Guest Editorial

Optimizing care for combat amputees: Experiences at Walter Reed Army Medical Center

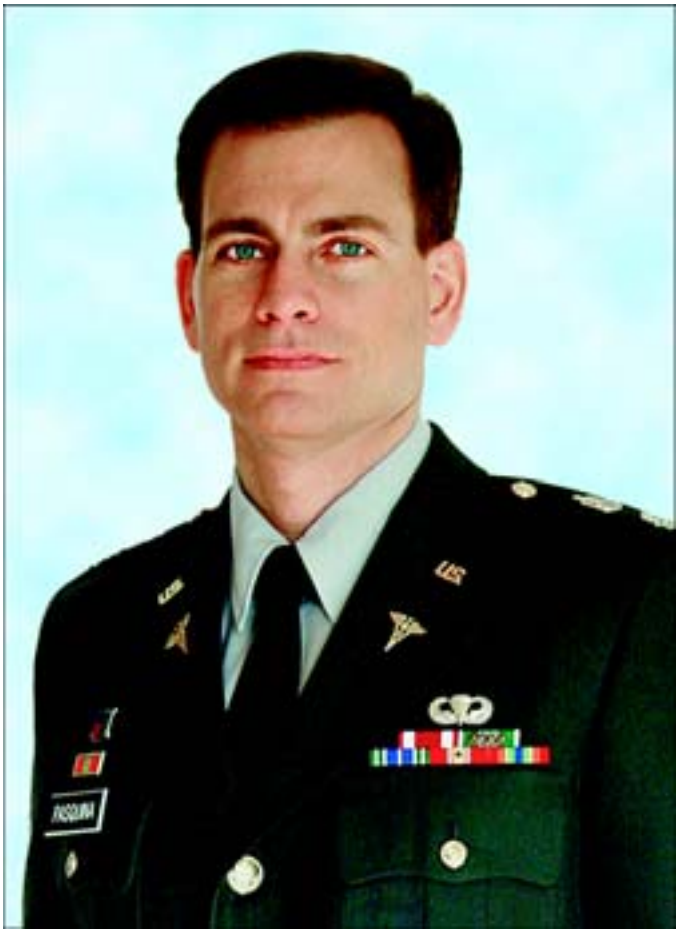
INTRODUCTION

Optimizing medical care for the combat amputee is a complex task. To date, Walter Reed Army Medical Center (WRAMC) has cared for more than 100 patients who have sustained a major limb amputation during Operation Enduring Freedom (OEF) and Operation Iraqi Freedom (OIF). Managing these individuals, along with the thousands of other patients, has been challenging for the medical and administrative staff at WRAMC, especially those within the Department of Orthopaedics and Rehabilitation.

Technological advances in body armor, along with rapid evacuation and early medical attention, have increased the survival rate of combat amputees. Despite these advances, many members of the armed services continue to return with severe limb wounds. While experienced military physicians and surgeons do everything possible to salvage viable limbs, frequently amputation is necessary.

Combat amputees represent a unique patient population, because of the complex nature of their wounds and the extent of their comorbidities. Comorbid conditions—loss of vision, spinal cord injury, traumatic brain injury, fractures, and severe nerve and vascular injures—present significant medical, surgical, and rehabilitative challenges. In addition, an increased risk exists for the development of secondary complications such as infection, heterotopic ossification, and venous thrombus, all of which require close monitoring and attention. Finally, each patient has distinctive psychosocial needs, greatly impacting on issues such as pain management, adjustment to disability, body image issues, movement through the military disability system, and reintegration into the community or back to active-duty service.

Providing optimal care requires the development of a well-functioning and coordinated multidisciplinary team, where each member is recognized as having equal importance. Our experience at WRAMC has supported the creation of a dedicated Amputee Inpatient Service as well as a separate Outpatient Amputee Clinic, both under the management of Physical Medicine and Rehabilitation (PM&R). Following a rehabilitation model, the physiatrist functions as the primary care provider for the amputee, coordinating the recommendations and interventions of multiple medical and surgical subspecialists, therapists, nurses,



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*The views expressed in this article are those of the author and do not reflect the official policy or position of the United States Army, the Department of Defense, or the United States Government.

prosthetists, psychologists, and social workers. This system assures that holistic care is provided and also helps to improve the quality and standardization of care across the healthcare network. Critical elements to the functioning of the team include strong leadership, clear designation of duties and responsibilities, an ongoing educational program and, most of all, communication.

The ongoing educational program must be comprehensive, while at the same time target individual disciplines. Key leaders need to be identified within each service (PM&R, nursing, orthopedics, prosthetics, occupational and physical therapy, and psychology). The leaders must first identify the educational needs of their services and then determine how these educational needs can be met. This may be facilitated in a cost-effective way by bringing in outside experts or partnering with existing national organizations, such as the Department of Veterans Affairs (VA), the Defense Advanced Research Projects Agency (DARPA), and universities, as well as private companies and foundations. Issues of a cross-disciplinary nature, including pain and wound management, psychological adjustment, etc., should be presented in a forum where all disciplines are present to promote interdisciplinary discussion.

Communication is enhanced by establishing regularly scheduled inpatient multidisciplinary team conferences, dedicated multidisciplinary outpatient amputee clinics, and monthly programmatic meetings where the directors from each service share ideas to maximize efficiency and quality of care greatly enhance communication. In order to facilitate communication and patient flow through the medical system at WRAMC, we established the following flowchart (**Figure**).

In addition to creating an amputee care program model to help streamline and standardize patient care, our experience over the past year managing young traumatic combat amputees has brought to light many critical elements and lessons learned. We continue to discover ways to integrate advances in technology and medicine to optimize care and, with hope, positively influence rapid recovery and long-term quality of life. Examples of these critical elements are discussed in the following sections.

PAIN MANAGEMENT

Over the past several years, new Joint Commission on Accreditation of Healthcare Organizations (JCAHO) standards, as well as recognition of pain medicine as a distinct medical subspeciality by the Accreditation Council for Graduate Medical Education (ACGME), has not only sensitized the entire nation on a patient's right to pain management but also has led to advances within the field. At WRAMC, we completed significant groundwork to assure that proper pain management systems were in place prior to OEF/OIF.

Nurses, physicians, and therapists all play critical roles in ensuring recognition of pain problems and optimizing care. Research supports the importance of effective pain control in allowing patient participation in therapy, as well as in reducing long-term pain complications, such as residual limb and phantom limb pain. Our experience has shown that adequate pain control in most combat amputees requires a multimodal medication approach. Nearly every patient is issued a patient-controlled anesthesia (PCA) pump during the perioperative period and then quickly converted to long-acting opioids after his or her definitive surgery is performed. Short-acting opioids are also used for breakthrough pain or premedication prior to therapy. Most patients are prescribed an anticonvulsant (gabapentin, oxcarbazepine, lamotrigine), a tricyclic antidepressant (nortriptyline, amitriptyline, desiprimine), and a nonsteroidal anti-inflammatory agent (NSAID), typically one that is cyclooxygenase-2 (COX-2) selective, given the number and nature of comorbidities as well as frequent concurrent use of anticoagulation medication. We have found quetiapine fumarate to be a very effective sleep aid, especially in cases when the soldier reports trouble with nightmares. In addition to pharmacological management, we have found physical agent modalities (ice, heat), desensitization, and transcutaneous electrical nerve stimulation (TENS) units helpful. Perhaps most effective, however, has been the support of the regional anesthesia team. The placement of peripheral infusion catheters to the brachial, lumbosacral plexus, or sciatic nerves has had a

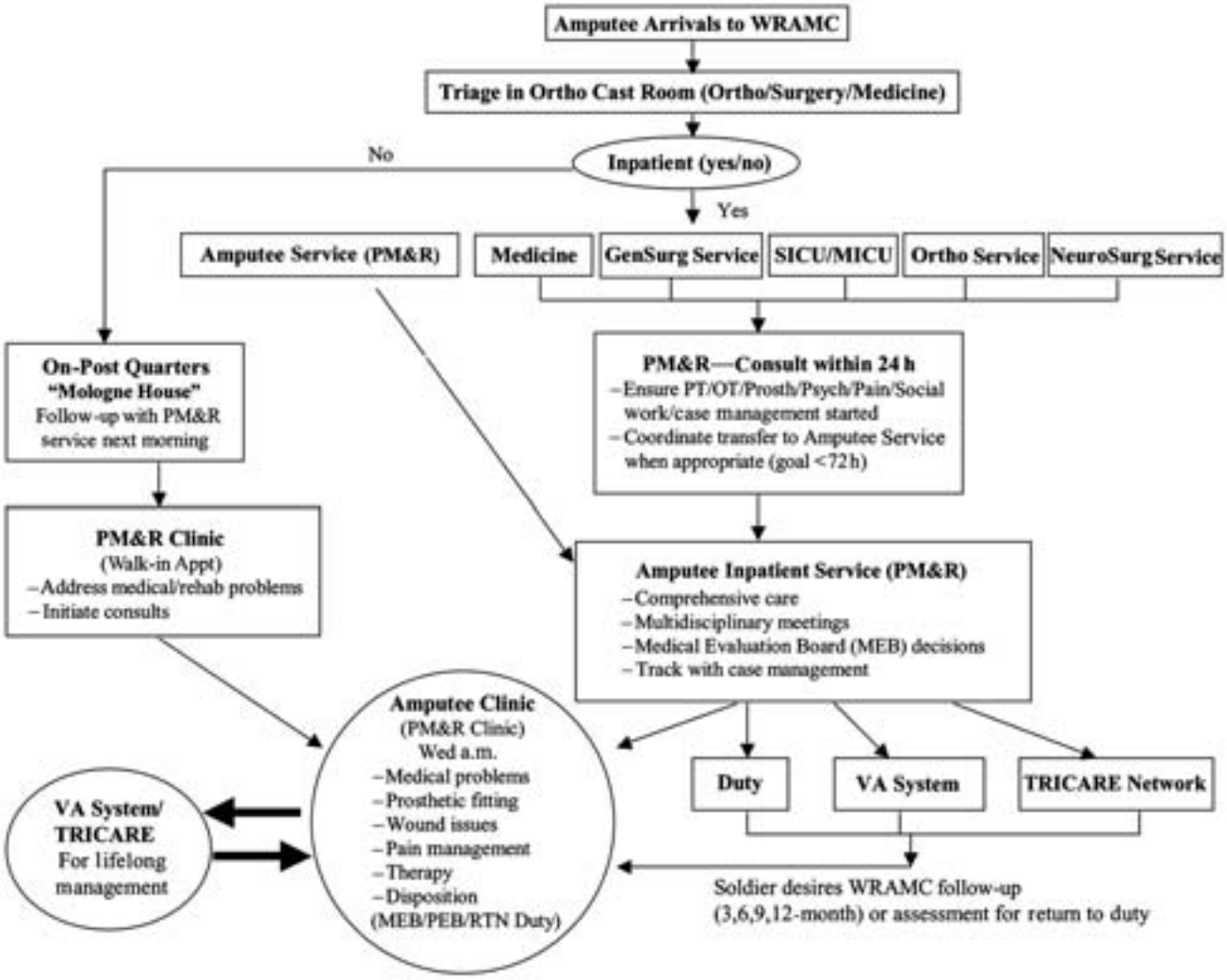

Figure.
Patient flow for combat amputees at Walter Reed Army Medical Center (WRAMC). MICU = medical intensive care unit, PEB = Physical Evaluation Board, PM&R = Physical Medicine & Rehabilitation, RTN = return, and SICU = surgical intensive care unit.

dramatic positive effect on pain control, reduction in medication use, and participation in therapy.

MEDICAL MANAGEMENT

As mentioned earlier, most combat amputees face multiple comorbidities and greater risk for secondary complications. Traumatic amputees are at increased risk for developing deep venous thrombosis (DVT) in both their intact and residual limbs. For prophylaxis, all patients are started on low molecular-weight heparin (enoxaparin), unless contraindicated. We have also noticed that a high percentage of combat amputees develop heterotopic ossification (HO). Whether this correlates with the nature of injury (typically, from a blast), the patient's age, or perhaps the presence of comorbid head injury is unclear. The secondary effects of HO can lead to significant pain, skin breakdown, or trouble with prosthetic fitting.

We have initiated the use of a COX-2 selective NSAID on all patients, unless contraindicated, for both prophylaxis and treatment of HO. Our experience has shown that in this patient population, signs of secondary complications such as DVT or HO are typically very subtle and may first present with only

a mild low-grade fever, therefore medical vigilance is imperative. Because of the high incidence of comorbid head injury, it is important that the medical staff have experience in managing patients with cognitive deficits. For posttraumatic seizure prophylaxis and treatment, we have found levetiracetam very effective. Finally, because of the high incidence of multitrauma and blood loss, combat amputees have benefited from the use of epoetin to stimulate red blood cell production. This treatment not only helps healing but also promotes more energy during rehabilitation.

SURGICAL CONSIDERATIONS

Standardizing surgical approaches to amputation is challenging, especially for combat victims whose wounds not only are extensive but also are contaminated with dirt, bacteria, and shrapnel. Most require comanagement of multiple surgical subspecialities (orthopedics, vascular, plastics, neurosurgery), so good communication between these services is essential. Limb-salvage decisions remain complex and should be made in conjunction with the patient, as well as the entire medical and rehabilitation team. Tools, such as the Mangled Extremity Severity Score (MESS), are helpful in facilitating these decisions. In addition to anatomic and physiologic factors, one should not lose sight of anticipated functional outcome, especially for this generally young and active patient population, who are eager to return to high-level sporting and recreational activities. Similar considerations must be made when the rehabilitation team decides on amputation length and level. It is critical that the rehabilitation team, especially the prosthetist, be involved in these decisions preoperatively to ensure optimal length for prosthetic fitting and function.

ADVANCES IN PROSTHETICS

We believe that the technological advances in prosthetic design and fit not only significantly improve patient satisfaction and function but also facilitate progression in rehabilitation.

Upper-Limb Amputees

Because of the complex nature of combat wounds, prosthetic fitting is often delayed to allow time for graft healing. Comorbid fractures, nerve plexus injuries, or soft tissue defects often prohibit the use of body-powered prostheses and suspension harnesses or cables. During the immediate postoperative period, we focus our attention on identifying myoelectric control sites.

Occupational therapists work closely with the patients using electronic sensors over remaining intact muscles. These sensors capture electromyographic (EMG) signals that trigger audio and video feedback to the patient and therapist. These signals are also used to operate video games, which create a friendly and therapeutic competitive environment for the patients and lead to quick mastering of certain skills. Once these skills are acquired, patients progress rapidly to operating myoelectric prostheses as soon as their limb is cleared for fitting. Body-powered prostheses are introduced later, as their comorbid injuries permit. Advanced prosthetic components such as the Utah Arm 3™ allow simultaneous operation and control of the elbow and terminal device. The addition of a wrist control unit permits more useful upper-limb functioning. The SensorHand™ SPEED allows a faster and more responsive opening and closing terminal device, as well as the ability to maintain constant grip force, because of built-in sensors within the fingertips. These sensors provide feedback to a microprocessor, which automatically tightens the grip to prevent objects from slipping out of the hand.

Lower-Limb Amputees

We have found that the computer-aided design and manufacture (CAD/CAM) equipment has significantly improved our ability to provide prostheses for traumatic lower-limb amputees. The computerized system allows the fabrication of a custom-made socket in a fraction of the time needed for traditional casting. The shorter fabrication time is especially helpful in caring for the combat

amputee, whose residual limbs have complex scar and suture lines and experience significant rapid volume changes. We have also found that advances in lower-limb prosthetic components, such as microprocessor knees and dynamic response feet, not only enhance function but also promote a more rapid progression through rehabilitation.

The amputee's ability to program microprocessor knees to provide more or less stance and/or swing control assists advancement from early weight-bearing to initial ambulation and, eventually, to stair and obstacle negotiation, without having to change prosthetic components or alignment. We have also found that during initial ambulation, patients perform well with multiaxial feet and vertical compression pylons. However, as their confidence and activities increase, they perform better with lighter-weight feet that have vertical compression features built into the keel of the foot itself. Our 3D motion analysis gait laboratory provides useful functional measures during the early phases of fitting to aid with prosthetic alignment and choice of components, as well as feedback to the patients and therapists on specific items to work on during therapy sessions.

THE ROLE OF GRADUATE MEDICAL EDUCATION (GME)

Our experience throughout OEF/OIF has demonstrated the critical impact that GME has had in providing the finest care to those wounded in combat. Ongoing educational programs that include military-specific curricula help military facilities stay current with state-of-the-art medicine, surgical, and rehabilitative approaches to care. Of note, WRAMC operates the only PM&R Residency Program in the Department of Defense (DoD). This has greatly enhanced the incorporation of fundamental rehabilitation principles to the care of combat amputees. Last, the presence of a vital and active research program at WRAMC has helped to bring cutting-edge interventions to this group of patients.

PEER AND PSYCHOSOCIAL SUPPORT PROGRAMS

An extremely important aspect of a comprehensive program includes professional psychological and amputee peer support. We have formed partnerships with the VA and Amputee Coalition of America (ACA) to find and train outstanding individuals who volunteer their time to support combat amputees returning from war. It is ideal if these volunteers have military experience. They provide emotional support and valuable feedback to the rehabilitation team as to how a patient is progressing both physically and emotionally. They are also helpful in facilitating guidance through the military medical disability system. Events, such as the National Disabled Veterans Winter Sports Clinic (sponsored by the VA) and those funded by the ACA, Disabled Sports USA, and numerous other private and public organizations help to introduce patients to the variety of sports and recreational activities available for individuals with disabilities. Support to family members is an equally important aspect of the program. WRAMC successfully established a Family Assistance Center (FAC) within the hospital to meet this need. Social workers and nurse case managers are critical members of the team, coordinating continued care, discharge planning, equipment purchases, etc.

MILITARY MEDICAL DISABILITY SYSTEM

Navigation through the military medical disability system is complicated. A single amputee service promotes communication and standardization. Physicians should be well educated and experienced in writing medical evaluation boards (MEBs). In addition, a Physical Evaluation Board Liaison Officer (PEBLO) counselor should be assigned to each patient during his or her inpatient stay. VA counselors are also necessary to ensure each patient is aware of his or her eligible benefits. Educational programs need to be tailored to the soldiers' needs, especially those with head injury and/or hearing or vision loss.

Optimal disposition of patients is often complicated by the frequent geographical challenges created when the patient's duty station, home of record, and nearest military or VA medical facility are not located near each other. In these situations, medical follow-up must be coordinated through the TRICARE military healthcare system. Unfortunately, standards and availability of healthcare services vary in both the private and public sectors across the United States. Through partnerships between the DoD and the VA, WRAMC is hopeful to be able to continue to follow and treat these combat amputees to ensure the best long-term care.

CONCLUSION

Over the past decade, a cultural shift has occurred within the military, giving individuals with limb loss the opportunity to stay on active-duty service. Advances in medical, surgical, and rehabilitative care, as well as prosthetic design, should help individuals achieve this goal. Whether or not the soldier desires, or has the ability, to remain on active-duty service, WRAMC is committed to helping all combat amputees reach their maximal function and return to the highest possible quality of life.

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