JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE

Acute Extremity Compartment Syndrome (CS) and the Role of Fasciotomy in Extremity War Wounds

Guide providers in the evaluation and treatment of patients with extremity war wounds, including the role of prophylactic and therapeutic fasciotomy.

CONTRIBUTORS

CDR Christopher H. Renninger MC, USN
COL Jean-Claude G. D'Alleyrand MC, USA
Col (Ret) Mark Bowyer, USAF, MC
COL Daniel J. Stinner MC, USA
LCDR Michelle M. Gosselin MC, USN
Lt Col Robert J. McGill USAF, MC
CAPT Christopher S. Smith MC, USN
COL Jerome M. Benavides, MC, USA
CAPT Charles J. Osier MC, USN
COL (Ret) Kenneth J. Nelson MC, USA
Col (Ret)Brandon R. Horne, USAF, MC
Col (Ret) Joseph J. Stuart USAF, MC
COL (Ret) Benjamin K. Potter MC, USA CAPT Douglas E. Pittner MC, USN
CAPT Matthew D. Tadlock, MC, USN
Lt Col Remealle A. How, USAF, MC
MAJ Carter W. Kaminski Jr, USAF, MC
CDR J. Michael Van Gent, MC, USN
COL Jennifer M. Gurney, MC, USA

Thanks to CPG Manager Katherine Robbel, USAF (Ret) for CPG coordination, Col (Ret) Kenneth Leffler, USAF, MC for Infographic collaboration and Ms. Elizabeth N. Weissbrod, MA, CMI, FAMI for medical illustrations.

Previous contributors: LTC Gordon Wade USAF, MC; LCol Max Talbot RCMS, CAF; John Shero MHA, FACHE; LTC Anthony Johnson MC, USA; CDR Luke Balsamo MC, USN; CAPT Zsolt Stockinger MC, USN

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TABLE OF CONTENTS

Summary of Changes

1. Clarified indications for prophylactic fasciotomy
2. Emphasis placed on complete fasciotomy technique
3. New appendix detailing procedural steps for forearm and leg fasciotomies
4. Clarified approach to delayed evacuation and late presentations

Acute Extremity Compartment Syndrome and the Role for Fasciotomy in Extremity War Wounds

Compartment Syndrome (CS) BLUF

- CS = time critical emergency (Appendix A: Risks)
- CS diagnosis in deployed env. is primarily clinical
- Consider prophylactic fasciotomy if high risk
- Generous incisions: Open all compartments

Background

- ↑Myofascial space pressure→↓perfusion/tissue viability → rhabdomyolysis/ renal failure → death
- ↑ in tibial plateau Fx; ↑ ISS/ (15% of combat injuries)
- Non-Fx risk factors: Vessel injury /TQ use/ ↑fluids

Evaluation and Diagnosis

- Edema peaks at 24-48h (up to 5 d w/ TQ or Shunt)
- 5Ps: Pain/Pallor/Paralysis/Paresthesia/Pulseless
- 36% of acute CS is w/ tibia Fx (↑ w/open fx)
- No specific technique to establish Dx → suspicion!
- No role for pressure measurements in theater
- Burns NOT automatic indication for fasciotomy

Treatment

- Established Dx CS→ immediate fasciotomy to interrupt cascade of ischemia/necrosis
- Prophylactic fasciotomy based on:
  - Injury pattern/reperfusion physiology
  - Operational issues /delay in evacuation/ inability to monitor (Appendix A)
  - Performed at first surgical facility in MEDEVAC chain
- Pitfalls of attempting fasciotomy outside of OR
  - Uncontrolled bleeding
  - Neurovascular injury
- Use negative pressure wound therapy with caution/ monitor bleeding
  - Wet → dry dressings/ hydrogel dressings OK

Lower Leg Fasciotomy

- Generous two Incision/4 compartment release
  - Lateral fasciotomy Panels A-D
  - Medial fasciotomy Panels A-C
- Incomplete Fasciotomy → inferior results
- Missed lower extremity compartments due to:
  - Failure to ID septum dividing anterior and lateral compartments
    - 1 fingerbreadth anterior to fibular head
    - Use H incision: transverse incision in proximal 1/3 of leg
    - Deliberately open anterior and lateral compartments separately
  - Failure to develop deep posterior release
    - Failure to take soleus muscle off posterior tibia
    - Neuro/vascular bundle exposed in fully decompressed post compartment
  - Fascial incisions too short/not covering entire extent of fascial compartments

Forearm/Hand Fasciotomy

- Volar incision (Panel A) opening flexor compartment including mobile wad and carpel tunnel
- Dorsal incision (Panel B) posterior compartment
- Carpel tunnel ligament opened (Panel C)
  - Spare palmaris longus and median nerve
- Hand compartments: (Panel D)

Thigh Fasciotomy

- Consider in Femur Fx w/ vascular injury
- Lateral incision on iliotibial band (Panel B)
  - Anterior/posterior compartments
- Medial incision for medial compartment; rarely required

Metrics

- ✓ Fasciotomy performed at earliest surgical role of care
- ✓ Patients at risk of CS have prophylactic fasciotomy performed
- ✓ All muscle compartments of the affected extremity will be completely released
- ✓ Neurovascular exams documented q4hrs and reason for deferral of fasciotomy
- ✓ Tourniquet place, application and removal times documented

This information is pulled from the evidence-based Joint Trauma System (JTS) Acute Extremity Compartment Syndrome (CS) and the Role for Fasciotomy in Extremity War Wounds Care Clinical Practice Guideline (CPG).
JTS CPGs can be found at the JTS CPG website or the JTS Deployed Medicine site.

BLUF BOX

1. Compartment syndrome is a time-critical, surgical emergency and should be addressed expeditiously with full-length fasciotomies of the affected extremity.
2. The diagnosis of compartment syndrome in the deployed environment is primarily clinical and there is a very limited role for compartment pressure monitoring in that environment.
3. Prophylactic/early fasciotomies should be considered in patients with high-risk injury patterns and operational limitations for ongoing observation and repeated examinations; such as Critical Care Air Transport Team (CCATT) transfers.
4. When fasciotomies are performed, incisions should be generous and all compartments should be fully opened.

PURPOSE

This Clinical Practice Guideline (CPG) provides an overview of acute extremity Compartment Syndrome (CS) and presents a standardized approach to guide providers in the evaluation and treatment of patients with extremity war wounds, including the role of prophylactic and therapeutic fasciotomy.

BACKGROUND

Acute extremity CS is a common and disabling sequelae of extremity war injuries. CS is a clinical syndrome in which elevated pressure within a myofascial space reduces perfusion and decreases tissue viability. Furthermore, hypotension from severe polytrauma in the setting of elevated compartment pressures increases the risk of CS. Recent research indicates proper detection of CS is lifesaving and a delay in diagnosis can be lethal secondary to rhabdomyolysis and renal failure.[1] Therapeutic fasciotomy is indicated for diagnosed CS, and prophylactic fasciotomy is indicated when there is a substantial risk of CS. Indications for prophylactic fasciotomy are broader in the combat environment[2] because of greater concern for CS in combat injuries: they often involve a higher overall trauma burden, receive massive transfusions, and have concomitant extensive soft tissue injuries, arterial injuries, and multi-level limb trauma and potentially hypotension.

Between 3% and 27% of civilian tibia fractures result in compartment syndrome, with higher energy tibial plateau fractures associated with the highest rates of acute compartment syndrome.[3-9] A similar incidence can be expected in cases of fractures from non-battle injuries in deployed areas. However, up to 20-25% of cases of compartment syndrome can occur without fracture.[10] Non-fracture risk factors for acute compartment syndrome include limb injury severity (particularly vessel injuries) and overall casualty injury severity (particularly shock) with a lesser factor being aggressive resuscitation (particularly >5 liters of crystalloid). As a cumulative result of these factors, as high as 15% of all military orthopaedic trauma casualties require at least one prophylactic or therapeutic fasciotomy.[11] The most common location of CS is the leg, followed by the forearm, but CS can be present in the gluteal region, thigh, foot, arm and hand.[10,12]

Tissue edema, and subsequent swelling due to injury, plateaus in 24 to 48 hours. Additional swelling from post-injury ischemia reperfusion (e.g., revascularization including after shunt placement, shock, and tourniquet use) appears to delay the maximal time of limb swelling further, perhaps as long as 2 to 5 days post injury. Compartment syndrome can lead to significant morbidity and mortality (Table 2), therefore, **once the decision is made to perform a prophylactic or therapeutic fasciotomy, a complete fasciotomy must be performed.[12,1,13] Evidence supports complete compartment release by full-length skin and fascial incisions being superior to limited fasciotomy.[14] Incomplete fasciotomy, is a preventable and technical problem, risks increased patient morbidity, mortality, and poor functional outcomes.**

EVALUATION & DIAGNOSIS

Tissue edema due to injury peaks at 24-48 hours, but vigilance should be maintained in the first week post-trauma, especially in cases requiring sequential surgical procedures, ongoing resuscitation, or in the presence of ischemia-reperfusion. The diagnosis of CS can be difficult even in the awake, alert patient. The signs and symptoms of CS are the classic "5 Ps" which include: pain; pallor; paralysis (weakness); paresthesias (sensory deficit); and pulselessness.[12,15,16] Pain out of proportion to the injury or with passive stretch of a muscle group is thought to be the most important clinical finding, but is often obscured in combat casualties due to altered mental status, heavy sedation, or mechanical ventilation. Palpably tense compartments as a clinical finding are highly subjective and have not been found to be reproducibly used reliably to rule out CS. Paralysis and paresthesia are less useful acutely as they can also result from direct neural trauma. Pulselessness is a late and ominous sign in CS, but occurs more commonly in combat injuries, sometimes within minutes of an arterial injury or an expanding hematoma; however, irreversible tissue damage can occur in the setting of palpable pulses.[13,3,4,15]

About 36% of all compartment syndromes are caused by tibia fractures.[15,17] Open fractures, even with traumatic fasciotomy, have higher CS rates than closed fractures perhaps because they are more severe, with more swelling and a higher incidence of vascular injury. The most common missed compartment syndromes are in the anterior and deep posterior compartments of the leg, which are also the most common incompletely released compartments.[18] Since there is currently no sensitive or specific technique for establishing the diagnosis of CS, a fasciotomy should be considered in any patient with significant mechanism of injury and clinical findings suspicious for CS.

Pressure measurement has significant limitations and is not recommended for routine use in theatre. Therefore, the diagnosis remains clinical in the deployed environment. Emerging technologies, such as ultrafiltration catheters, that allow continuous monitoring have not yielded acceptable diagnostic performance to adequately improve clinical decision-making in the identification and management of CS.[19,20] When monitoring patients for the development of CS, serial clinical examinations are repeated hourly when risk is high and less frequently when risk is lower. Provider education and training improves outcomes in at-risk combat casualties.[21] Documentation of extremity physical exam, including neurological and pulse exam, is important for both later providers and performance improvement.

In one study, burns sustained in combat have been associated with an increased fasciotomy rate.[1] In the absence of crush injury, fracture, poly-trauma, over-resuscitation, electrical injury, or similar indications, prophylactic fasciotomy on burned extremities may increase morbidity and mortality and may not be indicated, while escharotomy are frequently required for burned extremities, fasciotomies are not unless any of the above indications apply. (For additional information on escharotomy and fasciotomy in the management of patients with extremity burns, see JTS Burn Care CPG.[22]

TREATMENT

Operative Intervention

CS requires immediate operative intervention. Once intra-compartmental pressure reaches a critical threshold, only surgical treatment can interrupt the cascade of events leading to ischemia and tissue necrosis. This should be accomplished as soon as possible, as irreversible tissue necrosis occurs within a few hours. Delayed or incomplete compartment release has been associated with increased mortality and need for amputation in military casualties.[1] Therapeutic fasciotomy is performed for diagnosed CS while prophylactic fasciotomy is performed for limbs at risk of developing CS. The decision to proceed with prophylactic fasciotomy is based on the pattern of extremity injury, the patient's physiological profile, and operational considerations. **For both therapeutic and prophylactic fasciotomy - skin and fasciotomy incisions should be generous and all compartments should be opened widely (i.e. in the lower leg, a two – incision, four – compartment fasciotomy should always be performed even though other techniques have been described). This is to ensure there is proper decompression and prevention of further muscle death.**

PROPHYLACTIC FASCIOTOMY: INDICATIONS & CONSIDERATIONS

Fasciotomy during the lag phase between injury and syndrome onset is considered prophylactic. Early detection is challenging, so prophylactic fasciotomy should be routine when developing CS is likely. Prophylactic fasciotomy is most

commonly indicated in patients with certain "at risk" fractures or following limb reperfusion in the setting of prolonged ischemia or vascular injury. Injury, treatment, and casualty factors influence overall risk (Table 1 and Table 3) and may be interrelated.[1,23,24] The difficulties associated with monitoring a patient's physical exam during lengthy periods of transport must be considered in the decision to perform prophylactic fasciotomy, along with the inability to intervene surgically during evacuation.

We recommend prophylactic fasciotomy in the following situations:

1. Any limb at risk of CS in an austere location especially when prolonged evacuation is anticipated
2. Presence of a high-risk fracture pattern (See Table 1)
3. Following extremity reperfusion post prolonged ischemia time (> 3 hours)
    a. If the decision is made do not delay fasciotomy for any concomitant non-life saving interventions.

We recommend that prophylactic fasciotomy be performed when casualties reach the first surgical facility in the evacuation chain.

This treatment paradigm avoids missed CS or delayed compartment release, especially during times of high battle rhythm. The difficulties associated with monitoring a patient's physical exam during lengthy periods of transport must be considered in the decision to perform prophylactic fasciotomy, along with the inability to intervene during casualty evacuation. While animal models have shown a very small change in compartment pressure with high altitude (including normal aeromedical evacuation [AE] aircraft cabin pressure) transit simulations, clinical studies have found no associated between AE and the development of compartment syndrome.[25,26]

DELAYED EVACUATION / MISSED COMPARTMENT SYNDROME

Occasionally, casualties present with CS of prolonged duration (> 12 hours) due to delayed evacuation. This situation is associated with markedly increased risk of complications after fasciotomy, including death and infection.[27] This clinical situation remains controversial. These casualties may be best treated after fully resuscitated with urine alkalization, mannitol use, and intensive care support to manage the physiologic sequelae of the resultant limb ischemia.[28] Such aggressive medical management has data supporting better outcomes.[23] While there are some studies that suggest compartment syndromes with greater than 12 hours of warm ischemia with potentially nonviable muscle should not routinely undergo fasciotomy;[29] given the difficulty in assessing the specific time course of ischemic injury in many cases of delayed CS, we recommend to err on the side of fasciotomy to maintain viability of any remaining healthy muscle tissue. The role of acute amputation is currently unclear in this situation and, in the absence of severe physiological derangement, risk of sepsis, or extreme delays in evacuation amputation should be delayed until the casualty arrives to a higher level of care and/or consultation with multi-disciplinary team.

FASCIOTOMY

Once the decision is made to perform compartment release, a complete fasciotomy must be performed.[13, 14] This involves releasing all compartments in the affected anatomic region over their full length. There is no role for limited incisions or limited fasciotomies in the setting of CS in the deployed, combat trauma environment.

In the calf/leg, the anterior, lateral, superficial posterior and deep compartments must be released through two full length incisions. Although a one-incision approach is possible in expert hands, in the deployed environment, a two incision technique should remain the standard of care.[30,31] The most common incompletely released compartments are the anterior and deep posterior compartments of the calf/leg.[1,18] In the forearm, the superficial and deep volar compartments must be released through an incision that extends from the lacertus fibrosus to the carpal tunnel. The dorsal compartment, when involved, is released through a separate incision. Incomplete fasciotomy can be secondary to failure to release a specific compartment or limited fascial incisions. Incomplete fasciotomy is associated with worse outcomes. Improved surgical education has been shown to decrease the rate of fasciotomy requiring revision.[1,21] Fasciotomies are an operative procedure performed in an operating room. Venous hypertension is a sine qua non of CS and therefore negative pressure/suction on the muscle can result in substantial bleeding. Wet-to-dry dressings, or hydrogel dressings are

appropriate and, Negative Pressure Wound Therapy (NPWT) should be used with caution and if used bleeding should be monitored from the wound vac.[29]

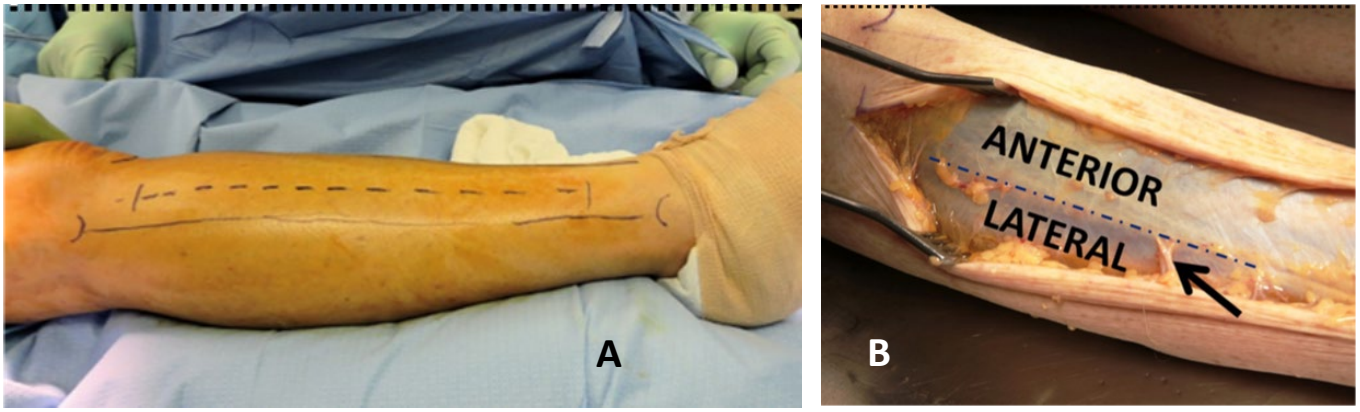
The common reasons for incomplete leg fasciotomy are:

- Improper identification of the septum dividing the anterior and lateral compartments. The location of the fibular head is key. Most misidentify the edge of a muscle belly as the septum if they are too far posterior. It is key that they locate the fibular head and ensure they are a fingerbreadth anterior to it. Identifying the fibular head can sometimes be difficult in edematous legs, and reorientation during the fasciotomy may be required. Make the initial transverse incision in the fascia overlying the septum, then deliberately opening the anterior and lateral compartments separately, creating a so called "H" incision, preferably in the proximal 1/3 of the leg.
- Incomplete development of the deep posterior compartment release by not deliberately taking the soleus muscle fibers off the posterior tibia. If performed correctly, the neuro-vascular bundle should be exposed in a fully decompressed deep posterior compartment.
- Fascial incisions that are too short and do not cover the entire extent of the fascial compartment, either at the knee or ankle levels.

LOWER LEG FASCIOTOMY

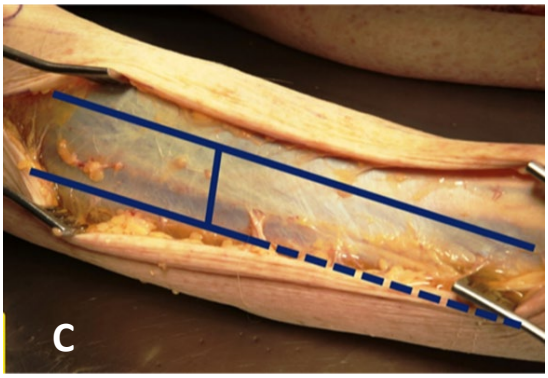
The lower leg has four compartments: anterior, lateral, superficial posterior and deep posterior. A two-incision, four compartment fasciotomy is the most reliable method to ensure all four compartments are open and fully decompressed.

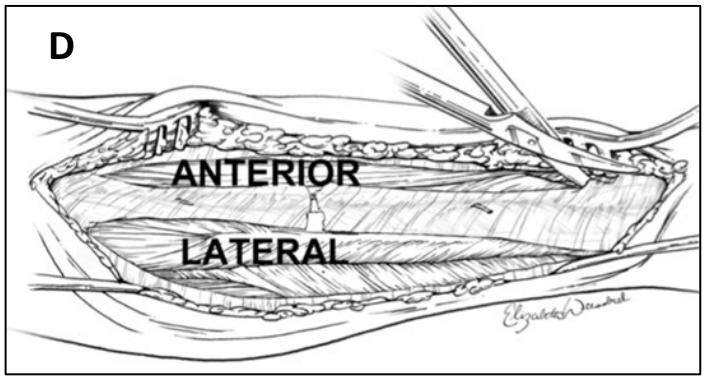
Figure 1. Lateral Fasciotomy



Panel A: The fibula is palpated and the lateral incision is made a finger width anterior to the fibula (finger in front of the fibula) **and 2 finger breadths above the ankle and below the knee.**

Panel B: The septum between the anterior and the lateral compartment is identified**. The arrow depicts a perforating vessel which both enters and helps identify the septum.**

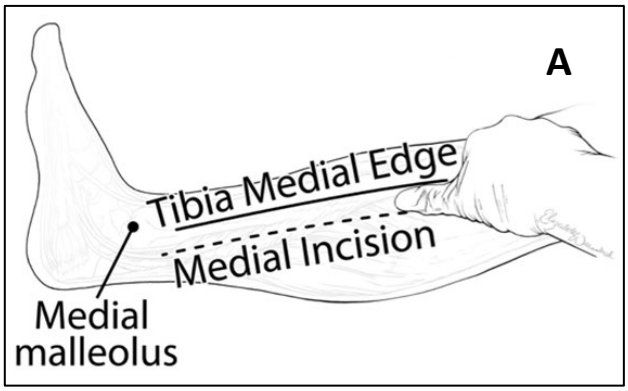


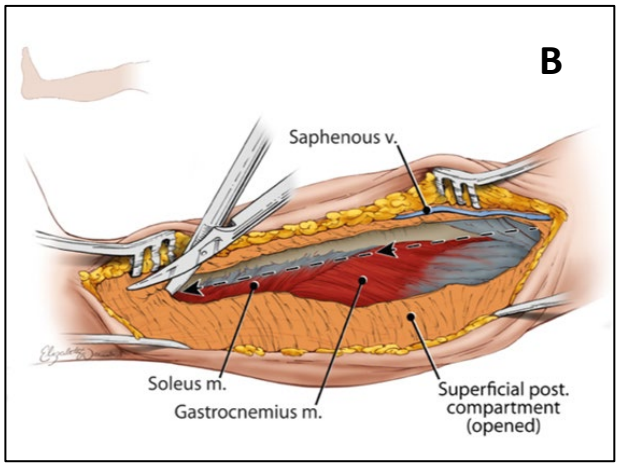


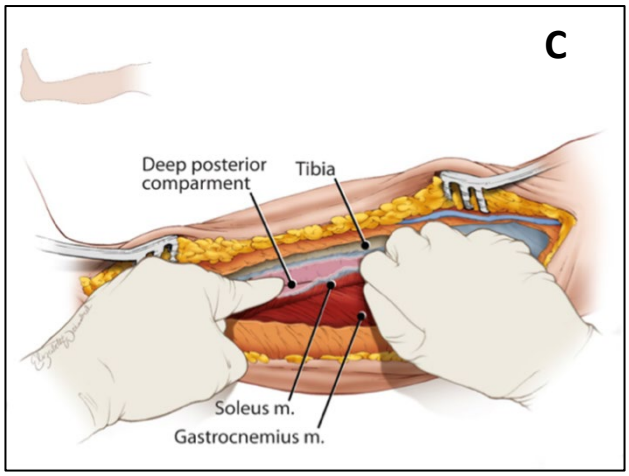
Panel C: A transverse incision is then made through the septum. This allows confirmation that the anterior and lateral compartments are accurately identified. The fasciotomies are then carried proximally and distally parallel to the septum. **The tips of the scissors should be turned away from the septum to prevent injury to the underlying nerve.**

Panel D: This depicts a complete fasciotomy of the anterior and lateral compartments of the lower leg.

Figure 2. Medial Fasciotomy







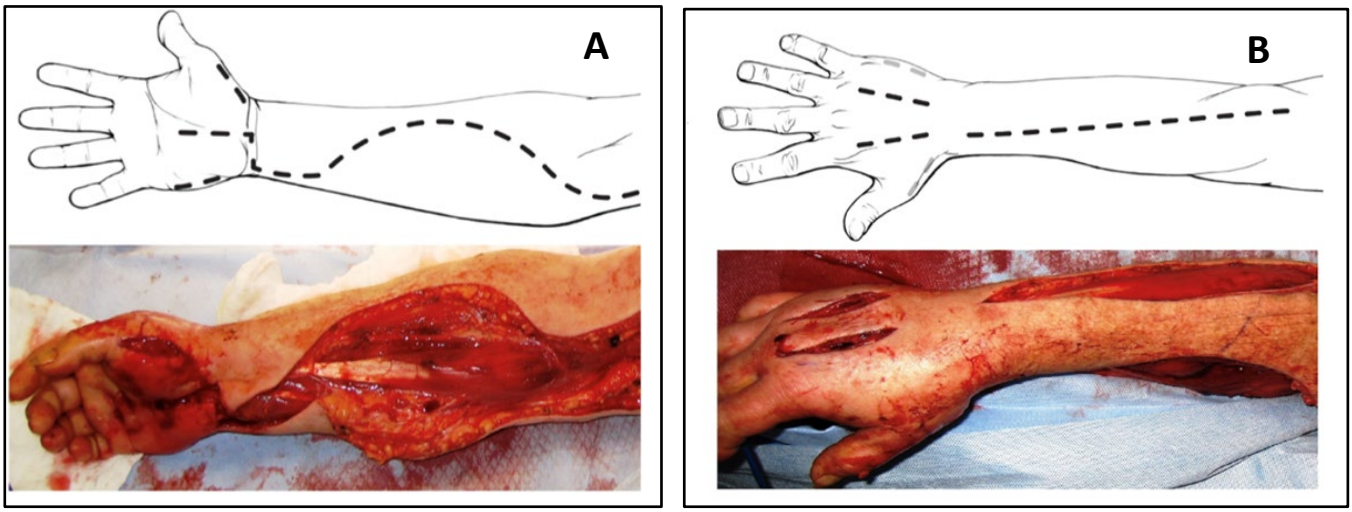
Panel A: The medial incision is made one thumb posterior to the tibia, avoiding the saphenous vein.

Panel B: The fascia below the incision is opened (superficial posterior compartment) and the deep compartment is visualized behind the tibia.

Panel C: The fibers of soleus are dissected from the surface of the tibia, gaining access and decompressing the deep posterior compartment.

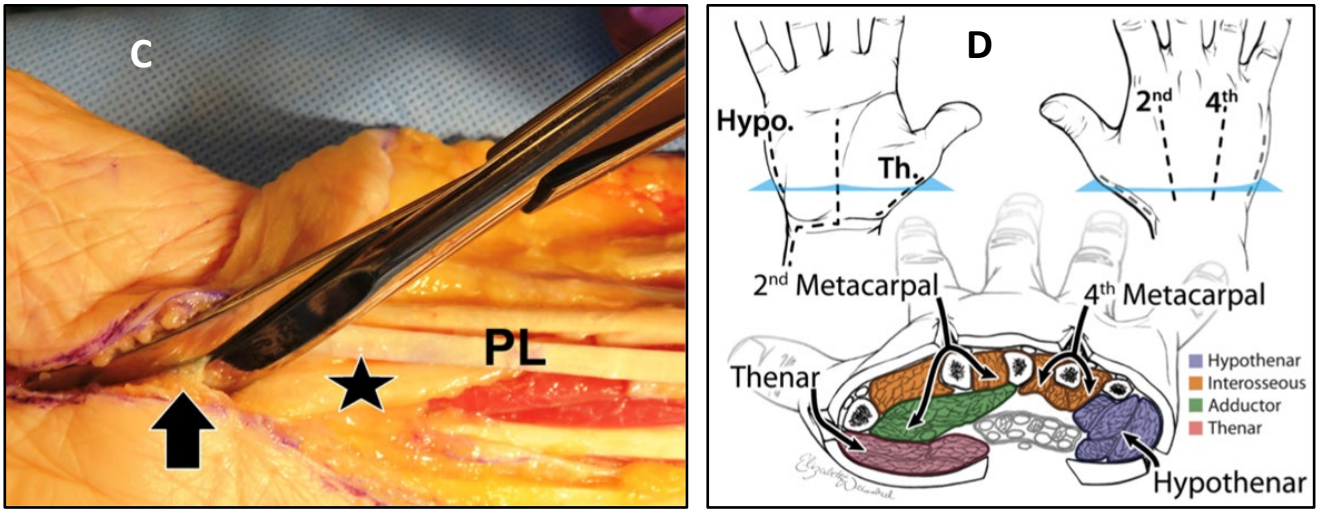
FOREARM / HAND FASCIOTOMY

Figure 3. Forearm/Hand Fasciotomy



Panel A: The volar incision is marked, and the incision is carried down to the fascia, opening the anterior (flexor) compartment. This includes opening the mobile wad and carpal tunnel.

Panel B: The dorsal incision is marked, and the posterior (extensor) compartment is opened.



Panel C: The carpal tunnel ligament is opened, avoiding injury to the palmaris longus tendon (PL) and median nerve (star)

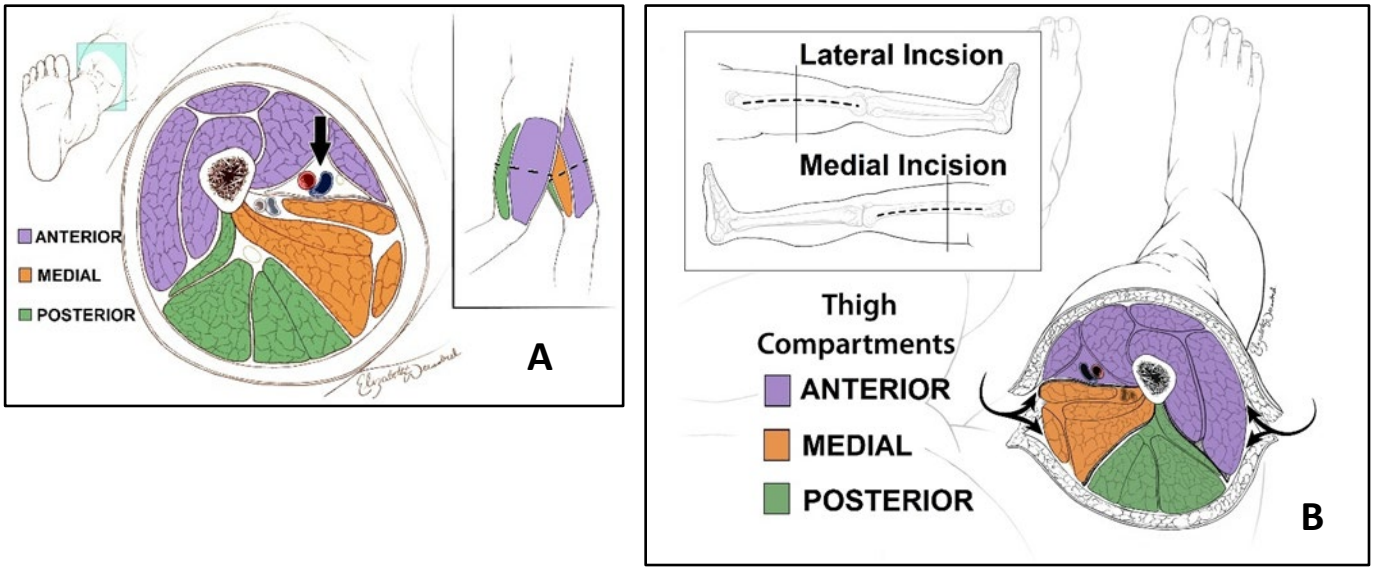
Panel D: The compartments of the hand are visualized. Incisions are made on the dotted lines to open the interosseous, adductor, hypothenar, and thenar compartments.

THIGH FASCIOTOMY

Compartment syndrome of the thigh is less frequent than that of the lower leg due to its larger volume and more compliant compartments. The most common etiology for CS of the thigh is femur fracture with associated vascular injury. This is generally most prominent in the anterior and posterior compartments and typically requires only a lateral incision and rarely a medial incision. The lateral incision is made from the greater trochanter to just above the knee along the iliotibial band.

The lateral intermuscular septum lies deep to this line and separates the anterior from the posterior compartment which is opened through the septum.

Figure 4. Thigh Fasciotomy



Panel A: The thigh has three compartments with the major vessels found in the anterior compartment.

Panel B: The lateral incision is made over the iliotibial band entering first the anterior compartment and then releasing the posterior compartment through the intermuscular septum. A separate medial incision can be made if there is still concern for CS of the medial compartment.

TREATMENT OF FOOT CS

Fasciotomy for treatment of CS of the foot remains controversial. While there is literature that supports acute compartment releases, the sequelae of foot fasciotomy can, in many instances, result in more severe sequelae (infection, skin grafting, difficulty with shoe wear) than from compartment syndrome managed non-operatively (claw toe deformity). Within the DoD Trauma Registry, case-control data suggest that performing foot fasciotomies do not yield clear clinical benefit when compared to non-operative management.[32] The surgeon must, therefore, carefully weigh the advantages and disadvantages prior to performing foot fasciotomies and based on the limited available data, in combat injured servicemembers, we recommend that foot CS should not routinely undergo compartment release.

PERFORMANCE IMPROVEMENT (PI) MONITORING

POPULATION OF INTEREST

- All patients diagnosed with extremity CS
- All patients with tourniquet time > 2 hours
- Patients with vascular injury at or above the level of the elbow or knee who undergo revascularization

INTENT (EXPECTED OUTCOMES)

1. Patients diagnosed with CS will have complete therapeutic fasciotomy performed at earliest surgical role of care.
2. Patients at risk of developing CS will have complete prophylactic fasciotomy performed at earliest surgical role of care.
3. When therapeutic or prophylactic fasciotomy is performed, all muscle compartments of the affected extremity will be completely released.
4. When prophylactic fasciotomy is deferred for an at-risk patient, neurovascular exams will be performed at least every 4 hours and documented, along with reason for deferral.
5. When presenting with tourniquet(s) in place, application and removal times will be clearly documented for all tourniquets placed.

PERFORMANCE / ADHERENCE METRICS

1. Patients with diagnosis of CS who underwent therapeutic fasciotomy.
2. Patients with risk factors for CS who underwent prophylactic fasciotomy.
3. Fasciotomies performed with complete release of all muscle compartments of affected extremity.
4. Performance and documentation of neurovascular exams at least every 4 hours when prophylactic fasciotomy deferred.
5. Tourniquet application and removal times are documented in the record.

DATA SOURCE

- Patient Record
- Department of Defense Trauma Registry (DoDTR)

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 Chief and the JTS 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.

DOTMLPF-p Implementation Requirements: Acute Extremity Compartment Syndrome	
Doctrine	Update Joint and Service-specific trauma doctrine to formalize the clinical (rather than device-reliant) diagnosis of CS in austere environments. Establish the two-incision, four-compartment fasciotomy as the primary doctrinal technique for lower extremity compartment release.
Organization	Ensure Role 2 forward surgical teams and Role 3 military treatment facilities are structurally task-organized to perform time-critical prophylactic and therapeutic fasciotomies prior to Aeromedical Evacuation.
Training	Incorporate specific surgical education modules into pre-deployment training (JETT course for Role 2) focusing on clinical diagnosis (without relying on pressure monitors) and proper full-length release techniques (e.g., identifying the fibular head, fully releasing the deep posterior compartment) to reduce the occurrence of incomplete fasciotomies.
Materiel	Standardize and pre-position specific Class VIII materiel (as detailed in Appendix E) sets at Role 2/3 to include adequate orthopedic/general surgical instruments, electrocautery units for hemostasis, and NPWT/VAC systems for post-operative management and transport.
Leadership & Education	Command emphasis is required to ensure leaders understand the risks of delayed evacuation and prioritize immediate surgical intervention for casualties with high-risk injury patterns (e.g., prolonged tourniquet times, crush injuries). Deployed Trauma Medical Directors and each Role 2/3 Trauma Team Leaders must enforce adherence to the CPG and track compliance metrics..
Personnel	Deploy appropriately credentialed surgical personnel (e.g., general and orthopedic surgeons) capable of performing full-length fasciotomies to the earliest echelons of care. Ensure AE/CCATT personnel are capable of managing post-fasciotomy patients in transit.
Facilities	Maintain fully functional operating rooms at forward operational locations. Fasciotomies are formal operative procedures that require anesthesia, sterile surgical environments, and bleeding control mechanisms not suited to be done outside of the operating room.
Policy	Enforce Service and Joint policies requiring mandatory documentation of serial neurovascular exams (at least every 4 hours) for high-risk patients when prophylactic fasciotomy is deferred. Mandate accurate logging of tourniquet application and removal times in the patient's record.

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APPENDIX A: RISKS

Table 1. Risks for Acute Traumatic Compartment Syndrome

Risks for Acute Traumatic Compartment Syndrome	
Decreased Compartment Volume	• Tight cast or dressing, closure of prior fasciotomy, excess traction • External limb compression or crush particularly in obtunded or incapacitated casualty • Frostbite, burns or electric injury (may include escharotomy)
Increased Compartment Contents	• Edema accumulation: embolism, intravascular thrombosis, replantation, venous tourniquet, injections, extravasation, infiltration, ergotamine ingestion, ischemia-reperfusion, swelling, artery injury or spasm, revascularization procedures, prolonged arterial tourniquet use, shock hypoperfusion, angiography and catheterization, limbs positioned well above heart, mal-positioned joints (ankle dorsiflexion,) or stretched muscles • Prolonged immobilization and limb compression particularly with obtunded or drugged casualty, some surgical positioning • Hemorrhage, hemophilia, coagulopathy, anticoagulation, vessel injury • Large volume crystalloid resuscitation • High-risk fracture: Adults: open tibia fracture; higher energy tibial plateau fracture; ballistic tibia or fibula fracture, especially proximal one third; open fractures that are highly displaced, comminuted, or associated with significant hemorrhage. Pediatric: supracondylar humerus fracture. • Popliteal cyst, long leg brace

Table 2. Morbidity Risk and Sequelae of Compartment Syndrome and Fasciotomy

Morbidity Risk and Sequelae of Compartment Syndrome and Fasciotomy	
Potential Morbidity: Compartment Syndrome and Early Fasciotomy	• Skin scar, scaly skin, ulceration, tethered tendons • Postoperative arterial or graft thrombosis, thromboembolic disease • Wound infection, non-healing fasciotomy wounds • Limb swelling or chronic edema, shape change of limb, muscle hernia • Pain, paresis or paralysis, paresthesia • Coverage challenge: primary closure, delayed primary closure, skin graft, flap • Possible repair of arterial injury worsening ischemia-reperfusion injury
Potential Sequelae List: Compartment Syndrome with Late or Incomplete Fasciotomy	• Mortality, sepsis, multi-organ failure, acute kidney failure • Myonecrosis, myoglobinemia, myoglobinuria, or rhabdomyolysis • Paresis or paralysis • Stiffness or contracture • Limb amputation, tissue loss (e.g., muscle debridement)

APPENDIX B: COMPARTMENT SYNDROME HEALTHCARE RECORD DATA

Table 3. Healthcare Record Data in the Setting of Compartment Syndrome During War

Healthcare Record Data in the Setting of Compartment Syndrome During War
• Was the fasciotomy prophylactic (compartment syndrome absent) or therapeutic (compartment syndrome present)?
• When was the fasciotomy indicated and when was the injury?
• When was the procedure (to determine treatment lag)?
• Was the casualty able to be followed closely? If so, what was the clinical course? Was the casualty alert, intubated, or head injured?
• Was there a nerve injury or nerve block/regional anesthetic?
• What was the injury or risk factors (e.g., ischemia-reperfusion) that indicated the procedure?
• What are the sources of ischemia-reperfusion in the injury and care of this case?
• Associated injuries altering risk of compartment syndrome: shock, occult hypoperfusion, hypoxia, nerve dysfunction, impaired, obtunded, or uncooperative casualty, arterial injury or ischemia, fractures with soft tissue injury, over-resuscitation syndrome, coagulopathies (including hemophilia, etc.), hematoma formation, crush injury, capillary leak syndrome, and prolonged compression.
• What were the surgical findings and muscle compartment response to the procedure?
• What was the technique (dermotomy, fasciotomy, surgical approach, length of fasciotomy)?
• Was there retinaculotomy or epimysiotomy? List names of all compartments released.
• What delimited the fasciotomy extent (e.g., anterior leg fascia goes from the proximal tibial crest near Gerdy's tubercle to the anterior ankle extensor retinaculum [crural ligament])?
• List associated procedures: debridement, irrigation, fracture fixation, etc.
• Planned care: staged? Closure, repeat debridement, delayed primary, skin graft, or flap

APPENDIX C: COMPARTMENT DATA SHEET

Table 4. Data Sheet: Compartment Names, Main Muscles, and Diagnosis and Procedure Codes

Data Sheet: Compartment Names, Main Muscles, and Diagnosis and Procedure Codes				
Compartment	**Main muscle(s)**	**Left or Right**	**Wound Notes, Compartment Syndrome (CS), Diagnoses, Indications, & Findings**	**Procedure(s) and Tissue Response to Procedure**
			• 958.91: traumatic CS of upper extremity • 958.92: traumatic CS of lower extremity • 958.99: traumatic CS of other sites • 958.90: CS, unspecified • Prophylactic (CS absent) or therapeutic (CS present). • Artery, vein, clot, & hematoma findings in compartment on exploration	• 83.12: fasciotomy of hand • 83.14: fasciotomy, division of fascia • 83.09: incision of fascia • 86.09: escharotomy dermotomy, epimysiotomy • Response: muscles bulged through fasciotomy, no bulge, pulse returned after absence
Deltoid	Deltoid			
Arm, Anterior	Biceps, Brachialis			
Arm, Posterior	Triceps			
Forearm, Volar	Flexors			
Forearm, Dorsal	Extensors			
Forearm, Mobile Wad	Brachioradialis			
Hand, Interossei	Interossei			
Hand, Central Palmar	Flexors			
Hand, Hypothenar	Digiti Minimi			
Hand, Thenar	Thumb Muscles			
Gluteus Maximus	Gluteus Maximus			
Gluteus Medius	Other Glutei			
Tensor Fascia Lata	Tensor			
Thigh, Anterior	Quadriceps			
Thigh, Posterior	Hamstrings			
Thigh, Adductor	Adductors			
Leg, Anterior	Tibialis Anterior			
Leg, Lateral	Peronei			
Leg, Deep Posterior	Tibialis Posterior			
Leg, Superficial Posterior	Gastrocnemius			
Foot, Interossei	Interossei			
Foot, Central	Flexors			
Foot, Lateral	Digiti Minimi			
Foot, Medial	Great Toe Muscles			
Iliacus	Iliacus, Psoas			

APPENDIX D: OPERATIVE NOTE TEMPLATE

Table 5. Operative Note Template for Dictation, Surgical Planning, or Data Collection

Operative Note Template for Dictation, Surgical Planning, or Data Collection	
1. Patient	2. Surgeon
3. Date of Surgery	4. Anesthesia
5. EBL:	6. Tubes
7. Specimens	8. Complications
9. Implants, Devices	
10. Indication for operation: a. Established compartment syndrome (therapeutic) b. Risk of compartment syndrome developing (prophylactic)	
11. Preoperative wound appearance: a. Size (volume of damaged tissue: large surgeon hand ~500ml) b. Depth, location, contamination material or matter	
12. Preoperative imaging findings: a. Soft tissue injury seen & fracture	
13. Examination under anesthesia, fluoroscopy, and surgical exploration findings: a. Distal pulse status b. Wound size, depth, location, contamination, materials or matter; burn eschar location and depth c. Vessel status, pulse, limb perfusion, capillary refill, congestion, edema, color of skin, warmth d. Clot presence, intravascular or extra vascular site, size (volume), location e. Hematoma presence f. Compartment hardness: soft, hard i. Epimysiotomy (if done by muscle name or compartment if known) ii. Retinaculotomy (if done by name [e.g., partial proximal ankle extensor]) iii. Retinaculotomy extended from anterior leg compartment fasciotomy iv. Result of fasciotomy and procedure (distal perfusion and pulse; gap in fasciotomy edges on release in cm; bulging out of muscles in compartment) v. Compartments soft or hard vi. Muscle color, consistency, contractility, capacity to bleed	
14. Patient condition, status, disposition and plan.	
15. Keynote for air evacuation: “Patient has been monitored for X hours after injury/surgery and has not had progression of signs or symptoms of compartment syndrome.”	

APPENDIX E: CLASS VIII MEDICAL MATERIEL

Below is a comprehensive medical materiel list that supports implementation of the JTS Acute Extremity Compartment Syndrome and the Role of Fasciotomy in Extremity War Wounds CPG.

Personal Protective Equipment (PPE)

- Sterile surgical gloves and non-sterile examination gloves (multiple sizes)
- Surgical masks
- Eye protection/face shields
- Surgical gowns, shoe covers, surgical caps/ bouffant caps

Surgical Instruments for Fasciotomy

Cutting Instruments

- Scalpel handles (3, 4) with number 10 scalpel blades and number 15 scalpel blades
- Scissors: (straight and curved) Mayo, Metzenbaum, and McIndoe dissecting scissors

Grasping/Tissue Handling

- Forceps: Adson (with and without teeth), DeBakey, Gillies, and Lane forceps

Hemostasis

- Mosquito hemostats
- Kelly and Crile clamps
- Needle drivers

Retraction

- Retractors: Army-Navy, Senn, Weitlaner, and Richardson retractors

Orthopedic Instruments (as needed)

- Periosteal elevators
- Bone rongeurs
- Orthopedic reduction clamps

Electrosurgical / Hemostasis Equipment

- Electrocautery unit / diathermy device
- Electrocautery handpieces
- Disposable cautery tips
- Suction machine
- Yankauer suction tips
- Suction tubing

Monitoring & Diagnostic Equipment

- Compartment pressure monitor
- Needle manometer system
- Stryker compartment pressure monitor kit
- Handheld Doppler ultrasound
- Standard patient monitor (ECG, pulse oximetry, blood pressure)

Anesthesia and Procedural Sedation

Airway/Monitoring

- Oxygen supply
- Bag-valve-mask
- Nasopharyngeal airway
- Endotracheal tubes
- Laryngoscope with blades
- Capnography

Local/Regional Anesthesia

- Lidocaine 1% or 2%
- Bupivacaine
- Regional nerve block kits
- Needles and syringes

Procedural Sedation/Analgesia

- Ketamine
- Fentanyl
- Midazolam
- Propofol
- Morphine
- Ketorolac
- Acetaminophen

Adjuncts

- IV start kits
- IV fluids (LR, NS)

Surgical Consumables

- Sterile drapes
- Universal surgical drape sets
- U-drapes for limb surgery
- Sterile towels
- Sterile basins

Skin Preparation

- Chlorhexidine solution
- Povidone-iodine (Betadine)
- Alcohol prep pads
- Sterile scrub brushes

Wound Irrigation & Debridement

Important because most war wounds require repeated irrigation and debridement.

- Sterile saline irrigation bags
- Bulb syringe irrigation devices
- Pulse lavage system
- Irrigation tubing
- Sterile gauze sponges
- Laparotomy sponges

Fasciotomy Wound Management

Dressings

- Non-adherent dressings (Adaptic/Telfa)
- Sterile gauze (4x4, 4x8)
- Abdominal pads
- Kerlix rolls
- Elastic bandage (ACE wrap)
- Velband or soft padding
- Crepe bandage

Advanced Wound Management

- Negative pressure wound therapy (VAC) systems
- VAC sponges and tubing
- Skin staplers
- Suture kits
- Split-thickness skin graft supplies: Skin graft mesher, and Dermatome

Limb Stabilization

- Splints: SAM, aluminum, plaster, and fiberglass splinting material
- Stockinette and cast padding

Vascular Injury Support

- Vessel loops
- Bulldog vascular clamps
- Fogarty balloon catheters
- Vascular shunts (Argyle/Javid)
- Vascular sutures (Prolene)

Medications

- Cefazolin
- Clindamycin
- Ertapenem (combat wounds)
- Tranexamic acid (TXA)
- Antiemetics (ondansetron)
- Rocuronium
- Succinylcholine

Laboratory / Monitoring Supplies

- Blood collection tubes
- ABG kits
- Urinary catheter kits
- Urine collection bags

For additional information including National Stock Number (NSN), please contact dha.ncr.med-log.list.lpr-cps@health.mil

DISCLAIMER: This is not an exhaustive list. These are items identified to be important for the care of combat casualties.

APPENDIX F: TELEMEDICINE / TELECONSULTATION

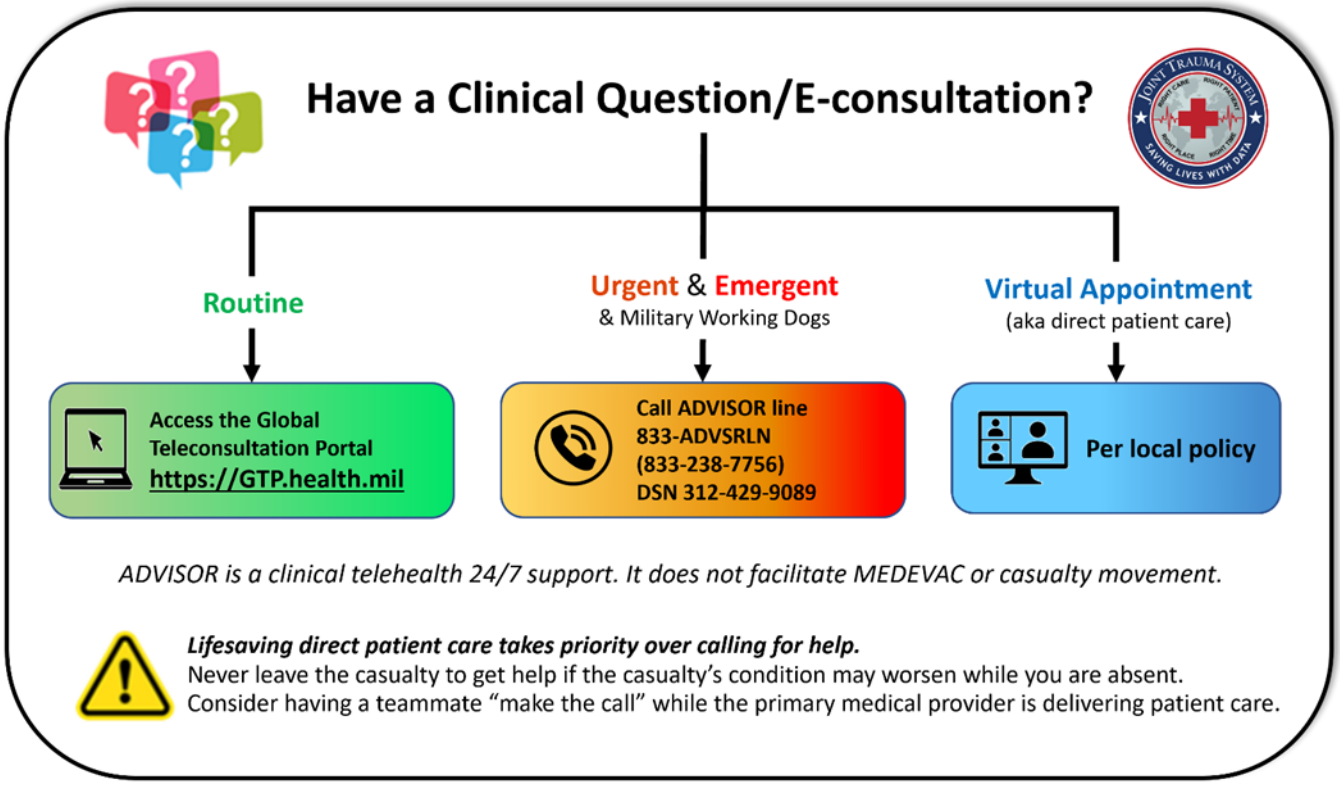

Illustration by Raymond Samonte

GTP: https://GTP.health.mil

Theater Patient Movement Requirements Center (TPMRC) to coordinate evacuation:

- *TPMRC-Americas (NORTHCOM & SOUTHCOM), 618-817-4200*
- *TPMRC- East (EUCOM, AFRICOM, CENTCOM), DSN 314-480-8040*
- *TPMRC- West (INDOPACOM), DSN 315-448-1062*

APPENDIX G: 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.