Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA) for Hemorrhagic Shock

Part of the Joint Trauma System (JTS) Clinical Practice Guideline (CPG) Training Series
This CPG reviews the range of accepted management approaches to profound shock and post-traumatic cardiac arrest and establishes indications for considering REBOA as a hemorrhage control adjunct.

*Presentation is based on the [JTS Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA) for Hemorrhagic Shock CPG, 06 Jul 2017 (ID: 38)](https://www.dha.mil/Portals/85/Documents/PPG/2017-07-JTS-REBOA-CPG.pdf). It is a high-level review. Please refer to the complete CPG for detailed instructions. Information contained in this presentation is only a guideline and not a substitute for clinical judgment.*
Agenda

1. Summary
2. Background
3. Indications and Techniques
4. ER REBOA
5. Pitfalls
6. Performance Improvement (PI) Monitoring
7. Additional Information
8. References
9. Appendices
10. Contributors
Summary

- Patients exsanguinating from the abdominal, pelvic, or junctional lower extremity may be candidates for REBOA.

- REBOA can be done before the patient is in extremis in patients with high risk injuries and unstable physiologic parameters.
Background

- Hemorrhage is the leading cause of preventable death on the battlefield.
  - Non-compressible torso hemorrhage (NCTH) is particularly lethal because it is occult and not amenable to control by direct pressure.
  - NCTH arises from trauma to torso vessels, organs, or bony pelvis.

- Resuscitative Aortic Occlusion (RAO) affords distal hemorrhage control while increasing afterload and central aortic pressure.
  - Used in treatment of NCTH in patients with profound shock.
  - Provides time until direct hemostasis can be obtained.
  - Options for RAO are:
    - Emergency Resuscitative Thoracotomy (ERT)
    - REBOA
Indications & Techniques

■ Initial management priorities for patients with traumatic arrest or impending arrest include early control of hemorrhage and hemostatic resuscitation.

■ Multiple Factors impact steps providers will undertake and include:
  - Mechanism and pattern of injury
  - Presence of a pulse
  - Duration of cardiac arrest
  - Presence of cardiac activity
  - Resources available
  - Number of concurrent casualties

■ Localize bleeding as best as possible with appropriate imaging or procedures.
REBOA may be a suitable option for the patient with traumatic arrest or impending arrest.

- Ideal for exsanguination from abdominal, pelvic, or junctional lower extremity bleeding.
- Evaluate for significant chest injury prior to use.

Source: Out Of The Crucible: How The US Military Transformed Combat Casualty Care In Iraq And Afghanistan
RAO Decision Algorithm

- Blunt trauma with no major chest bleeding seen on CXR, ultrasound, or bilateral chest tubes
- Penetrating trauma to abdomen/pelvis

If SBP < 90, see REBOA for Profound Shock Algorithm

ATLS Protocols:
- Intubation
- Volume infusion
- Rapid assessment for hemorrhage

Palpable carotid pulse?

Yes
- Organized EKG rhythm or cardiac contraction on ultrasound?
  Yes
  - Blunt Trauma
  No
  - Penetrating Trauma

No
- CPR <15 minutes
  Yes
  - Blunt trauma?
  - Penetrating Trauma
  No
  - Penetrating Trauma

Clinical response?

Yes
- Penetrating Trauma
No
- Penetrating Trauma

Consider Thoracotomy vs REBOA if reversible cause suspected. Otherwise declare patient dead.

CPR <15 minutes

Yes
- Blunt trauma?
  - Penetrating Trauma
  No
  - Penetrating Trauma

No
- Penetrating Trauma

Penetrating Neck → Operating Room
Penetrating Chest → Thoracotomy
Penetrating Extremity → Tourniquet, Resuscitate

A/P/J

Thoracotomy vs Zone 1 REBOA

Dead

Source: JTS Resuscitative Endovascular Balloon Occlusion of the Aorta for Hemorrhagic Shock CPG, 06 Jul 2017
Indications & Techniques

- Neither REBOA or ERT have been shown to be superior over the other but current recommendations are:
  - REBOA is best for patients with site of hemorrhage below the diaphragm.
  - ERT is best for patients with significant thoracic or cardiac injury.

- Best to perform REBOA prior to cardiac arrest
  - Pre-emptive placement of an arterial line in the common femoral artery can facilitate eventual REBOA.
  - If SBP < 90 with only transient or no response, REBOA can be considered.

- Current REBOA balloon/catheter most commonly encountered is ER-REBOA (but other types/brands exist).
Algorithm: REBOA for Shock

SBP<90 with Transient or No Response to initial ATLS Resuscitation

**Blunt Trauma**

- **Severe Chest Injury?**
  - Yes: No REBOA
  - No
    - Abdominal FAST Positive
      - Yes: • Consider Zone I REBOA • Emergent Laparotomy
      - No
        - Pelvic Fx?
          - Yes: Consider Zone III REBOA
          - No

***
- Major chest bleeding seen with CXR, ultrasound, or bilateral chest tubes
- Suspected cardiac or aortic injury

**Penetrating**

- Neck
  - • REBOA not indicated • Operating room
- Chest
  - • REBOA not indicated • Consider thoracotomy
- Extremity
  - Consider Zone I REBOA
- A/P/J
  - Tourniquet, Resuscitate

Source: JTS Resuscitative Endovascular Balloon Occlusion of the Aorta for Hemorrhagic Shock CPG, 06 Jul 2017
REBOA Requires 6 General Steps using ER-REBOA

1. Arterial Access and Positioning of Sheath
   - Obtained at common femoral Artery either open or percutaneously
   - Must have a 7 fr sheath for REBOA

2. Selection and positioning of the balloon
   - Zone I: Thoracic Aorta: 46 cm or Measured from sternal notch to femoral access catheter
   - Zone III: Pelvic or junctional femoral hemorrhage: 27 cm or measured from umbilicus to the femoral access catheter

3. Inflation of the balloon
   - Guided by fluoroscopy, hemodynamic response, and/or loss of the contralateral pulse
REBOA Requires 6 General Steps using ER-REBOA

4. Operative/procedural control of bleeding
   - Zone I REBOA inflation time ideally less then 30 minutes with maximum of 60 minutes.
   - Zone III inflation time may be longer then Zone I.

5. Deflation of the balloon
   - Discussion prior to deflation with care team is critical.
   - Deflate slowly and anticipate a significant hemodynamic changes.
   - Intermittent balloon inflation/deflation may be necessary with ongoing resuscitation to reduce reperfusion effects.

6. Sheath Removal
   - Ideally flush with 100 mL of heparinized saline.
   - May require surgical repair.
   - Do not remove while coagulopathic.
**Pitfalls**

- **REBOA placement pitfalls to avoid:**
  - Making decision to perform REBOA too late, mortality high when patient pulseless.
  - Unfamiliarity with femoral artery anatomy.
  - Inserting the REBOA below the femoral artery bifurcation.
  - Unrecognized proximal femoral or iliac artery transection preventing endovascular access on side of injury – access side with stronger pulse, do not hesitate to switch sides, or perform thoracotomy.
  - Failure to address chest pathology – always evaluate the chest and convert to thoracotomy to address massive hemothorax.
  - Consider accessing the opposite groin or convert to thoracotomy if the catheter/guidewire does not pass freely.
Pitfalls

REBOA placement pitfalls to avoid (continued):

- Over inflating the balloon – typical inflation amounts for ER-REBOA are 8 mL for Zone I and 3 mL for Zone III.
- Failure to work with heightened urgency with return of improved vital signs and subsequently leaving the balloon inflated too long (60 minutes considered a maximum).
- Failure to adequately securing REBOA with resulting migration of the balloon.
- Deflating the balloon before adequate resuscitation.
- Removal of the arterial sheath while the patient is still coagulopathic.
- Injury to the arterial access point.
- Committing resources to a futile resuscitation.
Intent (Expected Outcomes)

- If performed, REBOA was performed for hemorrhagic shock associated with uncontrolled abdominal, pelvic, or junctional lower extremity bleeding.
- The chest was evaluated at the time of REBOA placement (ultrasound, chest-X-ray, or chest tube) for contraindications to REBOA placement.
- Abdominal FAST exam was documented at the time of REBOA placement.

Data Source

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

Performance/Adherence Measures

- If performed, REBOA was performed for hemorrhagic shock associated with uncontrolled abdominal, pelvic, or junctional lower extremity bleeding.
- The chest was evaluated at the time of REBOA placement (ultrasound, chest-X-ray, or chest tube) for contraindications to REBOA placement.
- Abdominal FAST exam was documented at the time of REBOA placement.
- REBOA was performed only in patients with signs of hemorrhagic shock.
- JTS identifies all REBOA to ensure appropriate capture of data in the DoDTR.
- Document all REBOA-related complications in the medical record.

PI Data Capture And Reporting

- Number of REBOA interventions, performance, and adherence measures will be reported quarterly by JTS PI Branch Chief to the JTS Director.
- JTS will identify REBOA patients in the trauma registry and facilitate capture of complete medical records.
Detailed descriptions of technique, equipment requirements and links to available videos can be found in the Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA) for Hemorrhagic Shock CPG Appendices at:

References (1)

References (2)


References (4)


Appendices in CPG

- **Appendix A:** Traumatic Arrest Algorithm for REBOA
- **Appendix B:** Algorithm for the Use of REBOA for Profound Shock
- **Appendix C:** Aortic Zones
- **Appendix D:** Equipment and Supplies for REBOA
- **Appendix E:** REBOA Steps Using the 7 French ER-REBOA
- **Appendix F:** ER-REBOA Procedure Checklist
- **Appendix G:** Additional Information Regarding Off-Label Uses in CPGs
Contributors

- Maj Jason Pasley, USAF, MC
- LtCol Jeremy Cannon, USAF, MC
- CDR Jacob Glaser, MC, USN
- CDR Travis Polk, MC, USN
- MAJ Jonathan Morrison, RAMC
- Maj Jason Brocker, USAF, MC
- LtCol Benjamin Mitchell, USAF, MC

- Maj Justin Manley, USAF, MC
- LTC Tyson Becker, MC, USA
- LtCol Joseph Dubose, USAF, MC
- Col Todd Rasmussen, USAF, MC
- Col Stacy Shackelford, USAF, MC
- CAPT Zsolt Stockinger, MC, USN

Slides: Maj Andrew Hall, MC, USAF

Photos are part of the JTS image library unless otherwise noted.