Upper-Limb Prosthetics: Using Evidence-Based Practice to Enhance Patient Care Experiences

■ Chris Lake, BS, CPO, FAAOP

Introduction

Evidence-based practice strikes at the core of ethical, conscientious, and proficient prosthetic care. From Sackett et al.'s original definition comes the analogy of evidence-based practice as a three-legged stool on which our patient sits. These legs draw their stability from searching for and integrating the current best research evidence, respecting and integrating the patient's values, and building the clinical expertise to address the patient's needs.[1] The strength of these factors provides a stable platform for improved patient outcomes. Conversely, a weakened or missing leg compromises the prosthetic outcome (Figure 1). As we strive to improve our patients' prosthetic outcomes, the evidence-based practice model provides an approach to increase the likelihood of patient success.

Figure 1: The three core factors of evidence-based practice help improve patient outcomes.

When it comes to the strength of our clinical foundation, a review of the evidence tells us the following:

- Subscribing to and using the best evidence allows the prosthetist to incorporate sound clinical and technical proficiency in everyday practice.
- Patient-oriented care provides a platform for favorable outcomes by making the patient the center of the prosthetic rehabilitation team.
- The prosthetist needs enough experience with clinical cases to evaluate, compare, and analyze the literature.

The purpose of this article is to discuss some of the recent literature and trends that highlight the importance of integrating evidence-based practice concepts into upper-limb prosthetic care.

Background

We use our hands in almost every activity of daily living (ADL). Our hands help us communicate, learn, show emotion, and support our families. Upper-limb injury is consistently one of the most common injuries requiring medical care.[2–3] A loss of even a part of the upper limb results in significant challenges to the patient. When a person loses his or her fingers and thumb, an overall 90 percent upper-limb impairment and 54 percent whole person impairment exists[4] (Table 1).

Furthermore, the prosthetic replacement of upper-limb function can be a daunting task for the rehabilitation team. A substantially larger amount of neurological area within the human brain is dedicated to the motor and sensory functions of the upper limb than the lower limb.[5,6] This creates an engineering hurdle for manufacturers and a noticeable gap in our technical ability to replace the functions of the human hand.

Individuals with upper-limb loss present very differently than those with lower-limb loss, and it is important to appreciate those differences. The prevailing cause of upper-limb loss is trauma (92 percent) in contrast to the vascular complications (78 percent) found in the lower-limb-loss population.[7] Individuals with upper-limb loss are generally between the ages of 16 and 44 at the time of amputation, whereas lower-limb loss is associated with individuals who are in their 60s or older.[8–10] Upper-limb amputees are usually healthier individuals at the time of amputation and can generally expect to live full lives.[10,11] In contrast, many lower-limb amputees may experience other complications that lead to poor survival rates at five- and ten-year post-amputation intervals.[8,12] Many times,

Table 1: Significant upper-limb impairment exists with loss of just the hand and increases as amputation levels move more proximal.

Level of Amputation	Whole Person Impairment	Upper-Limb Impairment
Transhumeral—Proximal Third	60%	100%
Transradial—Proximal Third	57%	95%
Partial Hand—Metacarpal Phalangeal Level	54%	90%

Adapted from Guides to the Evaluation of Permanent Impairment, *6th ed. American Medical Association: 2008.*[4]

lower-limb amputees are aware of an impending amputation secondary to the gradual disease process. Upper-limb patients have little or no warning of impending loss. As a result, upper-limb patients must immediately cope with the pain of the traumatic injury and amputation while at the same time facing the psychological blow of feeling less capable and independent in a world that often measures self-worth by what individuals can do.[13] Unlike individuals with lower-limb amputation, who may choose to cover their affected leg under long pants and shoes until they feel more comfortable discussing their loss, upper-limb patients find themselves more exposed from the very beginning.[14] Failing to recognize the psychological impact and post-traumatic stress associated with upper-limb amputation can negatively affect successful prosthetic use and coping.[14–16]

Review of Recent Literature

Integrating the Current Best Evidence

The turn of the century has brought a renewed investigation of what variables influence upper-limb prosthetic success.[17–21] Time to fit has always been a common variable associated with prosthetic acceptance. In the early 1980s, Malone et al., found that the greatest prosthetic success was achieved when an individual was fit within 30 days of amputation.[22] More recently, Biddiss and Chau found that this "time-to-fit" window might indeed be larger. Within their study population, "individuals fitted within two years of birth (congenital) or six months of amputation (acquired) were 16-times more likely to continue prosthesis use."[19] This new study provides current numbers and methods to expand on the highly quoted Malone et al., study. When examining consumer priorities for upper-limb prosthetics, comfort-related design issues were the primary concern of prosthesis users across all genres. These issues include the need for increased heat dissipation, improved socket-interface fitting, and reduction of prosthesis weight.[18]

The patient's perception of his or her prosthetist's skills can influence acceptance as well. Pezzin et al. found that patients with transradial- and humeral-level amputations tend to be less satisfied than transtibial-level individuals with the information their prosthetist provides. Contributing variables of this finding were the usefulness of the information offered, the prosthetist's ability to answer questions effectively, and the degree of confidence the patient had in the prosthetist's expertise and dependability.[23] A possible explanation for this finding surfaces when one considers the most common amputation levels seen today. There are approximately 65,000 new lower-limb amputations (Symes level and proximal), in contrast to approximately 2,000 new upper-limb amputations (wrist disarticulation and proximal).[24] This 30:1 ratio provides the prosthetist with many opportunities to sharpen his or her lower-limb skills and far fewer opportunities when it comes to upper-limb experiences. In 2007, Biddiss and Chau[19] found statistically significant results when comparing prosthesis rejecters to frequent users. Prosthetic rejecters reported less satisfaction with many aspects of their prosthetic care, as shown in Table 2. These various aspects, ranging from prosthesis fitting, follow-up, and repair to information provided with respect to prosthesis technology and use of multiple prostheses, speaks to the level of attention necessary to support the upper-limb patient.

Integrating the Patient's Values

When we integrate the patient's values, we make a conscious effort to put the patient at the center of the care model, from planning and implementation to service delivery and follow-up.[25] Patient-oriented care represents a fundamentally different medical philosophy from the traditional parental model. The prosthetics and orthotics field has not exclusively studied patient-oriented care, though the research discussed in the previous section highlights the poor results and experiences found when a patient feels less attended to and informed. The benefits of patient-oriented care are becoming more widely studied across the medical field. Two recent studies from the fields of pharmacology and hand surgery rehabilitation describe efficacy and cost savings when a patient-centered approach exists.

In the field of pharmacology, an investigation of medication decisions and management found fewer hospital admissions due to medicine mismanagement in the patient-centered model. One conclusion the authors made was, "No matter how sophisticated our medication technology becomes, ultimately, their success depends on the client's motivation and behavior."[26] A study from the University of Heidelberg, Germany, looked at the effectiveness of a patient-oriented hand rehabilitation program. The patient-oriented approach led to reports of reduced pain and greater patient satisfaction as well as an increased likelihood of returning to former occupations and less sick time taken from work.[27]

Table 2: Prosthetic Rejection Rates

Prosthetic rejecters reported less satisfaction with:

- Fitting of the prosthesis ($p<0.001$)
- Follow-up ($p<0.001$)
- Repair ($p<0.001$)
- Training ($p<0.007$)
- Information provision ($p<0.009$)
- Information provided with respect to prosthesis technology ($p<0.001$)
- Sources of funding ($p=0.01$)
- Use of multiple prostheses ($p=0.001$)
- Level of expectations set ($p<0.001$)
- Overall knowledge and experience of healthcare providers ($p<0.001$)

Source: Biddiss E, Chau T. Upper-limb prosthetics: critical factors in device abandonment: Am J Phys Med Rehabil. 2007;997–987.19

Using Evidence-Based Practice to Enhance Patient Care Experiences

Clinically, there is greater likelihood of patient success when patients take an active role in the decision process. Meier and Esquenazi recommend a standard education program as "a means of empowerment so that the amputee can make the best possible decisions for his life and future needs."[28] Van Dorsten states, "In every situation, healthcare providers have a responsibility to be knowledgeable about the forces affecting an individual at any given time and to proactively cooperate in facilitating the amputee's involvement in development and achieving goals that have meaning. Self-determination is fueled by challenge, fostered by supportive significant others, or extinguished by provincial paradigms of professional control. Successful outcomes are truly a team endeavor."[29]

Clinically, the upper-limb preparatory fitting protocol embodies a patient-oriented care approach by allowing for the verification of appropriate components based on patient feedback. The preparatory fitting became critical in the evaluation of a patient's candidacy for the externally powered prosthetic technology emerging in the early 1980s.[30] This type of fitting provides the foundation for expeditious changes to any prosthetic element, such as accommodation of residual-limb volume fluctuation. In its purest form, a preparatory fitting empowers the patient to make an informed decision regarding the direction of the prosthetic course (Figure 2). This mutual discovery process between the patient and the clinical team further allows the patient to influence the decision-making process and to help develop a prosthetic care plan and device that better meets the patient's expectations. Considerations for the length and level of amputation, as well as exploration of prosthetic options, have a real impact on patient outcome. Brenner and Brenner highlight the use of trial fittings that plot and change course based on patient feedback and technical assessment. The dynamic nature of the preparatory fitting helps the prosthetist develop case-specific evidence for definitive prosthetic management.[31]

Figure 2: The use of disconnect wrist and myo/body-powered wrist adaptors allow for the evaluation of myoelectric, body-powered, and activity-specific options in one preparatory fitting.

Building Clinical Expertise

Building expertise in upper-limb prosthetics requires the prosthetist to make a direct decision to specialize. Even with a significant level of commitment, it is difficult to gain the necessary experience. The increasing prevalence of vascular-related lower-limb amputations[7] will lead most prosthetists to find themselves in high-volume lower-limb practices. This increasing lower-limb population sets the stage to challenge access to specialized upper-limb care.[32] Furthermore, past trends have shown that traumatic amputation is decreasing,[11] which will further limit upper-limb patient exposure for the treating prosthetist. This is due to improvements in both occupational safety and surgical techniques. The aforementioned challenges are then complicated by the number of new patients versus prosthetists. The annual rate of 2,000 new upper-limb amputees (with limb loss between the wrist and shoulder region) per year potentially treated by one of the 3,300 prosthetists or prosthetist/orthotists certified by the American Board for Certification in Orthotics, Prosthetics, and Pedorthics (ABC) substantiates what is known as the "upper-limb dilemma."[13,33]

Medicine generally accepts the role of specialized care in treating rare and complex conditions, with specialty care dating back into the early 20th century.[34] The emergence of upper-limb specialty care is much more recent and fosters a partnership with occupational therapy to attain optimal patient outcomes.[35] In the O&P profession, specialization is also noted in the areas of pediatric prosthetics and orthotics, as well as in the management of spinal deformities, fractures, and cranial-facial deformities.[36]

In medicine, those who focus on specific patient populations exhibited greater command of the medical knowledge and were more up-to-date in the use of progressive diagnostic and treatment modalities. These observations led to the assumption that the practice pattern of the specialist can produce better outcomes. In general, the treatment of common conditions had similar outcomes regardless of the specialty of the provider. The true differences come when looking at conditions that are more complex and/or rare. In these situations, specialists tended to have shorter hospital stays, lower readmission rates, and lower mortality rates for their patients.[37]

Discussion

Appreciating the elements of evidence-based practice helps the prosthetist to incorporate sound clinical and technical proficiency in everyday practice. This proficiency, as observed by the patient, can encompass the patient's perception of the prosthetist's expertise and quality of fitting, follow-up, repair, training, provision of information, discussion of prosthetic options, and recognition of the need for peer support. Proficiency in these areas echoes that of a practitioner who specializes—having a command of the latest diagnostic and therapeutic modalities and the experience to execute a progressive care plan.

Various authors suspect the rate of upper-limb amputations is decreasing secondary to improvements in limb salvage and reconstruction as well as occupational safety. What is striking is the effect that emerging technology may have on the available population that could benefit from upper-limb treatment. Five to ten years ago, the levels most commonly fit with a functional prosthesis were proximal to the wrist. As both

electric and body-powered digital technology advances, a previously underserved population will have a functional prosthetic option to consider. This influx of upper-limb patients will bring the need for enhanced educational, technical, and clinical expertise.

Recent research suggests that greater prosthetist expertise and awareness of patient values can reduce rejection rates. Research further validates the clinical reality that the patient will often abandon the prosthesis when a fitting does not meet the patient's needs, whether in the areas of function, comfort, or aesthetics. It is imperative that we do everything in our power to continually raise the standard of upper-limb patient care.

Recommended Reading

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Chris Lake, CPO, FAAOP, is the president and chief clinical director of Lake Prosthetics and Research, Euless, Texas.