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# Video Games in Prosthetic Rehabilitation

## THE KEY TO OPTIMIZING UPPER-LIMB PROSTHETIC REHABILITATION

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# OUTCOME MEASURES:
## THE KEY TO OPTIMIZING UPPER-LIMB PROSTHETIC REHABILITATION

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Case studies: Jennifer Peterson, MA, PT; and Lauren Trent, MOT, OTR/L

Joe Yeakley uses his preparatory prosthesis to complete a performance-based assessment with Lisa Smurr Walters, OTR/L, MS, CHT, clinical therapy specialist with AAD.

What do we mean when we suggest that outcome measures are the key to optimizing upper-limb prosthetic rehabilitation? The answers to this question are important to a wide range of stakeholders, including current and future patients, clinicians and researchers, prosthetic manufacturers, private insurers, workers' compensation providers, the U. S. Department of Defense, and government-funded insurance programs.

In Advanced Arm Dynamics' (AAD's) practice of specialized upper-limb prosthetic rehabilitation, initial outcome measures assess a presenting individual's physical, psychological, and functional state. This data enables us to create or modify a rehabilitation plan to addresses his or her specific needs. As the process unfolds, additional outcome measures quantify the impact of the intervention used and, ultimately, the outcome of the individual' s prosthesis use.

For more than ten years, AAD has been collecting evidence-based data as a standard of care through a combination of performance-based and patient-perspective assessments. While the upper-limb prosthetic rehabilitation outcome measures commonly used in the profession are helpful, each measure focuses on a specific area of the rehabilitation process. Obtaining a more complete view requires using multiple unique measures. In the aggregate, this process is time-consuming, may be cognitively demanding for the patient and clinical team, and does not provide a holistic measure of a patient's progress. Additionally, many measures overlook the impact of new and emerging upper-limb component solutions, techniques, and technologies. To improve the relevance and usefulness of the data we collect, AAD has invested in developing, administering, and refining novel outcome measure assessments that are specific to our patient population. Internal use of these tools at seven regional AAD Centers of Excellence has had a positive influence on our patient outcomes by providing more objective measures of patient progress, beneficial information for modifying treatment plans, and continuous improvement of the prescriptive recommendation process. With analysis of thousands of upper-limb prosthesis users' data, we can provide objective information to payers during the justifications process, and contribute to a larger body of scientific evidence that informs regulation and review of prosthetic devices. Concurrently, the Defense Advanced Research Projects Agency (DARPA) is funding a collaboration between AAD and the U.S. Food and Drug Administration to analyze our multiyear outcome measure database leading to validation of our novel measures.

Because our care model includes prosthetic, therapeutic, and psychological professionals working collaboratively throughout the patient's rehabilitation, we're able to objectively assess patient progress, and identify and address potential obstacles that could negatively affect the patient's ability to maximize his or her rehabilitation. The on-site therapy team administers, scores, and interprets outcome measures throughout the continuum of fitting, training, and long-term use.

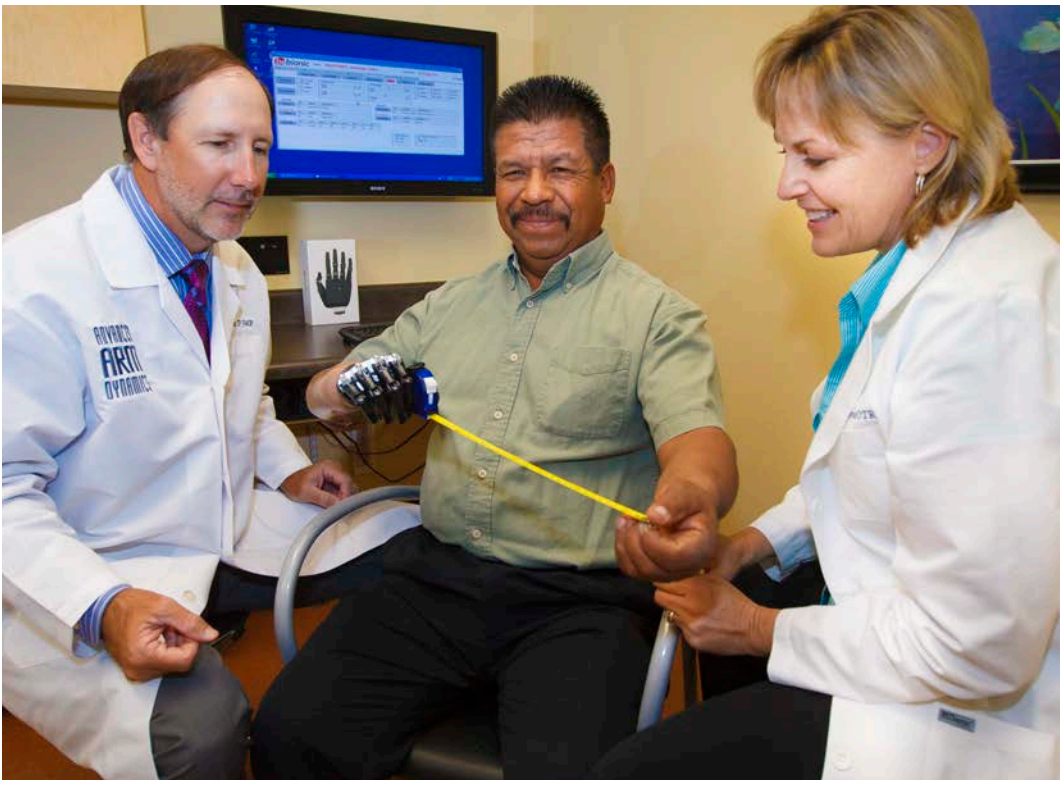
## Outcome Measures and Integrated Occupational Therapy

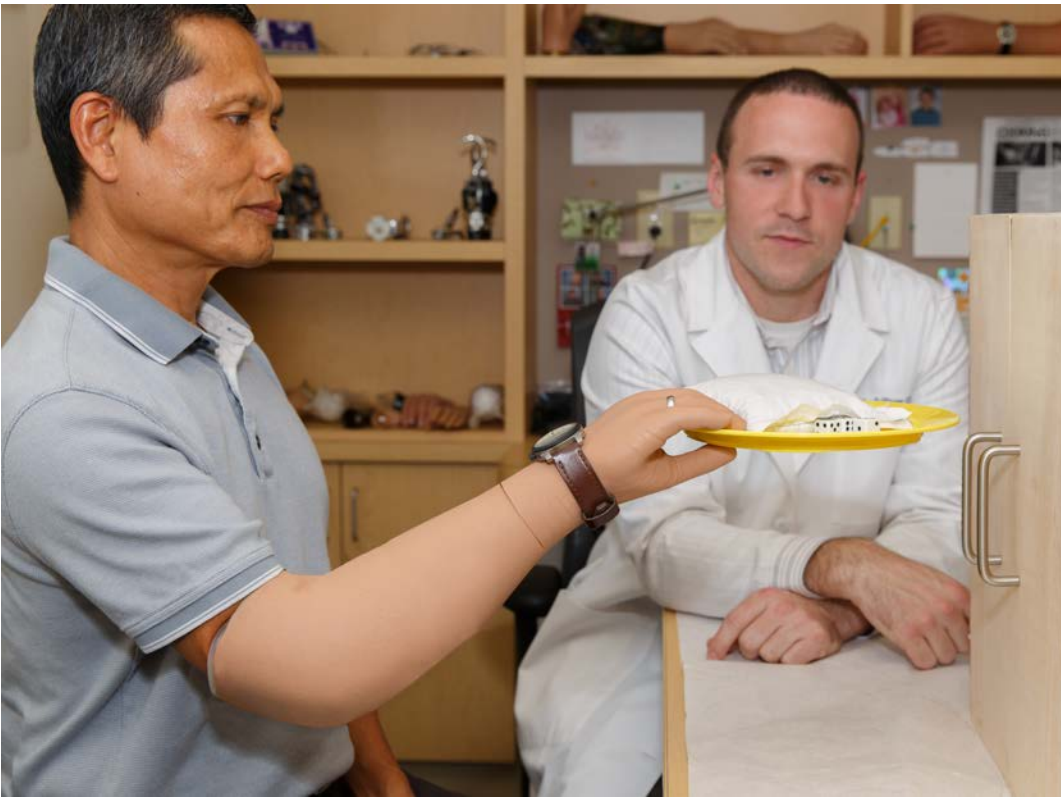
Rehabilitation requirements for people with upper-limb amputations are complex, and the support of a specialized team is necessary to maximize their prosthetic outcomes. Ideally, this team will at least include the patient, his or her physician, a prosthetist, an upper-limb clinical therapy specialist, a mental health professional, and a nurse case manager or social work professional. Our experience interacting with thousands of upper-limb patients makes us keenly aware of the positive impact that integrated occupational therapy has on prosthetic outcomes. Beginning with the first clinical appointment, the therapist and prosthetist work side by side with the patient. Together, they identify specific factors that influence component and design recommendations. This collaborative assessment enables the team to ensure the prosthesis is optimally designed and fitted for each patient's comfort and functional use.

Early therapeutic intervention may include wound care, edema control, and pain management. Therapists also assist with range of motion and desensitization, and develop intervention protocols to prepare and strengthen the residual limb for prosthesis wear and use. The clinical partnership continues throughout each stage of prosthetic care as the therapist trains the patient to use the prosthesis to its highest capacity with correct posture and proper body mechanics. This care model enables patients to become confident, lifelong upper-limb prosthesis users.

The short-term purpose of any outcome measure is to evaluate each patient's progress and effectively adapt the treatment approach to meet his or her needs. This ongoing experience and analysis of aggregate results allows for continuous assessment and evolution of the care model.

Santiago Martinez receives integrated multidisciplinary care from upper-limb specialists John Miguelez and Tiffany Ryan.





Than Lam completes one of the functional tasks included in AAD's novel outcome measures assessment, CAPPFUL. administered by clinical therapy specialist Chris Bollinger, MOT, OTR.

Notably, many measures commonly used in the field of upper-limb prosthetics were not designed specifically for people with upper-limb amputations, and instead have been adopted from other medical specialties. For example, the Disabilities of the Arm, Shoulder and Hand (DASH) is a patient reported measure originally developed and validated for people with musculoskeletal disorders of the upper limb, and not specifically for those with amputation, yet it is regularly administered to users of upper-limb prostheses.

The limited availability of scientifically sound, objective data to establish outcome norms for people with acquired and congenital upper-limb loss led the AAD clinical team to develop and administer three proprietary measures. The Wellness Inventory is a screening tool that addresses issues in psychological domains known to negatively affect people who have experienced trauma. The Capacity Assessment of Prosthetic Performance for Upper Limb (CAPPFUL) is a performance based measure of the factors impacting functional use of a prosthesis in all grip patterns and planes of movement, while performing representative and relevant tasks. The Comprehensive Arm Prosthesis and Rehabilitation Outcome Questionnaire (CAPROQ) is an interview-driven outcome instrument designed to gauge the patient's overall satisfaction with his or her prosthetic rehabilitation experience. It includes tracking data related to wear time, functional activities, and comfort level. This information guides the clinical team regarding patient-specific interventions to integrate the prosthesis into relevant tasks of daily living throughout the fitting process, and provides follow-up information at least every six to 12 months post-fitting. These assessments of upper-limb prosthetic function can also provide objective information for new and emerging technologies and their influence on recovery. AAD's novel outcome measure tools are in the final stages of validation.

Integrating occupational therapy throughout the process of upper-limb prosthetic rehabilitation is not well understood by most payer sources. Providing evidence-based data to validate prescriptive recommendations is another important use of outcome measures that is becoming increasingly relevant in the ever-changing health insurance landscape.

One way AAD validates the specialized multidisciplinary approach versus a less specialized model that does not include integrated occupational therapy is by applying the DASH to upper-limb prosthesis users. The aggregate of AAD DASH scores was compared with the DASH scores from a study by Judith Davidson, BAppSc (OT), MAppSc, with DASH scores from people with upper-limb amputations in comparison to patients with other upper-limb injuries. AAD DASH scores showed a 21.3 percent increase in perceived functional ability for major upper-limb amputations compared to a similar patient group in the Davidson study, who received generalized prosthetic care. For partial-hand amputations, the AAD DASH scores showed a 43.1 percent increase in perceived functional ability compared to people with partial-hand amputations in the Davidson study.(See Figure 1 on following page)

## Outcome Measures and Long-term Patient Success

To achieve superior long-term results, our baseline requirements at AAD are a well fitting and comfortable prosthesis with appropriate components selected for the patient's lifestyle and personalized goals, and integrated therapeutic training to ensure correct use of the prosthesis with proper body mechanics.

## ILLUMINATING PATIENT CHALLENGES, OPTIMIZING FUNCTION

CASE STUDIES

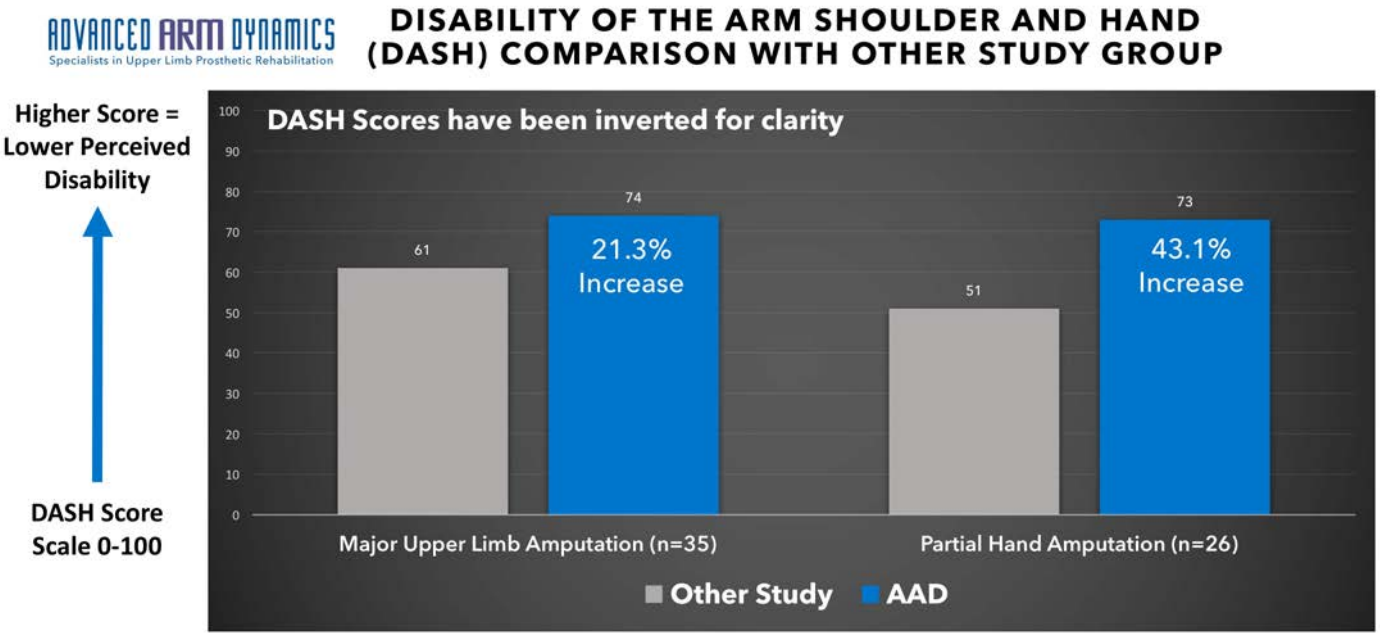
**The most compelling information we can provide regarding the impact of outcome measure results on patient care is to share case studies where outcome assessments led to modifications in the care plan, definitively increasing patient function and satisfaction.**

**Patient 1** is a woman with a transradial amputation who has been wearing a myoelectric prosthesis with a multiarticulating hand and an electric terminal device (ETD). She had therapeutic training during and immediately after her prosthetic fitting. When the patient was unable to visit the AAD office, the clinical therapy specialist made follow-up phone calls to her at standardized intervals. During those calls, the patient indicated satisfaction with her prosthesis, saying, "Everything is going great." However, during a subsequent clinical appointment, the patient completed the CAPPFUL, which illuminated issues she was having with prosthesis control, component positioning, and posture and body mechanics. This information led to modifications to the prosthesis and further therapeutic training. Software adjustments were made to optimize her control of the device, increase her grip speed, and improve her functional performance. Her pinch grip accuracy was improved by selecting an alternate grip mode. Additional therapeutic guidance increased her awareness of positioning the prosthesis to minimize compensatory movements.

**Patient 2** is a woman with quadrilateral amputations, including transradial amputations. She alternates between multiarticulating hands and an ETD. After the patient underwent initial controls training with her prostheses, the clinical therapy specialist administered the CAPPFUL. Concerns about limited elbow and wrist flexion on the right side were noted. A socket adjustment was recommended to increase elbow flexion, and it was determined the patient would benefit from the addition of a wrist flexion unit to improve her functional ability and body mechanics.

**Patient 3** is a man with a congenital transradial limb difference whose arm ends immediately below the elbow, resulting in a non-functional elbow joint. After years of choosing not to wear a prosthesis, he was fitted with a myoelectric system that includes an Ottobock DynamicArm to provide a functional elbow, a wrist rotator, a VariPlus Speed hand and an ETD. In the early stages of prosthetic training, the clinical therapy specialist noted some compensatory shoulder movement during elbow activation and addressed it with the patient. Following the definitive prosthetic fitting, while the patient was completing the CAPPFUL, the therapist observed compensatory shoulder elevation and abduction during tasks that involved moving the prosthesis from waist height to shoulder height. The patient was not utilizing the elbow mechanism to properly position the terminal device, which resulted in poor body mechanics and could lead to chronic shoulder and spinal disorders secondary to repetitive joint impingement or misalignment. Additional therapeutic guidance increased the patient's awareness of his shoulder position, as well as properly activating the elbow mechanism to help complete tasks where multiple levels of movement are required.

Figure 1




**Summary: In comparison to patients in the other study, AAD patients reported lower perceived disability.**
In AAD sample, transradial (n = 13), elbow disarticulation (n = 3), transhumeral (n = 12), shoulder disarticulation (n = 6), interscapular thoracic (n = 1). Both effects sizes (magnitude of difference between other patients and AAD patients) were medium to large. Statistical significance: Major upper limb amputation: p = .019; Partial Hand amputation p > .001.

Davidson, J. (2004). A comparison of upper limb amputees and patients with upper limb injuries using the Disability of the Arm, Shoulder and Hand (DASH). Disability and rehabilitation, 26(14-15), 917-923.

In a summary comparison of prosthesis use for bimanual independent living tasks, patients who experienced the AAD care model showed a significant increase in their ability to perform functional tasks, compared to similar patients who were not treated by a specialized inter-disciplinary care team. The assessments used to acquire this data include the Orthotics Prosthetics Users Survey-Upper Extremity Functional Scale (OPUS-UEFS) patient report survey to rate the level of difficulty associated with specific tasks. The tasks include: putting on socks; putting on and removing a t-shirt; buttoning a shirt with front buttons; folding a bath towel; stirring in a bowl; and carrying a laundry basket.

Additionally, it is imperative to maintain an ongoing assessment of patient progress well beyond the initial prosthesis fitting to provide consistent support to maintain each patient's physical, psychological, and functional success. An important aspect to measure is that of prosthesis wear time. A recent sample of 202 patients' internal CAPROQ outcome measures reported the number of hours per day the prosthesis was worn, beginning with initial fitting and ending 12-15 months after final fitting. Hours of wear per day steadily increased, culminating at 9.2 hours 12-15 months after final fitting.

## Conclusion

Collecting data through the consistent application of patient outcome measures at predetermined milestones throughout the prosthetic rehabilitation process is critical to gaining an objective view of the impact comprehensive upper-limb prosthetic rehabilitation has on people with acquired and congenital limb loss.

The data obtained through outcome measures enables us to accomplish three key goals in our specialized practice:

- Evaluate each patient's progress and adapt our approach to optimize his or her specific needs and goals
- Continually assess and evolve our care model and prescriptive recommendations based on trend analysis
- Provide evidence-based outcome data to validate prescriptive recommendations to reimbursement agencies.

Gathering and validating outcome measures that are specific to the patient population is a key strategy for optimizing upper-limb prosthetic rehabilitation. O&P EDGE

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ADVANCED ARM DYNAMICS
Specialists in Upper Limb Prosthetic Rehabilitation