JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Emergency Life-Saving Cranial Procedures by Non-Neurosurgeons in Deployed Setting

This CPG applies to military non-neurosurgeons in a forward deployed location with surgical capability (Role 2 surgical teams that meet capability requirements) outside of the United States. Based on the Committee on Surgical Combat Casualty Care Position Statement: Neurosurgical Capability for Deployed Operations.

CONTRIBUTORS

CDR Paul Porensky, MC, USN
CDR Vijay M. Ravindra, MC, USN
COL Linda C. Benavides, MC, USA
LTC Bradley A. Dengler, MC, USA
Lt Col Remealle A. How, USAF, MC
COL Tyson E. Becker, MC, USA
CAPT Matthew D. Tadlock, MC, USN
CDR J. Michael Van Gent, MC, USN
COL Jennifer M. Gurney, MC, USA

Previous Contributors: CDR Randy S. Bell, MC, USN; Col Randall McCafferty, USAF, MC; Col Stacy Shackelford, USAF, MC; CAPT Jeff Tomlin, MC, USN; LTC Michael Dirks, MC, USA; CDR Chris Neal, MC, USN; Col Jeff Bailey, USAF, MC; Don Marion, MD; COL Kurt Edwards, MC, USA; COL Mary Edwards, MC, USA; CAPT Zsolt Stockinger, MC, USN

First Publication Date: 23 Apr 2018	Publication Date: 10 June 2025	Supersedes: 23 Apr 2018

TABLE OF CONTENTS

SUMMARY OF CHANGES

1. Updated literature reference list to reflect current evidence for the following:
   - Superior patient outcomes when neurosurgeons are directly deployed to combat area of responsibility.
   - Committee of Surgical Combat Casualty Care position statement reinforcing optimal patient management requires the deployed neurosurgeon for management of severe Traumatic Brain Injury (TBI).
   - Superior patient outcomes with ultra-early surgical intervention for severe TBI.
2. Added two new 'synchronous' neurosurgical support tele-capabilities, including Advanced Virtual Support for Operational Forces and Navy Medicine Readiness and Training Command San Diego on-call neurosurgeon.
3. Provided a streamlined algorithm for clinical indications supporting cranial surgical intervention.
4. Provided clarifying radiographic information and CPG reference (Catastrophic Non-Survivable Brain Injury) for when NOT to perform a cranial procedure.
5. Expanded procedural check-list for both penetrating and non-penetrating cranial injury.

Emergency Life-saving Cranial Procedures by Non-neurosurgeons in Deployed Setting

Indications

- Severe closed supratentorial brain injury GCS ≤ 8
- Lateralizing cortical dysfunction
- Hemodynamic dysfunction
- Critical care measures fail to stabilize

Contraindications

- Stabilized with critical care measures
- Training/resources/follow-on are NOT adequate
- GCS=3 with fixed/dilated pupils
- Catastrophic injury on imaging

Cranial Procedure for Penetrating Head Injury

- Teleconsult with Neurosurgery
- Often deep uncontrolled bleeding not evident on cortical surface
- Do NOT explore below surface of brain
- Limit intervention to:
  - Remove bone
  - Open dura
  - Control bleeding
  - Close rapidly
- If cranial contents herniate from entry/exit wounds → allow and do NOT close wounds
  - Cover with loose clean Kerlex soaked with saline
  - Antibiotic coverage with CNS penetration
  - Rapid transport out—if evac not available, intervention may be futile

Cranial Procedure for Closed Head Injury

- No CT? → accurate neuro exam/skull x-ray for fx/penetration
- Proper positioning of patient
- Exploratory burr holes over frontal/temporal/parietal convexities
  - Adequate decompression: 15cm x 12cm
  - Burr holes alone unlikely to help
- Separate dura from inner table of skull (Penfield 1-3 Instruments)
- Connect burr holes (electric drill with side cutting or matchstick bit)
  STAY OFF MIDLINE (superior sagittal sinus)
- Epidural bleed → evacuate and cauterize visible bleeding source
- Subdural bleed → open dura/evacuate/cauterize visible bleeding source
  If brain herniates rapidly → close scalp immediately
  - Do not search for bleeding source
  - Do not close dura—loosely approximate/dural substitute, hemostatic strips or pericranium only
  - Do not replace bone
- Intracranial Pressure Monitor if available, External Ventricular Drain (EVD) is preferred
- Close scalp (2-0 Vicryl for temporalis/galea; staples for skin)

Craniectomy Checklist

- ☑ Teleconsult with neurosurgeon
- ☑ Perform head CT (if available)
- ☑ Unable to evacuate within 5 hours of injury
- ☑ Provided maximal critical care measures
- ☑ Adequate training/ resources/follow-on care

Refer to Appendix A and Appendix B

Teleconsultation

Neurosurgical interventions in austere locations require teleconsultation with a neurosurgeon

ADVISOR: 24/7 provider consult (833) 238-7756 or DSN (312) 429-9089

METRICS

- ✓ Document >5 hours transport time to neurosurgeon
- ✓ Document Indications for ECP
- ✓ Document neurosurgeon teleconsultation
- ✓ Document use of electric drill and saw

This information is pulled from the evidence-based Joint Trauma System (JTS) Emergency Life-saving Cranial Procedures by Non-neurosurgeons in Deployed Setting (CPG). JTS CPGs can be found at the JTS CPG website or the JTS Deployed Medicine site.

INTRODUCTION

The U.S. Military has deployed combat assets throughout the world. Catastrophic injuries can occur in austere environments with limited or no resources. The standard of care for the treatment of severe Traumatic Brain Injury (TBI) includes the direct evaluation and treatment by a trained neurological surgeon.[1,2,3] Because severe TBI can be rapidly fatal, and neurosurgical assets as well as timely critical care air transport of severely brain injured Service Members are not always feasible or available, the U.S. Military has recognized the potential need for non-neurosurgeons (usually general/trauma surgeons) to perform cranial procedures in a far forward setting.[4] Data from the DoD Trauma Registry demonstrate that craniectomy procedures have been documented at Role 2 surgical facilities in Iraq and Afghanistan at least 36 times, with indeterminate success. There is some precedent for this practice within the literature,[5-8] including reference to the need for this practice as early as World War II.[8] This concept is briefly addressed in the treatise on War Surgery from the International Committee of the Red Cross.[9] We acknowledge that neurosurgical procedures are possible in austere locations with appropriate training and resources, yet fully recognize that "there is no substitution for a fully trained neurosurgeon in any health care system, whether military or civilian."[3] It is the responsibility of the U.S. Military neurosurgical community to ensure that our deployed Service Members receive the best care possible from non-neurosurgical colleagues. The purpose of this Clinical Practice Guideline (CPG) is to provide specific and tailored guidelines for the performance of cranial procedures by non-neurosurgeons. The document has been developed jointly by the neurosurgeons of all three services to support the non-neurosurgeon faced with this difficult situation.

This CPG was developed by consensus opinion from the Joint Trauma System (JTS), neurosurgical members of the American Association of Neurological Surgeons/Congress of Neurological Surgeons (AANS/CNS), Joint Military Committee and the AANS/CNS Section of Neurotrauma. This document has been reviewed by and is supported by the Defense and Veterans Brain Injury Center.

Definitions
Craniotomy: The removal of part of the skull for the purposes of accessing contents of the calvarial vault, and then replacing the bone in its original position using plates and screws.
Craniectomy: The removal of portions of the skull for the purposes of accessing the contents of the calvarial vault without replacement of the bone.
Ventriculostomy: The placement of a silastic catheter within the body of the lateral ventricle through a small burr hole drilled approximately 10-11 cm posterior to the glabella and 2.5-3 cm lateral to midline. This catheter can be used to drain cerebrospinal fluid and to measure intracranial pressure.
Subdural hematoma: The accumulation of blood within the subdural space, usually as a result of trauma, and best diagnosed with a computerized tomography (CT) scan. Indications for surgery include hematomas > 1 cm in maximal thickness especially if associated with > 5 mm midline shift on a non-contrast CT of the head.
Epidural hematoma: The accumulation of blood within the epidural space, usually as a result of trauma, and best diagnosed with a CT scan. Common locations include the temporal region (middle cranial fossa) due to laceration of the middle meningeal artery. Some general indications for surgical intervention may include a hematoma > 30 mL in size on non-contrast CT head, especially if associated with evidence of uncal herniation. This can be clinically diagnosed when there is a dilated, unreactive pupil (3rd cranial nerve compression) with contralateral hemiparesis, with or without hemodynamic instability (hypertension, bradycardia, respiratory variation).
Intracerebral hemorrhage: The accumulation of blood within the parenchyma of the brain. This can result from trauma and is best diagnosed with a CT scan.
Penetrating brain injury: Injury to the brain resulting from penetration of the skull, dura, and brain parenchyma by a foreign body.

INDICATIONS TO PERFORM CRANIAL PROCEDURES IN AUSTERE SETTING

The decision to perform a neurosurgical intervention in an austere location is best made with the telemedicine support of a neurosurgeon.

> *Telemedicine consult may be obtained from the closest neurosurgeon in the evacuation chain. In addition, worldwide neurosurgery consultation is available at Advanced Virtual Support for Operational Forces (ADVISOR): Synchronous, 24/7 provider to provider consultation service for operational forces (833) 238-7756 or DSN (312) 429-9089*

If CT scan is available, obtaining a stat CT head (without contrast) will greatly facilitate the appropriate treatment and intervention.

When a CT scan is not available, there is a high risk that procedures may be performed without correct localization of pathology. It is therefore necessary to make an accurate diagnosis, appropriately resuscitate, and exhaust all medical interventions prior to performing a procedure in this environment. Regardless of whether a CT scan is available, the indications for surgical intervention are clinical.

WHEN TO PERFORM CRANIAL PROCEDURES

Perform only:

- After teleconsultation with neurosurgery
- Evacuation to a neurosurgeon is not available within approximately 5 hours of severe injury (see below)[2,11]
- Surgeon training and resources are adequate. See Appendix A (Training) and Appendix B (Resources).

Indications:

- Severe closed supratentorial brain injury with a presenting Glasgow Coma Scale (GCS) ≤ 8 **AND**:
  - **Lateralizing** cortical dysfunction such as unilateral dilated pupil or hemiparesis **AND**
  - **Hemodynamic dysfunction** indicative of impending herniation: hypertension, bradycardia, and respiratory variation (Cushing's reflex) **AND**
  - **Failure of maximal critical care management to stabilize the patient.**[2,10] This may manifest by the persistence of the above two findings despite maximal critical care interventions (Tier 1-3 interventions – see Traumatic Brain Injury and Neurosurgery in the Deployed Environment CPG), or the occurrence of a new or worsening lateralizing cortical finding (hemiparesis, rapidly expanding pupil) and/or further decline in GCS off of sedation

WHEN NOT TO PERFORM CRANIAL PROCEDURES

- Clinical condition and neurologic status stabilized or improved with aggressive medical management.
- Surgeon and resources are not adequate. See Appendix A (Training) and Appendix B (Resources).
- The patient has a post-resuscitation GCS = 3 with bilateral fixed and dilated pupils. This is non-survivable. Refer to Catastrophic Non-Survivable Brain Injury CPG for supportive care.[12]
- Imaging evaluation demonstrating catastrophic injury with poor clinical prognosis (consult with neurosurgeon, Example: missile crossing zona fatalis.)[13]

CHECKLIST/PROCEDURES FOR CRANIECTOMY

1. Obtain stat non-contrast head CT (if available).
2. **Establish teleconsultation with neurosurgeon.** Video consultation is preferred. If unable to communicate with a neurosurgeon, recommend a multi-disciplinary discussion which includes the local command authority prior to proceeding.

3. Make every effort to evacuate the patient to a facility where neurosurgery is available within **approximately 5 hours.**
4. Assess indications for craniectomy.
5. Assess availability of follow-on care.
6. **Ensure that maximal medical/critical care management and resuscitation of the patient's intracranial condition has occurred.** This should include appropriate blood component resuscitation, hypertonic saline, anticonvulsant, sedation, etc. in accordance with the Traumatic Brain Injury Management and Neurosurgery in the Deployed Environment CPG.[2]
7. Ensure that the surgeon training and the facility resources are adequate.
8. If the above indications are met, then, in consultation with a neurosurgeon (when possible), consider intervention as follows. (*Note: Review Emergency War Surgery Manual for further details*.[4])

CRANIAL PROCEDURES FOR CLOSED HEAD INJURY[14, 15]

If no CT scan is available, an accurate neurological examination must be obtained for the purposes of localizing the lesion. A skull X-ray may improve localization in cases of skull fracture or penetrating brain injury.

Proper positioning of the patient is essential.

1. Avoid any compression of the neck to assure unhindered jugular venous outflow. Temporary removal of cervical collar is recommended as well as the use of a generous shoulder bump to allow semi-lateral positioning without the need for severe head rotation.
2. The head should be positioned slightly higher than the chest to reduce venous congestion and decrease bleeding.
3. Rotate the head 30-40° off midline such that the side being operated on is highest.
4. Mark the midline of the scalp, as well as the location of anticipated burr hole and craniotomy incisions, prior to draping the head. The planned craniotomy should encompass any penetrating injury, if present. It is critical that the planned hemi-craniotomy/craniectomy should achieve adequate dimensions of decompression (15cm AP length, 12cm width, taken to the floor of the middle fossa to decompress the temporal lobe). Equally important is avoidance of iatrogenic superior sagittal sinus injury through inadvertent craniectomy too close to the midline.
5. A single myocutaneous flap should be elevated forward from the cranial surface using cautery and periosteal elevators. Multiple incisions have been described to achieve adequate exposure for optimal cranial decompression. The temporalis is divided superior to the root of the zygoma and dissected anteriorly with its pedicle deep to the zygoma. The flap is secured with skin hooks or suture, permitting access to the middle cranial fossa. Scalp hemorrhage can be extreme and should be meticulously controlled with Raney clips, suture, cautery, or hemostats.

If pre-operative imaging is not available, exploratory burr holes should be made over the frontal, temporal and parietal convexities using the cranial drill for the purposes of identifying a hematoma. Electric drills are carried by some Role 2 teams. Manual drill/saw with Hudson Brace and Gigli saw is an extremely time-consuming and energy intensive process

1. The dura can be opened carefully through the burr hole following cauterization if hemorrhage is subdural.
2. If there is evidence of acute epidural/subdural bleeding (bleeding is not controlled), or if the hematoma is not fully evacuated, a craniectomy should be performed.
3. Burr holes alone are unlikely to be helpful in the setting of severe TBI caused by penetrating trauma, acute subdural hematoma, or an acute epidural hematoma; while they are not therapeutic, they are diagnostic for localization of the bleed in the absence of preoperative imaging. Craniectomies should NOT be performed if no subdural or epidural hematoma is encountered, unless there is external evidence of ipsilateral penetrating injury.

Once the decision to proceed with craniectomy is made, the dura must be carefully separated from the inner table of the skull (Penfield 1-3 instruments) and the burr holes connected with the Gigli saw or electric drill using either a side-cutting bit or a "matchstick" bit.

1. An appropriately sized hemi-craniectomy is usually at least 15cm long in the sagittal plane and 12cm in height in the coronal plane, a smaller craniectomy is not advisable in the far-forward setting.
2. Take care to stay >2.5cm from midline in-order-to avoid injury to the superior sagittal sinus.
3. If the hematoma is epidural, it must be evacuated and the bleeding source cauterized.
4. If subdural, the dura must be opened, the hematoma evacuated, and if visible, the bleeding source cauterized.
5. DO NOT replace the bone. For U.S. Service Members, the bone should be discarded with planned future cranioplasty with custom implant.
6. If not visible, do not search for a hemorrhage source in order to minimize risk of further injury.
7. If subdural pathology, do not close the dura. The dura may be loosely reapproximated over the cerebral hemisphere. Dural allograft (e.g., Duragen), if available, should be placed over the decompressed cerebral hemisphere for improved cerebrospinal fluid (CSF) control and to assist with future cranioplasty. Alternative hemostatic agents (e.g., Gelfoam, Surgicel) or pericranium autograft can be used to create a barrier between cerebral cortex and scalp.
8. An intracranial monitor (external ventricular drain (EVD) or parenchymal intracranial pressure (ICP) monitor) should be placed if available and the surgeon is adequately trained to perform the procedure. EVD is preferred as it is both a diagnostic and therapeutic device.
9. In all circumstances, the scalp must be closed (interrupted 2-0 Vicryl to reapproximate Temporalis fascia, interrupted 2-0 Vicryl to close galea, running staple line for skin).

   **If the brain herniates rapidly after dural opening, close the scalp immediately due to risk of cyclical and catastrophic extracranial herniation, which is associated with a high mortality **

CRANIAL PROCEDURES FOR PENETRATING HEAD INJURY

Penetrating brain injury is one of the most challenging indications for cranial procedures performed by neurosurgeons.

1. Exploration without teleconsultation from a neurosurgeon is **NOT** recommended.
2. There is often deep and uncontrollable bleeding that may not be evident on the cortical surface.
3. Surgical exploration below the surface of the brain is **NOT** recommended.
4. Surgical intervention should be limited to removing bone, opening the dura, controlling bleeding, and closing the skin rapidly.

If cranial contents are herniated from either the entry or exit wound, allow this to continue. Do not close the wound. Recommend coverage with a loose, clean dressing (Kerlix soaked in saline) and initiate and maintain IV antibiotic coverage with central nervous system penetration.

Adequately resuscitate as necessary, and transport at the soonest opportunity.

If evacuation to a higher role of care is not possible, recognize that intervention in this case may be futile.

PERFORMANCE IMPROVEMENT (PI) MONITORING

POPULATION OF INTEREST

All patients at a Role 2 surgical capability with an initial GCS ≤ 8 AND diagnosis of traumatic brain injury.

INTENT (EXPECTED OUTCOMES)

1. Cranial procedures will be performed by non-neurosurgeons only when a neurosurgeon is not available within approximately 5 hours.
2. Only patients with following criteria undergo decompressive craniectomy by a non-neurosurgeon:

a. Traumatic brain injury with post-resuscitation GCS ≤8 AND

b. Lateralizing neurologic signs AND

c. Hemodynamic dysfunction (hypertension, bradycardia, and respiratory variation: i.e., Cushing's reflex) AND failure of maximal critical care management (new lateralizing cortical finding such as hemiparesis or rapidly expanding pupil, and/or further decline in GCS off of sedation).

3. Non-neurosurgeons will perform emergency life-saving cranial procedures only after teleconsultation with a neurosurgeon. If communications allow real time surgical teleconsultation with a neurosurgeon can augment surgical effectiveness.
4. Non-neurosurgeons will perform emergency life-saving cranial procedures using an electric drill and saw.

PERFORMANCE/ADHERENCE METRICS

1. Number and percentage of patients in the population of interest with documentation of anticipated length of time > 5 hours to arrive at a facility with a neurosurgeon.
2. Number and percentage of patients in the population of interest who have the following indications documented:
   a. TBI with post-resuscitation GCS ≤8 AND

   b. Lateralizing neurologic signs AND

   c. Hemodynamic dysfunction (hypertension, bradycardia, and respiratory variation: i.e., Cushing's reflex) AND failure of maximal critical care management (new lateralizing cortical finding such as hemiparesis or rapidly expanding pupil, and/or further decline in GCS off of sedation).
3. Number and percentage of patients in the population of interest who have documentation of teleconsultation with a neurosurgeon.
4. Number and percentage of patients in the population of interest who have documentation of the use of an electric drill and saw for the procedure.

DATA SOURCE

- Patient Record
- DoD Trauma Registry
- ICU flow sheet

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.

Deploying general surgeons and trauma surgeons should remain current with emergency cranial neurosurgical intervention through attendance at pre-deployment training (Emergency War Surgery course) AND by assisting in cranial procedures at their home institution.

REFERENCES

1. Breeze J, Bowley DM, Harrisson SE, et al. Survival after traumatic brain injury improves with deployment of neurosurgeons: a comparison of US and UK military treatment facilities during the Iraq and Afghanistan conflicts. J Neurol Neurosurg Psychiatry. 2020;91(4):359–365
2. JTS. Traumatic Brain Injury and Neurosurgery in the Deployed Environment CPG.
3. JTS Committee on Surgical Combat Casualty Care position statement: Neurosurgical capability for the optimal management of traumatic brain injury during deployed operations. J Trauma Acute Care Surg. 2023 Aug 1;95(2S Suppl 1):S7-S12.
4. Head Injuries: Emergency War Surgery Manual, 5th United States Revision. Office of the Surgeon General, United States Army. Borden Institute. Ch. 15; 213-234.
5. Rinker CF, McMurry FG, Groeneweg VR, et al. Emergency Craniotomy in a rural Level III trauma center. J Trauma. 1998;44(6):984-9.
6. Springer MF, Baker FJ. Cranial burr hole decompression in the emergency department. Am J Emerg Med. 1988:6(6);640-6.
7. Gilligan J, Reilly P, Pearce A, Taylor D. Management of acute traumatic intracranial haematoma in rural and remote areas of Australia. ANZ J Surg. 2017:87(1-2):80-85.
8. Luck T, Treacy PJ, Mathieson M, Sandilands J, Weidlich S, Read D. Emergency neurosurgery in Darwin: still the generalist surgeons' responsibility. ANZ J Surg. 2015;85(9):610-4.
9. Giannou C, Balda M. War Surgery: Working with limited resources in armed conflict and other situations of violence. Volume 1. International Committee of the Red Cross. Geneva, Switzerland. May 2010.
10. Fang R, Markandaya M, DuBose JJ, et al. Early in-theater management of combat-related traumatic brain injury: a prospective, observational study to identify opportunities for performance improvement. J Trauma Acute Care Surg. 2015;79(4 Suppl 2):S181–S187.
11. Shackelford SA, Del Junco DJ, Reade MC, et al. Association of time to craniectomy with survival in patients with severe combat-related brain injury. Neurosurg Focus. 2018 Dec 1;45(6):E2.
12. JTS. Catastrophic Non-Survivable Brain Injury CPG.
13. Rosenfeld JV, Bell RS, Armonda R. Current concepts in penetrating and blast injury to the central nervous system. World J Surg (2015) 39:1352–1362.
14. Ragel BT, Klimo P Jr, Martin JE, et al. Wartime decompressive craniectomy: technique and lessons learned. Neurosurg Focus. 2010 May;28(5):E2.
15. Rubiano AM, Maldonado M, Montenegro J, et al. The evolving concept of damage control in neurotrauma: application of military protocols in civilian settings with limited resources. World Neurosurg. 2019 May;125:e82-e93.

APPENDIX A: TRAINING FOR CRANIAL PROCEDURES IN AUSTERE SETTING

The training and experience of individual surgeons is a factor that must be considered on a case-by-case basis when deciding whether to perform a neurosurgical intervention in an austere environment. In some cases a prolonged evacuation may be preferred over intervention by an untrained surgeon, while in other cases, such as with host national casualties, evacuation is not an option and the deployed care available is the only option.

Since neurosurgical training is not standard training for the majority of general surgeons, the following recommendations have been established to allow general surgeons to better prepare for austere surgical missions. The main purpose is to establish a guideline that, per expert opinion, optimizes the benefit: risk ratio for injured patients cared for in the forward deployed, resource limited environment.

Recommendations for non-neurosurgeons to perform cranial procedures for specific clinical indications in austere environments include:

- Board certified/eligible general or head and neck surgeon.
- Participation in at least 10 cranial procedures supervised by a neurosurgeon. At least 1 of these procedures should occur within 1 year of scheduled deployment.
- Completed a cranial simulator course prior to deployment run by a board certified/board eligible neurosurgeon (i.e., Emergency War Surgery Course or ASSET+).

Training recommendations do not constitute a credentialing requirement. Individual surgeons may perform cranial procedures when the clinical situation, available resources, and analysis of the risks and benefits of both surgical and medical management favor surgical intervention.

In cases where a surgeon has not completed the recommended training, the risk of neurosurgical intervention may outweigh the benefit and medical management may be preferred.

For context and perspective, the minimum number of trauma craniotomies required to graduate a neurosurgical resident trainee is 40. The committee of subject matter experts suggest 10 for non-neurosurgeons in an effort to balance forward requirements with the necessary competency given the current training environment.

Recommendations based on Consensus opinion American Association of Neurological Surgeons/Congress of Neurological Surgeons Joint Committee of Military Neurosurgeons, meeting 24 Apr 2017.

APPENDIX B: RESOURCES FOR CRANIAL PROCEDURES IN AUSTERE SETTING

Neurosurgical intervention is greatly facilitated by obtaining the recommended supplies and equipment. The risk of neurosurgical intervention is higher when proper equipment is not available. Every effort should be made to obtain the necessary supplies and equipment if neurosurgical procedures are within the scope of a surgical team's mission. If only a Gigli saw and Hudson brace are available to an inexperienced provider, the risk of neurosurgical intervention may outweigh the benefit, and medical management may be preferred.

Recommended resources necessary to support non-neurosurgeons who may have to perform cranial procedures in an austere environment should include all of the following:

1. Teleconference capability (video-teleconference capability preferred).
2. Emergency cranial pack that includes an electric drill with cranial perforator bit and matchstick or cutting ball, a Leksell Rongeur, Penfield instruments, bipolar cautery, Raney clips or silk stitches to control scalp hemorrhage, dural substitutes, and hemostatic agents (i.e., gel foam, surgical, etc.). A Gigli saw and Hudson drill may be included as back up should the electric drill fail during the procedure.
3. Critical care capabilities.

***NOTE**: Non-invasive measures of intracranial injury are an emerging technologies that may be utilized to improve localization of injury or superficial hematoma.*

Non-invasive Measurement Resources

1. Quantitative pupillometry: This is a small hand-held device that initiates a miotic pupillary response, records the speed of the response, and supplies a normative pupillary index (NPI).[1,2]
   - As intracranial pressure increases, the NPI decreases.
   - Asymmetric injury can result in asymmetric NPI and can aide with determining the hemisphere injured.
2. Near—infrared spectroscopy and ultrasound measurement of optic nerve sheath diameter are other technologies with ongoing investigations to determine efficacy for diagnosing intracranial hypertension or hemorrhage.[3]

References

1. Taylor WR, Chen JW, Meltzer H, Gennarelli TA, et al. Quantitative Pupillometry, a new technology: normative data and preliminary observations in patients with acute head injury. Technical note. J Neurosurg. 2003:98(1);205-13.
2. Martinez-Palacios K, Vasquez-Garcia S, Fariyike OA, et al. Quantitative Pupillometry for Intracranial Pressure (ICP) Monitoring in Traumatic Brain Injury: A Scoping Review. Neurocrtical Care. 13 Feb 2024.
3. Sen AN, Gopinath SP, Robertson CS. Clinical application of near-infrared spectroscopy in patients with traumatic brain injury: a review of the progress of the field. Neurophoton. 2016:3(3); 031409.
4. Yic CD, Pontet J, Mercado M, Muñoz M, Biestro A. Ultrasonographic measurement of the optic nerve sheath diameter to detect intracranial hypertension: an observational study. Ultrasound J. 2023 Feb 2;15(1):4.

APPENDIX C: CLASS VII MEDICAL MATERIEL

To perform emergency life-saving cranial procedures in a deployed setting, non-neurosurgeons need a specific set of medical materiel. Here's an itemized list for such procedures, derived from the clinical practice guidelines and medical standards:

General Instruments and Supplies

1. Sterile surgical drapes
2. Sterile gloves
3. Surgical gowns
4. Sterile towels
5. Surgical masks
6. Face shields or eye protection
7. Sterile suction tubing
8. Sterile basins
9. Sterile sponges
10. Antiseptic solution (e.g., Betadine, Chlorhexidine, Chloraprep, Duraprep)

Instruments

1. Craniotomy Set

- Skin hooks

a. Hudson brace or pneumatic/electric drill

- Burr hole trephine
- Gigli passer/saw with handles or electric/pneumatic craniotome with side-cutting bit
- Rongeurs (Leksell double action, Kerrisons)
- Periosteal elevators and Penfield Dissectors
- Metzenbaum Scissors
- 15 Blade for dura, 10 Blade for skin

b. Ribbon brain retractors

- Plating system with screws for bone flap fixation

c. Non-suturable dural substitute (if available; surgical/gelfoam/autologous pericranium can also be utilized)

d. Irrigation

e. Subgaleal 7-10 Fr surgical drain to bulb suction

2. Craniectomy Set

- Same as craniotomy set minus the plating system

3. Ventriculostomy Set

- Handheld drill or pneumatic drill
- Burr hole bit
  a. Heiss retractor
  b. Hemostat (periosteal elevation)
  c. 18-g needle to fenestrate dura
- Silastic ventricular catheter with trocar for subcutaneous tunneling
- Sterile collection system for cerebrospinal fluid
- Pressure transducer system for intracranial pressure monitoring (if available)

Hemostasis

1. Electrocautery unit
2. Cautery tips (protected monopolar and bipolar)
3. Hemostatic agents (e.g., Surgicel, Gelfoam (thrombin soaked))
4. Bone wax
5. Hemostatic clips (e.g., Raney clips, hemostats)

Sutures and Closure

1. Suture material: 2-0 Vicryl galea, 2-0 Nylon to secure any drains, 4-0 Neurolon or Silk for dura if needed (not indicated for craniectomy/craniotomy with expansile duraplasty)
2. Skin stapler
3. Needle holders
4. Scalpel with blades: 10 and 15
5. Forceps (Adson and Geralds)
6. Loose sterile dressing: bacitracin ointment, 4x4s, LOOSE Kerlex wrap

Monitoring and Support

1. Portable anesthesia machine
2. Endotracheal tubes
3. Laryngoscope with blades
4. Ventilator
5. Pulse oximeter
6. Blood pressure cuffs
7. Intravenous lines and fluids
8. Intravenous pumps
9. Oxygen supply
10. Suction device

Imaging and Diagnostics

CT Scanner (if available)

Post-Operative Care

1. ICU supplies
2. ICP Monitoring equipment. If transducer unavailable ICP can be checked manually through the CSF collection system). A level and IV pole are helpful to ensure system drainage level.
3. Intravenous medications (e.g., antibiotics, antiepileptics, analgesics, sedatives)
4. Foley catheters
5. Nasogastric tubes
6. Chest tubes and drainage systems

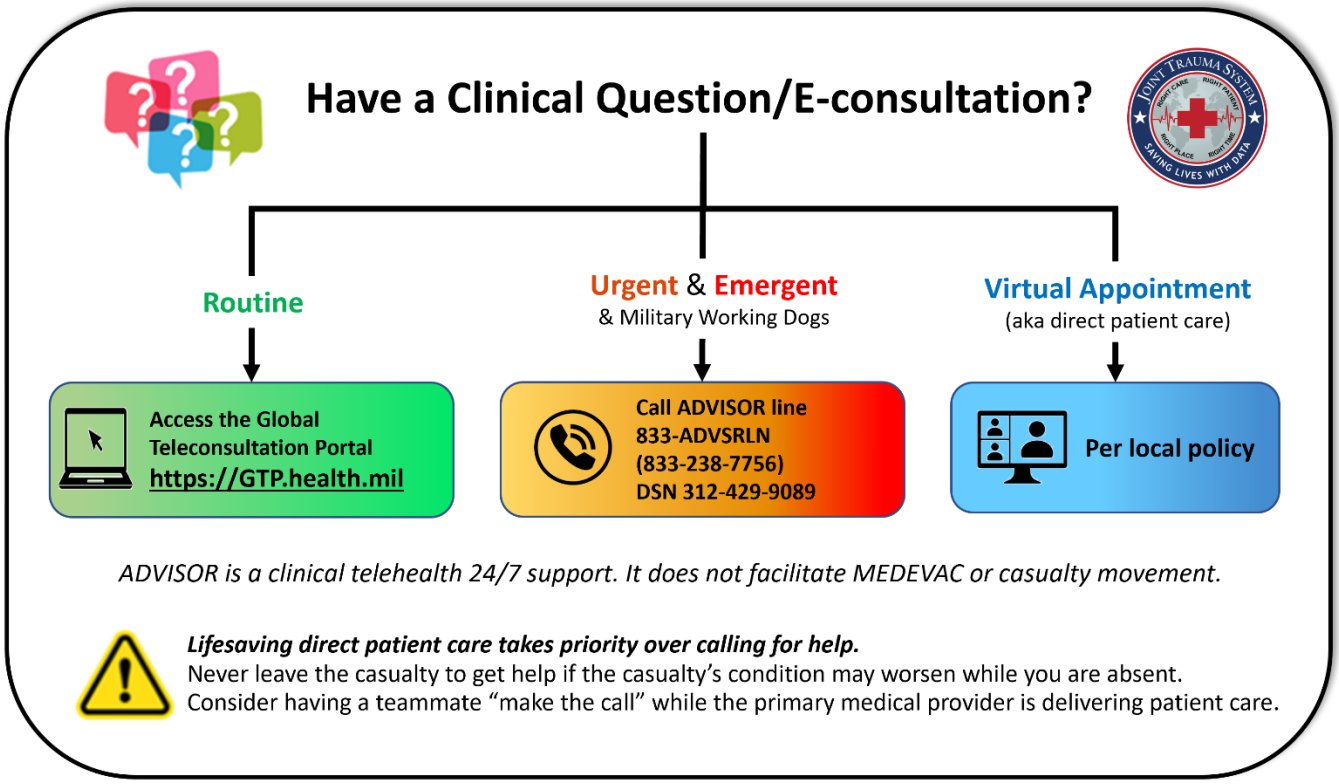
Documentation

1. Surgical logbook
2. Patient medical record forms
3. Procedure consent forms
4. ICU trifold

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 D: TELECONSULTATION / TELEMEDICINE



Teleconsultation infographic-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 E: 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.