Guest Editorial

A report on the amputee healthcare and prosthetics workshop sponsored by Walter Reed Army Medical Center and the Department of Veterans Affairs (VA)

In the past four years, more than 1,870 active duty and inactive military amputees have utilized non-VA U.S. Army medical facilities. In fiscal year 2003 alone, the VA received more than 10,000 visits related to lower-limb amputation, and more than 700 related to upper-limb amputation. During Operations Iraqi Freedom and Enduring Freedom, more than 120 service personnel have experienced major or multiple limb loss. One can imagine limb loss as a consequence of war, and therefore, amputee healthcare is the responsibility of the Department of Defense (DoD) and the VA.

But did you know that during their lifetimes, 15 percent of people with diabetes will experience a foot ulcer, and between 14 and 24 percent of those with a foot ulcer will require amputation and that diabetes is the leading cause of lower-limb amputation in the United States, veterans included? With continued military efforts abroad and expected increases in amputation due to diabetes here at home, amputation is quickly becoming one of the more prevalent disabilities among the veteran population.

With this information in mind, clinician scientists from the VA, Walter Reed Army Medical Center (WRAMC), academia, and the nonprofit sector met on November 17 and 18, 2003, in Arlington, VA. The purpose was to brainstorm possible ideas, collaborations, and initiatives aimed at addressing the nation's growing need for innovative and functional prostheses, as well as advances in medical management and postprosthetic rehabilitation. Today's amputee healthcare practitioners at the VA, WRAMC, and the private sector are at a distinct disadvantage. Current technological advances are underutilized. While technological breakthroughs, such as electronic knees and computer imaging, are changing the face of prosthetic design and manufacture, enabling some users to return to preinjury status, advancements in prosthetic design and manufacture are notoriously slow. Clearly, a disconnection exists between advances in platform technology and what is available to the amputee consumer. Methods developed in Europe have not been thoroughly tested here in the United States. Even when we look at what is commercially available, there is very little in the way of "this device works better than that device" numbers to justify where we are and where we want to go. The prosthetics industry is commercially driven, with little to no head-to-head design trials and evidence-based studies. Expensive may not always be the best. At this point, we do not know what the best is. The November conference on prosthetics and amputee healthcare in Arlington represents the first step in a series of increased efforts by the VA Rehabilitation Research and Development (RR&D) Service to advance the care of people who suffer an amputation.

Members of the WRAMC/VA State of the Art (SOTA) Conference identified and discussed several issues of critical importance, including upper-limb prostheses, platform technology, osseointegration, computer-aided design/computer-aided manufacturing (CAD/CAM), continuing education in amputee healthcare and prosthetic design, and postprosthetic amputee rehabilitation.

Many of the service members returning from Iraq are faced with the loss of one or both arms. This presents VA amputee healthcare and prosthetics professionals with the challenge of caring for a previously unique population. At this meeting, a group of leading upper-limb prosthetics research and design experts identified questions in upper-limb prosthetic development that beg investigation, and proposed a series of unique solutions incorporating several scientific disciplines. It is exciting to think that complex finger motions required for tying one's shoes may someday be done through the incorporation of tissue engineering, osseointegration, microstimulation, muscle actuation, and robotics, with little to no extra thought than when using one's natural limb.

Before this meeting, the VA's Office of Research and Development (ORD) decided to install an RR&D Platform Technology Center focused on amputee healthcare. The exciting challenge would

be to fund the development of technology that challenges our current thinking and provides unique solutions to old questions. Much like the discussions in the upper-limb prosthetic group, participants in the platform technology group focused on incorporation of several disciplines. Of special interest were discussions on the use of orthopedic bone-lengthening techniques and endoprostheses to help patients with less-than-optimal short residual limbs increase function through more manageable prosthetic interfaces.

Osseointegration is a novel technique for anchoring prosthesis directly to bone, eliminating many of the problems associated with traditional cuff-like prostheses. In addition, European osseointegration patients report improved perception of the environment and psychological acceptance of the prosthesis. However, transcutaneous implants such as these are prone to inflammation and infection, leading to bone loss and loosening of the implant. A working group composed of VA clinician scientists, orthopedic surgeons, molecular biologists, and an osseointegration patient engaged in a focused discussion to develop a plan of action and timeline for careful investigation and possible implementation of pilot studies within the VA. VA investigators have witnessed osseointegration surgery in Europe. VA investigators on the West Coast are examining immune responses to titanium implants, whereas VA investigators in the eastern portion of the country propose to engineer infection-resistant cellular seals, eliminating direct contact between bone and the environment and reducing the chances of infection.

The CAD/CAM discussion group agreed that CAD/CAM is widely accepted as the quickest, most cost-effective means of producing the sockets into which prosthetic legs are fitted. In the mid-1990s, the VA decided to install CAD/CAM equipment at 36 sites. However, this technology use has not been maximized. Therefore, users from the VA, nonprofit sector, academia, and industry discussed the reasons for this, such as present-day technology incompatibilities, employee turnover, and the need for increased infrastructure within the VA to support upkeep, maintenance, and training on equipment used largely by contract employees for a dispersed patient population. Currently, the VA's ORD and patient care services are working together to develop systems analyses and training programs that will determine efficient means of providing the best care using these and other technologies. Pilot studies will likely involve active educational components to support sustained change.

Similar to post-WWII, when the VA and the DoD launched the artificial limb program, the VA and DoD are again taking the lead to increase the capacity in prosthetics through education. Individuals in academic faculty positions, recent students, for-profit development companies, and the VA Employee Education System put together a plan of action to foster the development of diverse and highly qualified VA amputee healthcare professionals who can assume leadership roles in limb-loss clinical research by incorporating areas such as materials science, robotics, myoelectrics, and tissue engineering.

In recent years, prostheses have become lighter, more durable, better fitting, and more functional. Technology is fruitless if amputees are not comfortable utilizing advanced design prostheses, or if use leads to additional complications, such as low back pain and arthritis. VA lower-limb prosthetic researchers, physical therapists from WRAMC and the VA, engineers, and the director of the Mayo Clinic for Motion Analysis met to discuss creative ways to study barriers to prosthetic use, and the ways in which physical therapists and others can promote amputee rehabilitation techniques that focus on healthy use of properly prescribed prostheses. They also discussed ongoing rehabilitation programs that focus on long-term use and roles fellow amputees can play in promoting proper use of prosthetics.

At the close of two very long and productive days, VA and DoD research administrators had clear directions as to what needs to be done in the field of amputee healthcare and prosthetics research and development. With this list in hand, the VA and DoD are now working to design research protocols that answer some of our most pressing questions and recognize that developing shared outcome measures and data collection systems, among other things, are powerful ways to provide a continuum of

best care between medical treatment facilities and the VA. Findings within these facilities will then be translated into the private sector, resulting in maximum comfort and function for the amputees, who might also gain a sense of being made whole.

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