

INITIAL MANAGEMENT OF WAR WOUNDS: Wound Debridement and Irrigation

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Supersedes:	Extremity Soft Tissue Wound/Amputation Management, 1 Mar 2010		
<input type="checkbox"/> Minor Changes (<i>or</i>)	<input checked="" type="checkbox"/> Changes are substantial and require a thorough reading of this CPG (<i>or</i>)		
<input type="checkbox"/> Significant Changes	PI monitoring plan added; section on facial wounds added		

1. **Goal.** To review indications for and the procedures associated with battle related wound debridement and irrigation, and associated initial wound management strategies for penetrating war wounds.
2. **Background.** Wound debridement and irrigation (D&I) is the most frequently performed surgical procedure in the combat theater.¹ Given the power of today's munitions, prompt removal of nonviable tissue, debris, blood and bacteria is imperative to prevent local and systemic complications associated with such a wound.² **While the degree of initial debridement is left to the operating surgeon, care must be given to ensuring all nonviable tissue is removed, while at the same time attempting to preserve as much soft tissue as possible for reconstructive surgery at higher echelons of care. There are now several acceptable methods of adjunctive wound irrigation to include bulb irrigation, gravity irrigation, and pulse lavage. Serial D&I is the mainstay of therapy towards promoting growth of remaining viable tissues. In addition, closed negative pressure wound therapy (i.e., VAC with reticulated open cell foam (ROCF)) has been shown to be a useful but not yet a proven clinical adjunct in the management of a wide array of traumatic soft tissue injuries.³**
3. **Evaluation and Treatment.**
 - a. Thorough inspection of the wounds with liberal use of surgical wound extension (i.e., wide surgical exposure) is necessary to inspect all levels of tissue, including examination of fascial planes. It is critical that the wartime surgeon have an understanding or appreciation for the phenomenon of wound evolution i.e., an expectation that any given soft tissue wound will evolve with respect to extent and tissue viability over the course of several days following injury.

This being the case, the surgeon should anticipate the need to re-inspect and perform serial D&I on extensive soft tissue wounds. While there is not a strict guideline defining the time sequence of repeat D&I, a general rule is that wounds should be more frequently inspected in the operating room during the acute (<72 hours) phase and less frequently in the sub-acute phase (3-7 days old). D&I in the operating room approximately every 24 hours for 2-3 days has been found necessary in some instances of wounds with extensive contamination and questionably viable soft tissue. Once such wounds have stabilized (as evidenced by the presence of viable tissue within the wound and the absence of additional nonviable tissue), the inspections can be separated in time by 2 days or more until a final wound closure strategy is identified (i.e., delayed primary closure with or without closed

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suction drain, split thickness skin graft with or without preceding tissue transfer). Patient movement decisions should be adapted to the requirements of surgical management – not the reciprocal.

- b. **Sharp surgical debridement is the mainstay of care for penetrating war wounds; irrigation is an adjunct to surgical debridement and in no way replaces sharp surgical debridement for removal of dirt, debris and non-viable tissue in wounds.** Therefore, a meticulous sharp debridement using a scalpel and/or scissors should be a starting point for nearly all wartime penetrating wounds. Assurance of hemostasis and removal of all nonviable tissue, including skin, fat, fascia, muscle, and bone, are essential to reduce the load of contamination and necrotic tissue in the wound prior to evaluation for dressing or closure.⁴
- c. **Devices:** There are several devices acceptable and available for adjunctive wound irrigation. Simple bulb irrigation and gravity irrigation have been the preferred method of wound irrigation. The bulb and syringe method has been more widely accepted and is significantly less expensive. Large bore gravity-run tubing has been favored for quick irrigations. Pulsatile jet lavage irrigation using a battery powered system is another method of adjunctive irrigation in the overall management of contaminated crushed wounds.⁵ It must be emphasized again that all methods of wound irrigation, including pulsatile lavage, are adjuncts to sharp, surgical debridement and not a substitute for surgical debridement.
- d. **Fluids:** Normal saline, sterile water and potable tap water all have documented similar usefulness, efficacy and safety. **Sterile isotonic solutions are readily available and remain the fluid of choice for irrigation.** If unavailable, sterile water or potable tap water can be used.
- e. **Volume:** Bacterial loads drop logarithmically with increasing volumes of 1, 3, 6, and 9 liters of irrigation. The current recommendations are as follows: 1-3 liters for small volume wounds, 4-8 liters for moderate wounds, and 9 or more liters for large wounds or wounds with evidence of heavy contamination.
- f. **Frequency: Depends on the nature of the wound and the degree of contamination** (see [3.a. above](#)). Obviously, those wounds with more significant contamination will require more frequent D&I and consideration should be given to performing one final D&I procedure prior to strategic aeromedical evacuation.

4. **Negative Pressure Wound Therapy with Reticulated Open Cell Foam (NPWT/ROCF)** dressing, commonly referred to as the VAC dressing, is an alternative wound dressing strategy to wet to dry and other temporary wound coverage strategies. VAC dressing can be utilized and left in place for 24 to 48 hours depending upon the extent and acuity of the wound. Utilization of negative pressure therapy requires a hemostatic wound bed. Foam should not be placed onto exposed vessels. More extensive and acute soft tissue wounds should have the VAC dressing removed with further debridement and irrigation during the acute (<72 hours) phase and less frequently in the sub-acute phase (wounds 3-7 days old). Recent clinical experience suggests that when used as part of a strict wound management strategy, NPWT with ROCF assists in initiation of delayed primary closure from the ends of the wound. Initiation of delayed primary closure may be started during these repeat

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irrigations with re-application of smaller VAC dressing sponges as the wound is sequentially closed.^{4,6,7} In instances where delayed primary closure is not possible, the described wound management strategy using the VAC adjunct has been observed to facilitate wound preparation (i.e., granulation and contraction) for placement of a split thickness skin graft.

NOTE: Use of VAC dressings has been demonstrated to be safe in patients during strategic aeromedical evacuation (AE). NPWT/ROCF is the preferred combat wound dressing method within the modern Air Force AE system. It has several advantages over moist to dry dressings. Advantages are that it 1) allows accurate measurement of fluid loss from the wound(s), and 2) prevents fluid accumulation on the transport gurney and on sheets and thereby may help prevent further patient hypothermia. For some wounds moist to dry dressings +/- Dakin's solution may be indicated when early infection is apparent or when NPWT sponges are in short supply. In general, this is an accepted alternative for short intra-theater patient movements but for intercontinental or long range intra-theater patient movements use of the NPWT/ROCF system is preferred wound dressing method within the AE system.

- a. The efficacy and long-term sequelae of NPWT/ROCF is not yet fully established but current clinical experience has been largely favorable. Surgeons who elect to employ this wound coverage method as part of their overall wound management strategy should be thoroughly familiar with the VAC system and its correct use.
 - b. **It is critical that the down-range surgeon be mindful of timing of D&I with casualty evacuation.** Anticipation of required wound debridements and performance of this down range prior to casualty movement is necessary to avoid extended periods without wound inspection and/or debridement. Given the propensity for soft tissue wounds sustained in combat to evolve in their acute phase, it is necessary for the surgeon to have a low threshold to perform an additional inspection and D&I before evacuating the casualty. **This compulsive and meticulous approach to wartime soft tissue injuries may decrease the likelihood that a given wound will worsen enroute and lead to adverse patient physiology (i.e., sepsis) discovered upon arrival at the next higher level of care.**
 - c. Given the extent of soft tissue injury, many wounds are best managed with repeat debridements and dressing changes (VAC, wet to dry, etc.) performed in the operating room. This strategy affords the patient the comfort of conscious sedation or general anesthesia and the surgeon access to the full array of equipment necessary to perform sufficient debridement, irrigation and initiation of delayed primary closure. Also, reapplication of the VAC dressing may be more complete and effective if performed in the operating room with the support of operating room and anesthesia teams.
- 5. Closure.** With very few exceptions, war wounds should NOT be treated with primary wound closure. Though no hard rules exist for the closure of battle injuries, wartime experience shows three broad categories of wound outcome:
- a. Delayed primary closure with or without closed suction (i.e., Jackson Pratt) drain
 - b. Split thickness skin graft over available local soft tissue
 - c. Tissue transfer with subsequent split thickness skin graft

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Which of these three closure strategies is best suited for any given wartime soft tissue injury is left to the discretion of the surgical team.

- 6. Antibiotic beads.** The use of antibiotic impregnated polymethylmethacrylate (PMMA) can be used as an adjunct to D&I to deliver increased local antibiotic concentrations without associated side effects. Indications include contamination eradication (with open fractures/traumatic amputations), treatment of infections (osteomyelitis) and dead space management with associated soft tissue defect. Recent evidence has suggested that a PMMA bead pouch alone is possibly as or more effective than NPWT alone at treating contamination in amputations and open fractures from blast injuries. The PMMA beads are usually prepared on a suture or wire and laid within the wound and covered with a semipermeable membrane, forming a bead pouch. PMMA antibiotic beads can be used as a bead pouch or in conjunction with negative pressure wound therapy (NPWT). When using PMMA beads with NPWT the current OEF practice is to lay a piece of Adaptic[®] over the beads or close the deep tissue and then cover the wound with a NPWT device. Their use with NPWT or drain can decrease local antibiotic concentration. Although clinical efficacy has not been established, animal modeling has shown to result in a decreased bacterial load compared to NPWT alone. The choice of antibiotic should be directed by the local antibiogram. Common antibiotics include heat stable powder formulations of tobramycin, vancomycin, imipenim, and colistan. Recent evidence also supports prefabricating and sterile packaging PMMA beads for subsequent use, allowing for bead use in a multicasualty/time constrained setting.
- 7. Open wounds.** Both surgical and traumatic open wounds are at risk for retained foreign bodies. Experience in the continuum of care from as recently as 2012 confirms surgical and traumatic wounds have been the site of retained surgical sponges.
 - a. Features unique to combat casualties moving along an evacuation chain increase the risk of retained sponges in wounds.
 - 1) The combat casualty may have multiple surgical teams performing procedures on multiple wounds simultaneously.
 - 2) The same wound may have multiple surgeons performing procedures at different times at the same operative setting. For example, a temporary shunt is inserted by the vascular surgeon, prior to the placement of an external fixator. The general/vascular surgeon then returns to the same field.
 - 3) Instrument and sponge counts pre-operatively may unnecessarily delay operative interventions in the hemodynamically compromised patient.
 - 4) Combat casualties receive their resuscitative procedures, secondary procedures and definitive procedures at different medical treatment facilities along the continuum.
 - b. Measures to mitigate retained foreign body retention are primarily (a) communication along the continuum of care and (b) imaging of wounds prior to definitive closure. All members of the operating team must be aware of the great risk for retained foreign bodies in the combat casualty population for the reasons identified above.
 - 1) The medical record must reflect any material that has been purposefully left in a wound.

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- 2) Physician-to-physician communication (in addition to the medical record) should occur if packing remains in a wound.
- 3) In patients who are transferred to another MTF along the continuum:
 - a) ‘Meaningful’ wounds that are closed (either traumatic or surgical) warrant radiographic confirmation that no foreign body remains in the wound.
 - b) The definition of ‘meaningful’ will be left up to the surgeon and any member of the operating team.
 - c) One definition of ‘meaningful’ is any wound between the mandible and knees.
 - d) A low threshold to image wounds is encouraged.
 - e) Any imaging of a wound to exclude a foreign body is to be review by the surgeon and the radiologist on duty.
 - f) The radiographic images are to be reviewed before the patient leaves the operating room if possible.

8. Facial Wounds. While traumatic facial wounds are treated in a similar fashion to wounds in other areas of the body, some aspects of facial wound management deserve special attention. Maxillofacial wounds sustained in combat typically involve both soft tissue and other structures including bone, teeth, cartilage, mucosa-lined structures (sinuses, mouth, etc.), eyes, and the cranial vault. As such, maxillofacial wound management may be more complicated than soft tissue wounds in other parts of the body and may warrant multidisciplinary care. Facial wounds and their management can significantly impact the patient’s airway, vision, and ability to speak and eat.

The robust, redundant blood supply of the facial region promotes healing and reduces the incidence of wound infection compared to the trunk and extremities. As with other wounds, the first step in facial wound management involves profuse irrigation, cleaning, and meticulous debridement. All clearly non-vitalized tissue must be sharply excised. Given the rich vascular supply of this region, it is better to conserve as much tissue as possible during the initial debridement as opposed to aggressive, wide debridement. Primary closure, while contraindicated in wounds in other areas of the body, is acceptable for many wounds of the face. Large areas of missing tissue may be covered temporarily with dressings or split-thickness skin grafts, taking care to keep the tissues moist. Local or regional flaps should be considered in the acute phase when there is exposed bone or cartilage. It is important to cover all exposed bone and cartilage with vascularized tissue or an appropriate antibiotic ointment in order to prevent infections in these structures. The use of NPWT/ROCF has not been documented in the treatment of facial wounds but may be appropriate in some situations where there is extensive tissue loss. Foreign bodies, along with damaged bone and cartilage lacking periosteum and perichondrium respectively should be removed, taking care to preserve the remaining viable tissues to the greatest extent possible. Studies of combat maxillofacial trauma suggest that early repair of facial fractures prior to evacuation out of the combat theater results in fewer complications. Antibiotics may be considered for all extensive and/or contaminated facial wounds. Injuries to cartilaginous structures (ears, nose) are especially susceptible to *Pseudomonas aeruginosa* and *Staphylococcus aureus* infections.

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9. Performance Improvement (PI) Monitoring.

- a. Intent (Expected Outcomes).
 - 1) Large traumatic wounds are treated with D&I and left open at the initial operation.
 - 2) Prior to closure of open wounds, including open abdomens, appropriate imaging is obtained and read by the surgeon and radiologist on duty to prevent the occurrence of retained foreign bodies, including surgical sponges.
 - 3) The medical record contains accurate documentation of any foreign bodies (e.g., number of surgical sponges) purposefully left in an open wound.
- b. Performance/Adherence Measures.
 - 1) Large traumatic wounds, other than some facial wounds, underwent D&I and were left open at the first operation.
 - 2) Radiographic imaging (e.g., plain films, CT scan, etc) was obtained and interpreted by the operating surgeon and radiologist on duty prior to closure of large open wounds, including open abdomens.
 - 3) When foreign bodies were purposefully left in open wounds, this was accurately documented in the patient's medical record.
- c. Data Source.
 - 1) Patient Record
 - 2) Joint Theater Trauma Registry (JTTR)
- d. System Reporting & Frequency.

The above constitutes the minimum criteria for PI monitoring of this CPG. System reporting will be performed annually; additional PI monitoring and system reporting may be performed as needed.

The system review and data analysis will be performed by the Joint Theater Trauma System (JTTS) Director, JTTS Program Manager, and the Joint Trauma System (JTS) Performance Improvement Branch.

10. Responsibilities. It is the trauma team leader's responsibility to ensure familiarity, appropriate compliance and PI monitoring at the local level with this CPG.

11. References.

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Approved by CENTCOM JTTS Director,
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Opinions, interpretations, conclusions, and recommendations are those of the authors and are not necessarily endorsed by the Services or DoD.

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APPENDIX A

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGs

1. **Purpose.** The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of “off-label” uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.
2. **Background.** Unapproved (i.e., “off-label”) uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing “investigational new drugs.” These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.
3. **Additional Information Regarding Off-Label Uses in CPGs.** The inclusion in CPGs of off-label uses is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the “standard of care.” Rather, the inclusion in CPGs of off-label uses is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.
4. **Additional Procedures.**
 - a. **Balanced Discussion.** Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.
 - b. **Quality Assurance Monitoring.** With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.
 - c. **Information to Patients.** Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.