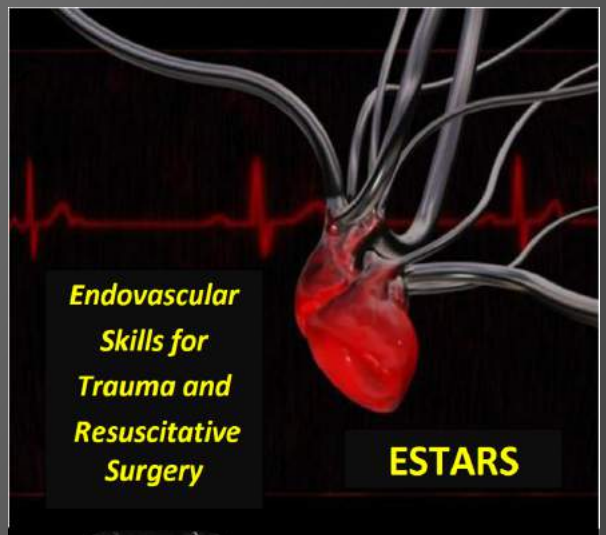
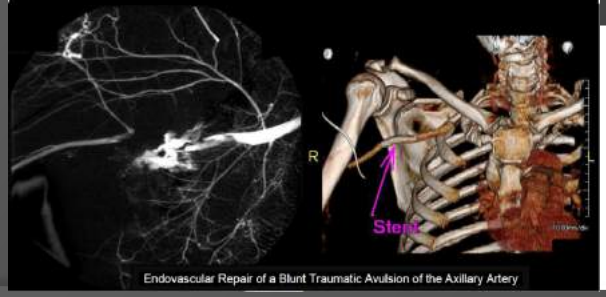
REBOA - Real World

Lena M. Napolitano, MD

REBOA:
ESSENTIAL!!!!!





Endovascular Skills for Trauma and Resuscitative Surgery

Lena M. Napolitano MD, FACS
Massey Foundation Professor of Surgery
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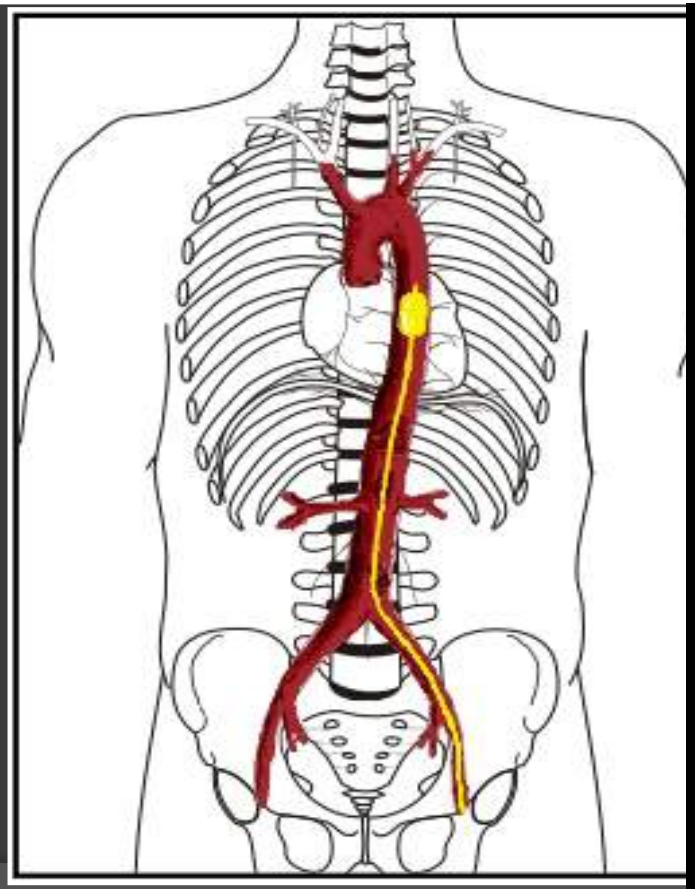
[Trauma, Burn, Critical Care, Emergency Surgery]
University of Michigan
Ann Arbor, MI

management of vascular trauma

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

Adam Stannard, MRCS, Jonathan L. Eliason, MD, and Todd E. Rasmussen, MD



- **REBOA: ESSENTIAL !**
- REBOA is an adjunct to provide early hemorrhage control
- REBOA provides early aortic occlusion to transiently stabilize patients to undergo definitive hemorrhage control

Journal of Trauma. 2011 Dec;71(6):1869–72.

REBOA: ESSENTIAL !

- **Need for the technique – patient population**
- Established technique already in use
- National/International & Military guidelines
- National Protocols
- Institutional Protocols
- Already adopted in clinical use

Hemorrhagic Shock

Major cause of trauma mortality (40% civilian/military)

Leading cause of potentially preventable death in trauma

87% due to Noncompressible Torso Hemorrhage

Injury Severity and Causes of Death From Operation Iraqi Freedom and Operation Enduring Freedom: 2003–2004 Versus 2006

Joseph F. Kelly, MD, Amber E. Ritenour, MD, Daniel F. McLaughlin, MD, Karen A. Bagg, MS, Amy N. Apodaca, MS, Craig T. Mallak, MD, Lisa Pearse, MD, Mary M. Lawnick, RN, BSN, Howard R. Champion, MD, Charles E. Wade, PhD, and COL John B. Holcomb, MC

Journal of Trauma. 2008;64(2Suppl):S21–6.

Impact of Hemorrhage on Trauma Outcome: An Overview of Epidemiology, Clinical Presentations, and Therapeutic Considerations

David S. Kauvar, MD, Rolf Lefering, PhD, and Charles E. Wade, PhD

Journal of Trauma. 2006;60(6 Suppl):S3–11.

REBOA: ESSENTIAL !

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- National Protocols
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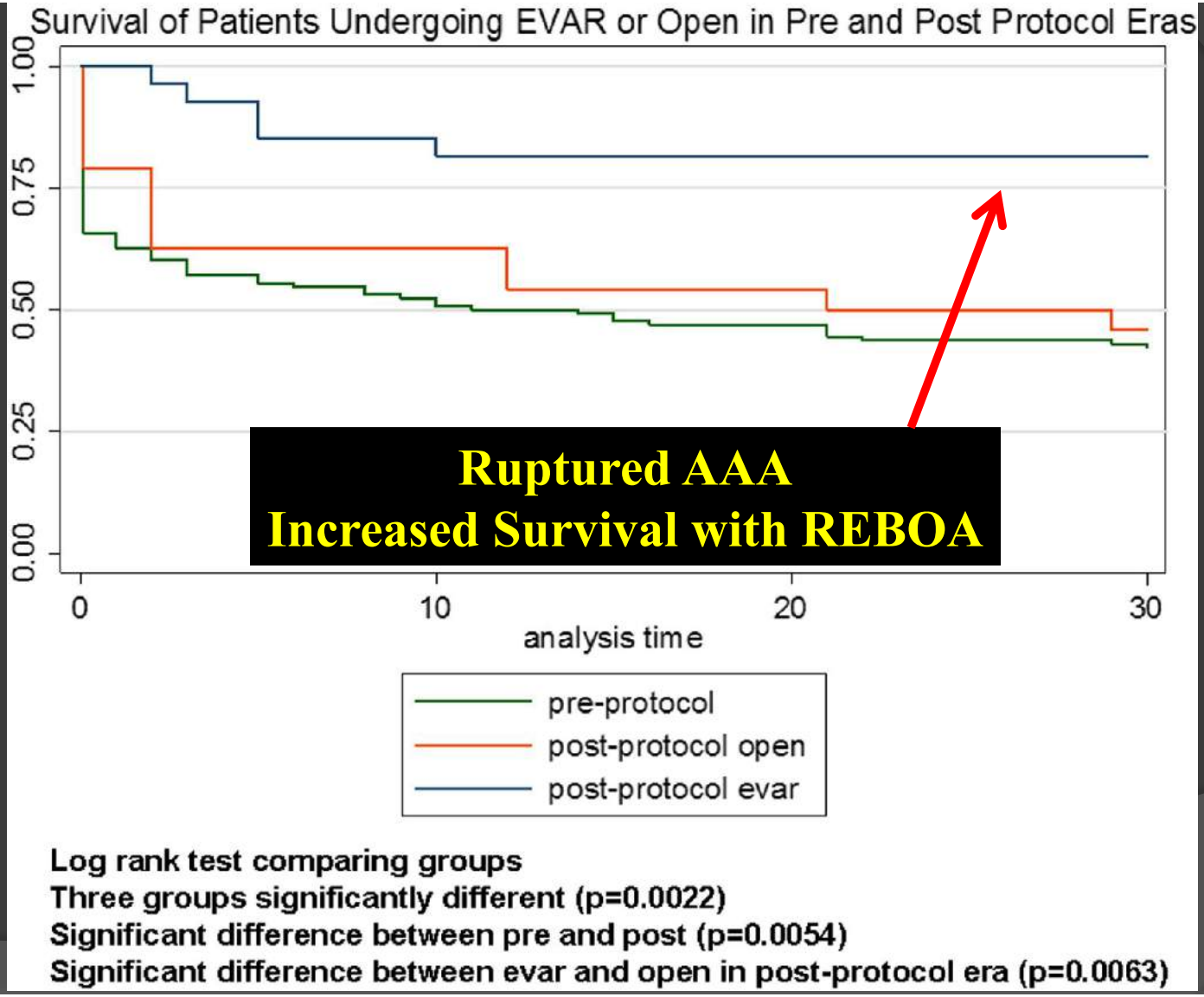
Survival of Patients Undergoing EVAR or Open in Pre and Post Protocol Eras
1.00
0.75
0.50
0.25
0.00
0
10
20
30
analysis time
Ruptured AAA
Increased Survival with REBOA
pre-protocol
post-protocol open
post-protocol evar
Log rank test comparing groups
Three groups significantly different (p=0.0022)
Significant difference between pre and post (p=0.0054)
Significant difference between evar and open in post-protocol era (p=0.0063)

REBOA: ESSENTIAL !

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Joint Theater Trauma System Clinical Practice Guideline

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

Original Release/Approval		16 Jun 2014	Note: This CPG requires an annual review.
Reviewed:	05 May 2014	Approved:	16 Jun 2014
Supersedes:	**This is a new CPG and must be reviewed in its entirety.**		
☐ Minor Changes *(or)*	☒ **Changes are substantial and require a thorough reading of this CPG (or)**		
☐ Significant Changes			

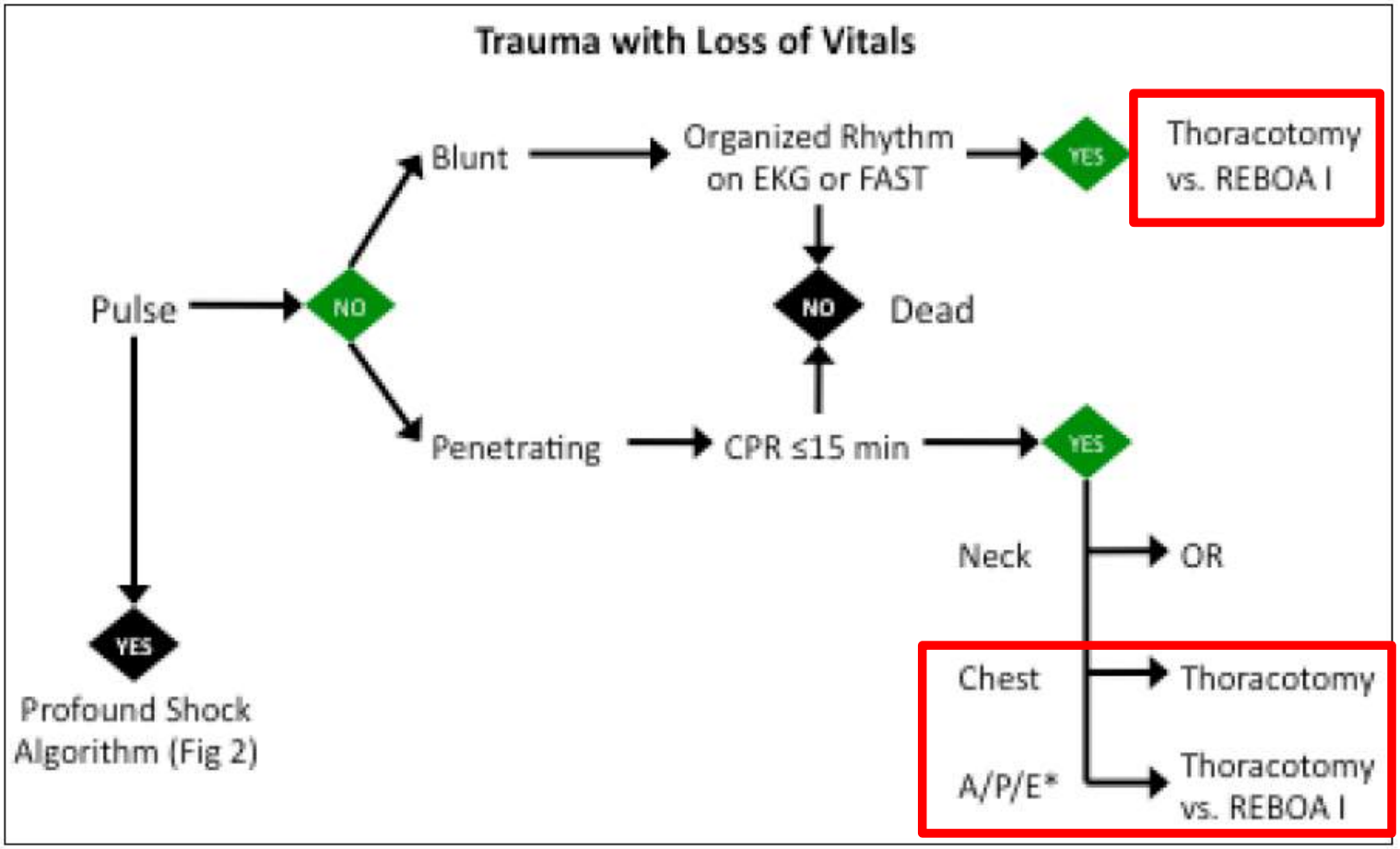
Approved June 2014

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, Eliason, and Rasmussen 2011 publication in the Journal of Trauma.[1]

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.

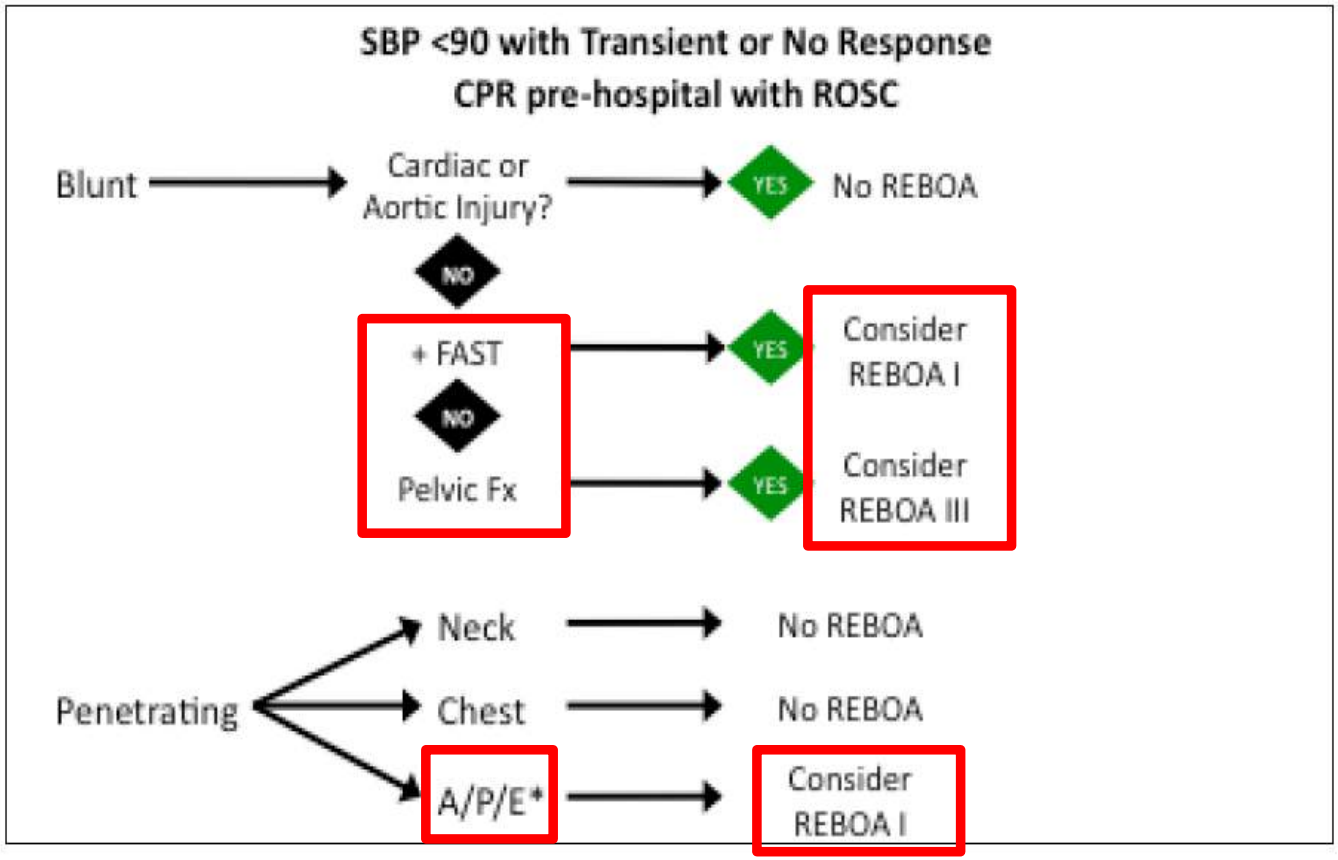
http://www.usaisr.amedd.army.mil/assets/cpgs/REBOA_for_Hemorrhagic_Shock_16Jun2014.pdf

TRAUMATIC ARREST ALGORITHM



*Abdomen/Pelvis/Extremity; REBOA I=Placement of aortic balloon in the thoracic aorta (2-8 cm above the xyphoid)

ALGORITHM FOR THE MANAGEMENT OF PROFOUND SHOCK



*Abdomen/Pelvis/Extremity; ROSC, Return of Spontaneous Circulation; REBOA I Placement of aortic balloon in the thoracic aorta (2-8 cm above the xyphoid); REBOA III Placement of aortic balloon directly above the aortic bifurcation (1-2 cm above the umbilicus)

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA) for Hemorrhagic Shock (CPG ID: 38)

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.

Contributors

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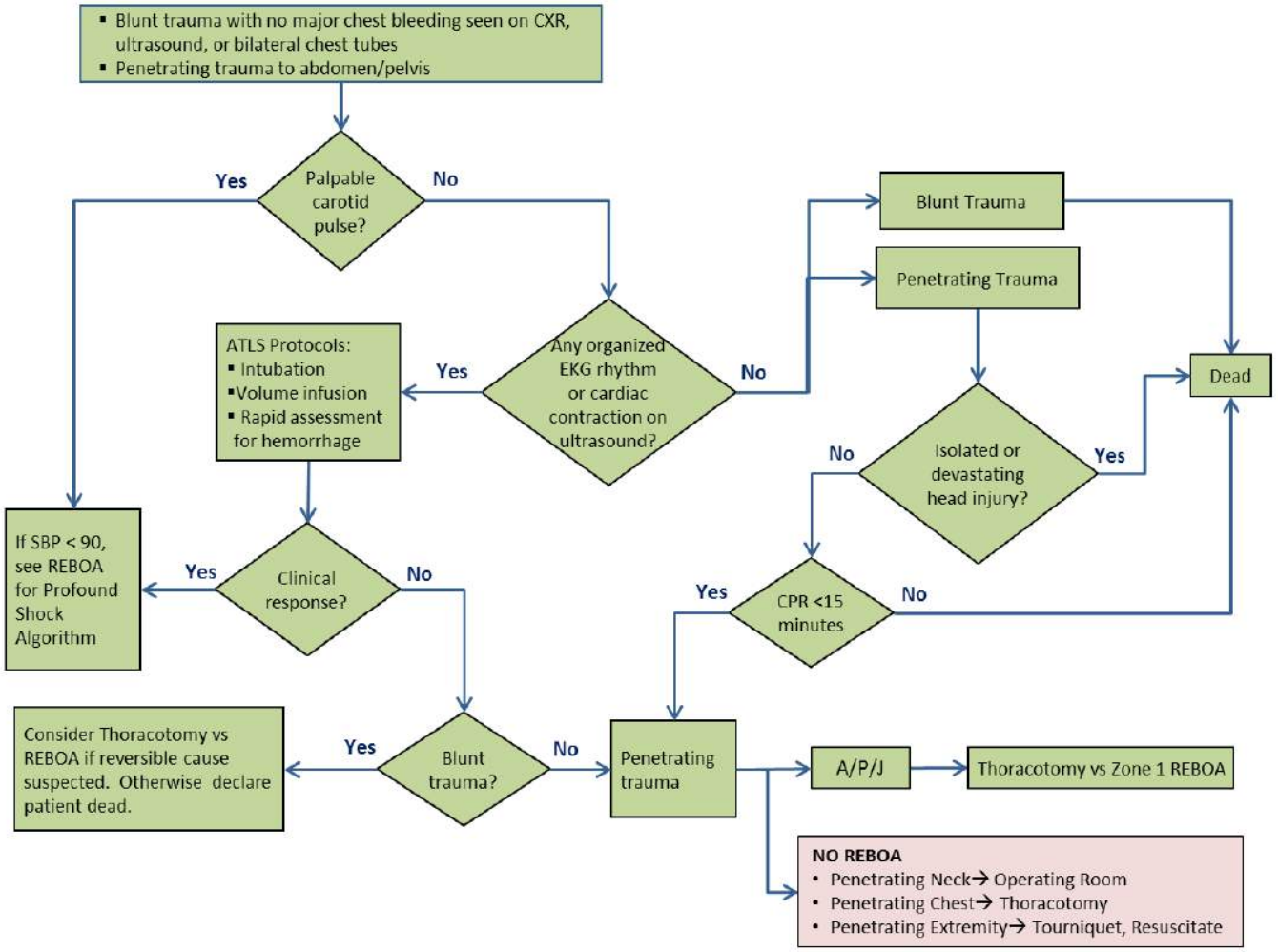
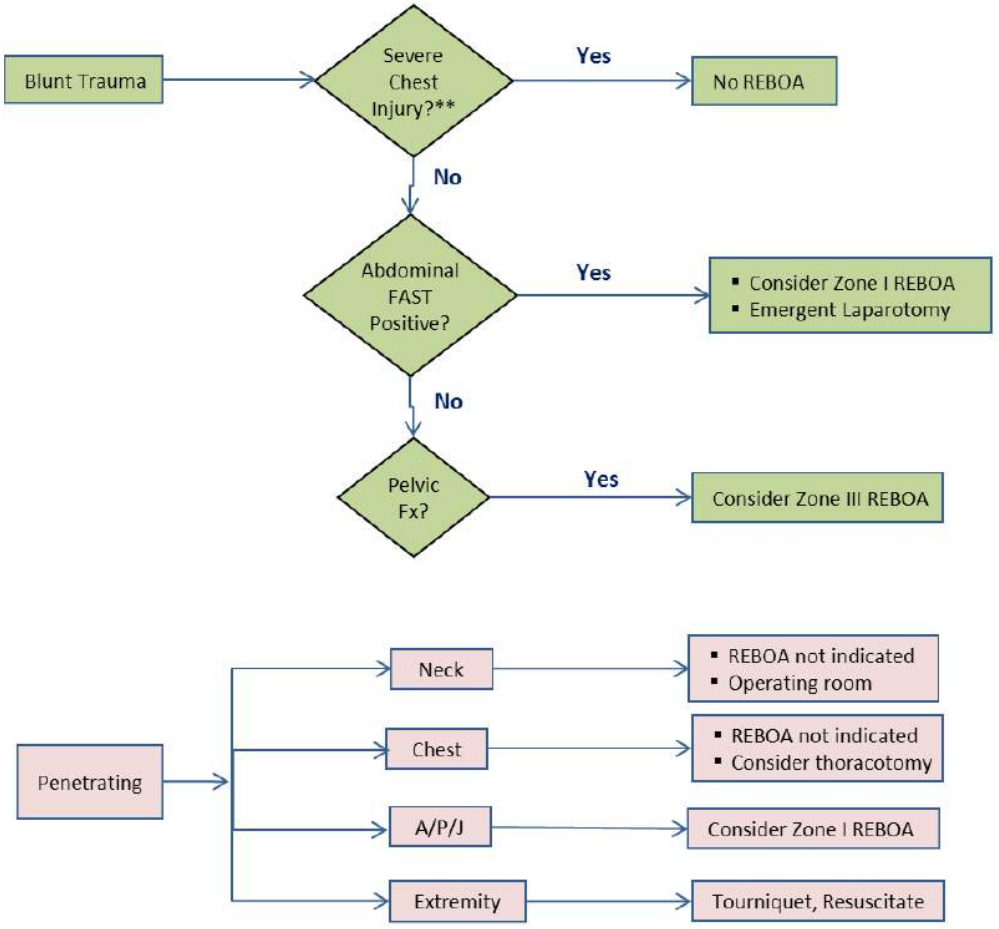
First Publication Date: 16 Jun 2014 | Publication Date: 09 June 2017 | Supersedes CPG dated 16 Jun 2014

APPENDIX A: TRAUMATIC ARREST ALGORITHM FOR REBOA



APPENDIX B: ALGORITHM FOR THE USE OF REBOA FOR PROFOUND SHOCK

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



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

The European guideline on management of major bleeding and coagulopathy following trauma: 4th Edition

- REBOA has been used in patients in end-stage shock following blunt and penetrating trauma together with embolisation of the vascular bed in the pelvis. Descriptions of REBOA are few and there are no published trials. Some combined approaches are reported and the technology is evolving [331]. These techniques can be combined with a consecutive laparotomy if deemed necessary [337].
- REBOA may decrease the high mortality rate observed in patients with major pelvic injuries who have undergone laparotomy as the primary intervention, however non-therapeutic laparotomy should be avoided [341]. Time to pelvic embolisation for haemodynamically unstable pelvic fractures may affect survival [331, 342].

Rossaint R et al. Critical Care 2016;**20**:100

REBOA: ESSENTIAL !

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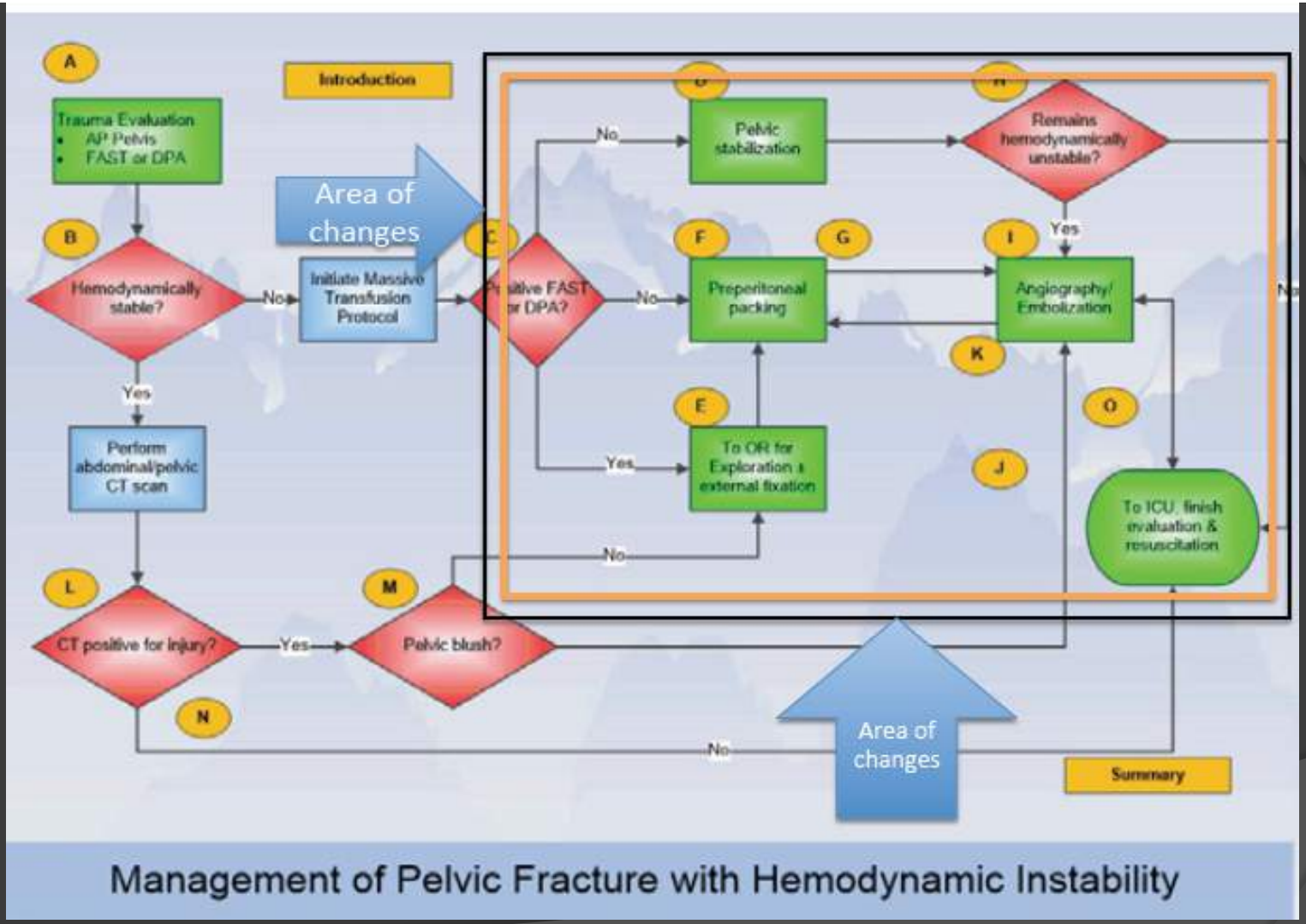
- Established technique already in use
- National/International & Military guidelines
- **National Protocols**
- Institutional Protocols
- Already adopted in clinical use


A
Introduction
Trauma Evaluation
AP Pelvis
FAST or DPA
Area of changes
B
Hemodynamically stable?
No
Initiate Massive Transfusion Protocol
Yes
Perform abdominal/pelvic CT scan
C
Positive FAST or DPA?
No
D
Pelvic stabilization
N
Remains hemodynamically unstable?
Yes
F
Preperitoneal packing
G
I
Angiography/ Embolization
K
E
To OR for Exploration & external fixation
Yes
O
J
To ICU, finish evaluation & resuscitation
No
L
CT positive for injury?
Yes
M
Pelvic blush?
N
No
Area of changes
Summary
Management of Pelvic Fracture with Hemodynamic Instability

Pelvic Fx Hemorrhage

- Mean 9.4 u PRBCs
- Median time to angio 286 min
- **Median time to hemostasis with embolization was 344 min**
- In a trauma center with robust resources

Session: VII: Shock Transfusion Papers 14-17
Paper 16: 10:40-11:00

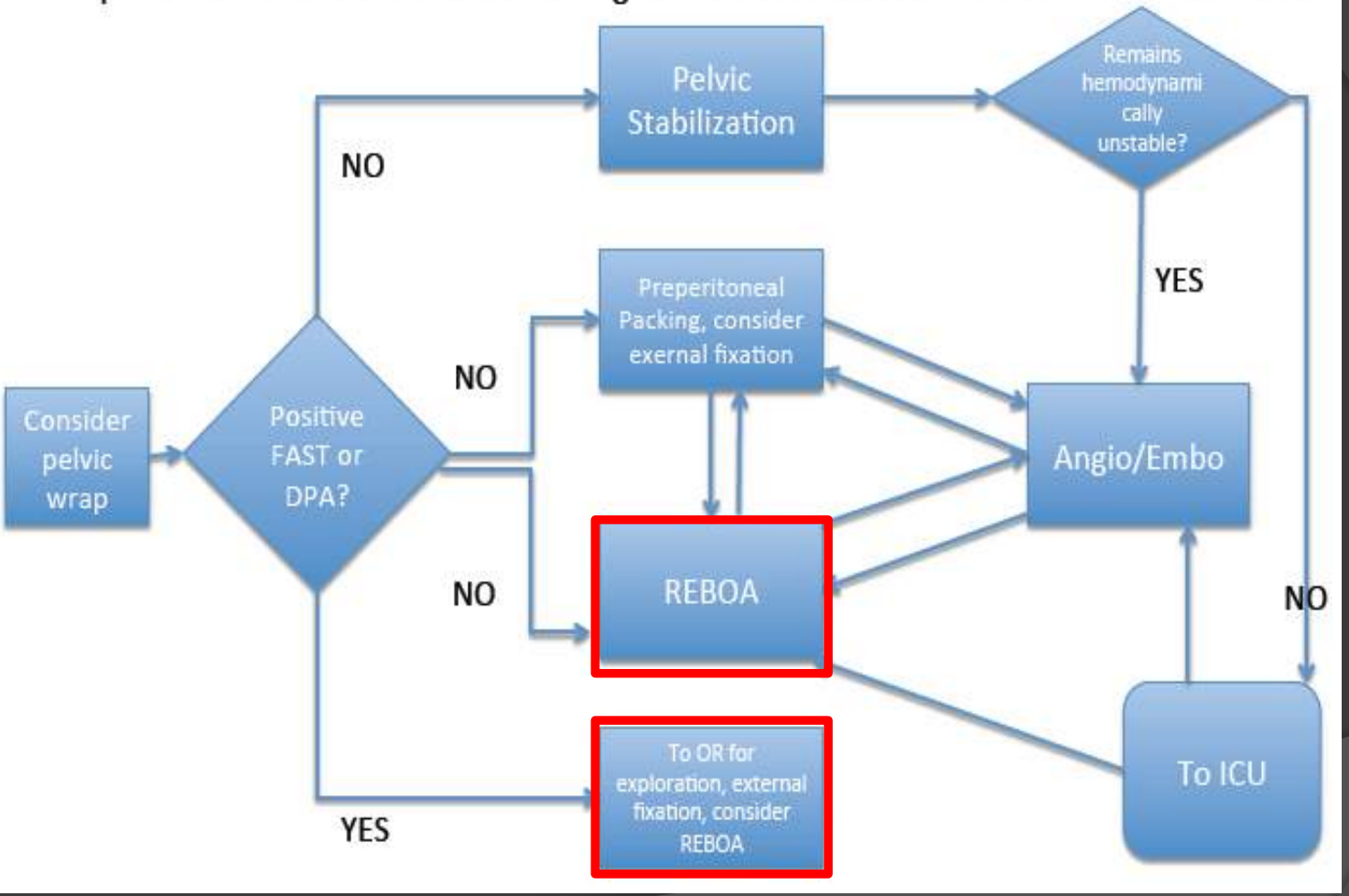
ANGIOGRAPHIC EMBOLIZATION FOR HEMORRHAGE FOLLOWING PELVIC FRACTURE: IS IT "TIME" FOR A PARADIGM SHIFT?

Ronald Tesoriero MD, Brandon Bruns MD, Mayur Narayan MD, MPH, MBA, Joseph Dubose* MD, Sundeep Guliani MD, Megan Brenner MD, Deborah Stein* MD, MPH, Thomas Scalea* MD, R Adams Cowley Shock Trauma Center

Invited Discussant: John Holomb, MD

Introduction: Major pelvic disruption with hemorrhage has a high rate of lethality. Angiographic embolization is the mainstay of treatment. Time spent awaiting mobilization of the resources needed to perform angiography allows ongoing hemorrhage. Alternative techniques, such as pre-peritoneal pelvic packing and aortic balloon occlusion (REBOA), now exist. We hypothesized that time to angiography and hemostasis using standard therapy would be vastly longer than anticipated.
Methods: A retrospective review was performed of all patients with pelvic fracture who underwent pelvic angiography at a level one trauma center over a 10 year period. The trauma registry was queried for age, sex, injury severity score (ISS), hemodynamic instability (HI) on presentation (SBP $\leq$ 90, HR $\geq$ 120), and transfusion requirements within 24hrs. Charts were reviewed for indications for, and time to, angiography, time to hemostasis by embolization, and mortality.
Results: 4712 patients were admitted with pelvic fractures during the study period. 344 (0.07%) underwent pelvic angiography. 71% were male. Mean age was 46 years. Mean ISS was 32. Mean 24 hour transfusion requirements were 9.4 units of RBC's and 11 units of FFP. 151 (43.9%) presented with HI and 104 (30%) received massive transfusion (MT). 212 (62%) had embolization. Median time to angiography was 286 min (interquartile range [IQR] 210-378) and time to hemostasis with embolization was 344 min (IQR 262-433). Median procedure time for embolization was 51 minutes (IQR 37-83). Times were significantly shorter when stratified for HI (HI 264 vs stable 309 min; p=0.03), and MT (MT 230 vs non-MT 317min; $p < 0.01$). However, time from admission to angiography still took nearly 4 hours. Overall mortality was 18%. Hemorrhage (16%) and sepsis/multiple organ failure (43.5%) accounted for most deaths.
Conclusion: Pelvic fracture hemorrhage remains a management challenge. In our trauma center, with robust resources, the median time to hemostasis was over 5 hours. Nearly 60% of deaths could be directly attributed to, or as a complication of, early uncontrolled hemorrhage. Earlier intervention by Acute Care Surgeons with techniques such as pre-peritoneal pelvic packing, REBOA, and utilization of hybrid operative suites with surgeon performed embolization may improve outcomes.

Expanded from zoomed area of Davis algorithm. Decisions will be based on local resources.



Western Trauma Association Critical Decisions in Trauma: Management of pelvic fracture with hemodynamic instability—2016 updates

Thai Lan N. Tran, MD, Karen J. Brasel, MD, PhD, Riyad Karmy-Jones, MD, Susan Rowell, MD, Martin A. Schreiber, MD, David V. Shatz, MD, Roxie M. Albrecht, MD, Mitchell J. Cohen, MD, Marc A. DeMoya, MD, Walter L. Biffl, MD, Ernest E. Moore, MD, *and* **Nicholas Namias, MD**, *Miami, Florida*

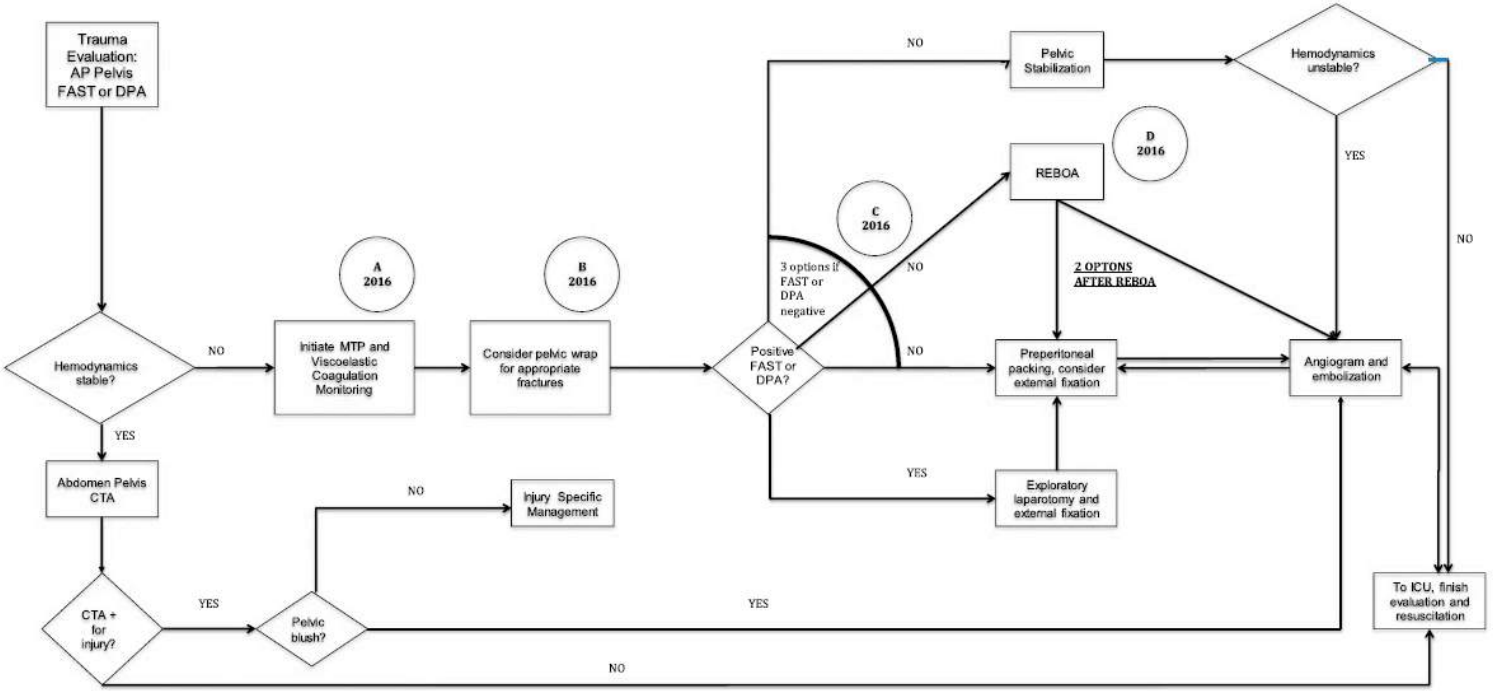
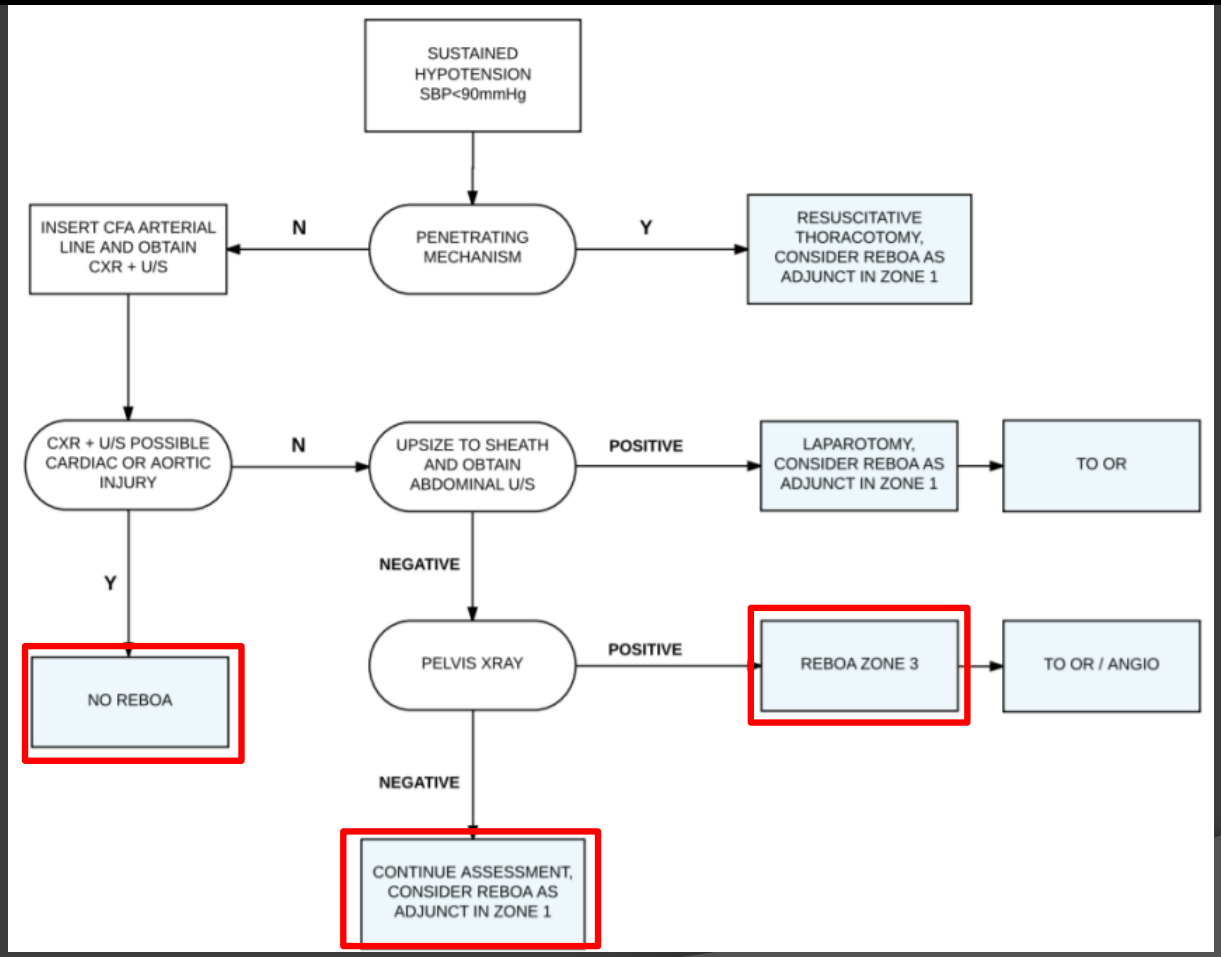


Figure 1. Management of pelvic fracture with hemodynamic instability.

Western Trauma Association (WTA) Algorithm

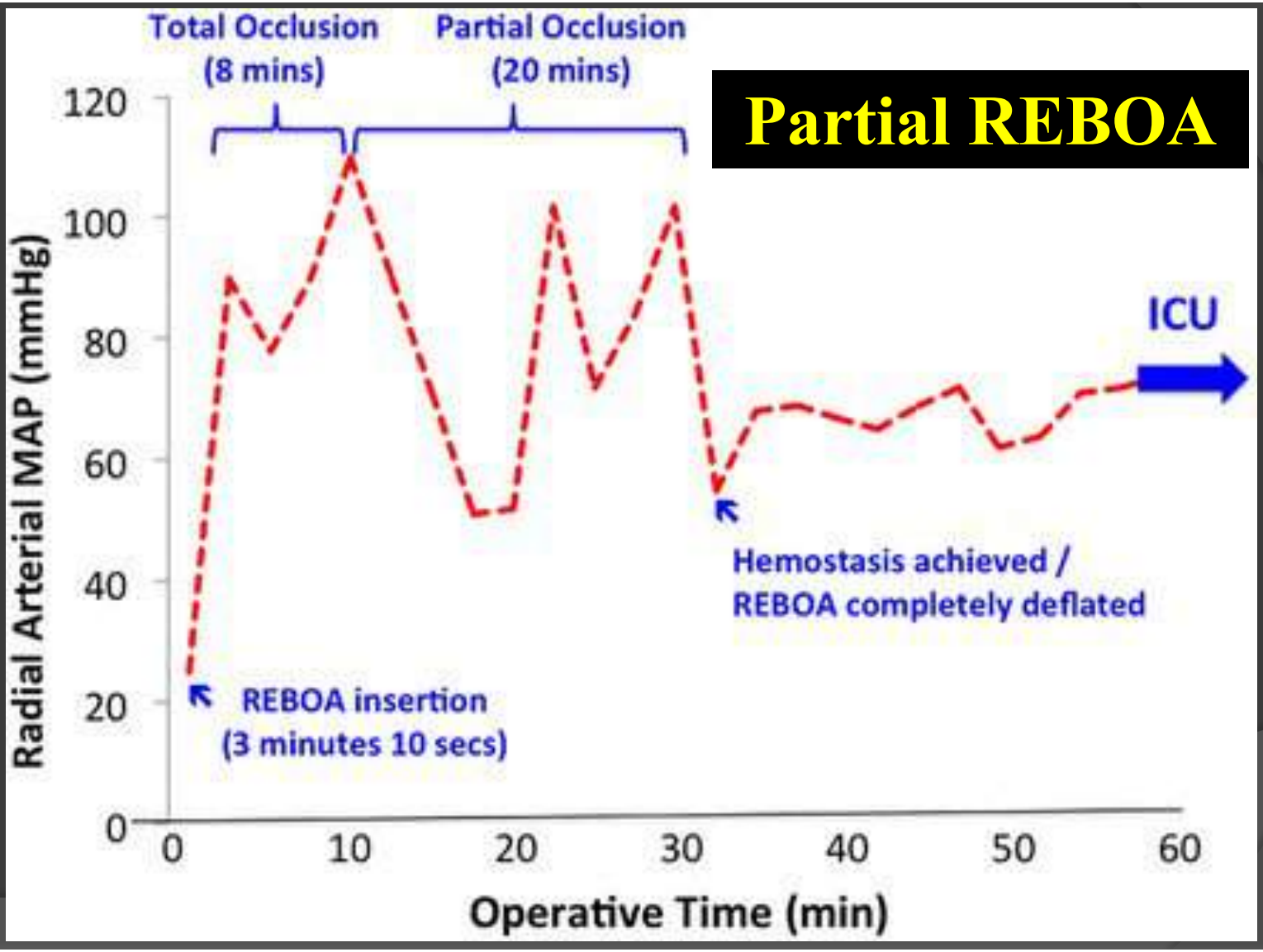


- Inaba K. ALGORITHM 2 – REBOA. Western Trauma Association 47th Annual Meeting. 2017.
- http://westerntrauma.org/documents/meeting/2017/AlgorithmDrafts/2017-WTA-ALGORITHM-REBOA.pdf

For exsanguinating pelvic hemorrhage from blunt trauma:

- **REBOA** (Zone III, above aortic bifurcation) is less invasive than resuscitative thoracotomy
- **REBOA** is more effective at aortic control than thoracotomy with aortic compression
- **REBOA** is quicker to perform than resuscitative thoracotomy
- **REBOA** is easier to control, i.e. intermittent balloon deflation to provide perfusion

Partial REBOA



REBOA: ESSENTIAL !

- Need for the technique – patient population
- Established technique already in use
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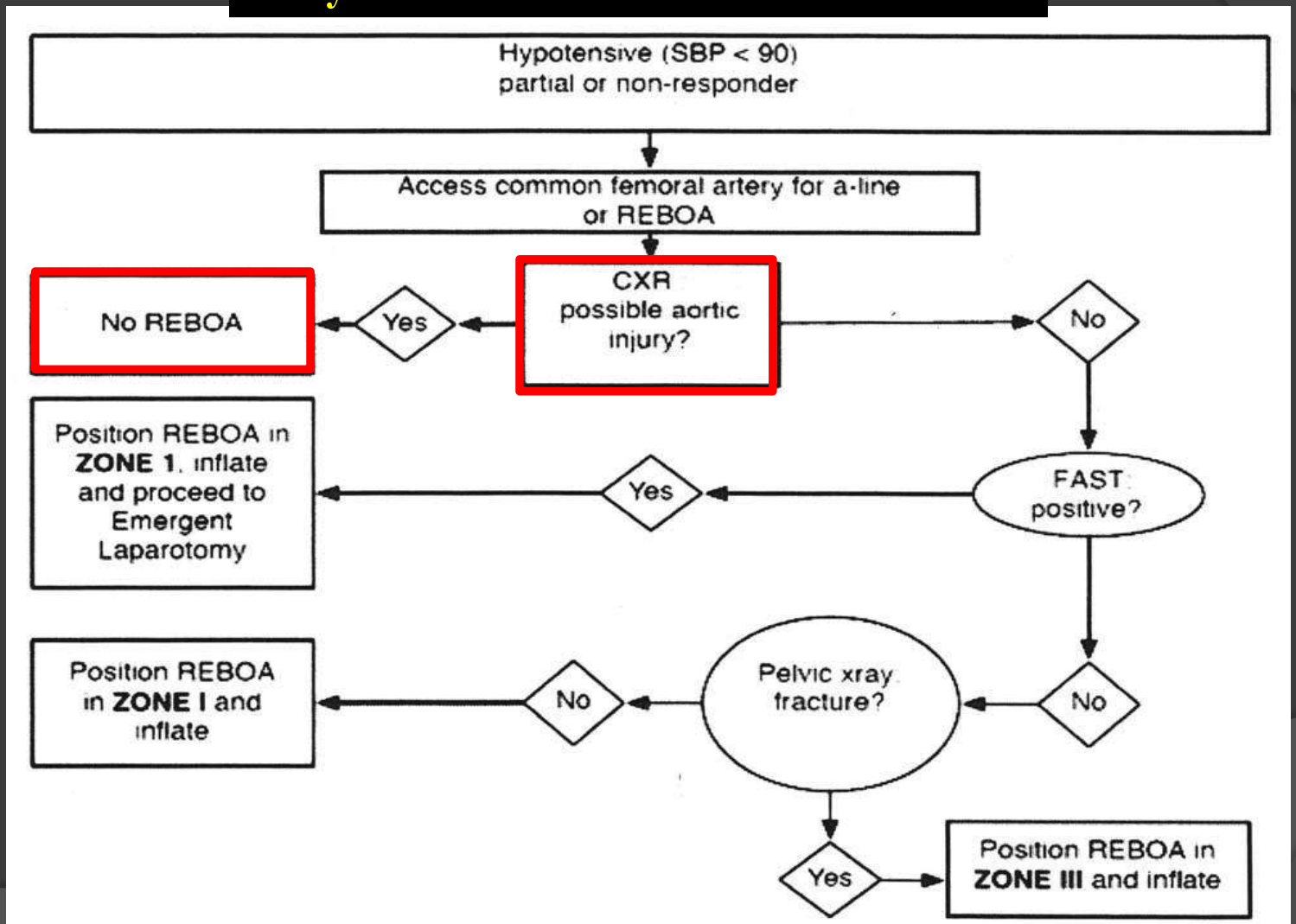
- National Protocols
- **Institutional Protocols**
- Already adopted in clinical use

Maryland Shock Trauma Center Protocol



REBOA

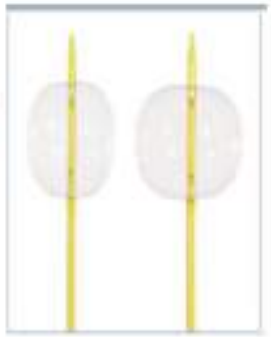
- Must have a protocol
- REBOA kit
- ED & OR
- Educate

University of Michigan
Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA) as Adjunct for Hemorrhagic Shock

Similar to resuscitative thoracotomy with aortic clamping for traumatic arrest due to hemorrhage, REBOA is used for temporary aortic occlusion. REBOA supports proximal aortic pressure and minimizes hemorrhage until hemorrhage control and hemostasis are obtained. REBOA can be used instead of resuscitative thoracotomy in hemorrhagic shock.

REBOA Steps:

1. **Arterial access and Sheath Placement**
   a. Ultrasound-guided femoral arterial access with Micropuncture kit (21 gauge needle, 4 or 5 French catheter and dilator, 0.018 inch guidewire)
   b. Or Femoral arterial cut-down, proximal/distal control for direct puncture
   c. Upsize to 14-French Introducer Sheath using Amplatz guidewire (0.035 in)
   d. Confirm Amplatz guidewire position in proximal aorta – digital radiography
2. **Balloon selection and positioning**
   a. Cook Medical CODA Balloon 14 Fr (32-40mm diameter, 120cm length)
   b. Compliant, low-atmosphere, high volume balloons
3. **Balloon inflation**
   a. Use the minimal pressure to gain wall apposition, to prevent aortic injury.
   b. 30-60cc syringe – fill with NS or ½ NS/Contrast for visualization
   c. All attempts should be made to minimize the time of balloon inflation
4. **Balloon deflation**
   a. Intermittent deflation of REBOA can be used to optimize visceral perfusion, goal SBP > 90 mm Hg
5. **Sheath removal – Primary arterial repair needed after 14Fr sheath removal**



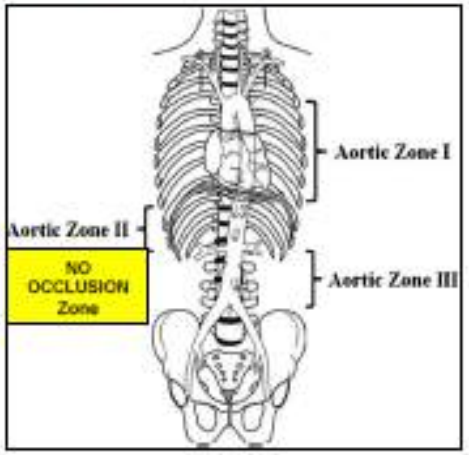
REBOA INTRA-AORTIC PLACEMENT

The placement of the balloon is determined by the location of the injury and ongoing hemorrhage:

Zone 1 Descending Thoracic Aorta (origin of left subclavian artery to celiac artery) is used for truncal hemorrhage control

Zone 2 Para-visceral Aorta (celiac artery to lowest renal artery): **NO-OCCLUSION ZONE**

Zone 3 Infra-renal Aorta (lowest renal artery to aortic bifurcation) for pelvic hemorrhage and junctional bleeding.

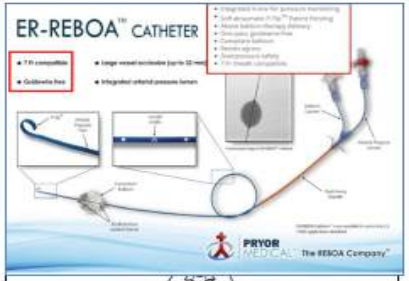


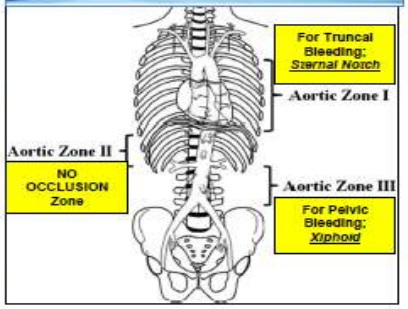
REBOA

- Must have a protocol
- REBOA kit
- Readily available
- ED & OR
- Educate

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

REBOA is used for temporary aortic occlusion in traumatic hemorrhagic shock. REBOA supports proximal aortic pressure and minimizes hemorrhage until hemorrhage control and definitive hemostasis are obtained.





REBOA Steps:

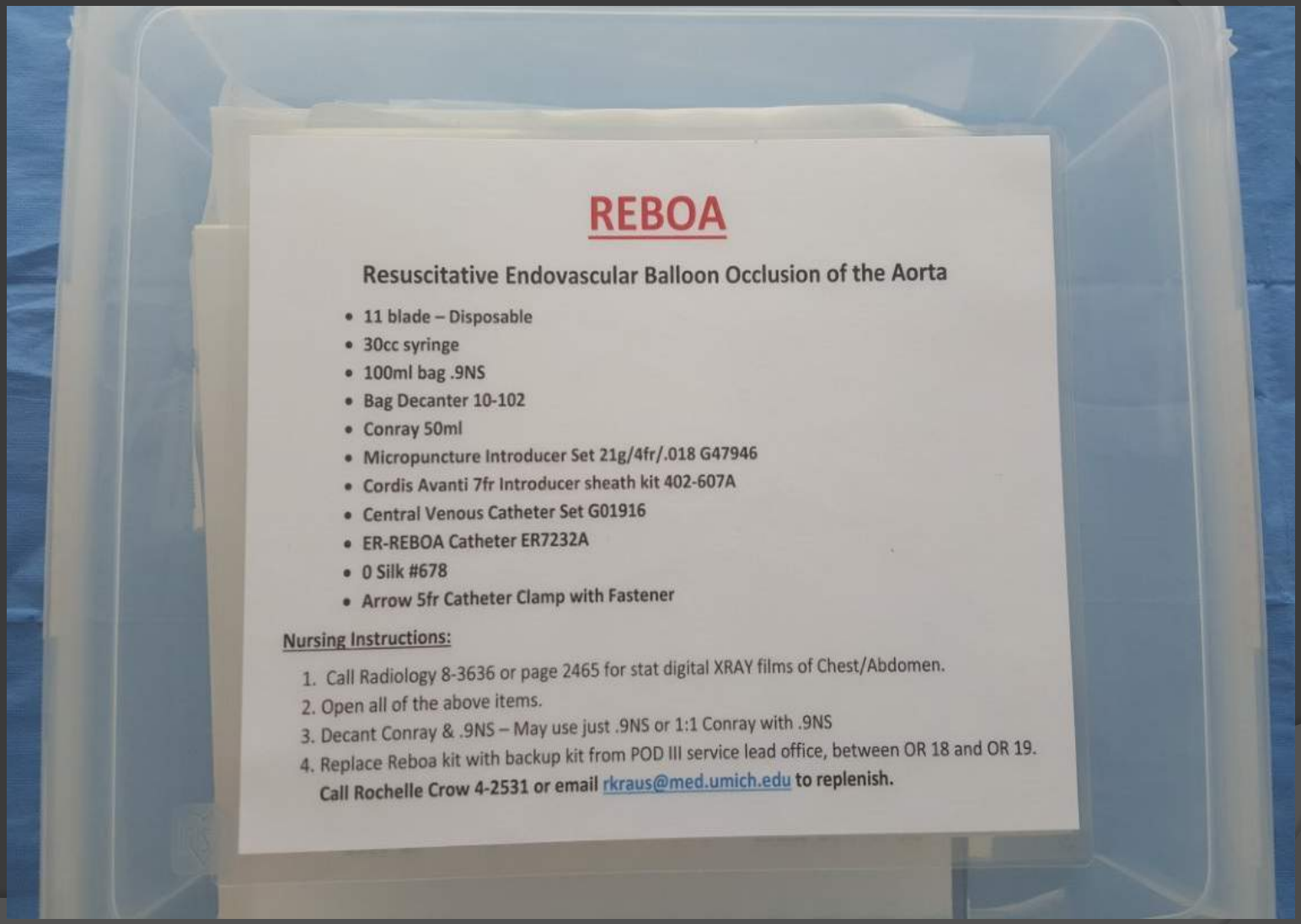
1. **Arterial access and Sheath Placement**
   a. Ulltrasound-guided common femoral arterial access with Micropuncture kit (21 gauge needle, 4 or 5 French catheter and dilator, 0.018 inch guidewire)
   b. Or Cook single lumen arterial line; or Femoral artery cut-down, proximal/distal control for direct puncture
   c. Insert 7-French Sheath (can upsize arterial line)
2. **Balloon selection and positioning**
   a. ER-REBOA catheter (32mm max balloon diameter)
   b. Flush ER-REBOA catheter with saline; connect arterial line to transduce while inserting
   c. Measure sheath to P-tip distance in cm REBOA: **Zone 1 approx 46 cm; Zone 3 approx 27cm**
   d. **Zone 1 P-tip sternal notch, balloon mid-sternum; Zone 3 P-tip xiphoid, balloon at umbilicus**
   e. Insert ER-REBOA to pre-measured distance
   f. Digital Xray to confirm REBOA balloon location
3. **Balloon inflation**
   a. Inflate balloon, tactile feedback
   b. **Zone 1 8cc; Zone 3 2cc "2 or 8, don't overinflate"**
   c. 30cc syringe; NS or ½ NS/Contrast; Max 24cc
   d. **Mark Inflation time**; Minimize balloon inflation time
   e. Suture catheter and sheath; transduce arterial line
   f. **Go to OR or IR for definitive hemorrhage control**
4. **Balloon deflation – Partial REBOA**
   a. Intermittent deflation of REBOA (Partial-REBOA) can be used to optimize visceral perfusion, goal SBP > 90 mm Hg
5. **Femoral Artery Sheath removal**
   a. HD stable, normal coagulation, withdraw balloon saline w/ 30cc empty syringe
   b. 30 min digital pressure at sheath site, keep patient supine for 6 hrs, no hip flexion
   c. Femoral arterial duplex at 24-72 hrs to evaluate patency of femoral artery

REBOA Intra-Aortic Balloon Placement for Hemorrhagic Shock

Balloon placement determined by injury/hemorrhage location:
Zone 1 Descending Thoracic Aorta (origin of left subclavian to celiac) for truncal hemorrhage
Zone 2 Para-visceral Aorta (celiac artery to lowest renal artery): **NO-OCCLUSION ZONE**
Zone 3 Infra-renal Aorta (lowest renal artery to aortic bifurcation) for pelvic/junctional bleeding.

References:
1. Stannard A, Eliason JL, Rasmussen TE. REBOA as an adjunct for hemorrhagic shock. J Trauma. 2011 Dec;71(6):1869-72
2. Brenner ML, Moore LJ, Dubose JJ, Tyson GH, et al. A clinical series of resuscitative endovascular balloon occlusion of the aorta for hemorrhage control and resuscitation. J Trauma Acute Care Surg. 2013 Sep;75(3):506-511.
3. Villamaria CY, Eliason JL, Napolitano LM, Stansfield B, Spencer JR, Rasmussen TE. An Endovascular Skills for Trauma and Resuscitative Surgery (ESTARS™) Course: Curriculum Development, Content Validation and Program Assessment. American Association for the Surgery of Trauma; J Trauma Acute Care Surg 2014 Apr;76(4):929-35.
4. Dubose JJ, Scalea TM, Brenner M, et al. AAST AORTA Registry: Utilization/outcomes of REBOA. J Trauma 2016 Sep;81(3):409
5. Johnson MA, Neff LP, Williams TK, DuBose JJ, et al. P-REBOA: Clinical technique & rationale. J Trauma 2016 Nov;92:S133.

MICHIGAN MEDICINE
UNIVERSITY OF MICHIGAN



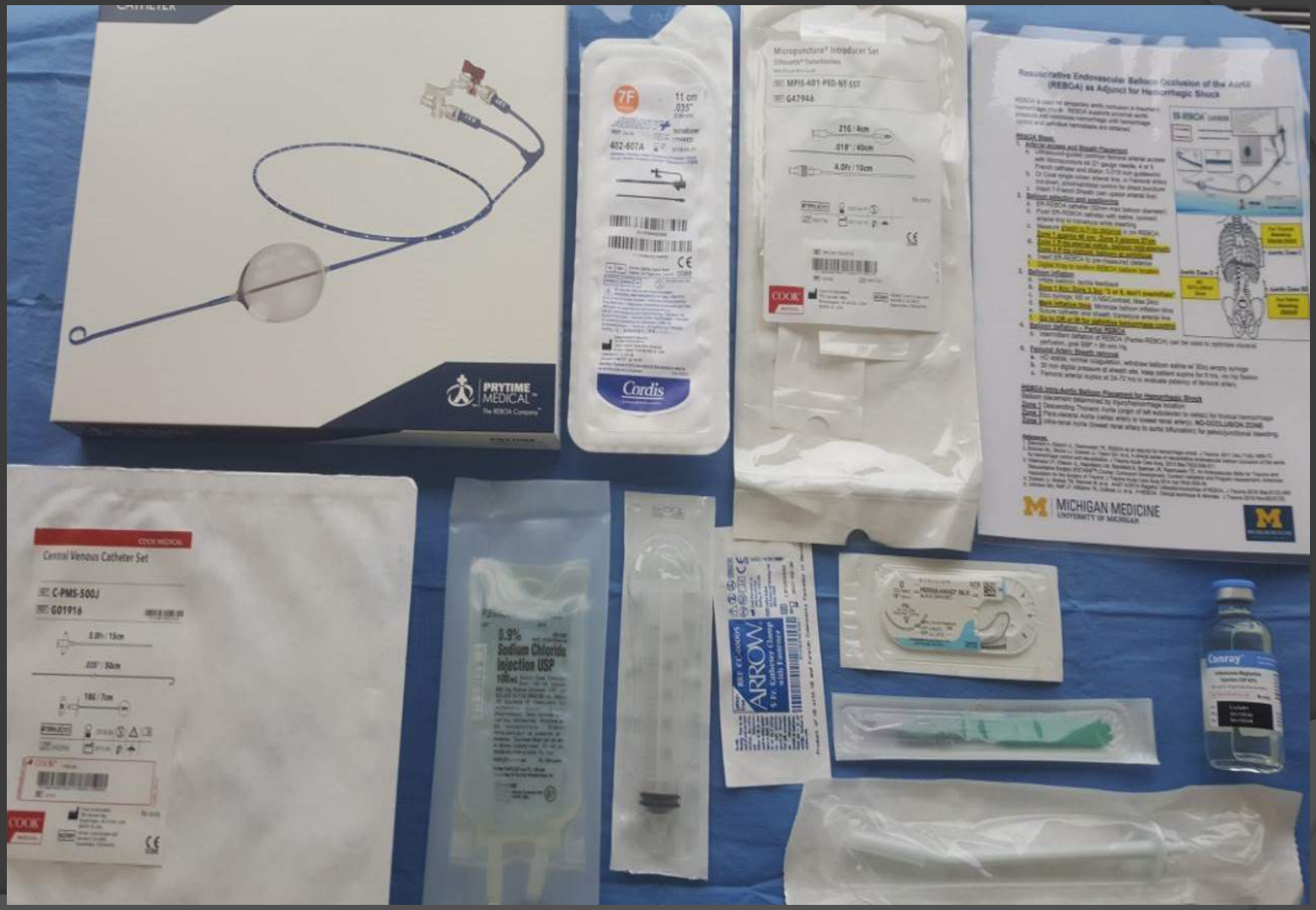
REBOA

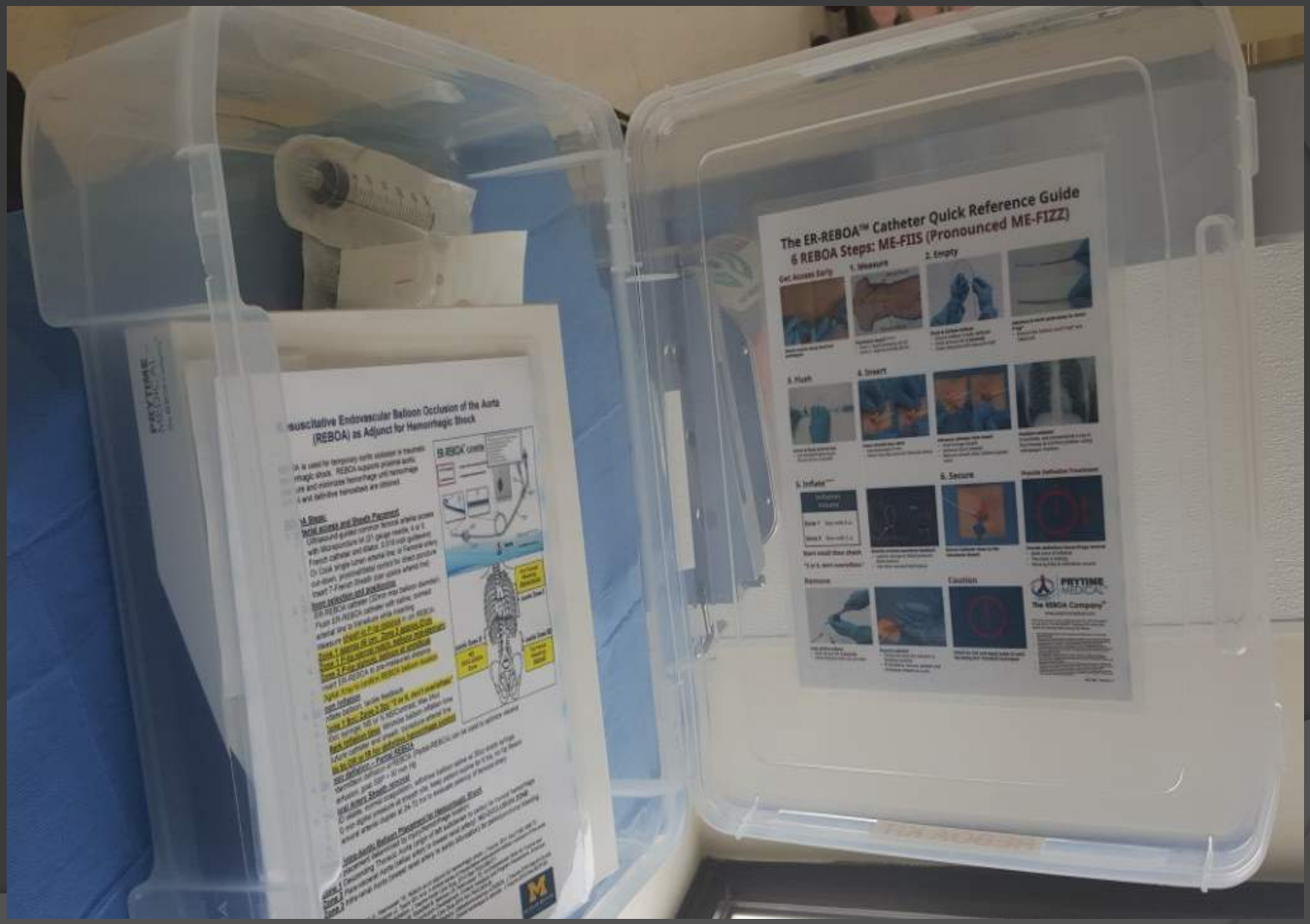
Resuscitative Endovascular Balloon Occlusion of the Aorta

- 11 blade – Disposable
- 30cc syringe
- 100ml bag .9NS
- Bag Decanter 10-102
- Conray 50ml
- Micropuncture Introducer Set 21g/4fr/.018 G47946
- Cordis Avanti 7fr Introducer sheath kit 402-607A
- Central Venous Catheter Set G01916
- ER-REBOA Catheter ER7232A
- 0 Silk #678
- Arrow 5fr Catheter Clamp with Fastener

Nursing Instructions:

1. Call Radiology 8-3636 or page 2465 for stat digital XRAY films of Chest/Abdomen.
2. Open all of the above items.
3. Decant Conray & .9NS – May use just .9NS or 1:1 Conray with .9NS
4. Replace Reboa kit with backup kit from POD III service lead office, between OR 18 and OR 19.
   Call Rochelle Crow 4-2531 or email rkraus@med.umich.edu to replenish.


PRYTIME MEDICAL
Cordis
Micropuncture® Introducer Set
Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA) as Adjunct for Hemorrhagic Shock
MICHIGAN MEDICINE
Central Venous Catheter Set
0.9% Sodium Chloride Injection USP
ARROW
Conray


The ER-REBOA™ Catheter Quick Reference Guide
6 REBOA Steps: ME-FIIS (Pronounced ME-FIZZ)
1. Measure
2. Empty
3. Flush
4. Insert
5. Inflate
6. Secure
Caution
PRYTIME MEDICAL
The REBOA Company®

REBOA

- Consider inclusion of quick insertion guide in your REBOA kit

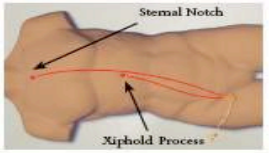
The ER-REBOA™ Catheter Quick Reference Guide

6 REBOA Steps: ME-FIIS (Pronounced ME-FIZZ)

Get Access Early

Obtain access using standard techniques

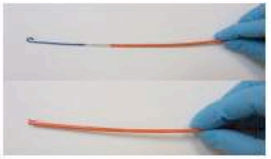
1. Measure



Placement depth[1,2,3,4,5,6]
- Zone 1: Approximately 46 cm
- Zone 3 : Approximately 28 cm

2. Empty

Flush & deflate balloon
- Ensure balloon is fully deflated
- Hold vacuum for **5 seconds**
- Close stopcock with vacuum held

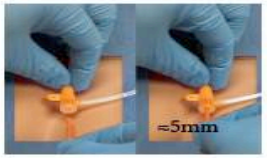


Advance & twist peel-away to cover P-tip®
- Ensure the balloon and P-tip® are captured

3. Flush

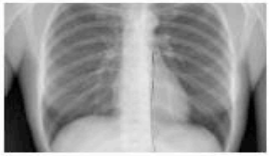
Attach & flush arterial line
- Use standard techniques
- Ensure all air is purged

4. Insert



Insert sheath into valve
- Approximately 5 mm
- Insert into the common femoral artery

Advance catheter into vessel
- Hold orange sheath
- Advance blue Catheter
- Remove sheath after balloon passes valve



Position catheter
If available, use conventional x-ray or fluoroscopy to confirm position using radiopaque markers

5. Inflate[1,2,3,4,5,6]

Inflation Volume	
Zone 1	Start with 8 cc
Zone 3	Start with 2 cc

Start small then check

"2 or 8, don't overinflate."

Monitor arterial waveform feedback
- Look for change in blood pressure above balloon
- Use other standard techniques

6. Secure

Secure Catheter close to the introducer sheath

Provide Definitive Treatment

Provide definitive hemorrhage control
- Mark time of inflation
- The clock is ticking!
- Move quickly to definitive control

Remove

Fully deflate balloon
- Hold vacuum for **5 seconds**
- Close stopcock with vacuum held

Remove catheter
- Corkscrew twist the catheter to facilitate removal
- If necessary, remove catheter and introducer sheath as a unit

Caution

Check for full and equal pulse in each leg using your standard technique

PRYTIME MEDICAL™

The REBOA Company™

www.prytimemedical.com

This instruction is not a replacement for the instruction for use (IFU). The ER-REBOA™ Catheter IFU should be read in its entirety before using the device

ADV-006 | Revision F

REBOA

- Royal London Hospital

Endovascular Skills for Trauma and Resuscitative Surgery

management of vascular trauma

ENDOVASCULAR SKILLS FOR TRAUMA AND RESUSCITATIVE SURGERY (ESTARS™) COURSE: Curriculum Development, Content Validation, and Program Assessment

Funding through Contract No FA8052-11C-0035 under BAA 11-01-HPW heading: Aerospace Medicine, Clinical Research, Human Performance Research, and Expeditionary Medicine

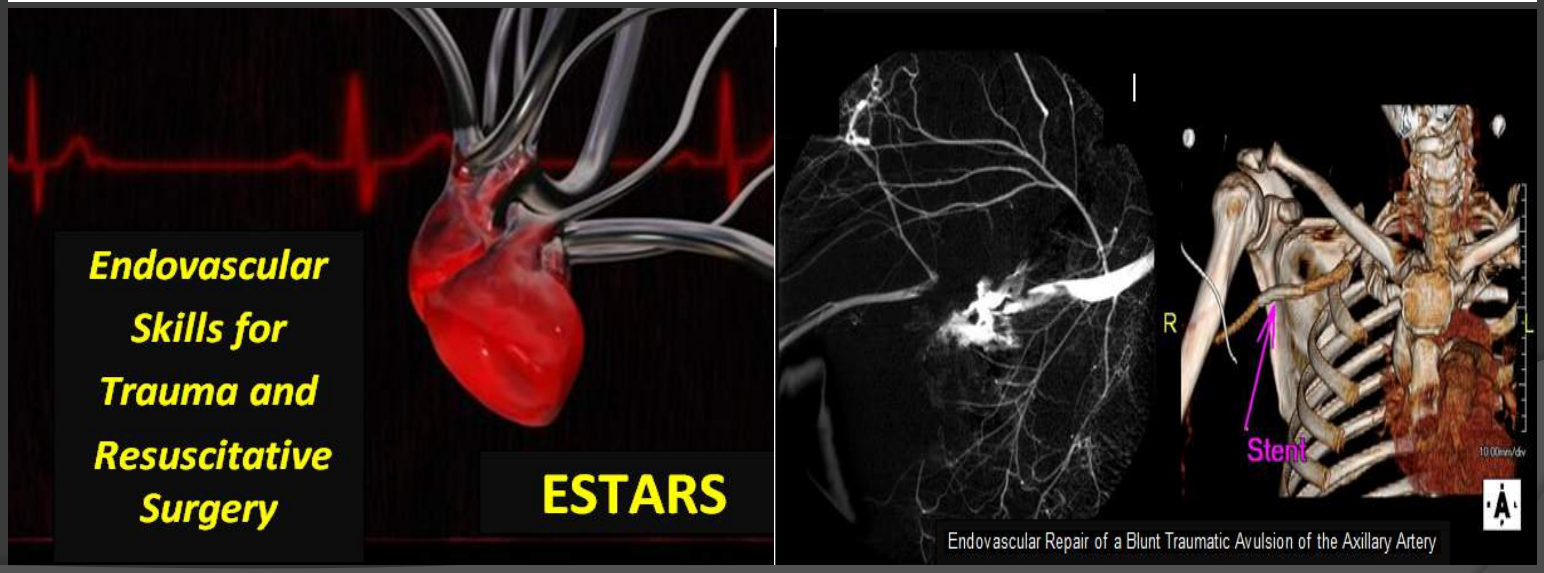
Jonathan L. Eliason MD, Lena M. Napolitano MD, Brent Stansfield PhD, Todd E. Rasmussen MD

Clinical Research Division, Lackland Airforce Base, San Antonio, TX

ORIGINAL ARTICLE

Endovascular Skills for Trauma and Resuscitative Surgery course: Curriculum development, content validation, and program assessment

Carole Y. Villamaria, MD, Jonathan L. Eliason, MD, Lena M. Napolitano, MD, R. Brent Stansfield, PhD, Jerry R. Spencer, BS, *and* Todd E. Rasmussen, MD, *Ann Arbor, Michigan*



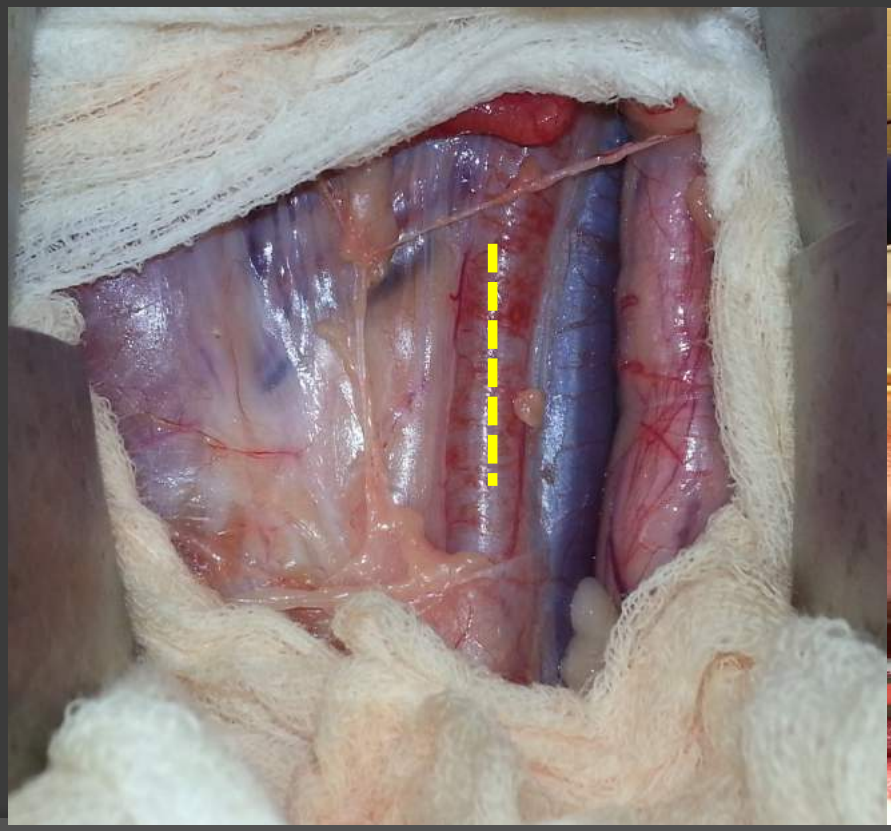
J Trauma Acute Care Surg. 2014 Apr;76(4):929-35.

ESTARS

Aortography

ESTARS

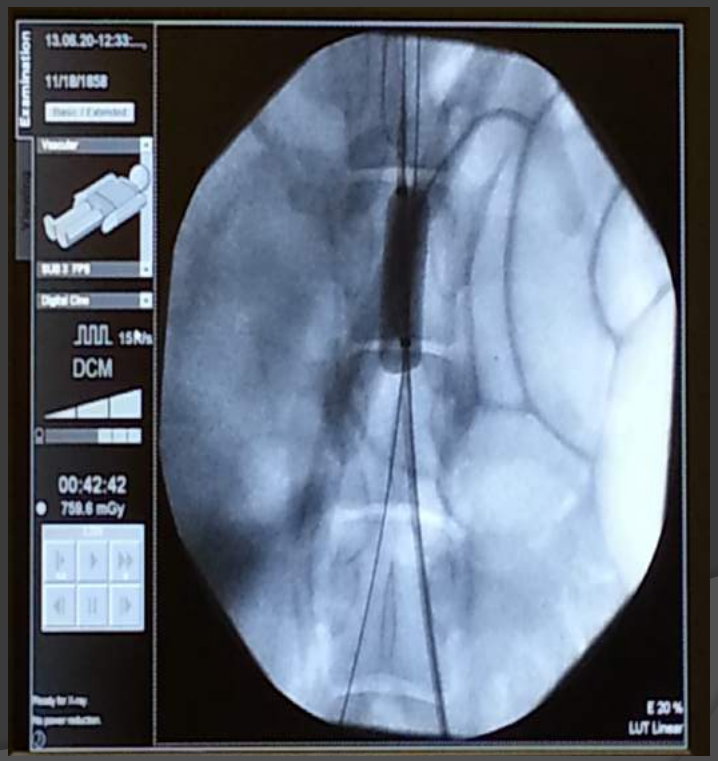
Injury of Iliac artery



Arterial hemorrhage

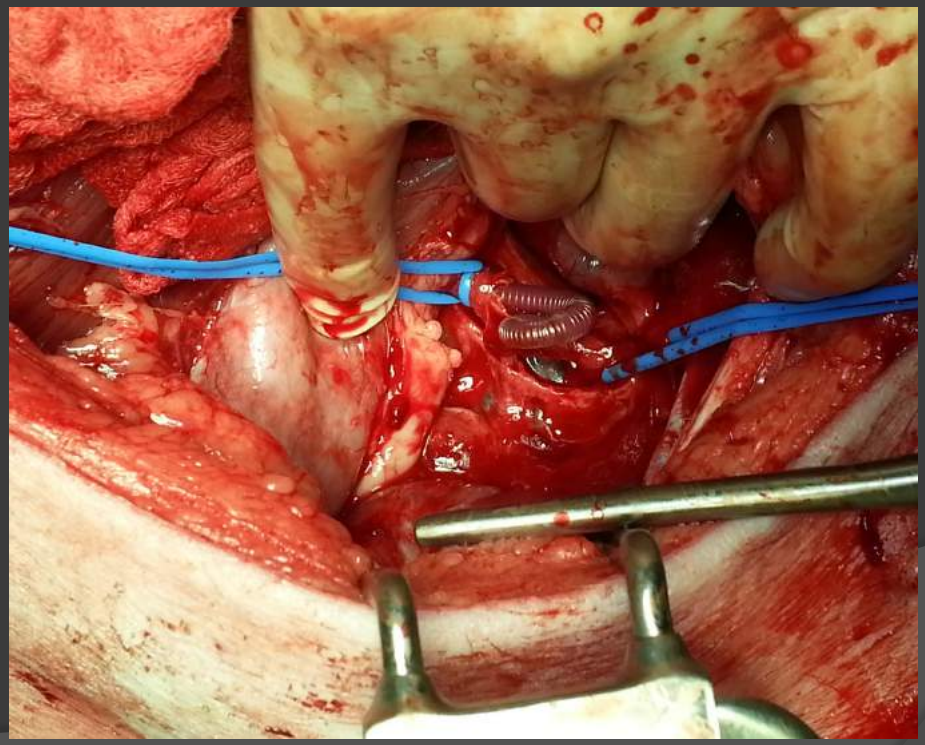
ESTARS

REBOA Balloon Occlusion for Hemorrhage Control

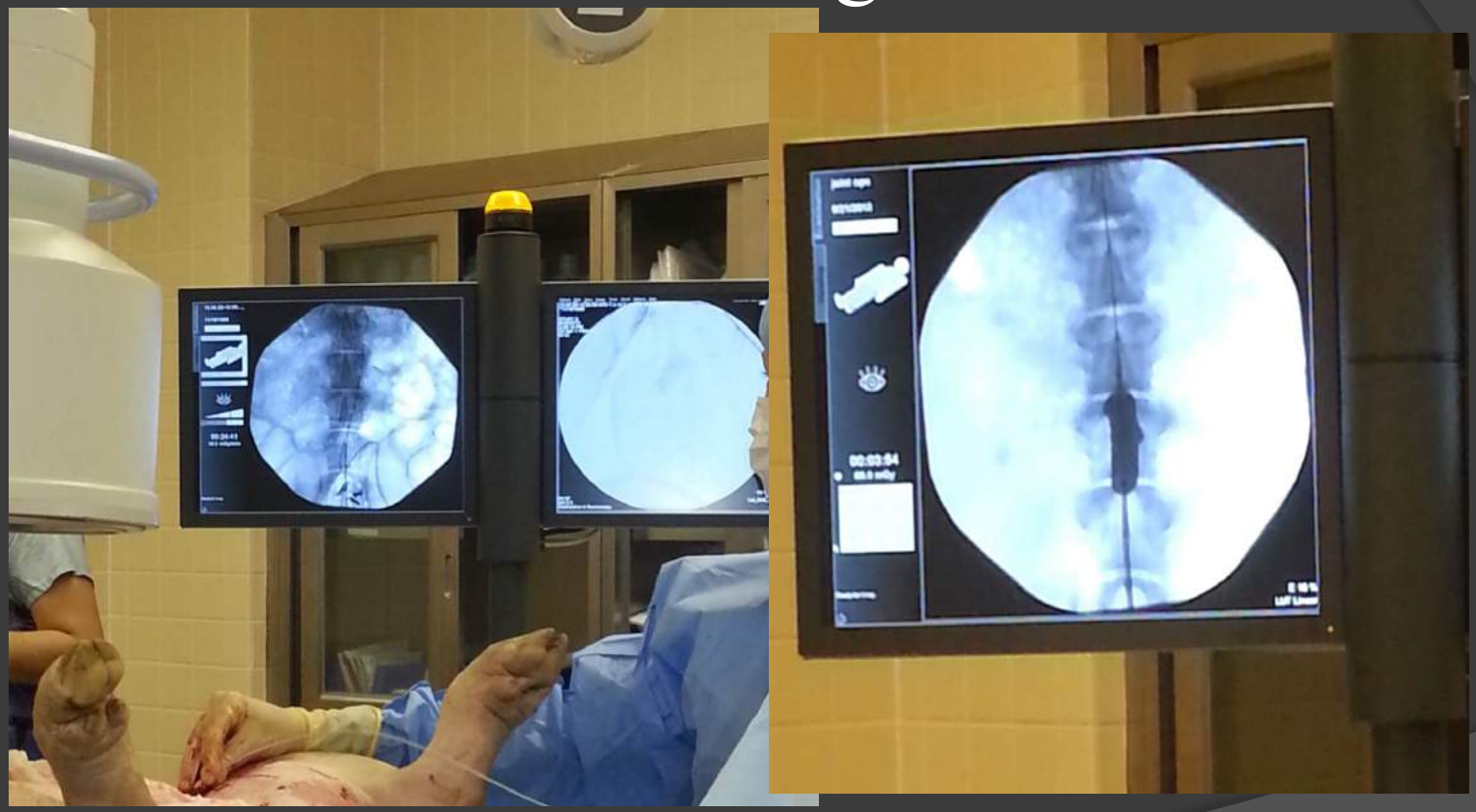


ESTARS

Iliac artery temporary vascular shunt placement
After proximal control of hemorrhage by REBOA



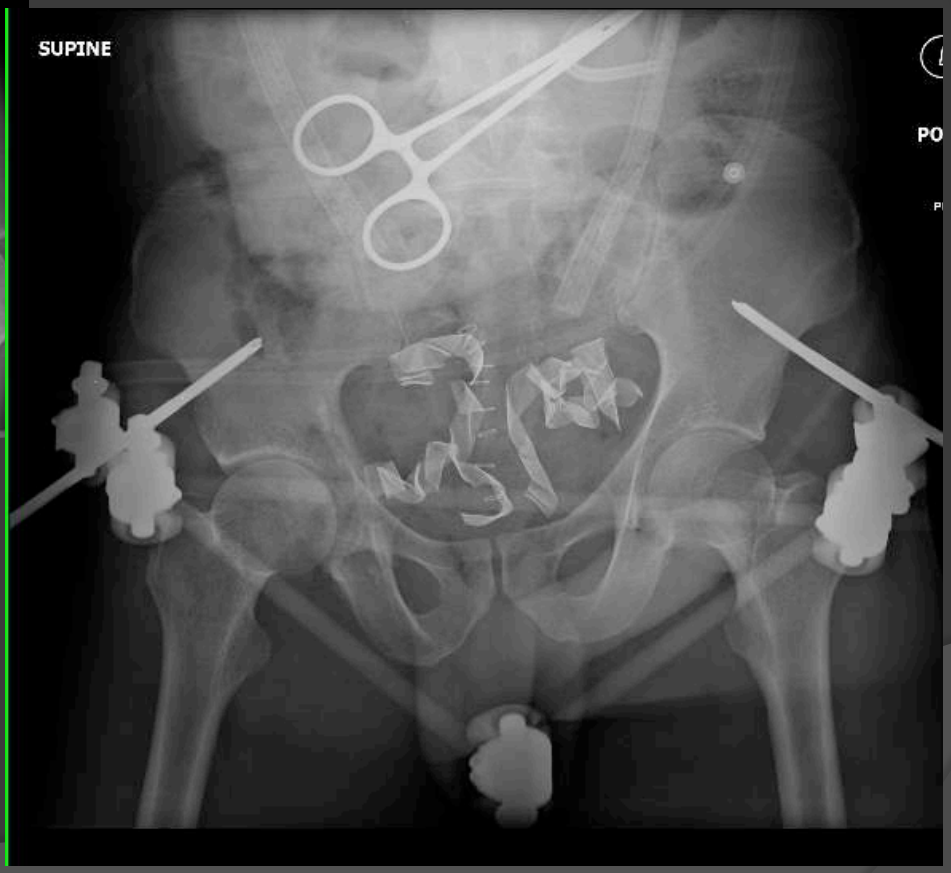
ESTARS Training: REBOA



Students were able to achieve first 3 steps of REBOA in 2 minutes (vascular access, balloon positioning, inflation)

Complex Pelvic Fractures

Complex Pelvic Fractures

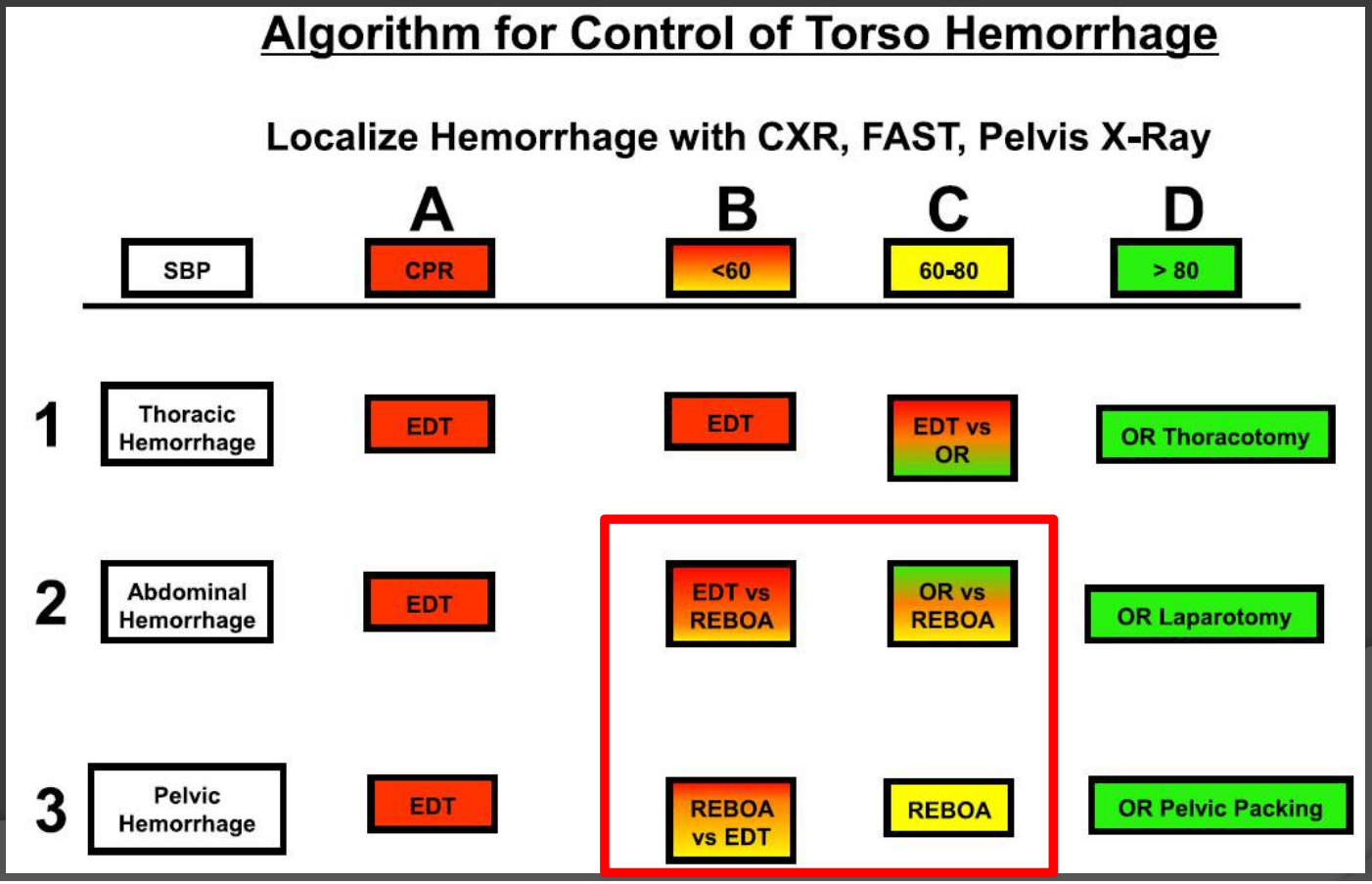


The role of REBOA in the control of exsanguinating torso hemorrhage

Walter L. Biffl, MD, Charles J. Fox, MD, *and* Ernest E. Moore, MD, *Denver, Colorado*

Algorithm for Control of Torso Hemorrhage

Localize Hemorrhage with CXR, FAST, Pelvis X-Ray



DHMC Algorithm: Management of Patient with Unstable Pelvic Fractures and Severe Hemorrhagic Shock

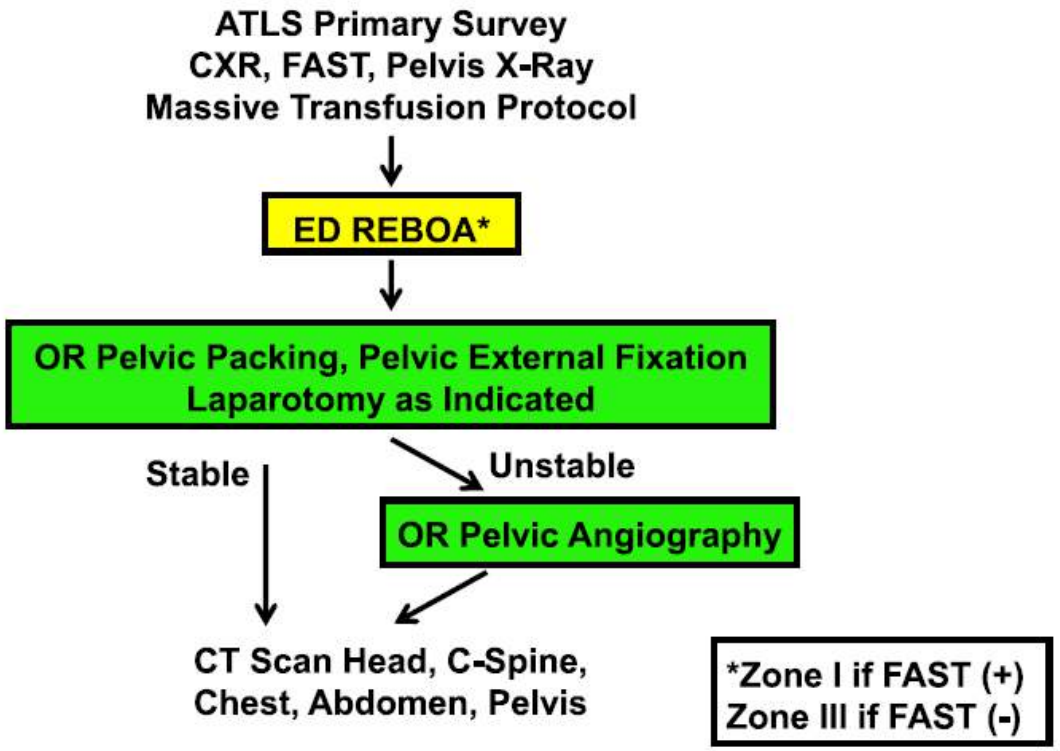


Figure 3. Revised Denver Health Medical Center (DHMC) algorithm for the management of hemodynamically unstable patients with mechanically unstable pelvic fractures. ATLS, advanced trauma life support.

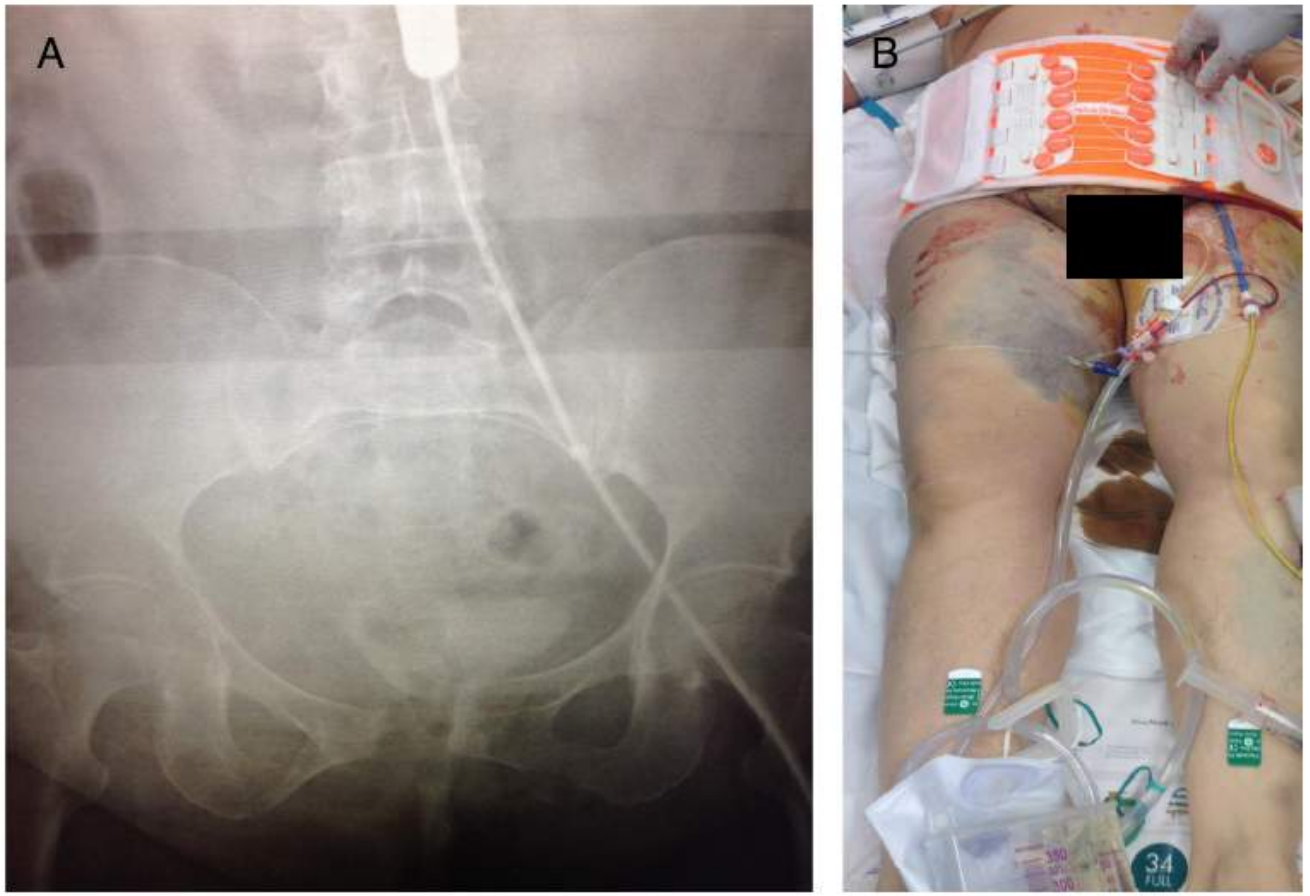


Figure 4. (*A*) Plain x-ray in ED demonstrating REBOA balloon inflated in REBOA Zone III. (*B*) Patient with pelvic binding device secured and REBOA catheter in place in left common femoral artery.

- 60 yo F
- MVC
- Unstable pelvic fx
- CT with traumatic lumbar hernia, right CFA injury
- Tx to Level I
- SBP 50mm
- REBOA Left CFA
- OR for pelvic packing and ExFix Pelvis, pelvic arteriography in OR, vascular repair

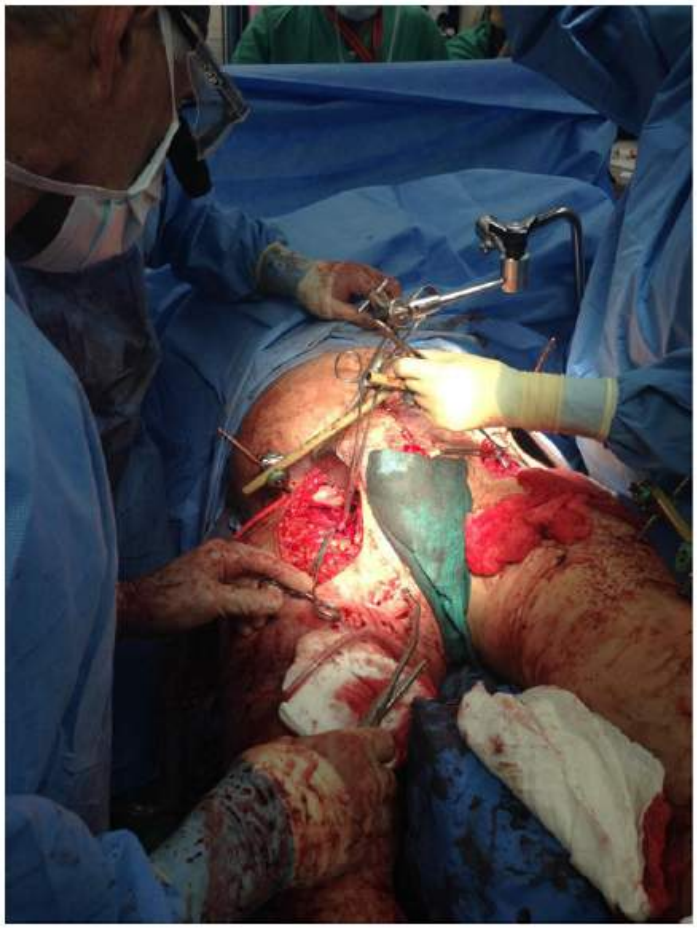


Figure 6. Repair of right common femoral artery. Anterior external fixation device is in place, REBOA has been removed, and the left common femoral artery has been repaired.

Exsanguinating pelvis: Occlude the aorta

Attachments... Police.ppt (2 MB) [Open as Web Page]

From: Moore, Ernest MD [Ernest.Moore@dhha.org]
Sent: Friday, December 11, 2015 5:26 PM
To: Napolitano, Lena (Lena)
Subject:

Your education in San Antonio saved this officers life; 44 mag x 7, no BP on arrival
Best regards

The Denver Health email system has made the following annotations
----------CONFIDENTIALITY NOTICE - T


Revolutionary surgical procedure saves life of Denver police officer
Doctors at Denver Health use new method for Officer Tony Lopez Jr.
DENVER
ONLY ON FOX31
DR. CHARLES FOX
DENVER HEALTH MEDICAL CENTER, CHIEF OF VASCULAR SURGERY

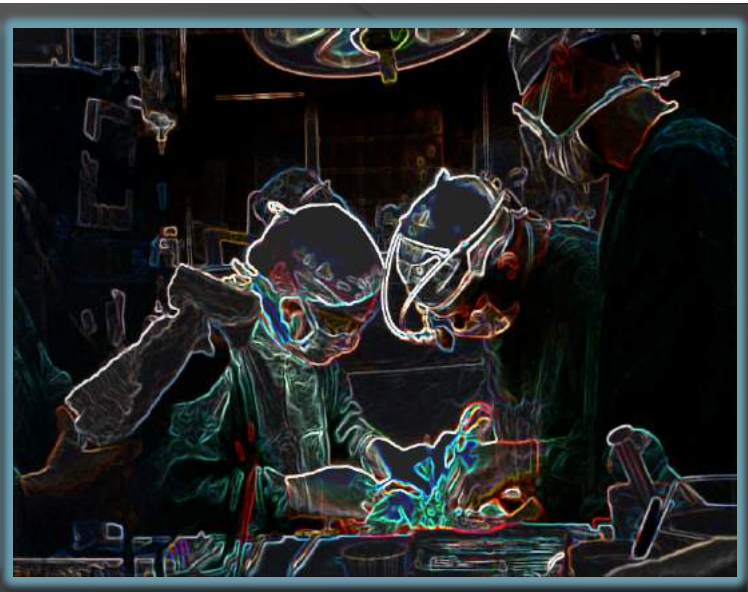
Denver Police officer Tony Lopez Jr. takes first steps after traffic stop shooting

BY: TheDenverChannel.com Team
POSTED: 7:45 PM, Dec 16, 2015
UPDATED: 10:09 PM, Dec 16, 2015
TAG: denver police | officer involved shooting | tony lopez jr.

Shot Denver Police officer Tony Lopez, Jr., released from Denver Health

BY: TheDenverChannel.com Team
POSTED: 1:48 PM, Dec 31, 2015
UPDATED: 10:48 PM, Dec 31, 2015
TAG: denver police | officer shot | tony lopez jr

- 12/11 Admit
- 12/31 D/C



CASE #1

Case #1

- 20 yo male
- Motorcycle crash at high speed
- GCS 15, neurologically intact
- SBP 90/60, HR 120
- Arterial oxygan saturation 99%
- Pelvis unstable by physical exam

- FAST exam negative

Case #1

- Hemostatic resuscitation initiated
- Initially transient responder
- Placed femoral arterial line - micropuncture
- **Non-responder**
- **BP 75/60, HR 130**
- **REBOA deployed in ED**
- **To IR for Pelvic angioembolization**
- Arterial oxygen saturation 90%
- Endotracheal intubation AFTER Reboa

University of Michigan Health System

Case #2
Prehospital / Trauma Bay

- 31 yo M, found in middle of a road after being hit by a car at 55mph, ped struck
- At scene, hypotensive, tachycardic, GCS 4
- BMV, O_2 sat 100%, intubated
- Access: IO x 1, IV x 1, MTP 1:1:1
- HR 120, palpable femoral pulse, sat 100%
- Femoral arterial line, femoral venous cordis
- pH 6.9, lac 7.9, HCO3 11

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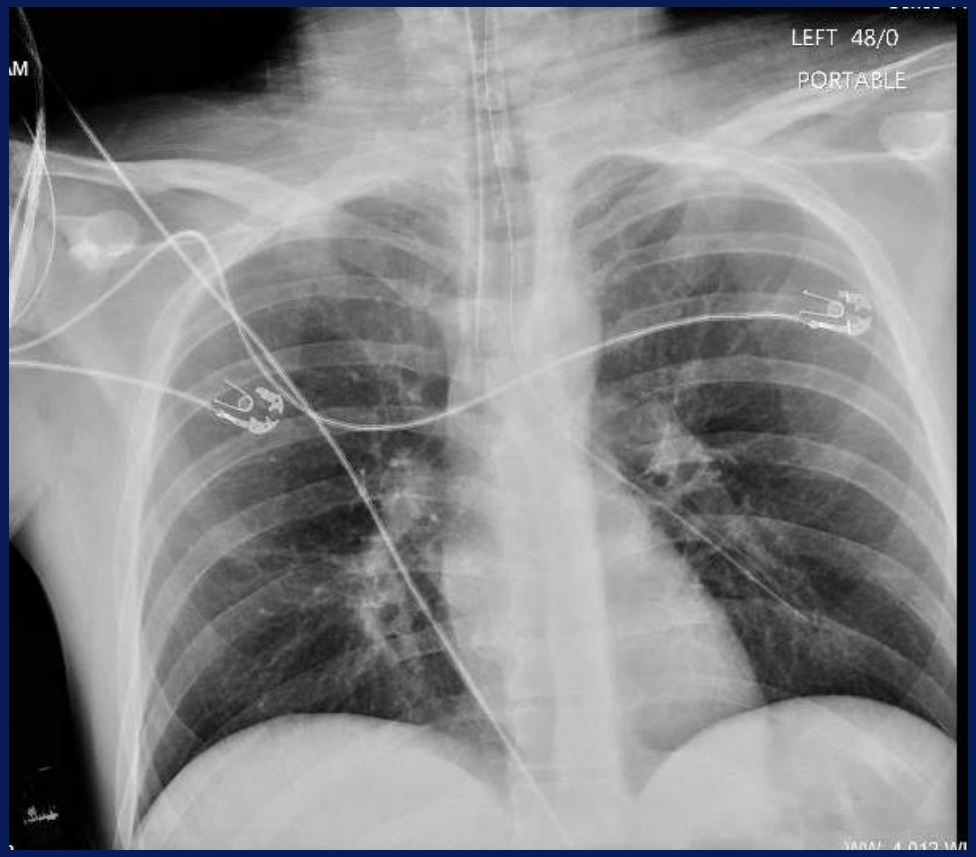
Resuscitation Bay



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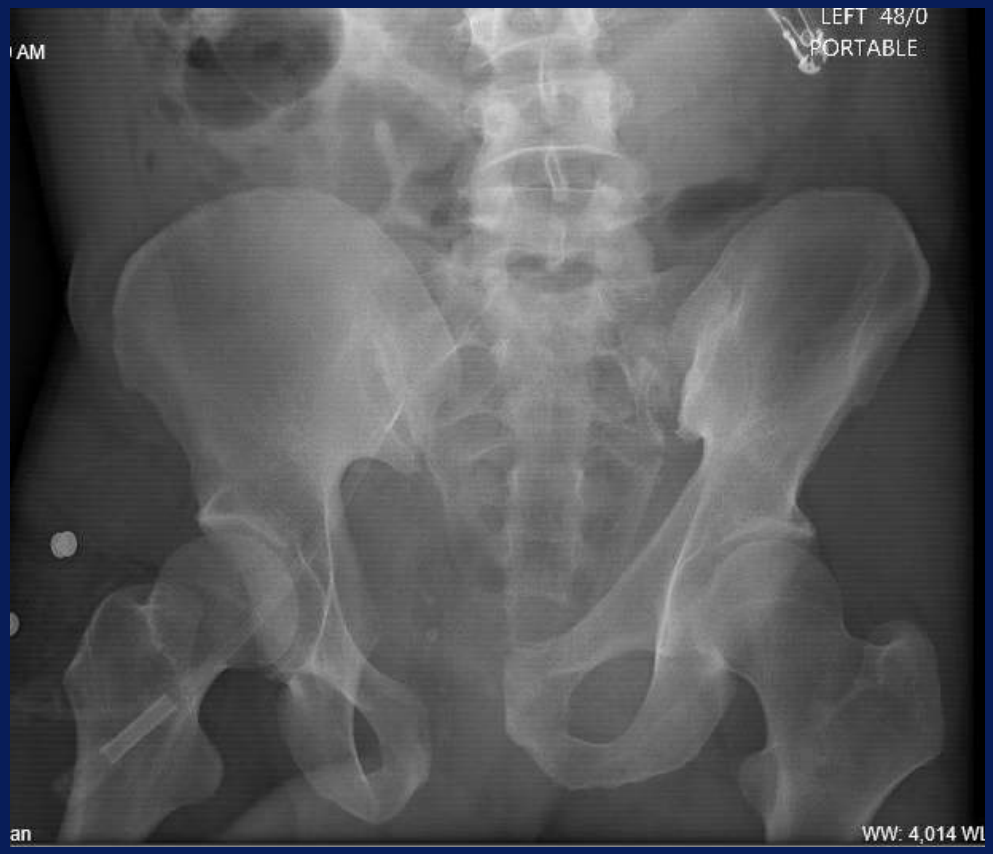
Resuscitation Bay



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Resuscitation Bay

University of Michigan Health System

To OR for Ex-lap

- After transfer to OR bed, sudden loss of BP, ACLS 30 seconds
- **REBOA inflated Zone 1**
- **SBP 70 increased to SBP 110**
- Ex-lap
  - No solid organ injury
  - Mesenteric arterial hemorrhage, vascular ligation
- **REBOA moved to Zone 3 for pelvic bleeding**
- **Pelvic Preperitoneal packing (IR not ready)**

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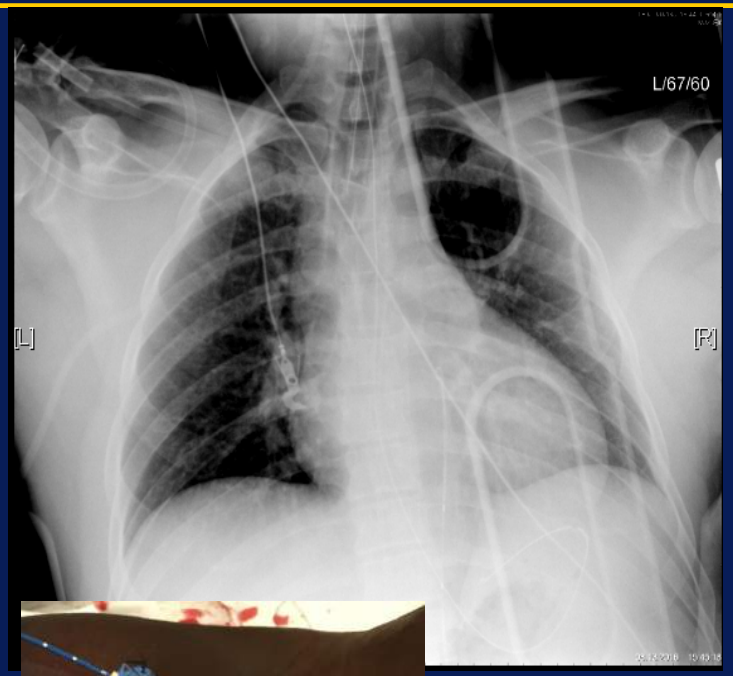
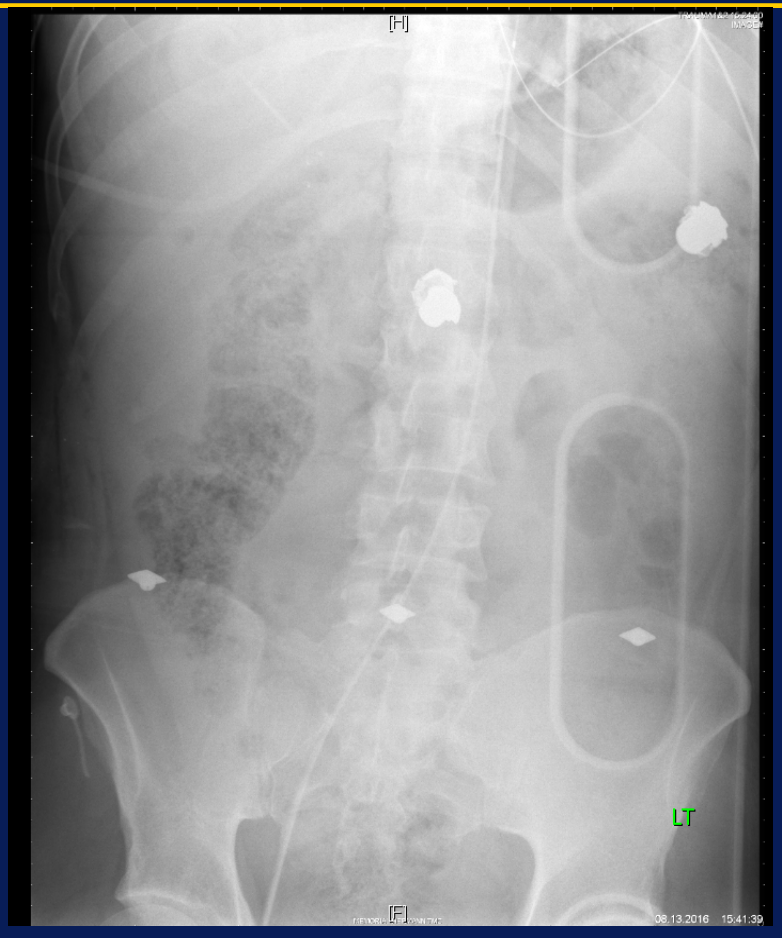
ER–REBOA – ZONE 1





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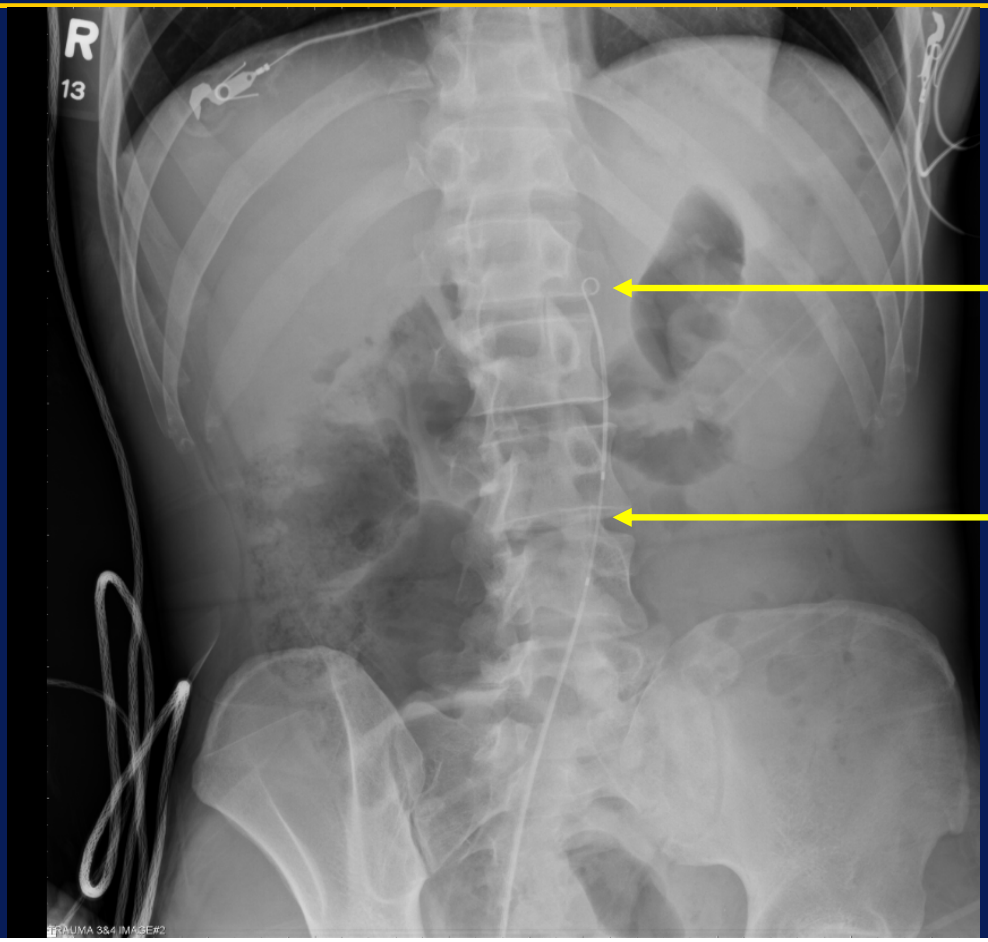
ER-REBOA – ZONE 3



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B/L internal iliac artery embolization

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ICU – Critical REBOA Adjuncts

- Continued **<u>hemostatic resuscitation</u>**
  - –Hypothermia: 33°C -> 37°C
  - –Acidosis: pH 6.9 -> 7.4, HCO_3 11->24
  - –1:1:1 blood products, minimal crystalloid
  - –Coagulopathy
    - TXA
    - Rotem
    - Calcium

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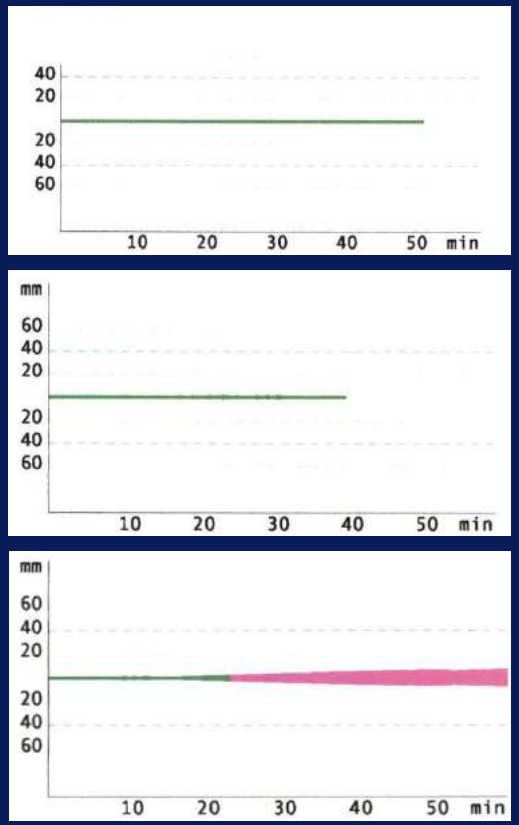
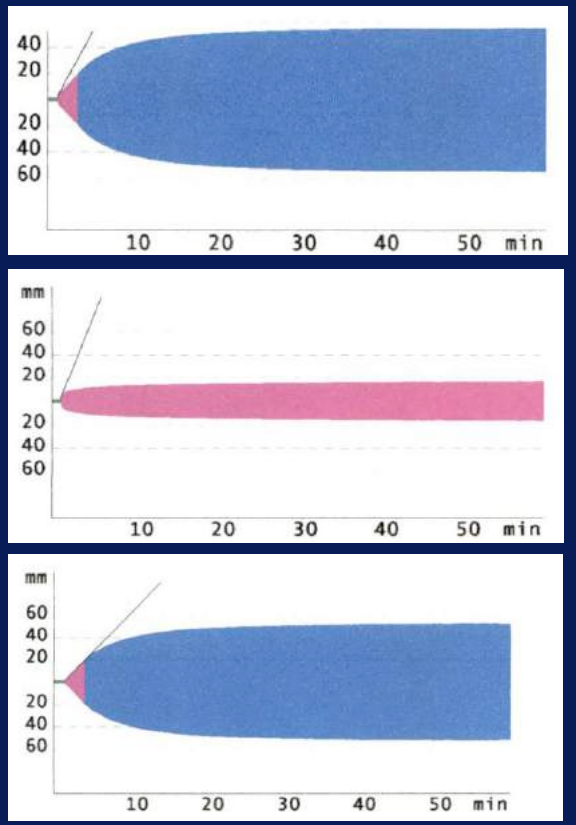
ROTEM

Extem

Fibtem

Aptem





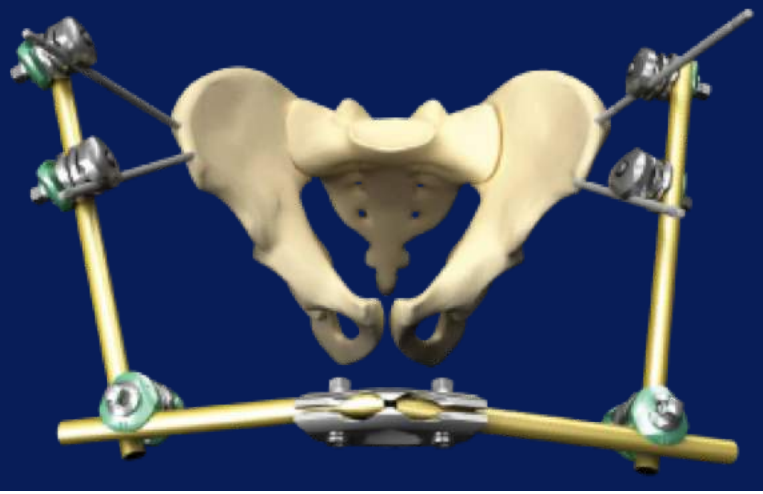
Arrival

Post-IR

University of Michigan Health System

Ex-lap #2

- 2L intraperitoneal blood evacuated
- Bleeding from mesenteric defect controlled
- Packs removed, no ongoing bleeding
- Pelvic ex-fix (Ortho)
- Abthera Abc VAC



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Head CT

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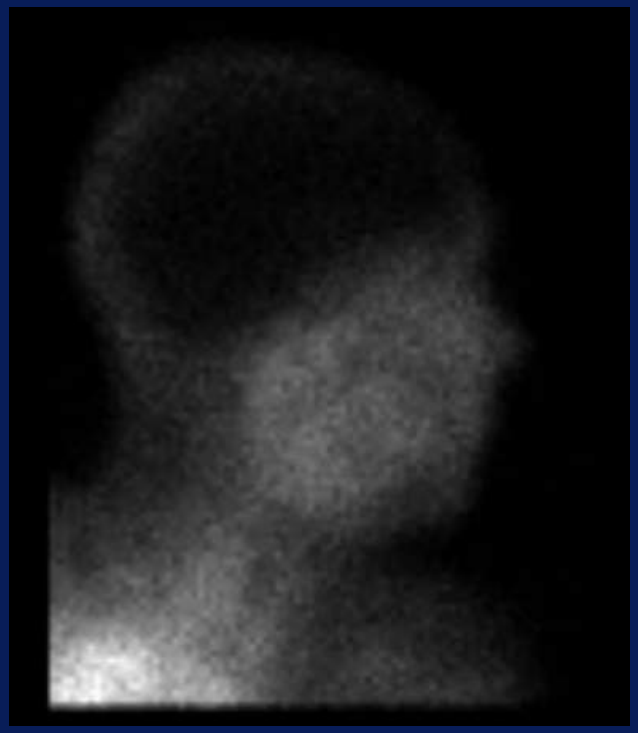
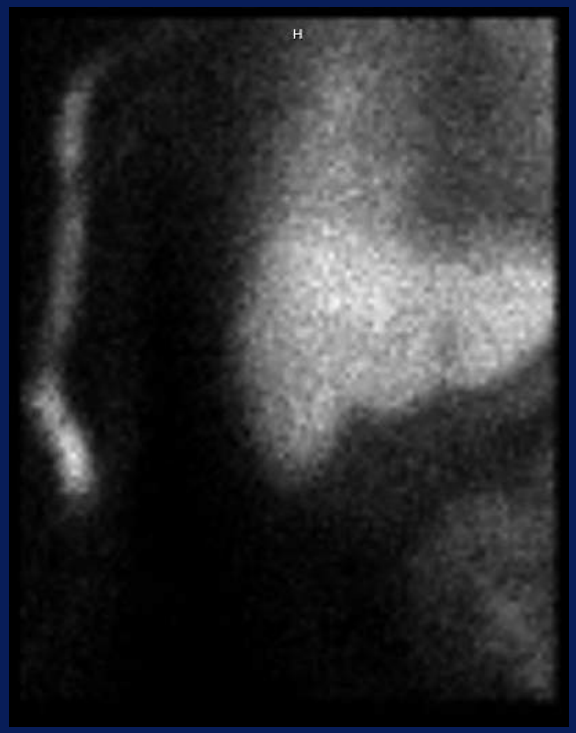
Brain Scan / Gift of Life





Donated heart and liver to in-house recipients

Prehospital REBOA

- London's Air Ambulance Crew
- 1st used in UK by Royal London Hospital
- 2 yrs later…
- Modified technique for prehospital use

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16 June 2014 Last updated at 22:11 ET

Share

Balloon surgery stops fatal bleeding at roadside

By Smitha Mundasad
Health reporter, BBC News

London's Air Ambulance aim to bring the emergency department to the roadside

London's Air Ambulance crew have become the first team in the world to use a balloon device to control catastrophic bleeding at the roadside.

Related St

LONDON'S AIR AMBULANCE
Registered charity 801013

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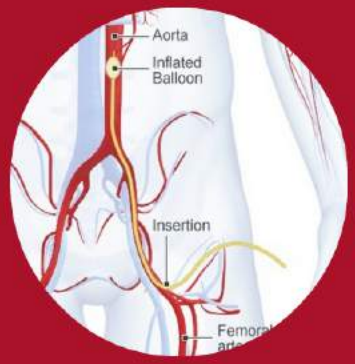
World's first pre-hospital REBOA performed

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.

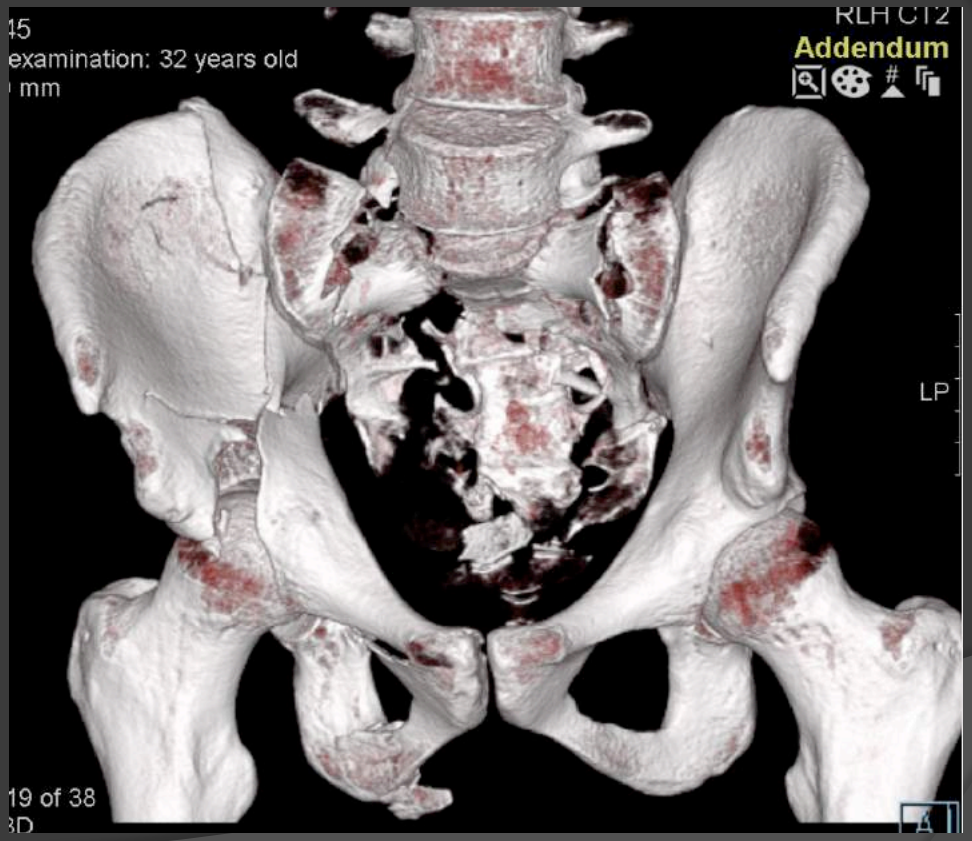
Prehospital REBOA

- 32yo M fell 15 meters on concrete, catastrophic internal hemorrhage due to pelvic fractures.
- He was treated by the Physician-Paramedic team with insertion of a REBOA balloon catheter at the scene to control likely fatal exsanguination.
- He survived transfer to hospital, emergency angioembolization and subsequent surgery.
- He was discharged neurologically normal after 52 days and went on to make a full recovery.

Sadek S. et al. Resuscitative endovascular balloon occlusion of the aorta (REBOA) in the pre-hospital setting: An additional resuscitation option for uncontrolled catastrophic haemorrhage. Resuscitation. 2016 Jul 1. [Epub ahead of print]

Prehospital REBOA

- Team arrived 34 min after injury
- **No BP, HR 130**
- Intubation
- Resuscitation
- 6u PRBCs
- TXA, splint pelvis
- Closest trauma ctr 30 minutes
- **REBOA 7 Fr**



Balloon catheter with guide-wire in situ

REBOA balloon at terminal aorta

Field REBOA

EMCrit Blog

A Discussion of the Practice of ED Critical Care

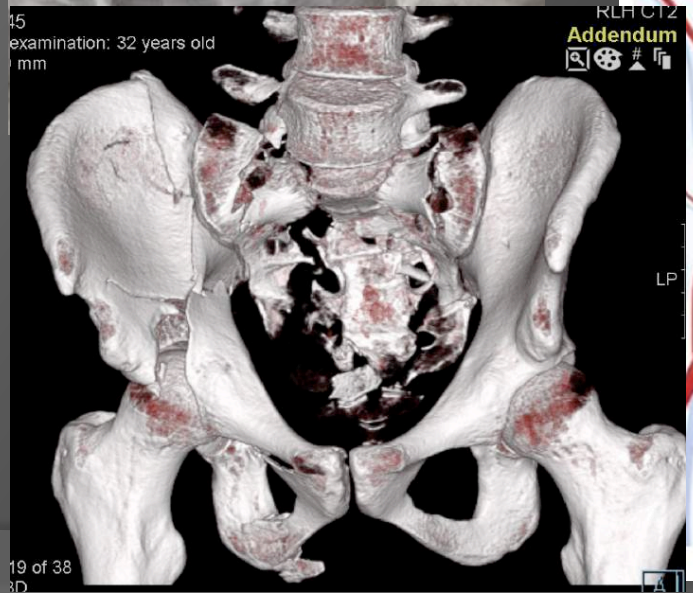
Resuscitative Endovascular Balloon Occlusion of Aorta

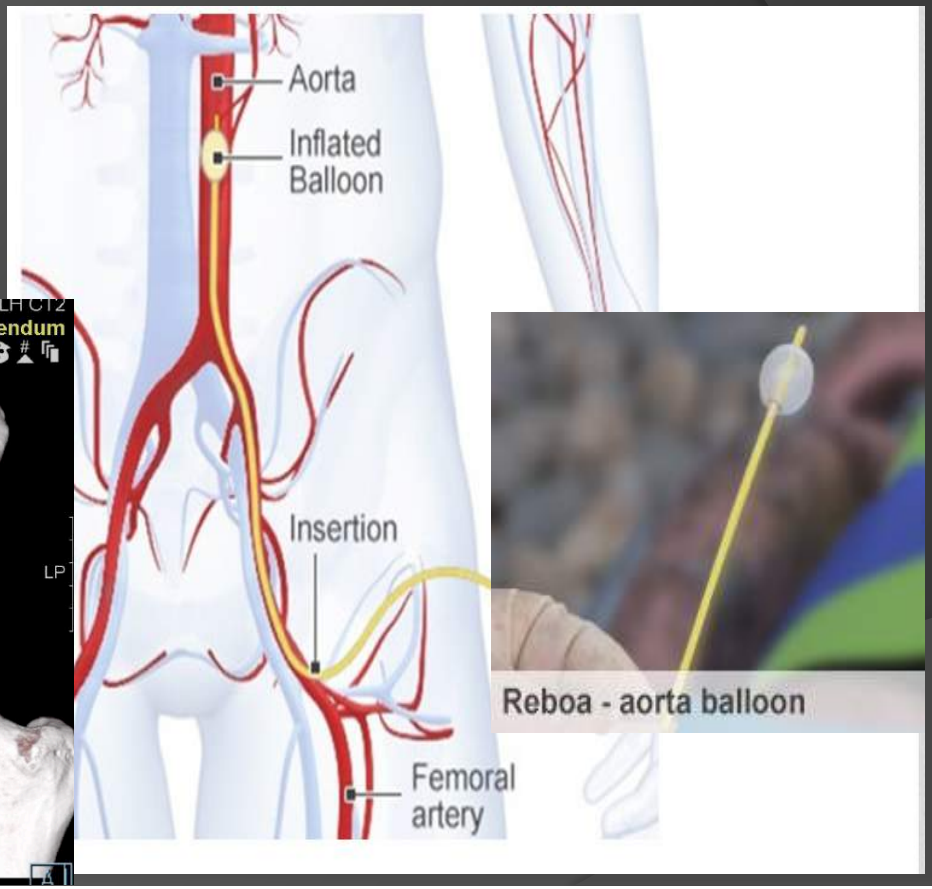
EMCrit Podcast 121 – REBOA

Exsanguinating Torso Hemorrhage

- The most appropriate means of prompt torso hemorrhage control must be tailored to the clinical situation
- Trauma surgeons should have expertise with all approaches:
  - **Resuscitative thoracotomy**
  - **Trauma laparotomy**
  - ***REBOA***

REBOA: ESSENTIAL!





Resuscitative Endovascular Balloon Occlusion of the Aorta: Indications, Outcomes, and Training

Lena M. Napolitano, MD, FCCP, MCCM

KEYWORDS

- Resuscitative endovascular balloon occlusion of aorta • Hemorrhagic shock
- Aortic occlusion • Aortic balloon • Noncompressible torso hemorrhage
- Resuscitative thoracotomy

KEY POINTS

- Resuscitative endovascular balloon occlusion of aorta (REBOA) is an adjunct to trauma hemorrhage control; it provides early aortic occlusion to improve blood pressure and sta-

Critical Care Clinics 2017

Endovascular Skills for Trauma and Resuscitative Surgery

management of vascular trauma

- **<u>Endovascular / REBOA Trauma Education:</u>**

- National Standardized education and training
- <u>Competency-based</u> education
- Take a Course!

- ***<u>REBOA Implementation:</u>***
- Get examples of REBOA protocols / kits from others

- REBOA Module to be added to ASSET and ATOM ACS Courses soon

GUIDELINES

Current opinion on catheter-based hemorrhage control in trauma patients

John B. Holcomb, MD, Erin E. Fox, PhD, Thomas M. Scalea, MD, Lena M. Napolitano, MD, Rondel Albarado, MD, Brijesh Gill, MD, Brian J. Dunkin, MD, Andrew W. Kirkpatrick, MD, Bryan A. Cotton, MD, Kenji Inaba, MD, Joseph J. DuBose, MD, Alan M. Cohen, MD, Ali Azizzadeh, MD, Megan Brenner, MD, Mitchell J. Cohen, MD, Charles E. Wade, PhD, Alan B. Lumsden, MD, Richard Andrassy, MD, Peter M. Rhee, MD, MPH, Barbara L. Bass, MD, Kenneth L. Mattox, MD, L.D. Britt, MD, A. Brent Eastman, MD, David B. Hoyt, MD, Todd E. Rasmussen, MD, *and* the Catheter-Based Hemorrhage Control Study Group, *Houston, Texas*

COMPETENCY AND CREDENTIALING IN CATHETER-BASED HEMORRHAGE CONTROL

At present, no common standard for competency/credentialing exists for endovascular interventions for catheter-based hemorrhage control, but we must work toward this goal for the future, being certain to include the trauma and acute care surgeons in the provider group.

J Trauma Acute Care Surg. 2014 Mar;76(3):888-93

First Endovascular Hemorrhage Control Course at American College of Surgeons Clinical Congress 2015

SSC08 | Endovascular Skills for Hemorrhage Control

Track: VAS
6 Hours, Verification Level III
Monday, October 5, 2015 | 10:00 am–5:15 pm

Chair: Lena M. Napolitano, MD, FACS, FCCP, FCCM, Ann Arbor, MI

Co-Chair: Jonathan L. Eliason, MD, FACS, Ann Arbor, MI

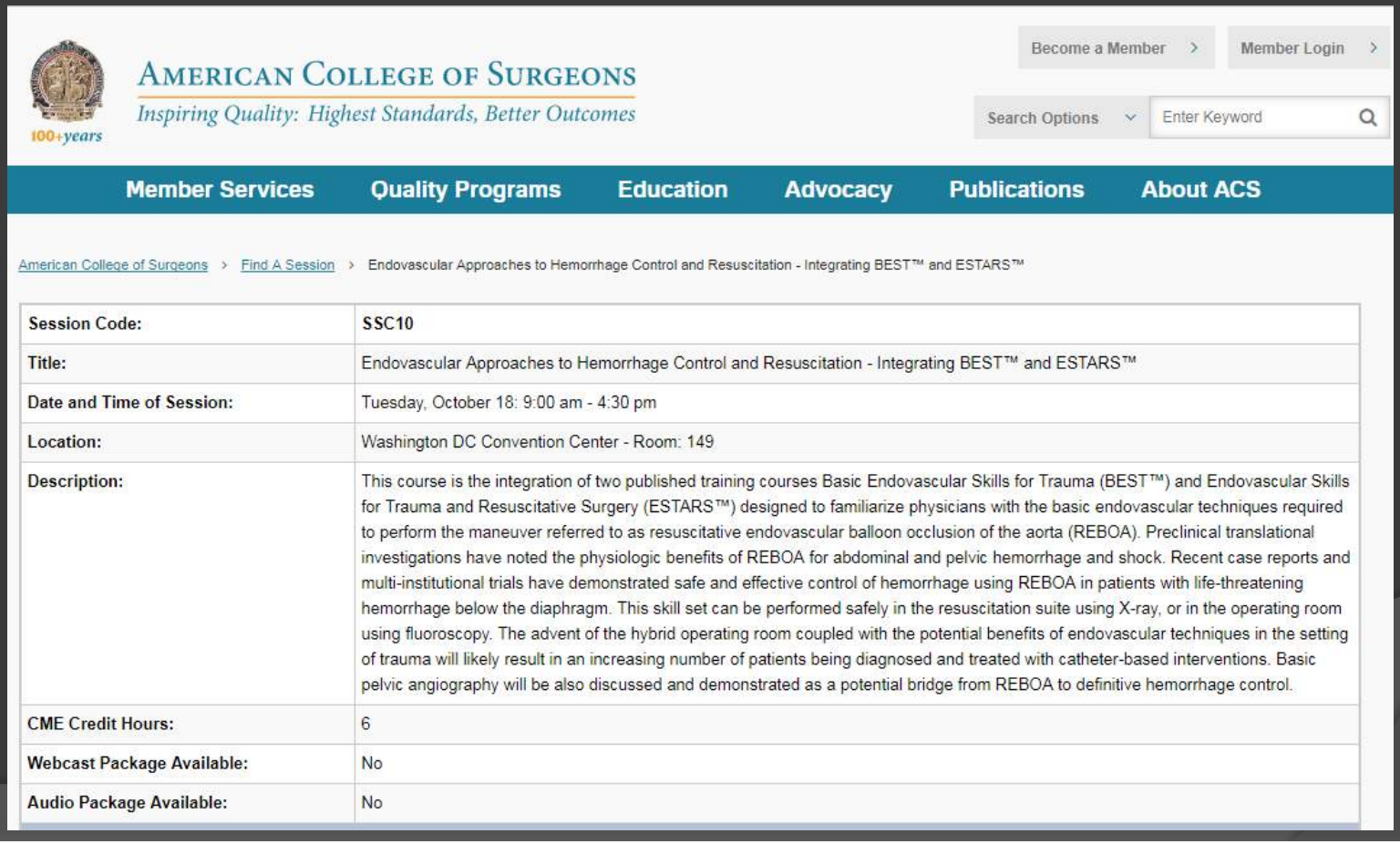
There is an ever-evolving role of endovascular techniques for traumatic vascular injuries. These techniques should be incorporated into the early treatment algorithm of trauma patients, particularly for those requiring difficult operative exposure. This course will provide both lecture and hands-on skills in the use of the Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA) and the necessary tools used in the procedure. This course is for vascular and non-vascular surgeons. Note: Live fluoroscopy will be used during the surgical skills lab portion of the course.

Sponsored by: Committee on Surgical Skills Training for Practicing Surgeons

Fee: FELLOW $1,000 | NON-FELLOW $1,275
RAS $500 | NON-RAS $575

SSC10 Endovascular Approaches to Hemorrhage Control and Resuscitation: Integrating BEST™ and ESTARS™

Fellow $995 | Non-Fellow $1,150 | RAS $500 | Non-RAS $580 (2016)



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American College of Surgeons › Find A Session › Endovascular Approaches to Hemorrhage Control and Resuscitation - Integrating BEST™ and ESTARS™

Session Code:	**SSC10**
Title:	Endovascular Approaches to Hemorrhage Control and Resuscitation - Integrating BEST™ and ESTARS™
Date and Time of Session:	Tuesday, October 18: 9:00 am - 4:30 pm
Location:	Washington DC Convention Center - Room: 149
Description:	This course is the integration of two published training courses Basic Endovascular Skills for Trauma (BEST™) and Endovascular Skills for Trauma and Resuscitative Surgery (ESTARS™) designed to familiarize physicians with the basic endovascular techniques required to perform the maneuver referred to as resuscitative endovascular balloon occlusion of the aorta (REBOA). Preclinical translational investigations have noted the physiologic benefits of REBOA for abdominal and pelvic hemorrhage and shock. Recent case reports and multi-institutional trials have demonstrated safe and effective control of hemorrhage using REBOA in patients with life-threatening hemorrhage below the diaphragm. This skill set can be performed safely in the resuscitation suite using X-ray, or in the operating room using fluoroscopy. The advent of the hybrid operating room coupled with the potential benefits of endovascular techniques in the setting of trauma will likely result in an increasing number of patients being diagnosed and treated with catheter-based interventions. Basic pelvic angiography will be also discussed and demonstrated as a potential bridge from REBOA to definitive hemorrhage control.
CME Credit Hours:	6
Webcast Package Available:	No
Audio Package Available:	No

SC10 | Basic Endovascular Skills for Trauma (BEST™) Workshop

4 credits, Verification Level III
Tuesday, October 24; 1:00–5:15 pm
Chair: Megan L. Brenner, MD, FACS, Baltimore, MD
Co-Chair: Joseph J. DuBose, MD, FACS, Davis, CA
Fellow $425 | Non-Fellow $500 | RAS $225 | Non-RAS $300 (2017)

Session Code:	**SC10**
Title:	Basic Endovascular Skills for Trauma (BEST™) Workshop
Date and Time of Session:	Tuesday, October 24: 1:00 pm - 5:15 pm
Location:	San Diego Convention Center - Room: 18
Description:	The utilization of endovascular techniques for vascular control in the bleeding injured patient requires an understanding of indications and contraindications of the procedure as well as a hands-on experience utilizing the required devices. Recent case reports have demonstrated safe and effective temporary control of hemorrhage using Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA) in trauma patients with life-threatening hemorrhage below the diaphragm. The BEST™ Workshop uses simulation models and is intended to serve as an introduction to REBOA and lays the foundation for more in-depth training at the BEST™ Course.
CME Credit Hours:	4
Webcast Package Available:	No
Audio Package Available:	No

BEST™

BASIC ENDOVASCULAR SKILLS FOR TRAUMA

THE COMMITTEE ON TRAUMA

Target Audience

This course is designed for practitioners seeking to develop or improve their understanding and skills for Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA)

Course Objectives

- To demonstrate indications for REBOA
- To demonstrate access and closure of the common femoral artery
- To demonstrate tools required for REBOA
- To demonstrate technique of REBOA

Course Agenda

*Welcome/Registration and Pre-Test

Introduction, History of REBOA, and Translational Research

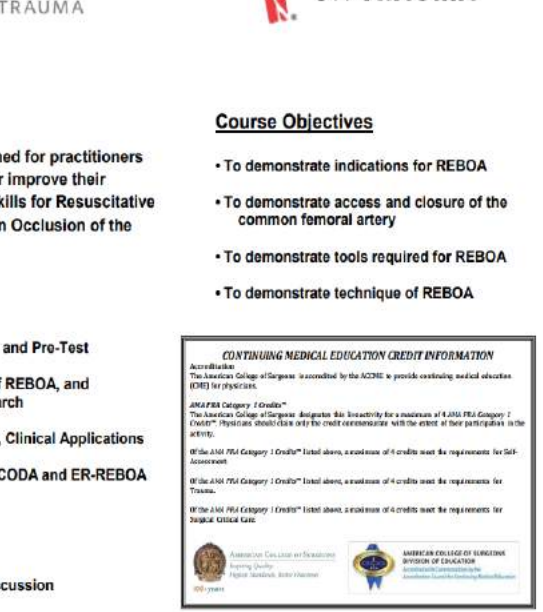
Indications for REBOA, Clinical Applications

Technique of REBOA: CODA and ER-REBOA

Simulator Lab

Cadaver Lab

Post-Test, Wrap-up Discussion



CONTINUING MEDICAL EDUCATION CREDIT INFORMATION

Accreditation

The American College of Surgeons is accredited by the ACCME to provide continuing medical education (CME) for physicians.

AMA PRA Category 1 Credit(s)™

The American College of Surgeons designates this live activity for a maximum of 4 AMA PRA Category 1 Credit(s)™. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

Of the AMA PRA Category 1 Credit(s)™ listed above, a maximum of 4 credits meet the requirements for Self-Assessment.

Of the AMA PRA Category 1 Credit(s)™ listed above, a maximum of 4 credits meet the requirements for Trauma.

Of the AMA PRA Category 1 Credit(s)™ listed above, a maximum of 4 credits meet the requirements for Surgical Critical Care.

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BEST™

BASIC ENDOVASCULAR SKILLS FOR TRAUMA

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Basic Endovascular Skills for Trauma

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FEBRUARY 2018

	Date	Event	Location	Contact Email	Contact Phone	Event Website
☐	Feb 28	Basic Endovascular Skills for Trauma	UC Davis, Sacramento, CA	khuntsman@ucdavis.edu	916-734-8356	www.facs.org...

MARCH 2018

	Date	Event	Location	Contact Email	Contact Phone	Event Website
☐	Mar 7	Basic Endovascular Skills for Trauma	UT Houston—Houston, TX	best@uth.tmc.edu	713-500-7217	www.facs.org...
☐	Mar 14	Basic Endovascular Skills for Trauma	UC Davis, Sacramento, CA	khuntsman@ucdavis.edu	916-734-8356	www.facs.org...

APRIL 2018

	Date	Event	Location	Contact Email	Contact Phone	Event Website
☐	Apr 4	Basic Endovascular Skills for Trauma	UC Davis, Sacramento, CA	khuntsman@ucdavis.edu	916-734-8356	www.facs.org...
☐	Apr 18	Basic Endovascular Skills for Trauma	UT Houston—Houston, TX	best@uth.tmc.edu	713-500-7217	www.facs.org...
☐	Apr 18	Basic Endovascular Skills for Trauma	Shock Trauma Center, Baltimore, MD	best@umm.edu	410-328-9878	www.facs.org...
☐	Apr 20	Basic Endovascular Skills for Trauma	UC Davis, Sacramento, CA	khuntsman@ucdavis.edu	916-734-8356	www.facs.org...

MAY 2018

	Date	Event	Location	Contact Email	Contact Phone	Event Website
☐	May 9	Basic Endovascular Skills for Trauma	UT Houston—Houston, TX	best@uth.tmc.edu	713-500-7217	www.facs.org...
☐	May 16	Basic Endovascular Skills for Trauma	Shock Trauma Center, Baltimore, MD	best@umm.edu	410-328-9878	www.facs.org...
☐	May 23	Basic Endovascular Skills for Trauma	UC Davis, Sacramento, CA	khuntsman@ucdavis.edu	916-734-8356	www.facs.org...

JUNE 2018

	Date	Event	Location	Contact Email	Contact Phone	Event Website
☐	Jun 13	Basic Endovascular Skills for Trauma	Shock Trauma Center, Baltimore, MD	best@umm.edu	410-328-9878	www.facs.org...