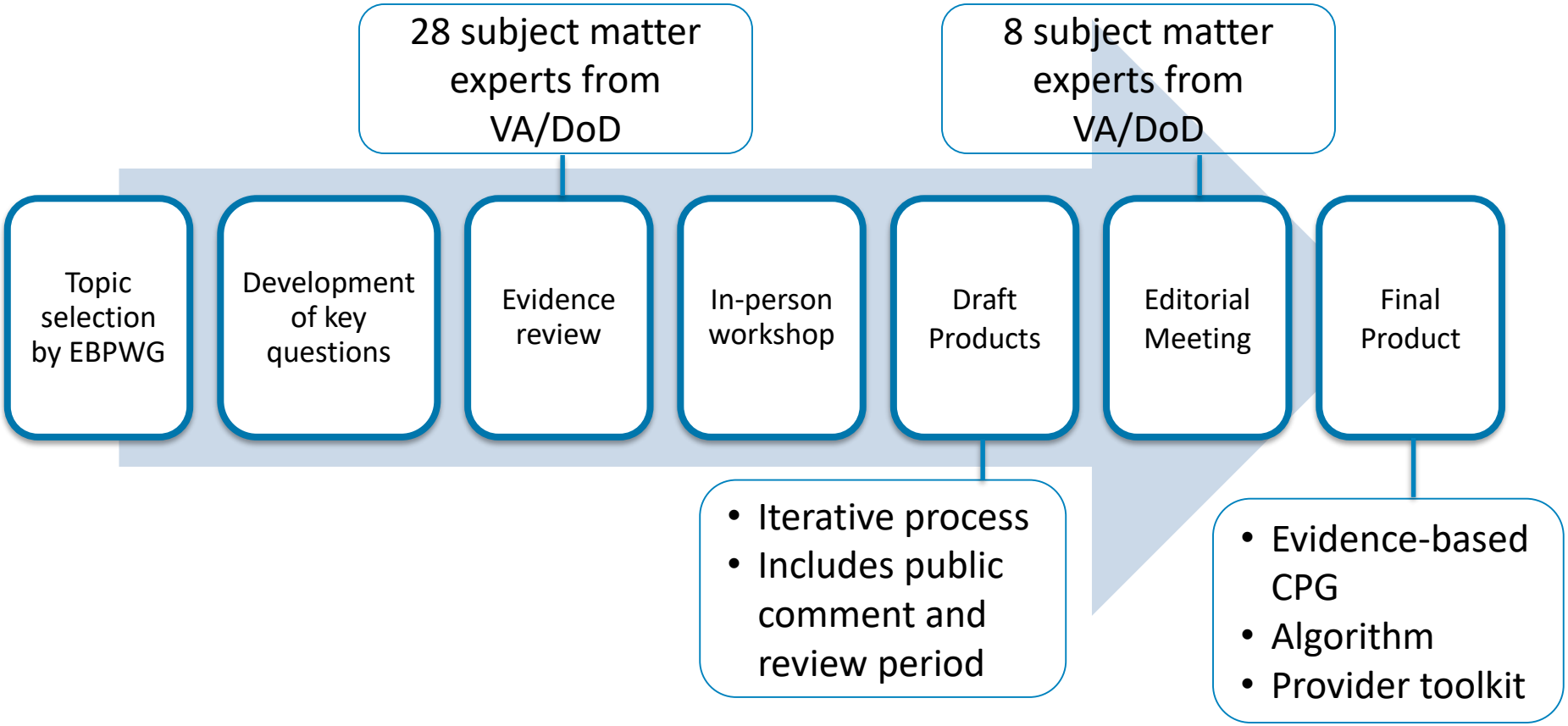
Products:

1. Full Clinical Practice Guideline
2. UEAR CPG Provider Summary
3. UEAR CPG Patient Summary
4. Provider Pocket Card

- **Patient Education Book "Within Reach"**



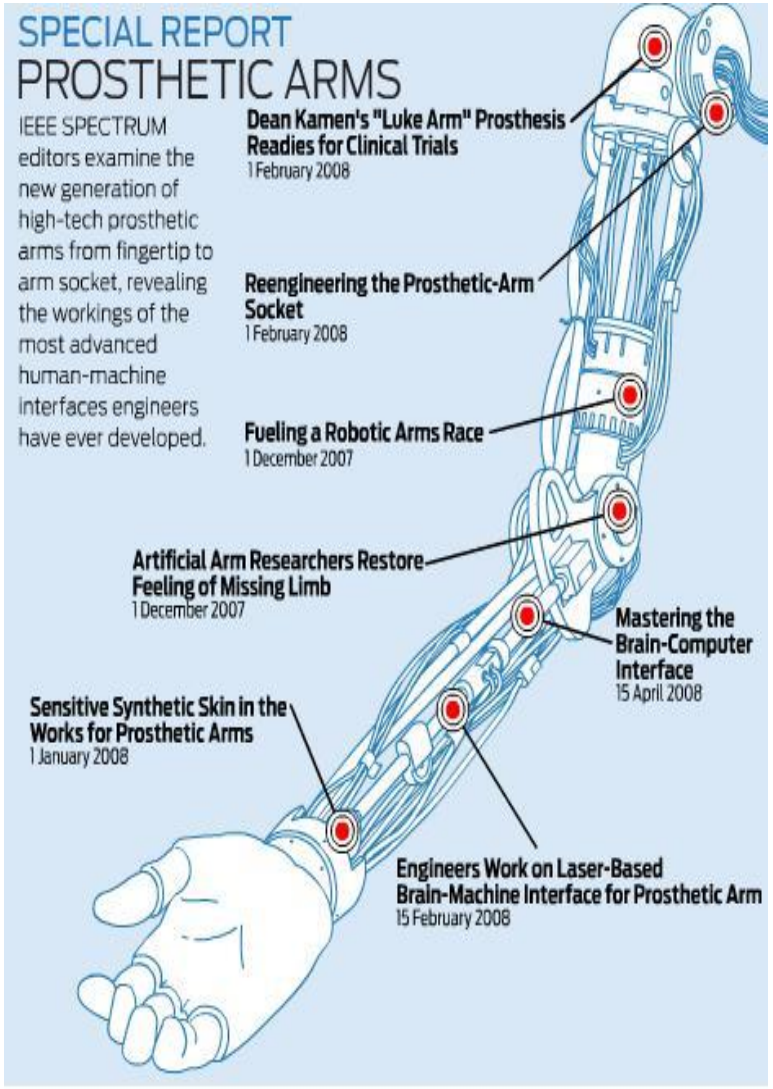
# Guideline Development Process




- **Total of 27 recommendations provided across the 3 core areas and 4 phases**

# Revolutionizing Prosthetics Program

- **Defense Advanced Research Project Agency (DARPA)** announced the Revolutionizing Prosthetics Program in 2005
- RP 2007 – $18.1 million project awarded to DEKA
- RP 2009 - $30.4 million project awarded to APL at Johns Hopkins



# DEKA Home Study Design

- **Two-part study**
  - Part A consisted of in-laboratory training
  - Part B consisted of up to 12 weeks of home use

- **Comparisons were made between DEKA Arm and Conventional prosthesis**
  - 23 prosthesis users completed Part A
  - 15 prosthesis users completed Parts A and B

*Resnik LJ, Borgia ML, Acluche F, Cancio JM, Latlief G, Sasson N. How do the outcomes of the DEKA Arm compare to conventional prostheses?. PLoS One. 2018;13(1):e0191326.*

# DEKA vs. Conventional Prosthesis

**End of in-laboratory training**

- No differences in activity performance
- Activities slower to perform

**End of Home study**

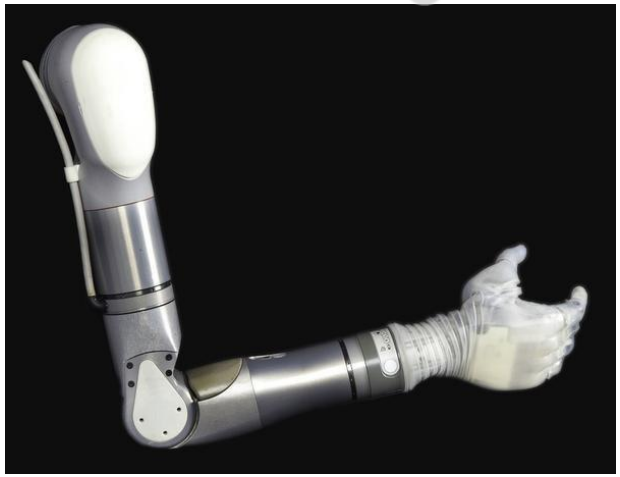
- Activity performance better
- No differences in speed of performing activities

**Both time points**

- Performed more activities using the prosthesis
- Had less perceived disability
- No differences in dexterity, prosthetic skill, spontaneity, pain, community integration or quality of life

# DEKA Arm / LUKE Arm

- Partnership with the VA for research and development of Generation 3 DEKA arm,
  Optimization and Take-Home Studies
- FDA approval in May 2014
- The LUKE Arm commercially available through Mobius Bionics LLC
- Modular (10 powered degrees of freedom)
- Multiple control options (IMUs)
- End-point control / Haptic Feedback



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# Take Home Points:

*Research efforts have resulted in new types of "advanced" upper limb prostheses*

*All prosthetic types have advantages and disadvantages that must be considered*

The Power of You!

# National Study of Veterans

Survey
baseline and
1–year follow-up

In-person testing
protocol

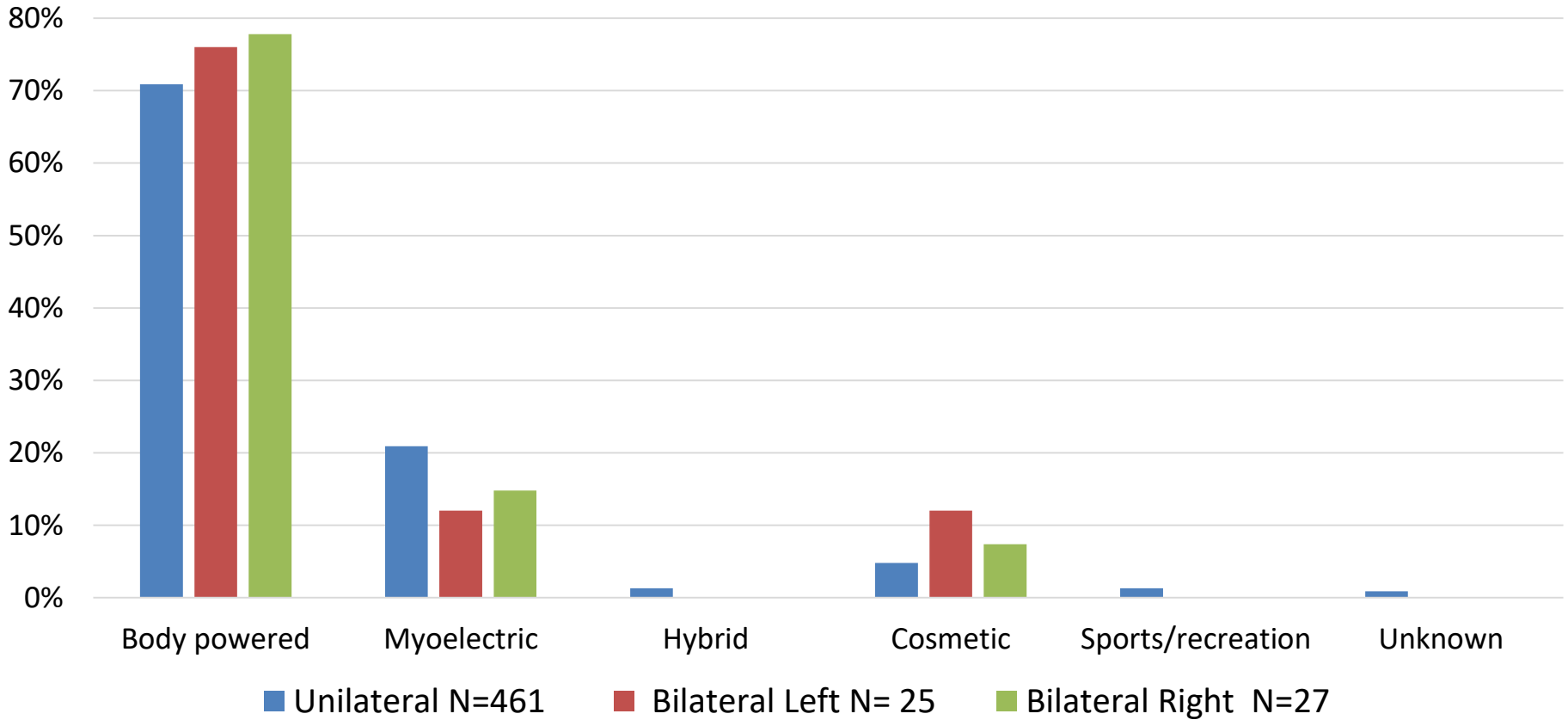
Patient reported
outcomes study

# National Study of Veterans

| Baseline N=808 | | |
|---|---|---|
| Unilateral Amputation | N=776 | (96.0%) |
| WD/TR | N=406 | (50.3%) |
| TH | N=275 | (34.0%) |
| SH | N=95 | (11.8%) |
| Bilateral Amputation | N=32 | (4.0%) |

| Follow-up N=585 | | |
|---|---|---|
| Unilateral Amputation | N=776 | (96.1%) |
| WD/TR | N=293 | (52.1%) |
| TH | N=206 | (36.6%) |
| SH | N=63 | (11.2%) |
| Bilateral Amputation | N=23 | (3.9%) |

# Primary Type of Prosthesis Used



# Measures

- Health related quality of life:  VR-12
- Activity difficulty: unilateral and bilateral tasks
- Disability: QuickDASH
- Need for help with daily activities (ADL) and hours of help needed

# Conclusions

- Amputees who did not use a prosthesis or used a cosmetic prosthesis reported more difficulty in activities and greater disability as compared to those that use body-powered and myoelectric devices.
- Nonusers were more likely to need help with ADLs as compared to those who used a body powered prosthesis.
- **Findings highlight the clinical importance of encouraging prosthesis use.**

Resnik L, Borgia M, Clark M. Function and Quality of Life of Unilateral Major Upper Limb Amputees: Effect of Prosthesis Use and Type. *Arch Phys Med Rehabil*. 2020;101(8):1396-1406.

# Prosthesis Abandonment

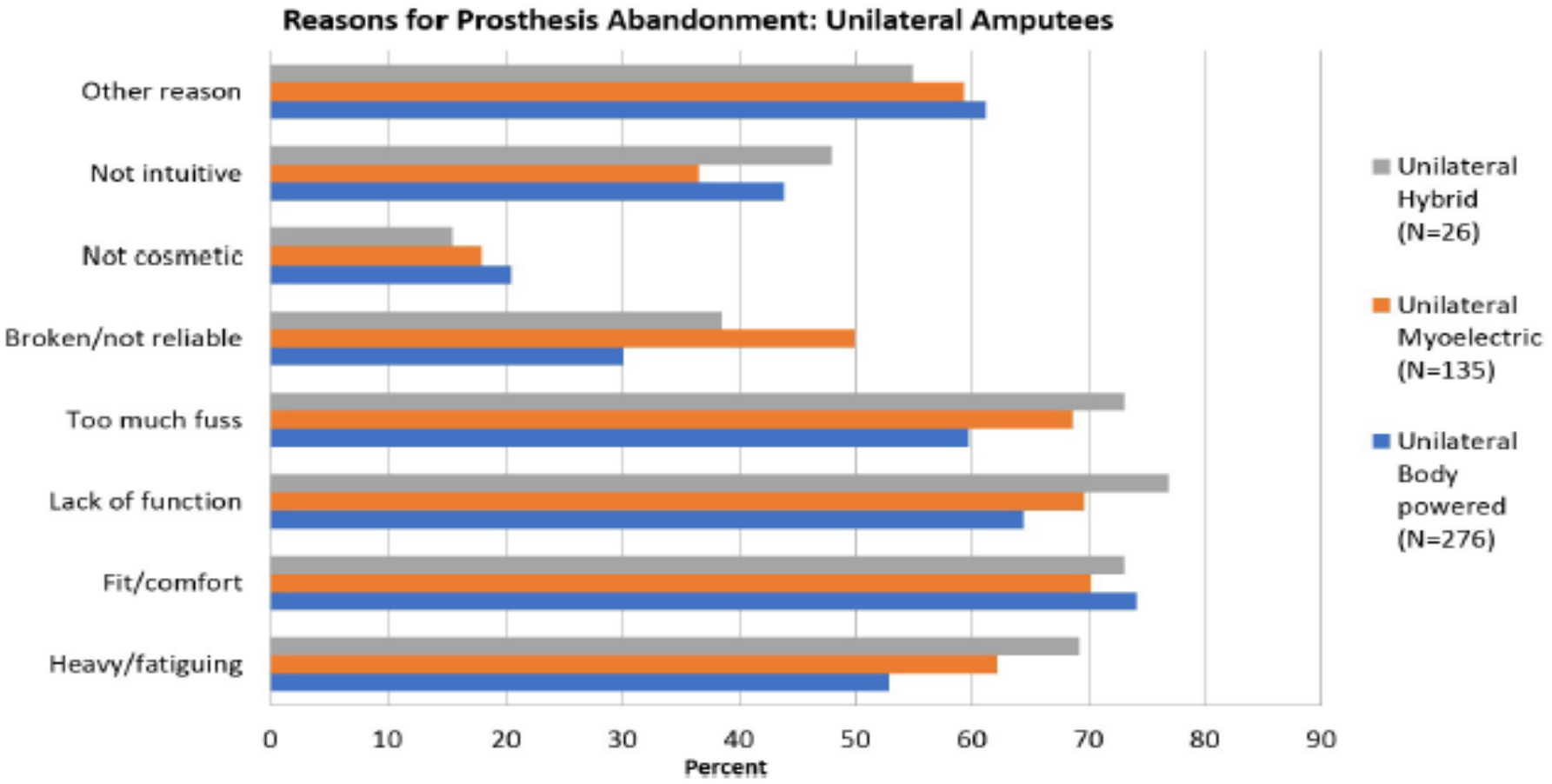



**Fig 2. Reasons for prosthesis abandonment by type of device: Unilateral amputees.**

# Hours/day of Prosthesis Use

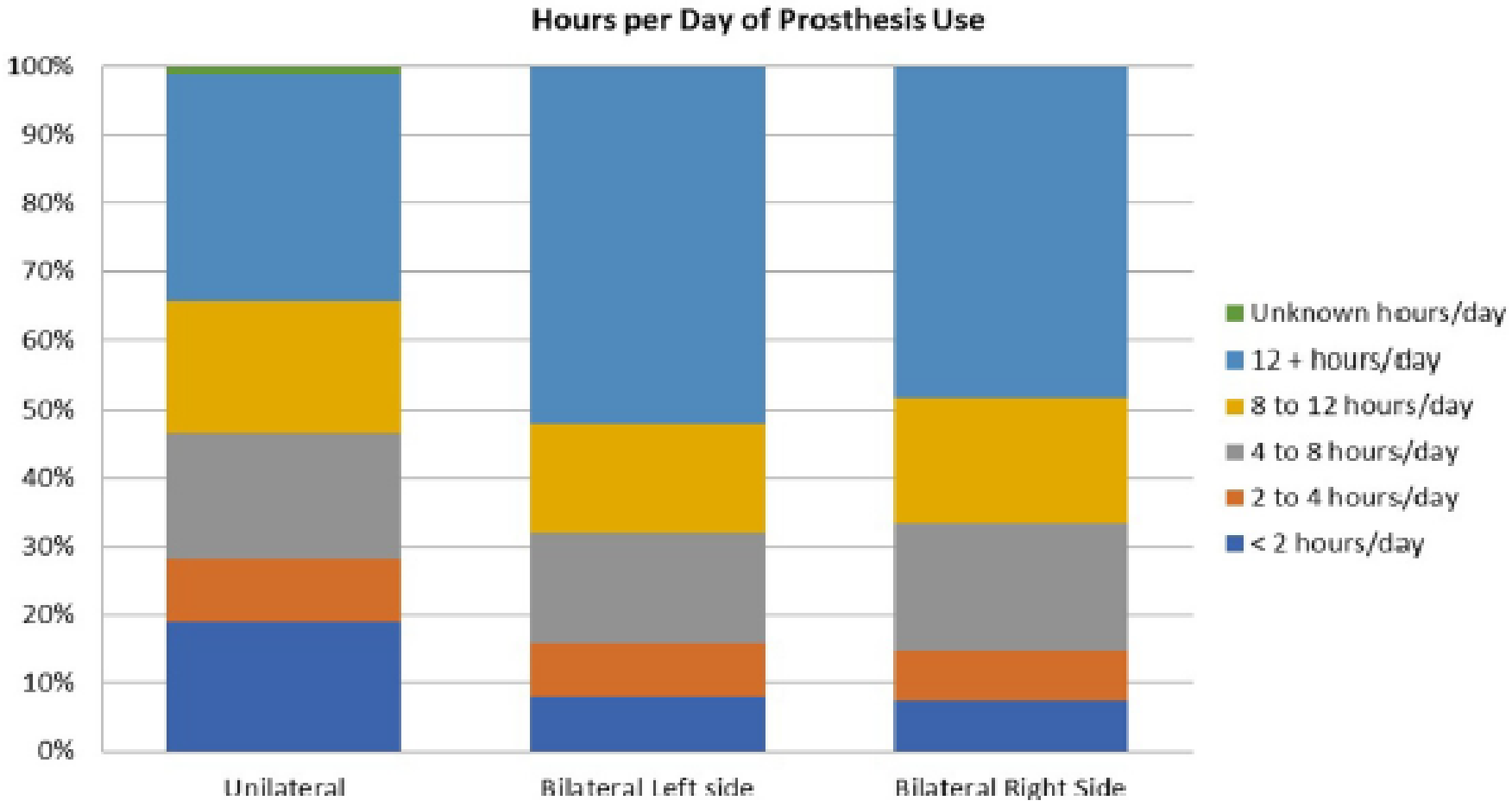



**Fig 5. Hours of prosthesis use per day.**

# Pain

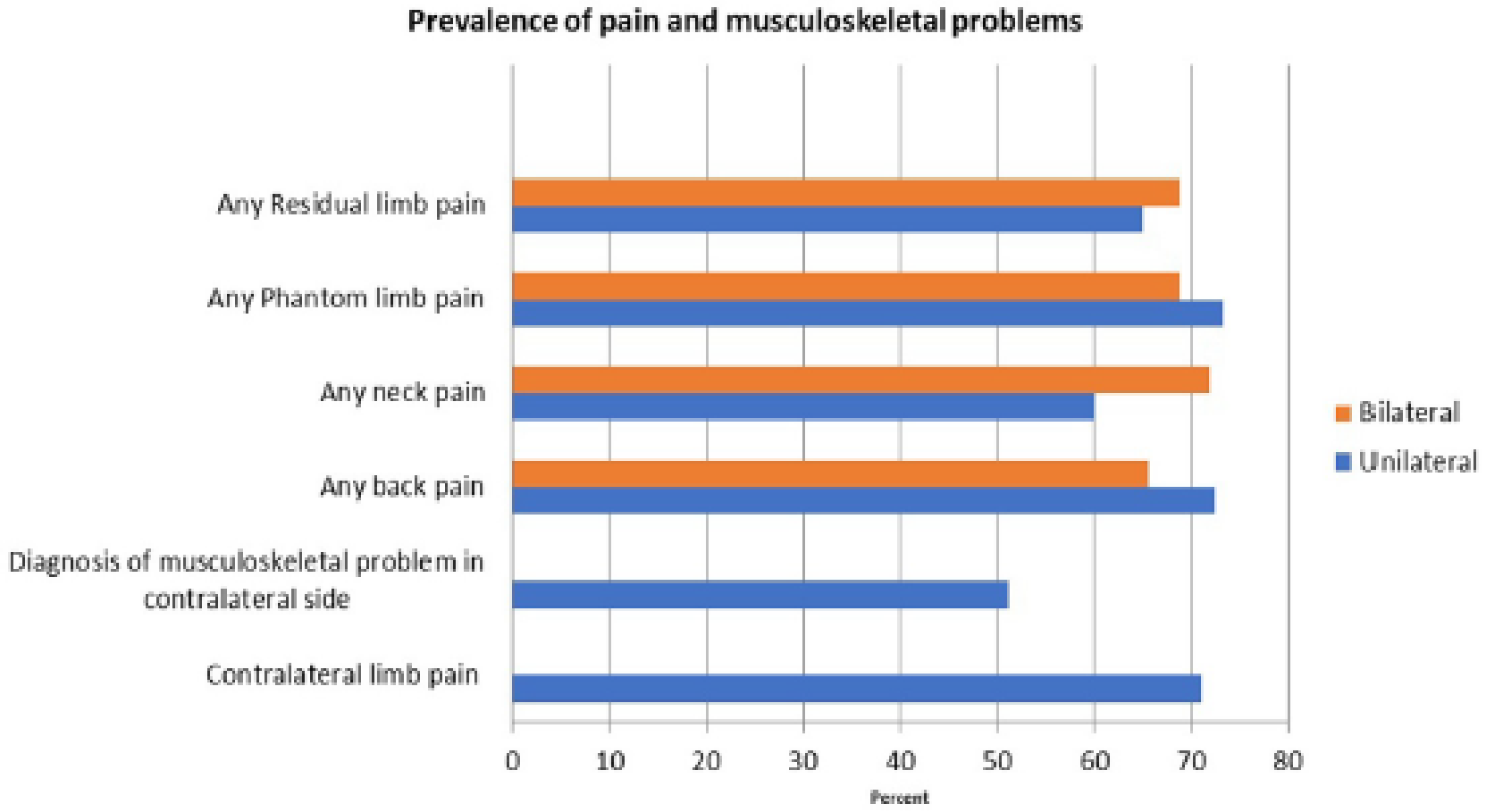



**Fig 6. Prevalence of pain and musculoskeletal problems.**

# In-person study: outcome data

- **127 participants**
  - Mean age 57 years
  - 59% percent body-powered protheses users
- **Dexterity**
  - Differed by amputation level; better for TR vs. TH and SH amputation levels
  - Comparisons of body-powered users with TR amputation found that dexterity was better for those with bilateral compared vs unilateral amputation
    - Suggests that increased prosthesis engagement results in better prosthetic function
- **Activity performance and self-reported disability**
  - Differed by amputation level; best for TR

# In-person Study: Outcome Data

- Evaluation of outcomes based on prosthesis type

  – Subgroup Analysis: 75 persons with unilateral TR Amputation

  – Three subtypes of prostheses
    - body-powered
    - myoelectric single DOF terminal device
    - myoelectric multi-DOF terminal device

Smither, FC, Webster, J, Borgia, M, Phillips, S, Resnik, L Comparative Effectiveness and Functional Performance of Multiple Degree of Freedom Prosthetic Hands in Individuals with Unilateral Transradial Amputation, Proceedings of MEC, 2020

# Preliminary Results

| | Body powered vs. Myo single DOF | Body powered vs. Myo multi DOF | Myo single DOF vs Myo multi-DOF |
|---|---|---|---|
| JTHF Small objects (dexterity) | No difference | **Body powered is better** | No difference |
| Nine hole peg (dexterity) | No difference | **Body powered is better** | No difference |
| BAM-ULA (Activity performance) | **Myo single DOF is better** | No difference | No difference |

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# Take Home Points:

*Recent research provides new information on the extent of limitations that result from loss of the upper limb*

*Research provides new, preliminary information on the comparative performance of different types of prostheses*

# Future Research

**Comparative Effectiveness of Upper Limb Prostheses and Component Effects**

USAMRMC, W81XWH1910800

- Performance measures of function during one study visit
- Provide data to guide prosthesis prescription by:

  Comparing effectiveness of currently available upper limb prostheses and components

  Evaluating heterogeneity of treatment effects for key subgroups

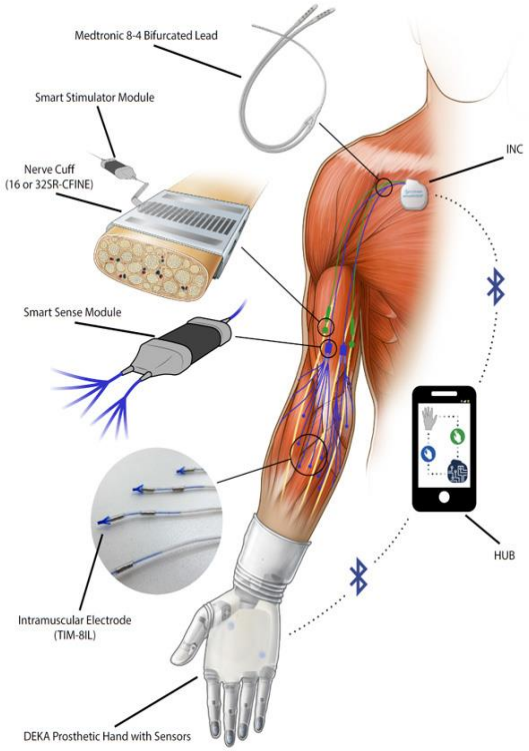
# Research Participation

- **How to participate**
  - Recruitment on pause due to Covid-19
  - Resuming next year, subjects are needed!
  - Look for eblast announcement from Amputee Coalition

- **Four study sites**
  - Richmond, VA
  - Tampa, FL
  - Seattle, WA
  - San Antonio, Tx

# Other Research

- Osseointegration
- Risk-benefit and patient perspectives
- Neural implants to improve motor control
- Sensory restoration



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# Discussion and Questions