

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)



Unexploded Ordnance (UXO) Management (CPG ID: 41)

This CPG provides details on the procedures to safely remove unexploded ordnance from combat patients, both loose and impaled, to minimize the risks to providers and the medical treatment facility while ensuring the best outcome for the patient.

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INTRODUCTION

The purpose of this Clinical Practice Guide (CPG) is to provide details on the procedures to safely remove Unexploded Ordnance (UXO) from combat patients, both loose and impaled, to minimize the risks to providers and the Medical Treatment Facility (MTF) while ensuring the best outcome for the patient. Military ordnance, to include bullets, grenades, flares, and explosive ordnance, retained by a patient can be a risk to all individuals and equipment along the continuum of care. This is especially true from the point of injury to the first treatment facility. Ordnance can be categorized in many ways. For the purposes of patient care, it can be considered “loose,” referring to items on the patient’s gear or stored in their pockets, or “impaled” when it penetrates into the body.¹ While loose ordnance is fairly common among military patients and easy to address, embedded ordnance is rare and significantly increases the risk for the treatment team. Thirty-six reported cases of impaled ordnance from WWII through the Somalia conflict were discussed in a 1999 review article published in *Military Medicine*.² While cases have occurred in other non-US combat zones, this is held as the best-documented report of impaled ordnance. Of these cases, four were moribund upon arrival to advanced care and died while the other 32 survived their initial surgery. Of note, none of the 36 impaled UXO devices detonated or injured those caring for their patients. Four cases in Afghanistan and two in Iraq since 2005, with another US case reported from Pakistan in 2012, indicate that the risk of similar events is still present.³ Prior planning, establishment of a standard operating procedure and realistic training are the best ways to prepare for managing these soldiers and avoid “on the fly” decision-making. However, if a patient arrives early on in the establishment of a MTF, expeditious and flexible management by medical leaders faced with the prospect of surgically removing UXO will have the greatest impact on patient and treating team survival. A discussion of steps to avoid accidental discharge of the ordnance and steps to mitigate risks to providers and the surgical facility follows. These protective principles may also be applied to the management of ordnance (e.g., suicide vest) found on non-military patients treated at medical facilities.

ORDNANCE TRIGGERING MECHANISMS

Fundamental to this discussion is a basic understanding of triggering mechanisms for those ordnance types most likely to become impaled in the body. These include mortars, Rocket Propelled Grenades (RPG) and 40 mm projectiles (rifle-launched grenades). A basic, unclassified understanding on how triggering and arming of the explosive round occurs will ensure the surgeon and surgical team avoid causing the ordnance to explode.

Previous reports of UXO reveal that the impaled round was some sort of propelled explosive device. These rounds basically consist of a propulsion system, a trigger mechanism, and a main explosive charge.

It should be assumed that a malfunction occurred causing the ordnance not to explode on impact into the patient. One should always assume that an inadvertent bypass of the safety mechanism or a malfunction could cause the ordnance to explode. All retained ordnance should therefore be considered “armed” or activated to a degree that final triggering of the fuse would cause the ordnance to explode. Fusing and triggering mechanisms vary by the type and variety of ordnance and may even vary within the same type of ordnance depending on where the ordnance was manufactured.

The trigger is generally located at the tip of the main explosive charge. This trigger activates a firing mechanism that impacts onto a percussion cap that activates a detonator. The detonator explodes, thereby igniting the primary explosive charge.

There are a variety of arming mechanisms for explosive ordnance. Typically, a mortar or rifle grenades (e.g., 40mm, M203) becomes armed and capable of exploding based on the number of rotations or spins completed after leaving the launching tube. Upon impact, a nail-like device located in the cone or nose of the device is

pushed down into a fissile explosive that detonates the actual explosive charge. Pressure on the nose of the mortar may also trigger the device to explode.

Piezoelectric crystals are also utilized as another arming mechanism. This is most commonly employed in an RPG. The rocket consists of a propulsion device and stabilizing fins for flight. The trigger utilizes a piezoelectric crystal at the tip of the projectile that generates an electric charge upon direct impact with the target. This charge ignites the detonator that explodes the primary charge. This crystal may also be activated upon exposure to light, electricity, or thermal energy. Therefore, the explosive device may be triggered by reorienting the patient, shining direct sunlight on the crystal, or providing a direct electric current to the device such as contact with an electro cautery device.

ROUTINE INITIAL MEASURES

All patients, regardless of whether they are friendly or enemy, require an initial inspection in order to find and remove all weapons and ammunition prior to entry into a transport vehicle or treatment facility. Screening of their bags and the litter is also essential to ensure that no “loose” ordnance or ammunition is brought into an area where they could be accidentally armed and detonated. Items should be given to the soldier’s unit representatives or the area Explosive Ordnance Disposal (EOD) team or placed in a safe location (e.g., UXO pit) if these are not available. If “impaled” ordnance is identified during the initial inspection or triage, all non-essential individuals should go to a safe location and the higher command should be notified. In addition, it should be stated that a patient may have “impaled” ordnance that is not recognized until after initial Tactical Combat Casualty Care has been provided, ground or air transportation has been completed, or even during surgery. Therefore, individuals must always be prepared to execute the appropriate measures at any time during the continuum of patient care. Refer to Table 1 in [Appendix A](#) for more guidance.

TRANSPORT OF PATIENTS WITH SUSPECTED/CONFIRMED UXO

Casualties with suspected or confirmed “impaled” UXO should only be moved or evacuated if absolutely necessary. Whenever possible, surgical or diagnostic capabilities should be moved to the casualty’s location in order to decrease the chance of vibration or travel over rough terrain resulting in UXO detonation. If movement is required, the patient should be extracted and positioned in the same position they were found as repositioning the patient may cause the ordnance to shift and trigger a charge. If the patient requires rotary wing transportation while the ordnance remains in place, it is essential to properly ground the patient to the helicopter to avoid static electricity causing the ordnance to trigger and explode. The aircrew must be consulted to ensure proper grounding of the patient to the aircraft.

COMMAND DECISION PRIORITIES AT COMPOUND WITH TREATMENT FACILITY

Safe removal of UXO requires significant coordination with local security, the base command element, and EOD personnel. Specific duties include:

BASE SECURITY AND COMMAND TEAM

The area where the patient is located should be secured or cordoned off. The time to identify this area is during the initial establishment of a treatment facility, long before a potential patient may arrive in need of care. Non-treating personnel should remain in protected location at a safe distance beyond the blast radius of the ordnance. All non-essential personnel, including medical providers, should move to that stand off point. The local commander should be informed that a patient with UXO is under medical care at the MTF or is due to arrive if prior notification is given.

EXPLOSIVE ORDNANCE DISPOSAL TEAM

It is imperative that EOD staff participate in mass casualty exercises involving UXO scenarios in order to develop robust procedures and guidelines. Furthermore, EOD can advise and assist in construction of a UXO barricade where the UXO can be removed and a second secured area to place the UXO once it has been removed following surgery. This is best done after the primary MTF has been established. The EOD unit contact information should be clearly posted in the surgical facilities administrative area and the phone number validated periodically. The EOD technician or other subject matter expert must provide input on the type of ordnance present, whether the explosive portion is still present, and the likelihood of detonation. All of this information must be factored into a risk benefit analysis. As the common impaled ordnance types have a number of variants, the EOD specialist can provide advice on specific concerns to prevent arming and detonating the device. In some instances, EOD technicians have assisted in removal of the ordnance during surgery.

PATIENT TRIAGE

During patient triage, the triaging officer must always inspect soldiers for loose UXO and impaled UXO. This must occur at all levels of care within the evacuation chain. If possible, the initial triage of the patients once at an MTF should be done outside the main treatment facility. Ideally, this is done nearby, but at a safe standoff distance. To assist with this, standard metal detector wands can be used with little risk of causing loose or impaled UXO to arm or detonate. During mass casualty situations, a patient with an impaled UXO could potentially endanger the staff, other patients, ground and rotary transport vehicles and drivers, and the main MTF. If there is a low probability of survival, they must be triaged to a delayed or expectant category, particularly when there are multiple casualties requiring surgical care. Comfort care, when appropriate, can be provided with the patient moved to a safe distance from the fixed or tented surgical facility.

ANCILLARY SURGICAL SITE

Safe removal of the UXO should be accomplished in an ancillary surgical site when time and casualty flow permit. This is done to avoid bringing the ordnance into the main Operating Rooms (ORs). This ancillary site should be established outside the main surgical facility where the removal of the ordnance can be expeditiously and safely performed. This site should also be well lit and have all the necessary anesthetic and surgical equipment readily available. The floor should be level and large enough to place a field operating table, a litter stand, or a litter on a wheeled litter system since it can be moved with minimal amount of personnel and can immediately be converted to a stable platform for performing surgery. Ensure that the set-up can accommodate the use of portable X-ray since it may be required to help identify the ordnance. Ideally, the site would provide a blast wall next to the table or litter that other medical staff can stand behind and be available for assistance or consultation. This location should be clearly established during the initial establishment of the treatment facility since it is difficult to identify and create a site in the midst of a patient with UXO impaled in their body. Avoid conducting this type of surgery in a confined space such as a contained bunker since the overpressure from a blast will only exacerbate the trauma from an explosion. Once the UXO has been removed, the patient can be moved to the main surgical facility to complete the operation.

X-RAY AND ULTRASOUND

Plain radiographs are generally considered safe with respect to potential inadvertent triggering of the UXO.² The patient should not be reoriented to obtain the films as any movement can inadvertently complete the arming or triggering mechanism and cause an explosion. The effects of ultrasound or CT scan on UXO are not documented in the literature.⁴ Therefore; it is prudent to avoid these imaging modalities until studies confirm that they are safe.

SURGICAL INSTRUMENTS AND ADJUNCTS

Use of electrocautery, mechanical blood warmers, monitors, blood pressure gauges, infusers, or pumps should be minimized in order to reduce the risk of static electrical discharge.^{5,6} Likewise, mechanical saws and drills that utilize electricity and pneumatics should be avoided in favor of non-powered manual saws due to concerns of discharge and vibrations.⁶ In addition, surgical instruments, equipment, and supplies used for UXO surgery must be identified early on as part of the initial establishment or transfer of authority of a treatment facility. If available, these items should be placed in a container that can be rapidly moved to the ancillary surgical site. A list of items not in the container should be affixed to the top of the container so it can be collected Enroute to the ancillary surgical site. Do not use combustible agents in vicinity of patient (e.g., oxygen, alcohol-based solution, combustible volatile anesthetics).

OPERATING PERSONNEL

Personnel deemed not absolutely essential to achieve safe removal of the ordnance should be removed from the vicinity of the UXO.⁷ Furthermore, all necessary equipment should be laid out in advance of the operation, eliminating the need for an OR technician whenever possible. A surgical assistant should only be used if it is absolutely necessary and the safe removal of the ordnance could not otherwise be accomplished. The UXO triage and operating team will vary from unit to unit and based on the specifics of the “impaled” ordnance. Each unit will need to identify who their primary UXO staff will be upon establishment of the treatment facility. This group of providers will need to periodically practice performing this task due to the complexities and stress involved.

Personnel typically volunteer to participate in these operations despite the significant danger. Final selection of the surgeon(s) to conduct the operation should be left up to the lead surgeon. It is imperative that the unit commander and the lead surgeon make every effort to limit the need for additional staff. This is done in order to minimize the risk to the surgical team, particularly in cases of mass casualties. Personnel participating in the surgery should gown and glove over ballistic protective equipment including safety glasses, helmet, and body armor with ballistic plates. An alternative approach is to perform UXO surgery while wearing an EOD bomb disposal helmet and suit (See [Appendix B](#)). This can be practiced in garrison and while deployed in collaboration with the local EOD unit. These suits have built in communications, heat-reducing technology, and are significantly better at protecting the entire body. All but the gloves can be worn providing protection to over 95% of the wearer’s body.

ANESTHETIC CONSIDERATIONS

In most cases, general anesthetic will be used for these operations since it provides a more controlled environment.⁷ For stable patients where the ordnance is impaled in an extremity, a nerve block is an acceptable alternative.² Use of supplemental oxygen during the operation to remove the ordnance should be limited in order to eliminate this additional combustible source. Ensure that the “D” size oxygen tank is behind the barrier, where the non-participating staff is located, to prevent it from exploding if the ordnance detonates. Consider having the anesthesia provider remote to the patient but able to view monitoring devices.

SURGICAL STRATEGY AND PRIORITIES

The guiding principle is to remove the ordnance by the most expedient means possible. This may require “en-bloc” resection of the tissue around the ordnance with amputation of the affected limb above the ordnance if this is deemed the quickest way to safely remove the ordnance. In general, impaled ordnance should be surgically exposed to a degree that will allow easy removal of the object in the same orientation as it lies in the body. Every effort should be attempted to avoid pushing forward or twisting the UXO during exposure or removal as this may set off triggering mechanism. Great care should be made to avoid banging or contacting the

ordnance with hands or surgical instruments. If ordnance is impaled into a limb, the extremity should be stabilized to avoid excessive vibration or movement that could complete the trigger. Simultaneous damage control operations for other injuries should be limited to life and or limb preserving operations. Delay definitive procedures until after the ordnance is safely removed. Once the UXO is removed, it should be gently handed off to an EOD expert or placed in explosive containment device. If the UXO placed in a containment device is in the vicinity of the patient, consider rapidly moving patient to safer location to complete procedure.

LATE FINDING OF UXO

Three of the six cases of impaled ordnance found in patients during the Global War on Terrorism were not recognized until the patient was in the OR. The impalement was unknown at the point of injury, transport, or initial evaluation by a Role 2 or Role 3 trauma teams since it was completely embedded in a body cavity or extremity with no exposed portions to alert the staff. The time and location when impaled UXO was initially recognized is not mentioned in previous reports. Intra-operative is not the ideal time to find the ordnance, but due to the nature of trauma and war wounds, this may be the case. Units must have a plan to address this. The core principles used in a known case of an impaled UXO should be followed. Minimal staff to remove the device is recommended, limit patient movement, and stop the use of medical equipment that may arm or detonate the device. The facility leadership and EOD team need to be notified as soon as possible. If the patient is stable, pause until EOD can confirm and identify the impaled device. Staff remaining to care for the patient should have their protective gear brought to them so they can do it rapidly. One of the biggest decisions is to stay within the facility or to relocate. This decision is complex and is dependent on multiple tactical and clinical factors. The medical treatment facility commander and senior surgeon must rapidly decide on the best course of action and ensure the safety of the staff while striving for survival of the patient. The goal is to care for the patient while preserving the personnel and equipment to care for current and future patients as well.

BIOLOGICAL AND CHEMICAL IMPALED UXO

While there are no documented cases of combat patients with loose or impaled UXO containing chemical or biological agents, it is conceivable that ordnance containing these agents could become impaled in a patient. Current doctrine states that it is a “command decision,” on how to manage the patient.¹ However, it does not state if this is the local senior medical unit commander or local senior combatant commander that makes the decision whether to make the patient expectant or to provide full care. If the decision is made to provide full care and attempt to remove the agent containing UXO, individuals involved should be fully protected. All participating staff will need to wear available biological-chemical protective gear to include mask, body suit, boots, and gloves under their body armor if attempting to remove the ordnance. Ordnance containing chemical or biological agents usually has a much lower explosive force than traditional high-explosive or fragmentation ordnance to prevent destruction of the agents, and therefore the treating staff is at a lower risk of injury from a blast if the ordnance were to detonate. Therefore, there is more of a risk from contamination than blast when compared to a traditional high-explosive or fragmentation munitions. Agent containing ordnance should immediately be handed over to EOD followed by decontamination of the patient and medical staff when necessary before moving to the main treatment facility for further treatment.¹

IMPALED UXO IN KIA PATIENTS

While the Armed Forces Medical Examiners System staff is unaware of any cases where a UXO was found impaled in a deceased US soldier since 2001, it has been reported in the world literature.^{8,9} Since it has been recognized that many times the impaled ordnance is not identified until the patient is within a trauma treatment area of an MTF or in the OR, it again should be assumed that patients could die on the battlefield or in an MTF with unrecognized impaled ordnance. Therefore, it is recommended that all deceased individuals be screened

for impaled ordnance to prevent a catastrophic situation on the ground or in the air.¹⁰ This can be accomplished by conducting a simple body cavity screening with a metal detecting wand, or an X-ray to include the torso, head, or injured extremities. If anything is found, the same precautions for a live patient should be taken to include having all nonessential people leave the threat area, notifying the local command, having security establish a perimeter, having EOD identify and remove the object, etc.

PERFORMANCE IMPROVEMENT (PI) MONITORING

INTENT (EXPECTED OUTCOMES)

- EOD expertise is essential for aiding in the safe removal of the UXO.
- It is essential to protect medical personnel and the surgical facility from damage that could render the MTF mission non-capable.

PERFORMANCE/ADHERENCE MEASURES

- EOD was contacted early in the management of the case.
- The procedure was carried out in an ancillary surgical site away from the MTF.

DATA SOURCE

- Patient Record
- DoD Trauma Registry

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 JTS Director and PI Branch.

RESPONSIBILITIES

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

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APPENDIX A : TABLE OF UNEXPLODED ORDNANCE (UXO) PRACTICES

UXO Situational Practices
<ul style="list-style-type: none">▪ Establish triage/search/blast contaminant area external to medical treatment facility (MTF) or establishment of facility.
<ul style="list-style-type: none">▪ Upon discovery of UXO, immediately evacuate all non-essential personnel and move to a safe distance or protected one.
<ul style="list-style-type: none">▪ Notify Explosive Ordnance Disposal team and local command authority.
<ul style="list-style-type: none">▪ Using appropriate personal protective equipment, if possible move patient to a location separate from the MTF for evaluation and treatment.
<ul style="list-style-type: none">▪ Minimize number of personnel involved in patient treatment, use of electrical equipment that may detonate UXO (e.g., electrocautery) and presence of additional combustible agents (e.g., oxygen, alcohol-based solutions, combustible volatile anesthetic agent).

APPENDIX B: UXO PERSONAL PROTECTION EQUIPMENT



APPENDIX C: ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

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.

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.

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.

ADDITIONAL PROCEDURES**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.

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.

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.