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Resuscitative
Retrograde Endovascular Balloon Occlusion of the Aorta
(REBOA)
REBOA is an adjunct in the setting of hemorrhagic shock and an alternative to thoracotomy with aortic compression.
Objectives

- Review background
- Explain rationale
- Establish indications
- Itemize resources
- Describe technique for REBOA
Background

Truncal hemorrhage is the leading cause of preventable death on the battlefield and in motor vehicle collisions.
Background

Balloon occlusion of the aorta is not a new intervention.

The technique was described as a resuscitative intervention by Hughes in 1954.
Rationale and Indications

Non-Compressible Torso Hemorrhage (NCTH) is defined as hemorrhage arising from trauma to the torso vessels, pulmonary parenchyma, solid abdominal organs and / or a disruption of the bony pelvis.
Rationale and Indications

External cardiac compression has not proven beneficial in the setting of NCTH with cardiac arrest, hypotension or shock.
Rationale and Indications

Resuscitative aortic occlusion (RAO) for NCTH:

- mitigates hemorrhage
- increases afterload
- increases central aortic pressure
- buys time until surgical / IR hemostasis can be achieved
RAO Indications

In pulseless patients determine the following:

1. Mechanism and pattern of injury
2. Duration of CPR
3. Presence of an organized, narrow-complex cardiac rhythm and / or organized cardiac activity by FAST exam
RAO Indications

If RAO is to be performed, closed chest cardiac massage can continue while the surgeons are preparing for this procedure.

If RAO is not to be performed, resuscitative efforts should cease unless there is a compelling reason to consider a non-traumatic cause of the arrest.
Early identification of patients with pulses who are at risk for profound shock or traumatic arrest is essential. Early application of RAO / REBOA prior to arrest can lead to improved outcomes.
Resuscitative aortic occlusion (RAO) has traditionally required a thoracotomy or a laparotomy for aortic exposure.

This procedure usually occurs in the ER resuscitation bay where a left anteriolateral thoracotomy and direct aortic compression are performed.
RAO Techniques

1. Resuscitative thoracotomy
2. Trans-abdominal Aortic Occlusion
3. REBOA
1. Resuscitative Thoracotomy

Aortic occlusion is best performed through a left anterolateral thoracotomy.
Resuscitative thoracotomy with RAO has:

• high mortality rate
• potential for casualty morbidity
• potential for trauma team morbidity
• high resource utilization
2. Trans-abdominal Aortic Occlusion

The aorta can also be occluded trans-abdominally at any point along its length. It can be occluded with the application of a clamp, compression with a retractor, or manually.
3. REBOA

REBOA is an alternative to resuscitative thoracotomy in some cases of traumatic arrest.

An endo-aortic balloon can be placed preemptively in patients with high-risk injury patterns and unstable physiologic parameters.
REBOA Indications

REBOA is performed using transfemoral arterial access for aortic occlusion and allows for monitoring and support of central circulation in patients at risk of imminent cardiovascular collapse.
Positioning of the Balloon (Zones of the Aorta)

Zone I is the descending thoracic aorta
Zone II represents the paravisceral aorta
Zone III the infrarenal abdominal aorta
RAO algorithm

Trauma with Loss of Vitals

Blunt → Organized Rhythm on EKG or FAST → YES → Thoracotomy vs. REBOA I

Pulse → NO → NO → Dead

Penetrating → CPR ≤ 15 min → YES

Neck → OR

Chest → Thoracotomy

A/P/E* → Thoracotomy vs. REBOA I

Profound Shock Algorithm (Fig 2)
ALGORITHM FOR THE MANAGEMENT OF PROFOUND SHOCK IN PATIENTS WITH NCTH

REBOA I: Placement of aortic balloon in the thoracic aorta

REBOA III: Placement of aortic balloon directly above the aortic bifurcation
REBOA Resources and Technique

Arterial access and positioning of sheath

Selection and positioning of the balloon

Inflation of the balloon

Deflation of the balloon

Sheath removal
Establishing Arterial Access

Access to the arterial circulation for REBOA for trauma should be obtained through the femoral artery using one of three techniques:

• percutaneous,
• open exposure (i.e., cut down)
• exchange over a guide wire from an existing femoral arterial line.
The skills and technology for REBOA are available. It provides a less invasive but expedient means to control life threatening hemorrhage.

Skill:

Technology:
Selection and Positioning of Initial Sheath

Common sheaths are 5 Fr to 8 Fr and come in lengths from 8 cm to 15 cm.

The sheath can also be placed after removing an existing arterial line over a wire (i.e., “rewiring”).
Any balloon inflated inside the aorta to occlude flow must be soft or compliant and of large diameter.
Examples of compliant balloons with their range of diameter and required sheath sizes are:

- Coda balloon (Cook Medical): 32 mm to 40 mm, 14 Fr
- Reliant balloon (Medtronic): 10 mm to 46 mm, 12 Fr
- Berenstein balloon (Boston Scientific): 11.5 mm, 6 Fr.
The balloon which has greatest application to young trauma patients is the Coda.
Inflation of the Balloon

A large-volume syringe is filled with a half-and-half solution of sterile saline and iodinated contrast.

The balloon is inflated until the outer edges of the balloon change from convex to parallel as the balloon takes on the contour of the aortic wall.
Securing the Inflated Balloon, Sheath, and Wire Apparatus

It is important to hold the balloon, sheath, and wire securely so they do not change position as the central aortic pressure increases.
Care must be taken to deflate the balloon slowly as this step can be anticipated to result in a significant decrease in afterload and hypotension.

After prolonged balloon inflation, deflation of the balloon can be expected to result in a reperfusion washout of metabolic byproducts, and acidosis.

Intermittent balloon inflation and deflation may be necessary until hemodynamic stability is restored.
REMOVAL OF THE BALLOON AND SHEATH

After REBOA is no longer required, the deflated balloon and wire may be removed from the sheath which should then be flushed.

The large diameter sheaths are best removed with open surgical exposure of the femoral artery.

The resulting arteriotomy should be have a primary closure.

Restoration of flow through the arterial segment should be confirmed.
# Joint Theater Trauma System Clinical Practice Guideline

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

<table>
<thead>
<tr>
<th>Original Release/Approval</th>
<th>16 Jun 2014</th>
<th>Note: This CPG requires an annual review.</th>
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<td>Reviewed:</td>
<td>05 May 2014</td>
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### Supersedes
- This is a new CPG and must be reviewed in its entirety.
- **Significant Changes**: Changes are substantial and require a thorough reading of this CPG (see)
- **Minor Changes**: Minor changes are noted

1. **Goal**. Review background, explain rationale, establish indications, itemize resources, and describe technique for Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA) as an interventional capability for control of hemorrhagic shock in the setting of uncontrolled truncal and extremity bleeding in surgically capable theater facilities. This Clinical Practice Guideline has been substantially adapted from the Stannard, Ellisson, and Rasmussen 2011 publication in the Journal of Trauma.

2. **Background**. Truncal hemorrhage is the leading cause of preventable death on the battlefield. Balloon occlusion as a resuscitative adjunct is not a new or novel intervention. This technique was described as a resuscitative intervention by Hughes in 1994 in the review of three cases in which it was utilized in three moribund casualties undergoing what was then the convention of pre-operative resuscitation prior to laparotomy for trauma in the setting of combat injury with the goal of improving coronary perfusion and stabilizing the shock state. Since this publication, REBOA has been described as an adjunct in the setting of hemorrhagic shock as a selective alternative to thoracotomy with aortic compression in a number of animal and human applications. Despite its potential advantage over resuscitative thoracotomy for control of hemorrhage it has not, heretofore, been widely adopted. With increasing practice experience and improved technology for endovascular therapy, it has been applied in the setting of emergent control of hemorrhage associated with abdominal aortic aneurysm. Given that: (1) the skill and technology for application of this technique are available in theater; and (2) it provides a less invasive and expedient means to control life-threatening hemorrhage in appropriately selected casualties, this intervention is recommended as an adjunct to control life-threatening hemorrhage in the setting of truncal and extremity injury.

3. **Rationale and Indications**. Hemorrhage leads to cardiovascular collapse and death unless myocardial and cerebral perfusion can be maintained. Non-Compressible Torso Hemorrhage (NCTH) is defined as hemorrhage arising from trauma to the torso vessels, pulmonary parenchyma, solid abdominal organs and disruption of the bony pelvis. In the setting of NCTH resulting in hypotension or shock, external cardiac compression has not proven beneficial. Rather, resuscitative aortic occlusion for NCTH mitigates hemorrhage and increases afterload and central aortic pressure until hemostasis can be achieved.

Resuscitative aortic occlusion (RAO) has traditionally required a thoracotomy or a laparotomy for aortic exposure. For trauma patients in extremis, this procedure occurs in the resuscitation bay where a left thoracotomy and direct aortic compression are performed to

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**Guideline Only/Not a Substitute for Clinical Judgment**

June 2014

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

Page 1 of 18
World’s first pre-hospital REBOA performed

Monday 16th June 2014

- World’s first pre-hospital REBOA carried out by London’s Air Ambulance
- Pioneering new technique to prevent trauma patients bleeding to death
- Control of severe pelvic haemorrhage, an injury most commonly associated with cycling incidents and falls from height
- 2 years of development with The Royal London Hospital
- Boris, “stunning advances in medical care are helping people survive serious injury in London”

We have performed the world’s first roadside balloon surgery to control internal bleeding. Use of pre-hospital Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA), a technique used first in the UK at The Royal London Hospital, to control haemorrhage in trauma patients is a ground breaking move by London’s Air Ambulance.

On average the charity is called six times a day to deliver life-saving medical interventions to people seriously injured in the Capital. Many of these patients are suffering from catastrophic bleeding. Tragically some die at the scene as a result of their severe blood loss and never make it to hospital. London’s Air Ambulance can now perform REBOA on patients suffering severe pelvic haemorrhage, an injury most commonly associated with cycling incidents and falls from height.


Please address all questions and / or comments to:

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