

Moderators' Summary: Wound Management (Session II)

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In this session, emerging technologies in wound management and soft-tissue coverage developed for traditional civilian wounds during the past 20 years are presented for possible application to war injuries. Throughout the history of armed conflict, combat injuries to the musculoskeletal system have accounted for the majority of wounds. The current conflicts in Iraq and Afghanistan are no different; approximately 60% of the injuries are musculoskeletal. Most of the injuries in wounded warriors evacuated from theater have been the result of explosive devices, such as improvised explosive devices (IEDs), rocket-propelled grenades (RPGs), mortars, rockets, and land mines. These explosive devices, particularly the IED, are the preferred weapons of choice by the insurgency because they are relatively inexpensive, can be remotely detonated, and can cause a large number of injuries from a single detonation.

Crabtree provides an excellent overview of the scope of wounds he cared for during his recent deployment to Iraq. He describes the devastating nature of these injuries and highlights some of the differences between these wounds and a traditional, civilian type of wound. The type of extremity wound may be more complex in this conflict because injured warriors are surviving their wounds. This fact can be attributed to the widespread use of individual body armor and to the rapid evacuation from the blast injury site to resuscitative surgical care.

Bumbaširević and coauthors provide a thorough review of the current knowledge of blast injuries and

present their own experience in managing these wounds during the Balkan War. Management included radical débridement and early wound coverage. In the current conflict, wounds are débrided initially in theater, left open, and covered with a dry, absorbent dressing; sequential débridements are performed through the evacuation chain. Once the wounded warrior is back at one of the military medical centers in the continental United States and the injuries have been determined to be clean, without gross contamination or infection, the wounds are closed or covered via the principles of the reconstructive ladder of soft-tissue coverage. Immediate coverage is impractical because of limited equipment and expertise. In addition, immediate coverage is not safe because the wound will require treatment through an evacuation chain of multiple care providers, as opposed to a single provider or team. Therefore, the principle of open wound management of these war wounds is still applied.

Webb presents an overview of emerging technologies using topical negative pressure for wound débridement with the Versajet (Smith & Nephew, Memphis, TN) and temporary coverage with the vacuum-assisted closure (VAC) system. VAC wound care has revolutionized our management of wounds during this conflict; in fact, it probably will be one of the novel medical advancements in wound management popularized during this conflict. VAC allows for temporary coverage until definitive soft-tissue coverage is accomplished. It contains the wound,

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removes contaminants and dead tissue, prevents secondary infection and desiccation of tissues, resuscitates demarcating tissue in the zone of stasis, promotes development of granulation tissue in the wound, and provides a degree of pain relief. However, VAC has not been without problems. Application of this device without suction, as often happens in the air evacuation chain, is essentially the same as closing a wound. At Landstuhl Regional Medical Center (Germany), those wounds to which VAC had been applied without continuous suction were more contaminated than wounds covered with a standard dry dressing. Thus, the use of VAC during the evacuation process has been discouraged until airworthy VAC can be reliably connected to continuous suction and monitored by trained medical personnel. A wound VAC system properly applied to suction during evacuation might prevent secondary wound contamination, and overall wound care may improve; however, this has yet to be determined and demands further research.

McGuigan presents an extensive review of the emerging technology

of skin substitutes that are being used as alternatives to autografts in a wartime setting. The major indication for these products is for temporary wound coverage. These skin substitutes have been used quite successfully in the treatment of war injuries resulting in burns; however, McGuigan has correctly concluded that extrapolating the use of these products to the coverage of war wounds without burns does not appear to be clinically indicated at the present time.

Finally, Levin presents new flap techniques developed in the past several years that may be applicable in the management of these war wounds. Expanding the use of the fillet flap as either pedicle flap or free-tissue transfer is presented as a method for gaining more serviceable soft-tissue coverage and for preserving length of the residual limb when amputation is required. This concept reinforces the principle of stabilizing and salvaging limbs, as opposed to amputation on the battlefield, and will provide the surgeon who performs the eventual reconstruction or amputation with more choices for

wound closure. The sural artery fasciocutaneous flap described by Levin has become a standard for soft-tissue coverage of distal third open tibia fractures, exposed calcaneus fractures, and open wounds around the ankle when the overall wound is <6 cm in diameter. These flaps, as well as traditional rotation flaps, have been used extensively to provide soft-tissue coverage of some of these challenging wounds at our military medical centers. In addition, they have also been used quite successfully by our deployed surgeons when treating Iraqi and Afghan civilians who have sustained similar injuries in situations in which more advanced microvascular techniques are not possible.

In conclusion, the principles of managing war wounds remain the same as in previous conflicts; however, the methods of treatment have evolved. It is our task to determine which of these emerging technologies provide a true benefit as we attempt to apply the state-of-the-art care for treating civilian orthopaedic injuries to the management of war extremity injuries.