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Dignity Health

Aortic Control for Trauma

JAMES N BOGERT

Disclosures

Prytime Medical

Acute Innovations

Objectives

Importance of Hemorrhage Control

History

- Proximal control
- Aortic control

REBOA

- Technique
- Current Data
- Future Directions

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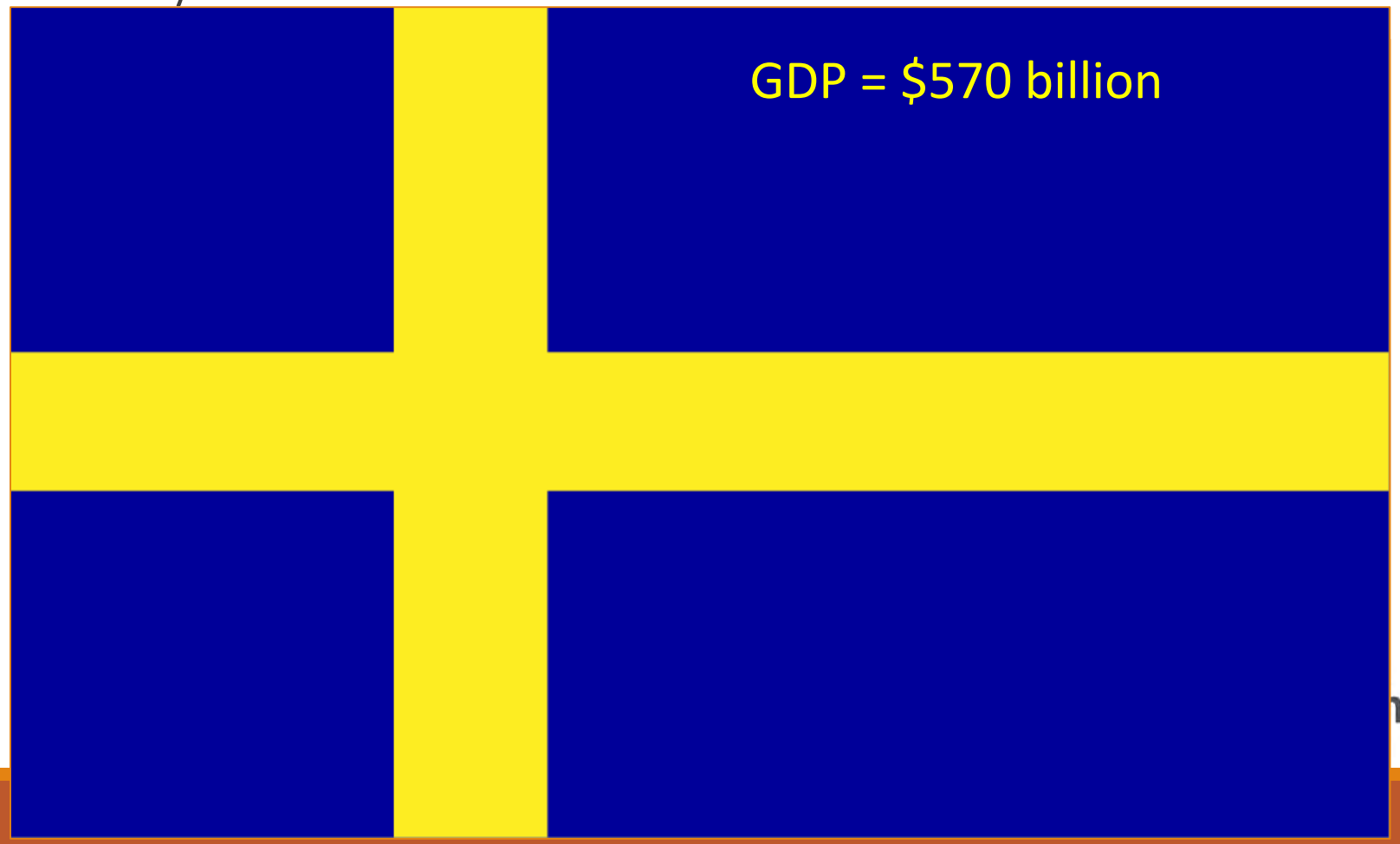
Trauma

Leading cause of death in patients < 44 years old

- Years of productive life lost
- Cost = $671 billion annually



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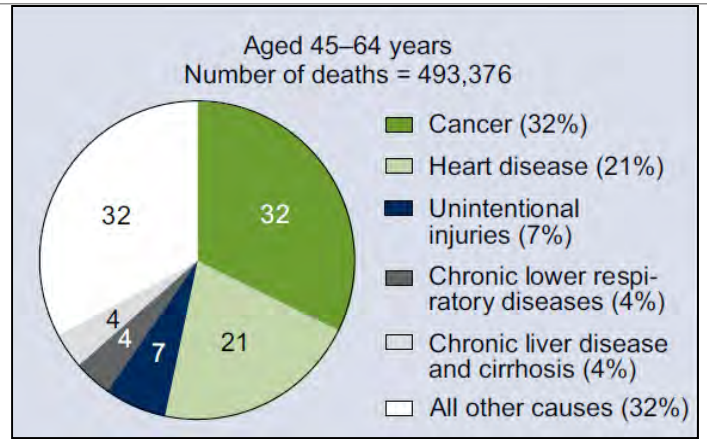
Trauma Deaths

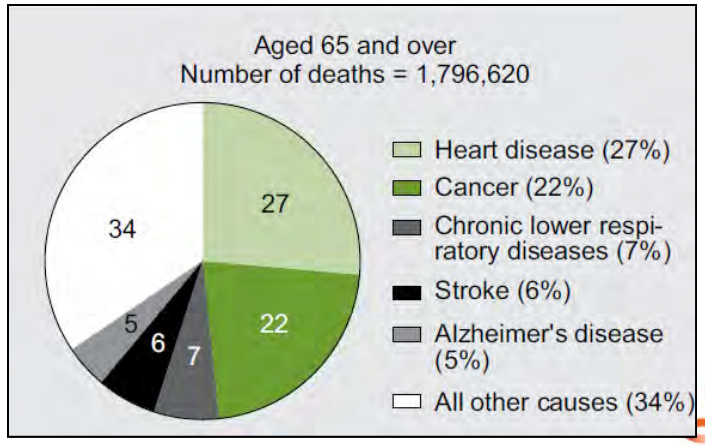
Trauma Deaths

- Disease of the young
- Hemorrhage
- Brain injury

Hemorrhage

- 40-60% of trauma deaths
- Damage Control Resuscitation
- Hemostasis





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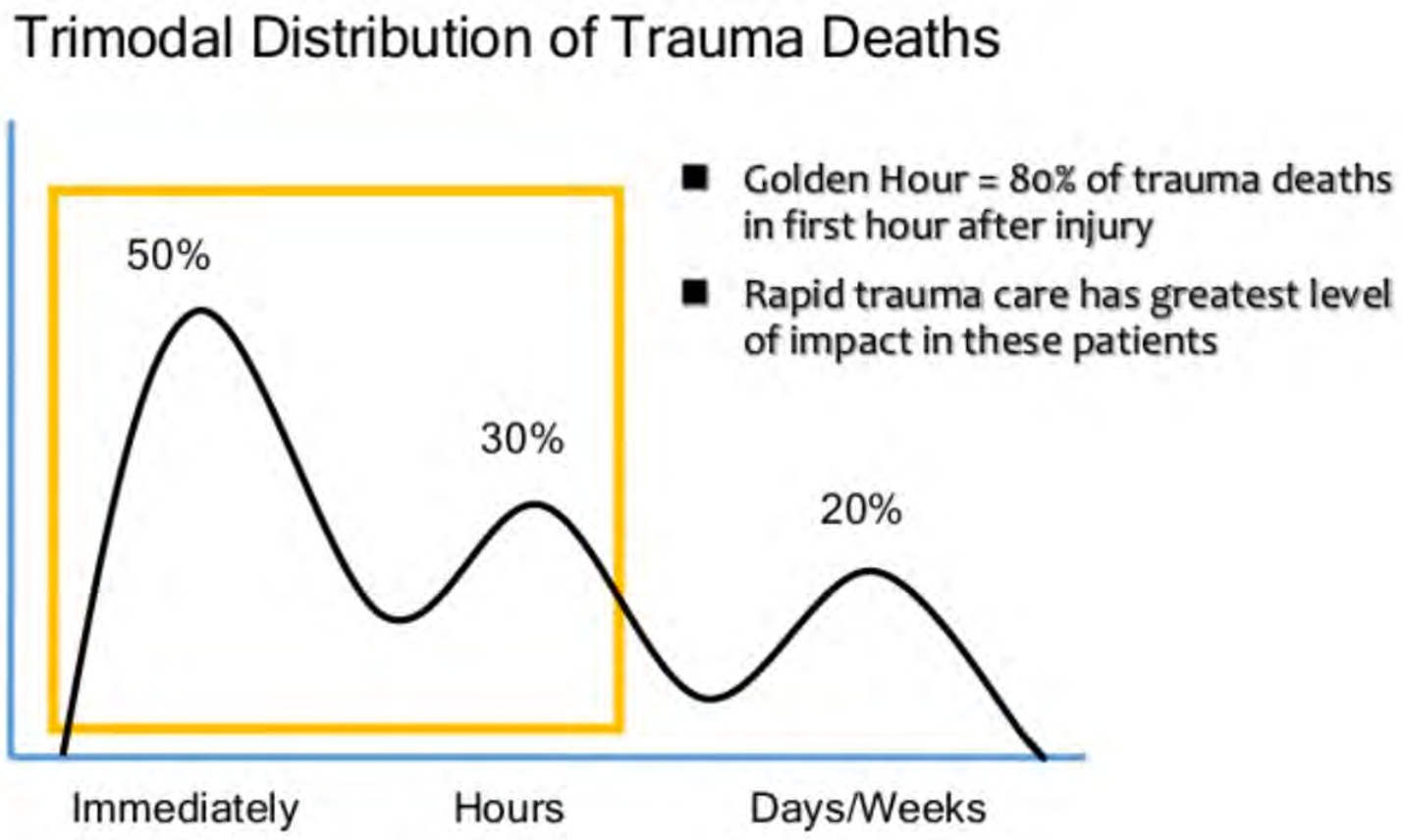
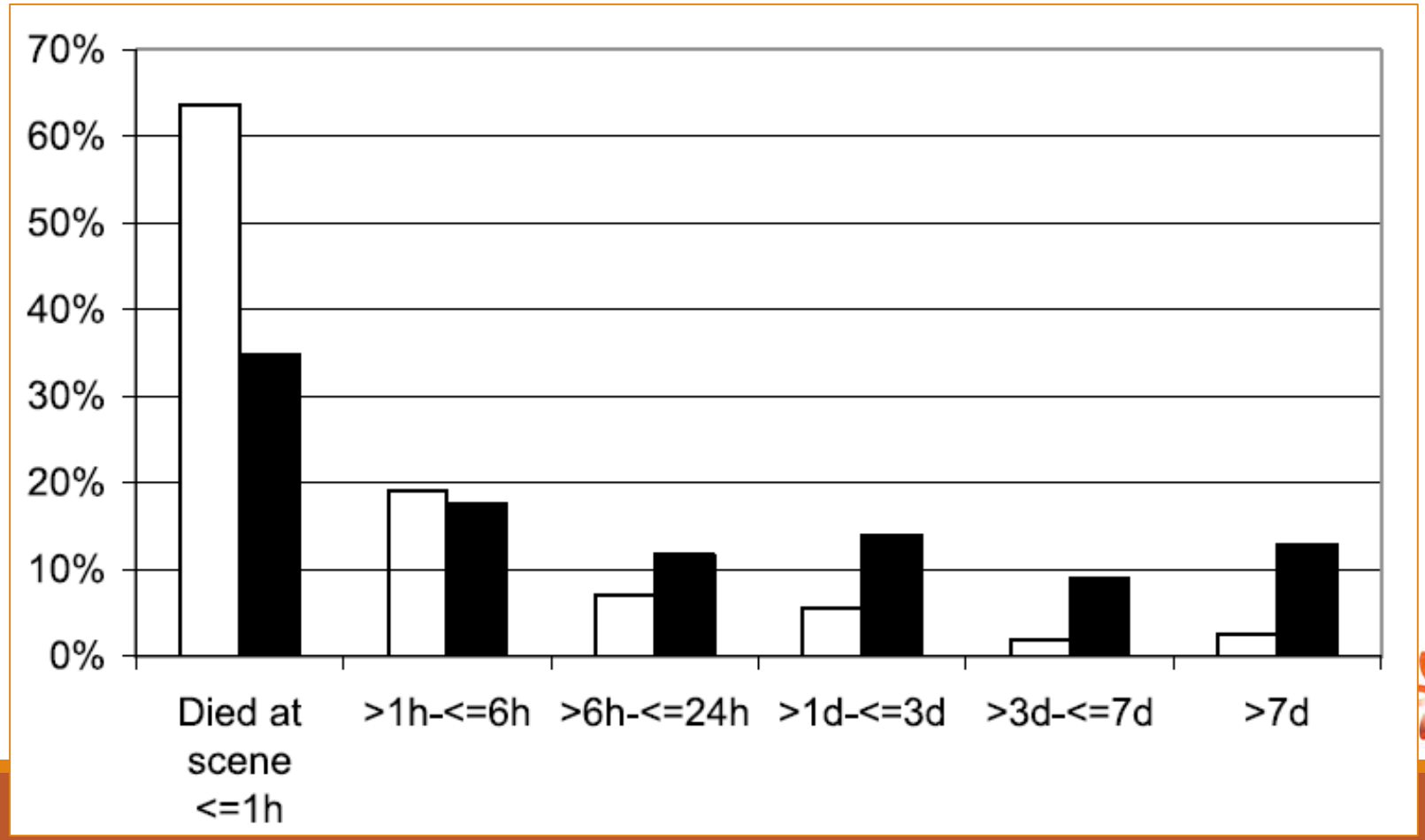
Trimodal distribution



Trauma Deaths in a Mature Urban Trauma System: Is "Trimodal" Distribution a Valid Concept?

Demetrios Demetriades, MD, PhD, FACS, Brian Kimbrell, MD, Ali Salim, MD, FACS, George Velmahos, MD, PhD, FACS, Peter Rhee, MD, FACS, Christy Preston, RN, Ginger Gruzinski, RN, Linda Chan, PhD

J Am Coll Surg 2005;201:343–348



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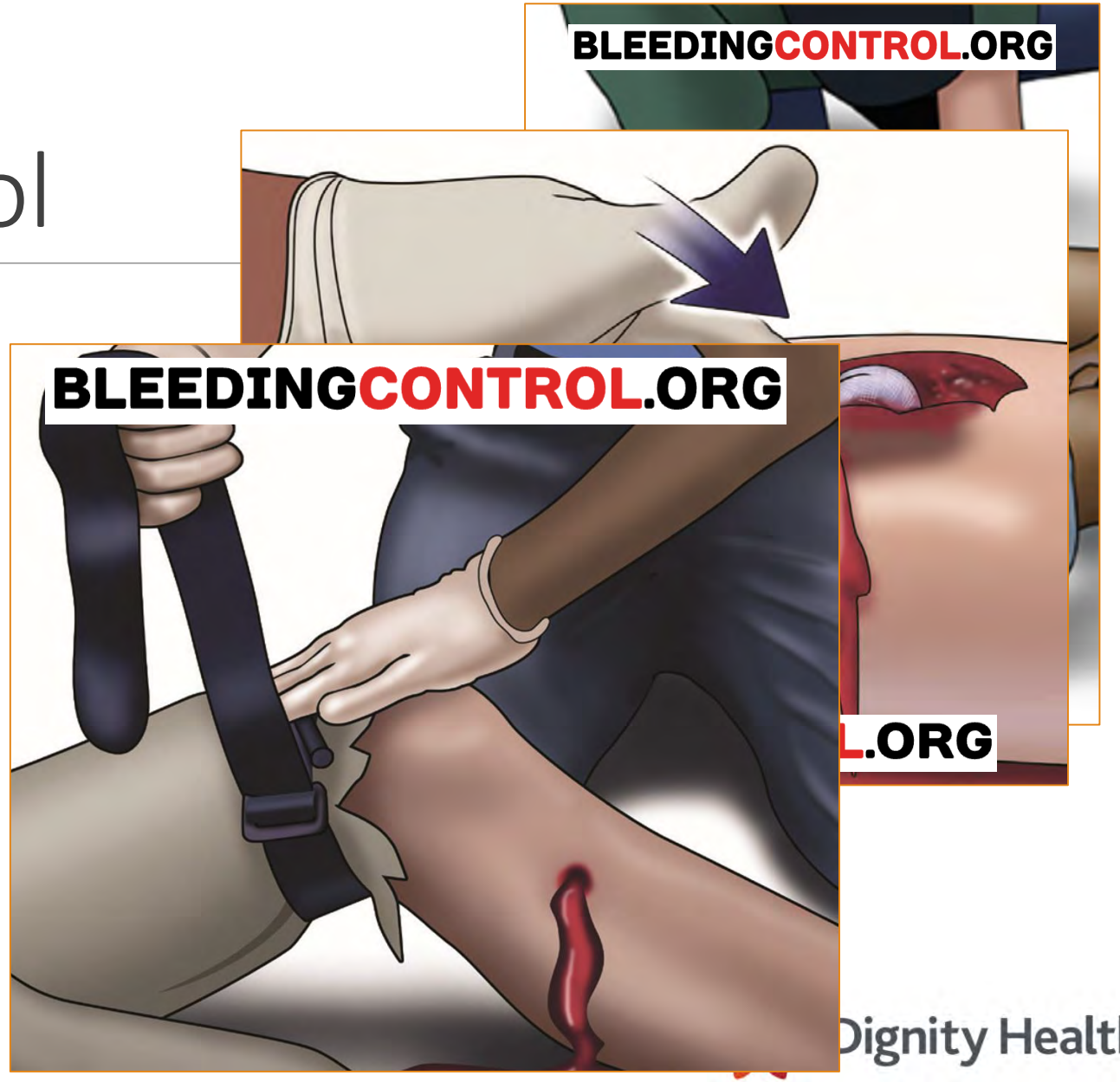
Hemorrhage control

Direct pressure

Hemostatic dressings

Proximal control

- Tourniquet



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Tourniquets

1517: Hans von Gersdorff

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Tourniquets

All shapes and sizes

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Stop the bleeding

What about truncal hemorrhage?

Conventional Management

- Replace volume
- Drive Fast
- Operative control

Proximal Control

- Tourniquet?

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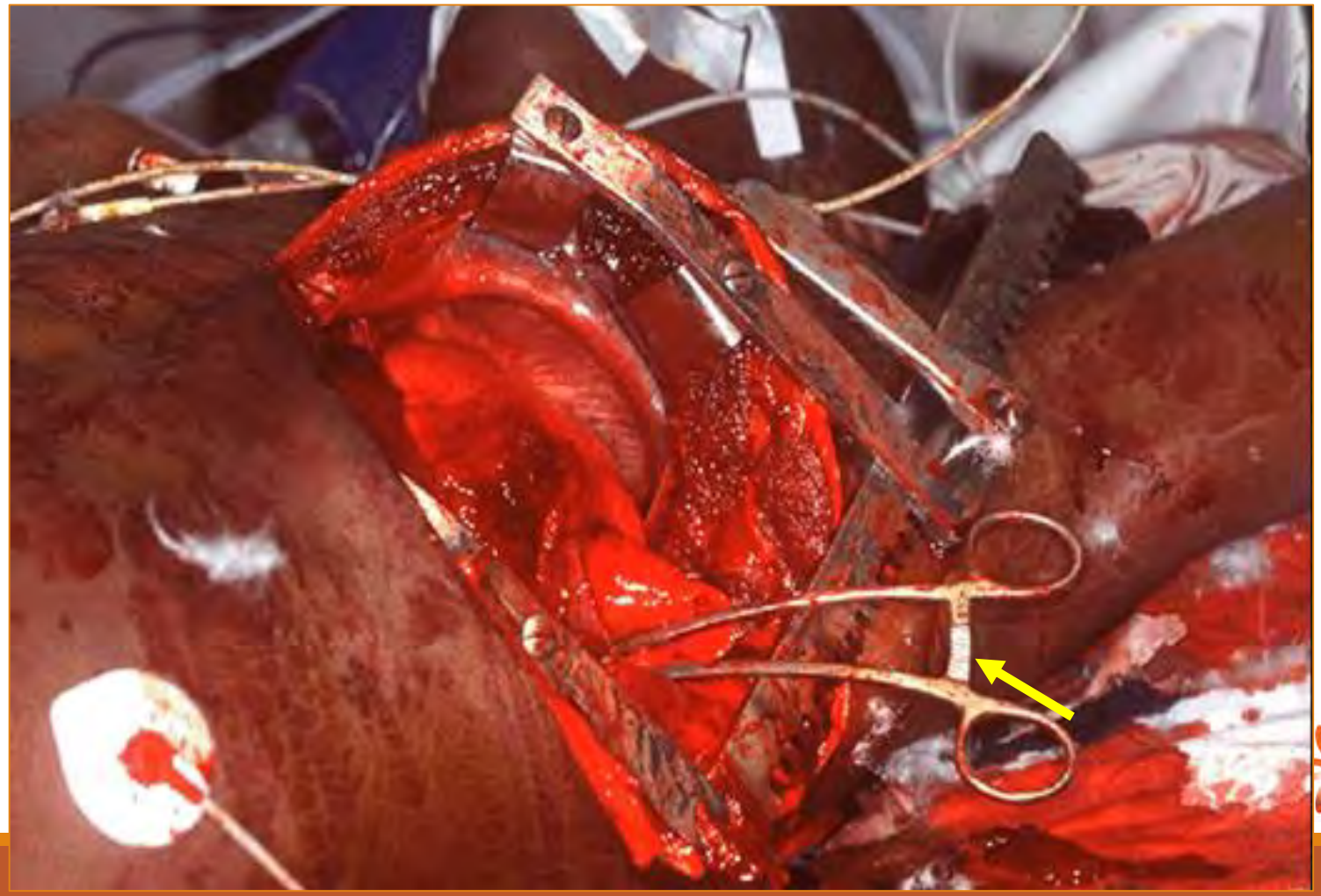
Tourniquet for the Trunk?



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THE ROLE OF THORACIC AORTIC OCCLUSION FOR MASSIVE HEMOPERITONEUM

ANNA M. LEDGERWOOD, M.D., MARIS KAZMERS, M.D., AND CHARLES E. LUCAS, M.D.

From the Department of Surgery, Wayne State University School of Medicine, Detroit, Michigan

THE JOURNAL OF TRAUMA

40 Hypotensive non-responders at Detroit Receiving Hospital

Massive abdominal hemorrhage

- 29 Thoracotomy with aortic occlusion (AO) first
- 11 Laparotomy first

Presented at the Thirty-fifth Annual Session of the American Association for the Surgery of Trauma, Scottsdale, Arizona, 11–13 September 1975.

No statistical analysis done

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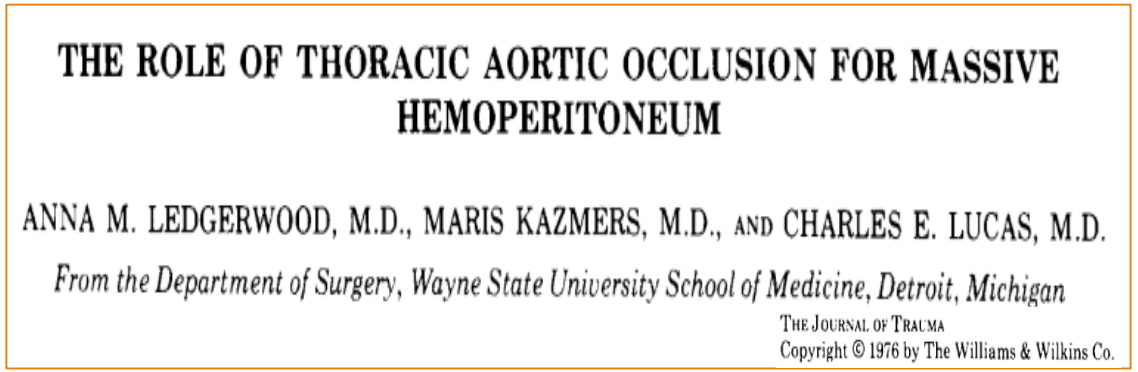
Laparotomy First – 11 patients

7 patients: immediate CV collapse
- Thoracotomy with AO
- 3/7 died

4 patients: persistent hypotension
- AO with T-bar
- 2/4 died

Mortality 5/11



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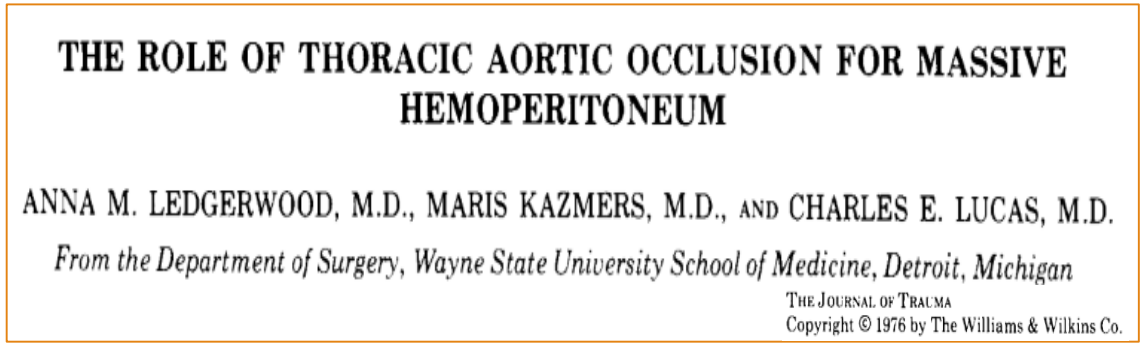
Thoracotomy first – 29 patients

22 patients: VS normal after AO
- 11/22 exsanguinated
- 27 min AO time in survivors

7 patients remained hypotensive after AO
- 100% mortality

Mortality: 18/29



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Conclusions

Restore normal perfusion to heart and brain

Prevent CV collapse when abdomen open

- "Internal Hemostat"

DISCUSSION

DR. KENNETH MATTOX (1200 M.D. Anderson Boulevard, Houston, Texas 77000): I have enjoyed the paper very much. As many of you know, we have long

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INTRALUMINAL AORTIC OCCLUSION AS A POSSIBLE MECHANISM FOR CONTROLLING MASSIVE INTRA-ABDOMINAL HEMORRHAGE*

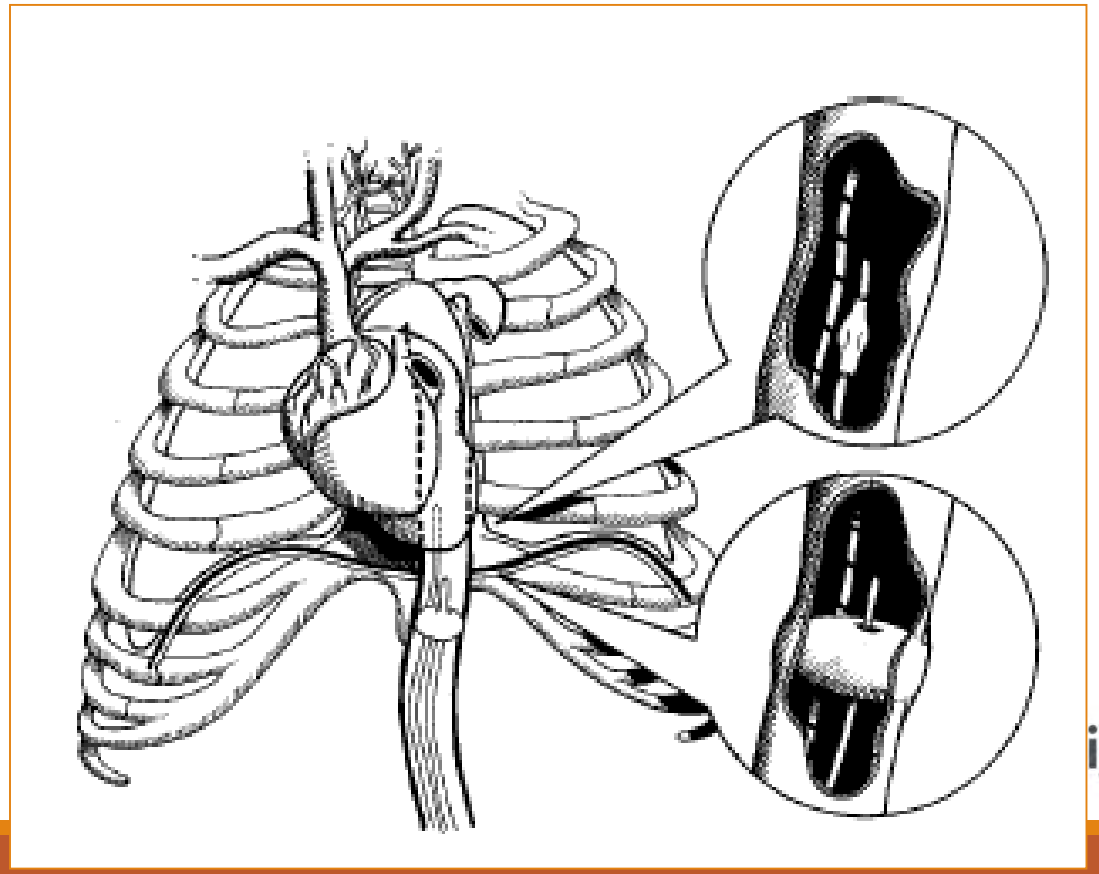
W. STERLING EDWARDS, PAUL P. SALTER, JR., AND VINCENT A. CARNAGGIO

1953

Intraluminal aortic occlusion in dogs

Feasible

Safe for up to 30 minutes



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USE OF AN INTRA-AORTIC BALLOON CATHETER TAMPONADE FOR CONTROLLING INTRA-ABDOMINAL HEMORRHAGE IN MAN

LIEUTENANT COLONEL CARL W. HUGHES, MEDICAL CORPS, UNITED STATES ARMY,
WASHINGTON, D. C.

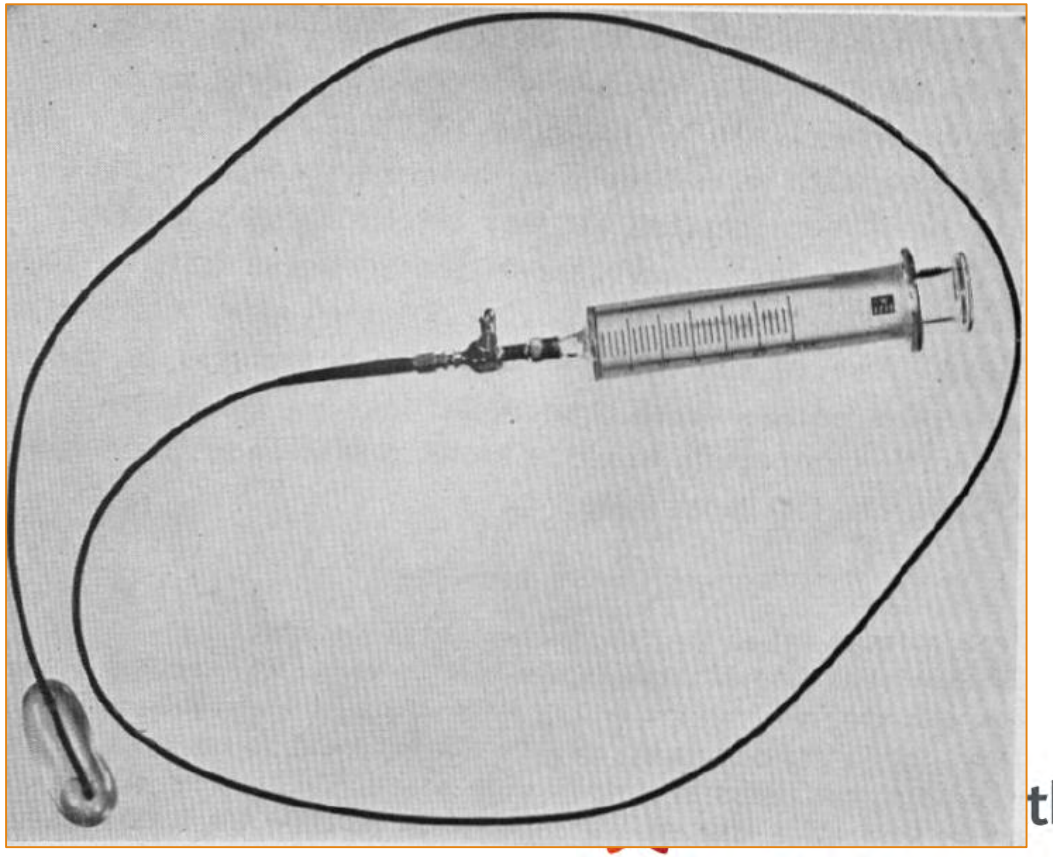
Surgery
July, 1954

1954

Intra-aortic occlusion of the aorta for refractory shock
- Moribund after 10 U RBCs

Three patients met criteria
- One died before balloon could be placed
- Two died after balloon was placed

Conclusion: Should be used earlier
- Rescue therapy



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th

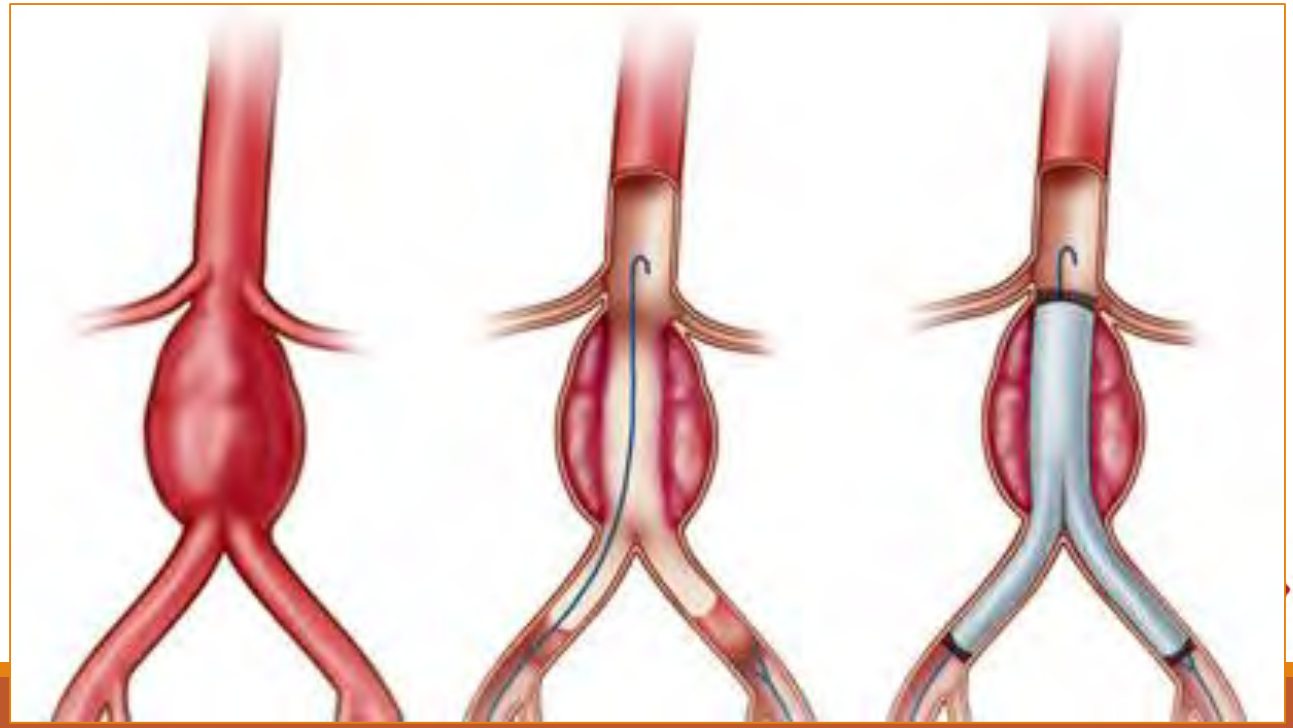
An Idea ahead of its time

Cumbersome equipment

Poor results

Intra-aortic occlusion fell out of favor among trauma surgeons

Then …



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Physiologic tolerance of descending thoracic aortic balloon occlusion in a swine model of hemorrhagic shock

Nickolay P. Markov, MD,[a,b] Thomas J. Percival, MD,[a,b] Jonathan J. Morrison, MRCS,[a,b,c]
James D. Ross, PhD,[a] Daniel J. Scott, MD,[a,b] Jerry R. Spencer, BS,[a] *and* Todd E. Rasmussen, MD,[a,b,d]
San Antonio, TX, Birmingham, UK, and Bethesda, MD

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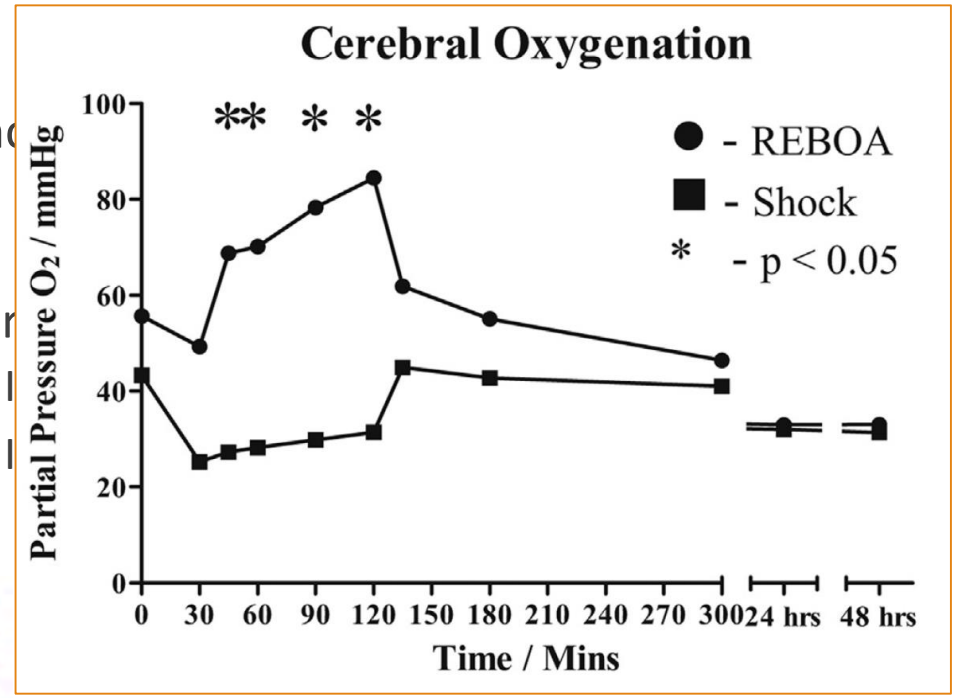

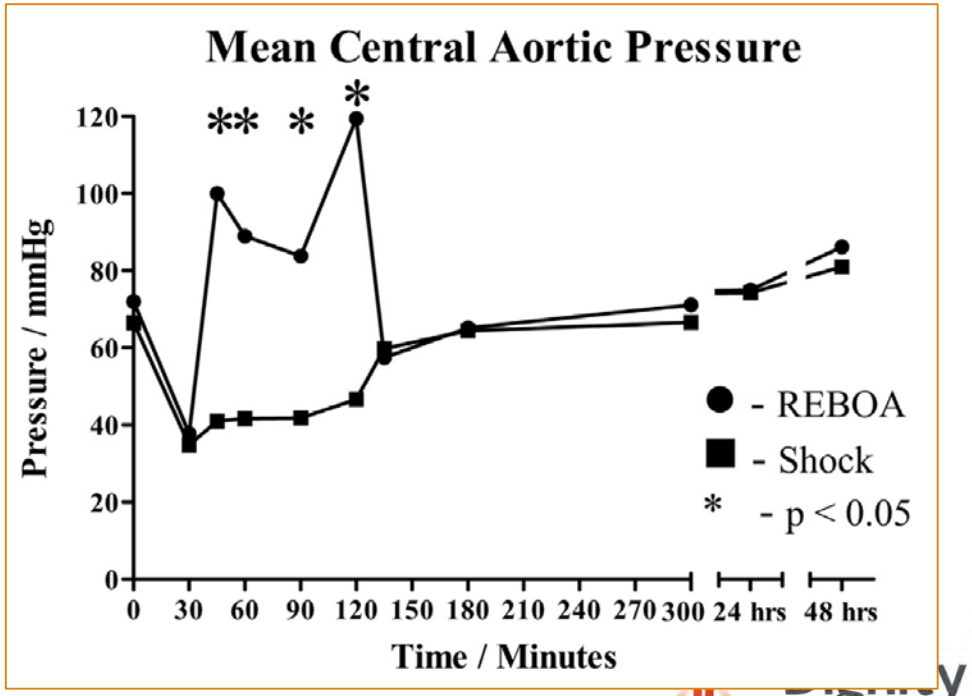

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Intra-Aortic Balloon Occlusion to Salvage Patients With Life-Threatening Hemorrhagic Shocks From Pelvic Fractures

Thomas Martinelli, MD, Frédéric
Christophe Broux, MD, Jérôm
and

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

Todd E. Rasmussen, MD

A clinical series of resuscitative endovascular balloon occlusion of the aorta for hemorrhage control and resuscitation

Megan L. Brenner, MD,
Michelle K. McNutt, MD, R

Ultrasound optimization for resuscitative endovascular balloon occlusion of the aorta

noenix, Arizona

Can contrast-enhanced ultrasonography improve Zone III REBOA placement for prehospital care?

Muzzafer Chaudery, MRCS, MEd, James Clark, MRCS, PhD, Jonathan J. Morrison, MRCS, PhD, Mark H. Wilson, FRCS, PhD, Duncan Bew, FRCS, *and* **Ara Darzi, FRS,** *London, United Kingdom*

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REBOA

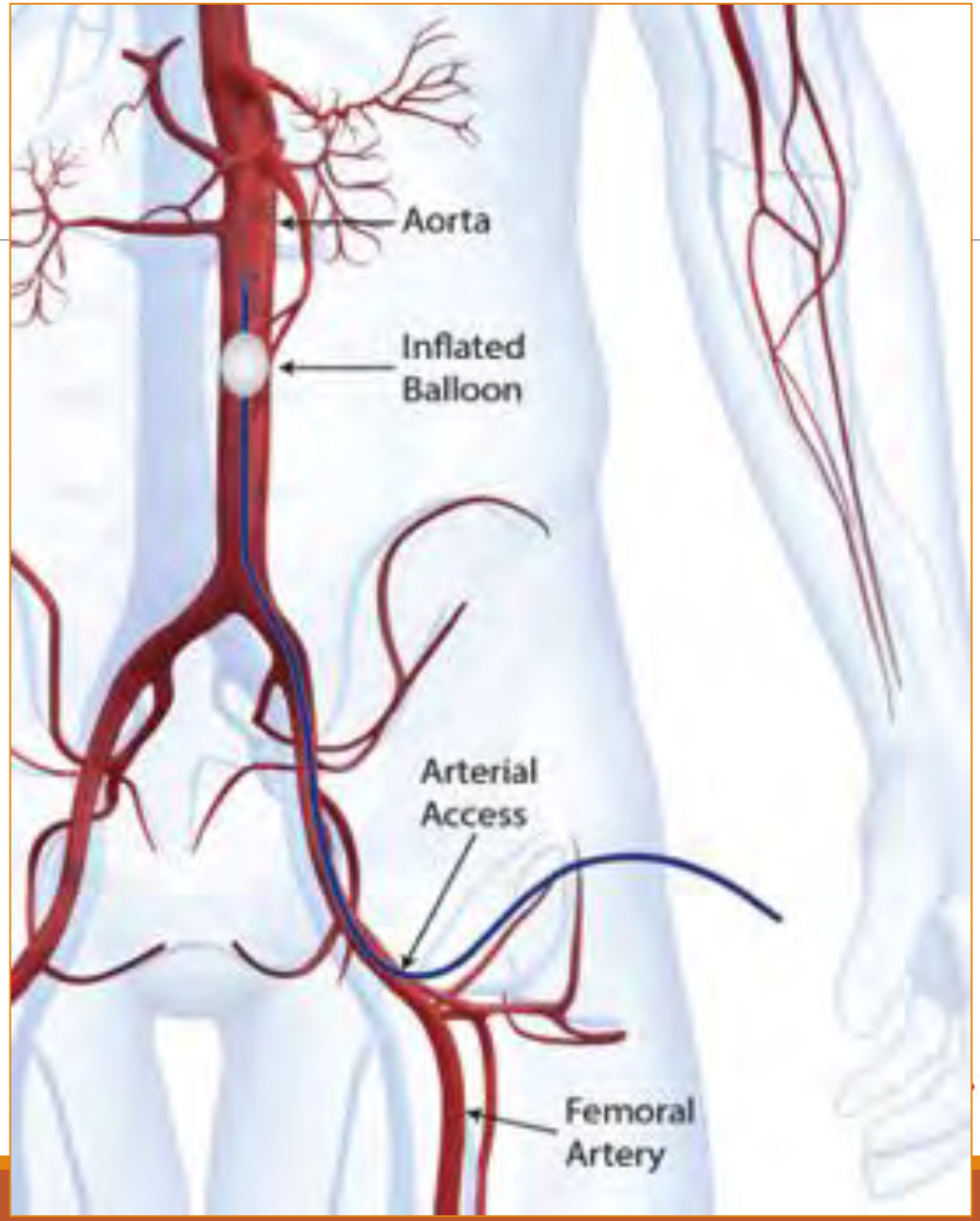
R resuscitative

E endovascular

B balloon

O occlusion

A aorta



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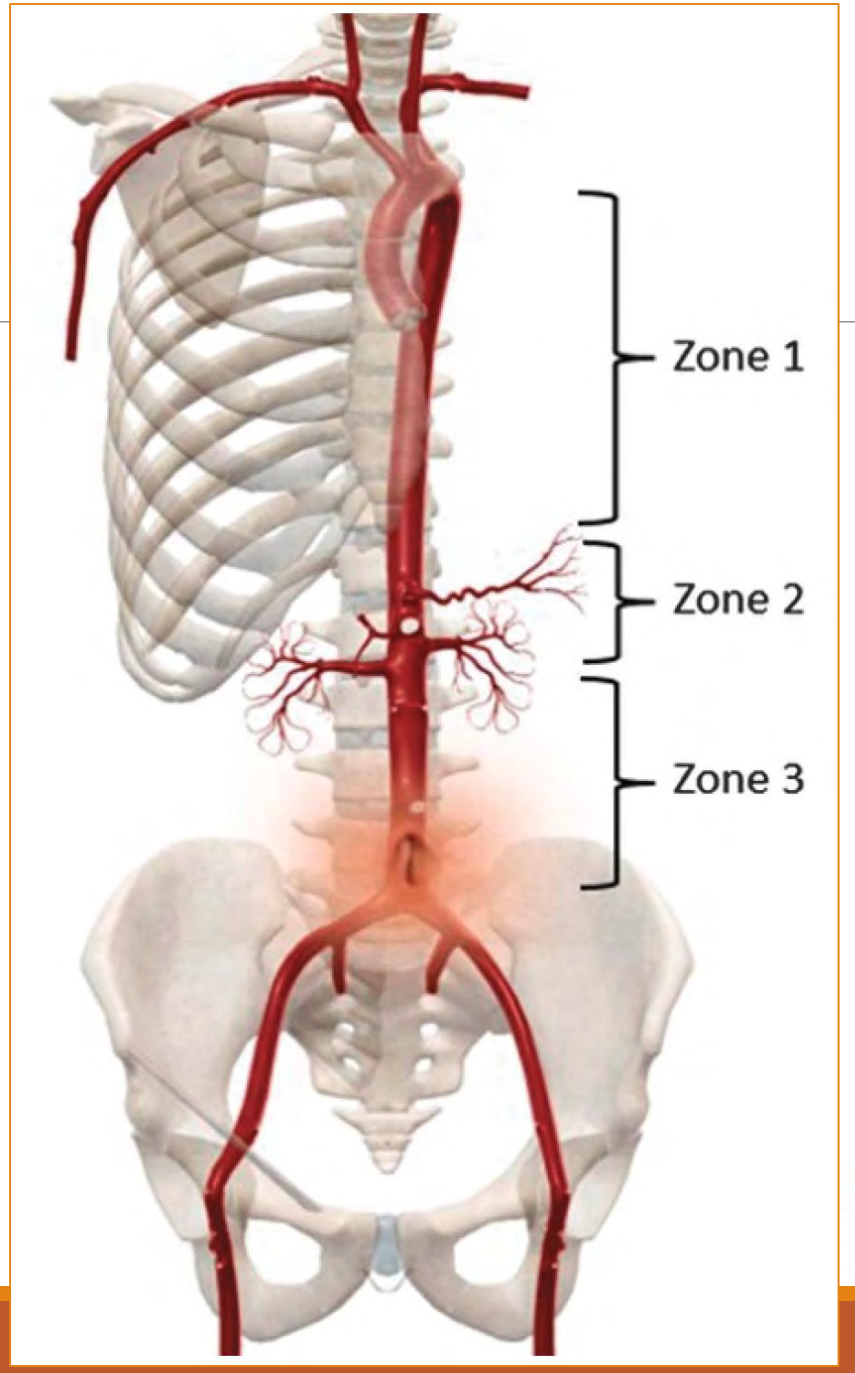
REBOA Anatomy

Zone I
- L Subclavian to Celiac

Zone II
- Celiac to Renal aa.

Zone III
- Renal aa.
- Aortic bifurcation



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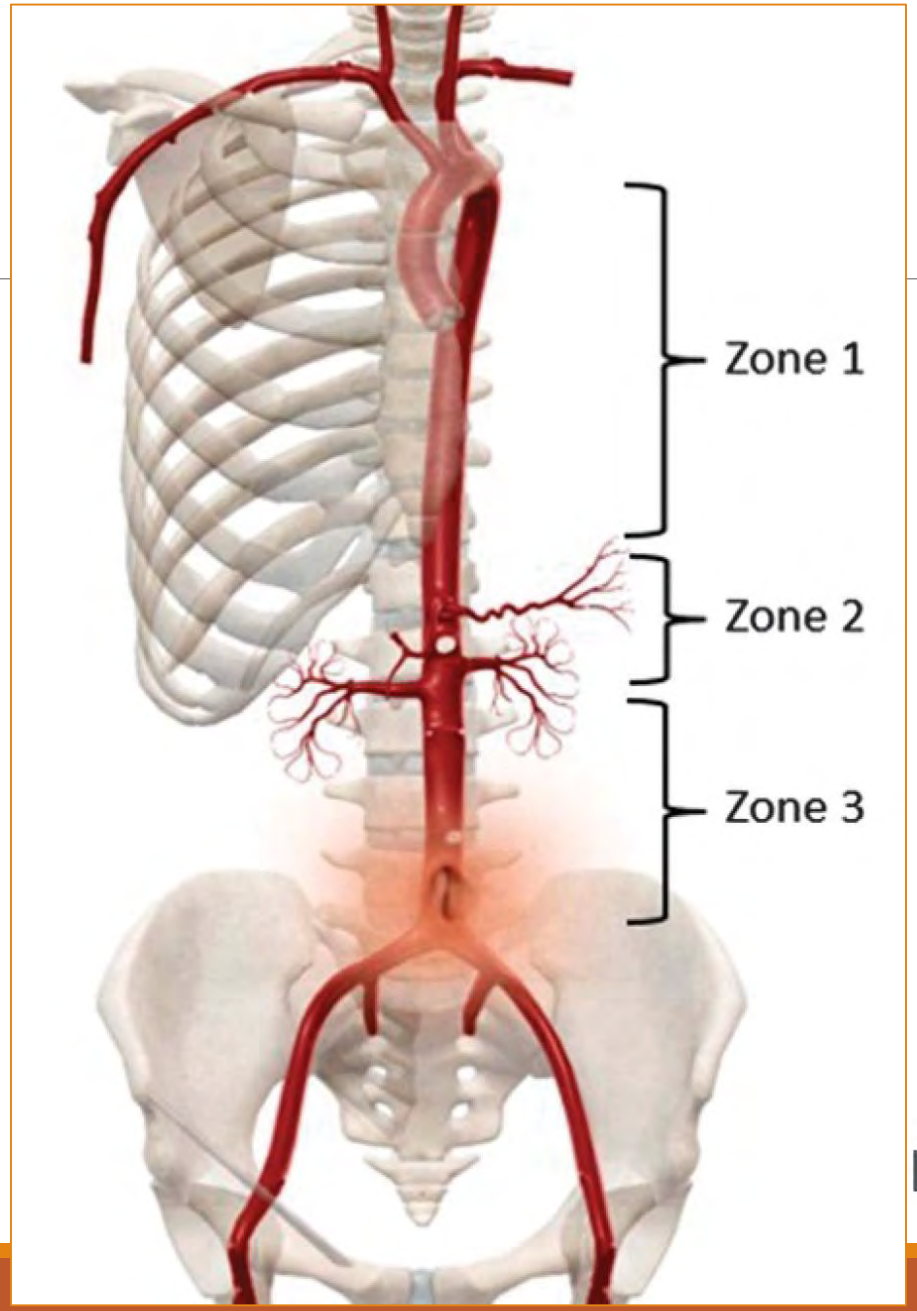
Surface Anatomy

Xyphoid process – T10

- Above celiac trunk
- Lower border Zone 1

Umbilicus – L4

- Aortic bifurcation
- Lower border of Zone 3



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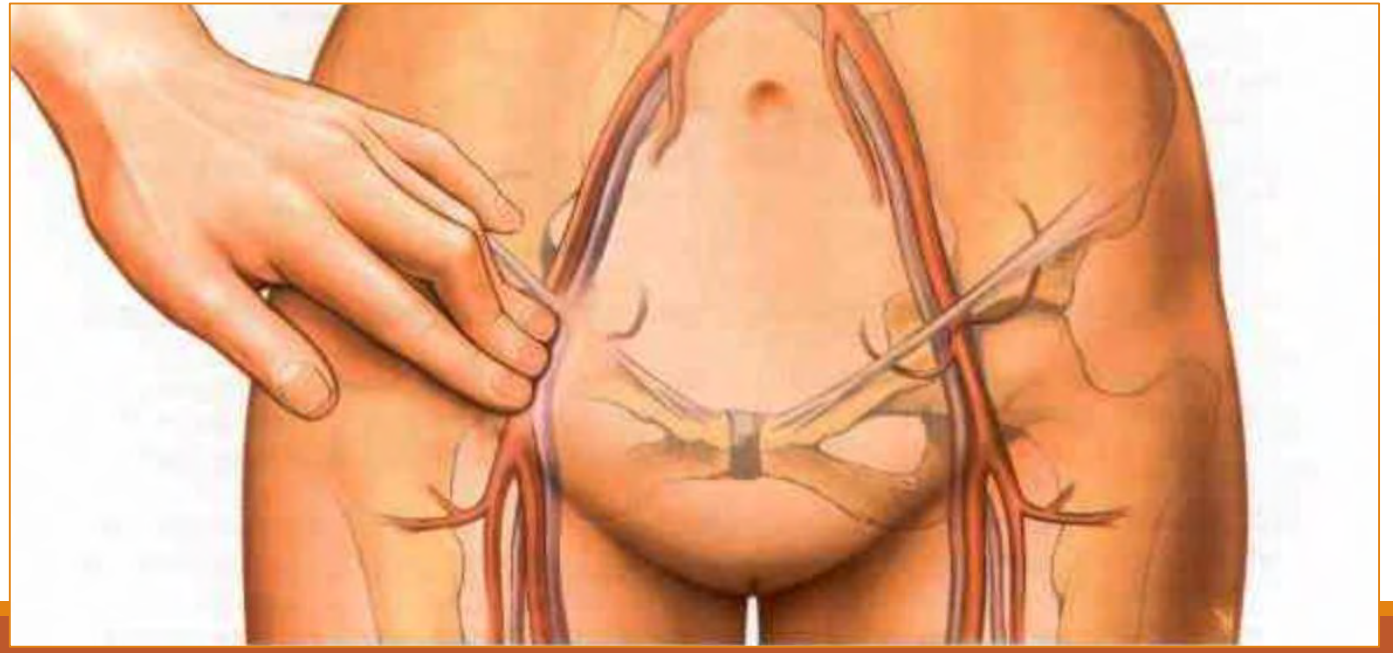
Femoral Access

Must avoid cannulating SFA

- Open cut down
- Ultrasound guided percutaneous access
- Blind percutaneous access (enter CFA within 2 cm of inguinal ligament)



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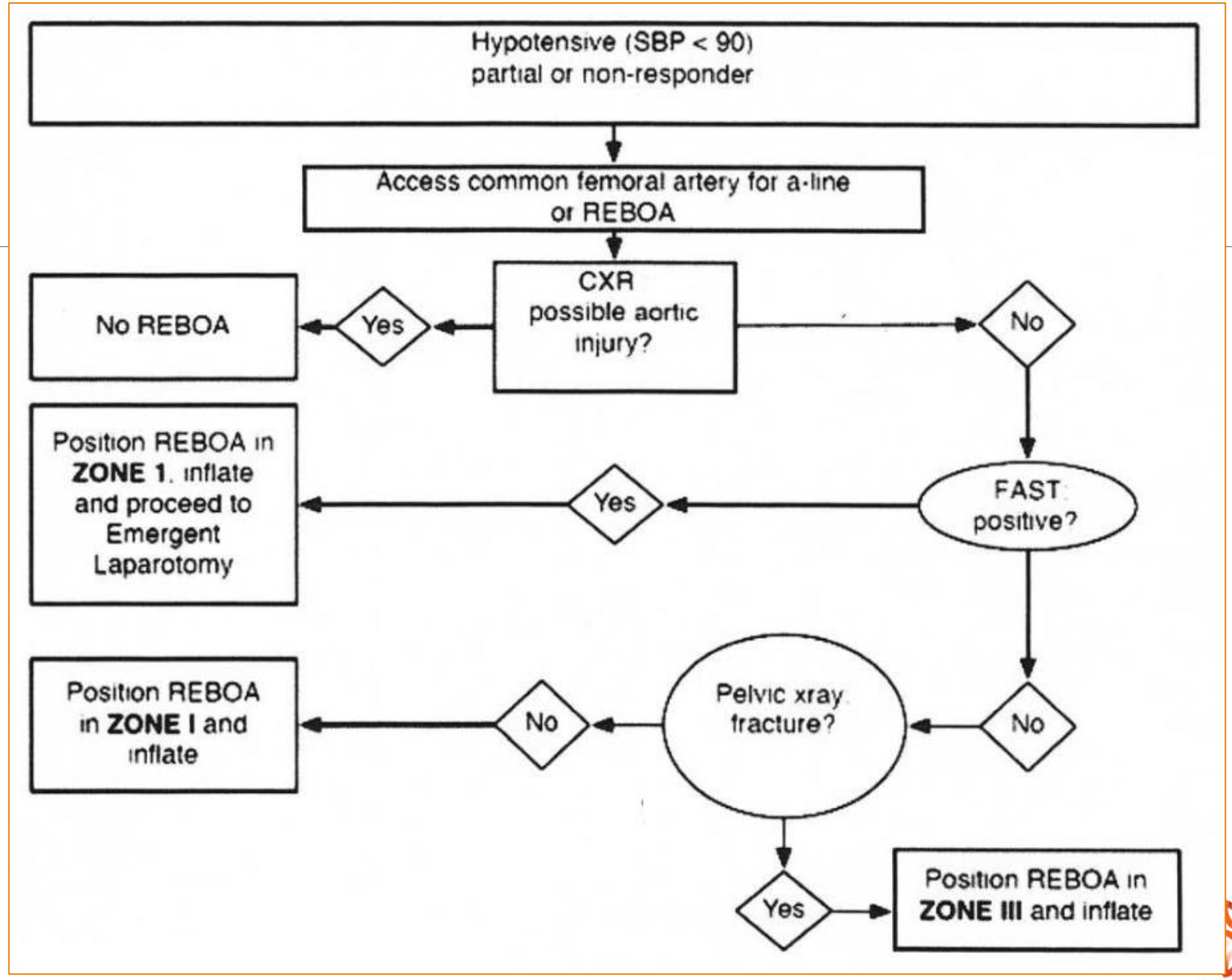

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AMERICAN COLLEGE OF SURGEONS

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BEST™

BASIC ENDOVASCULAR SKILLS FOR TRAUMA

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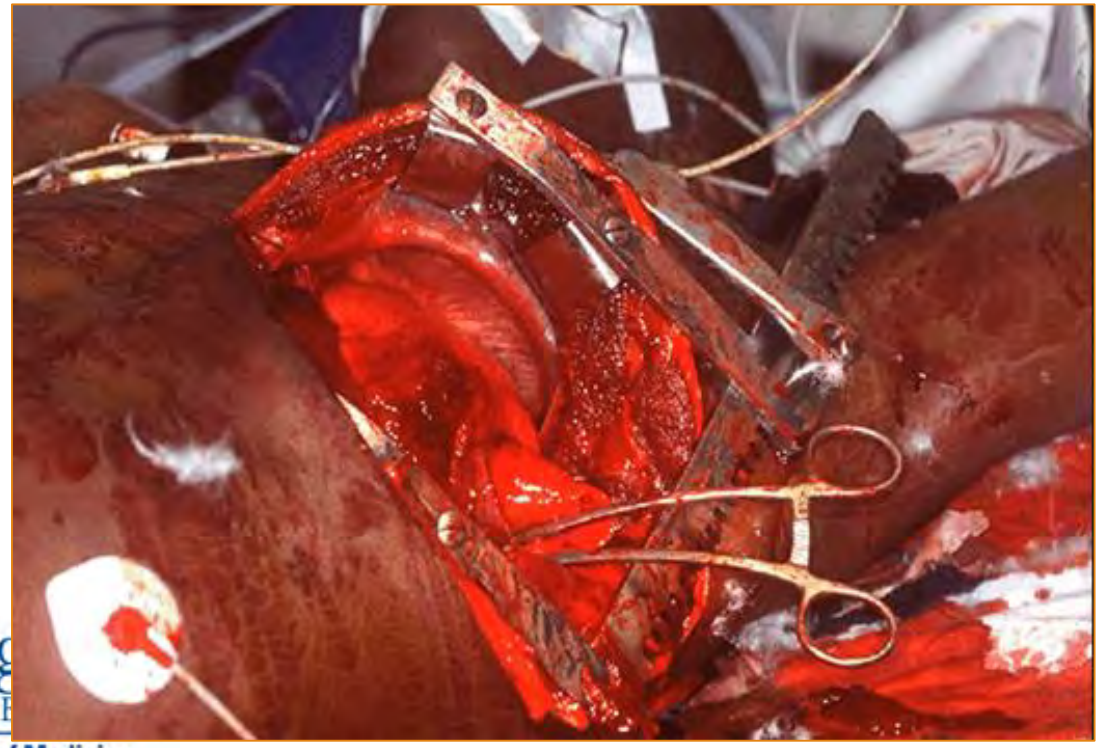
Non-compressible torso hemorrhage

Resuscitative Thoracotomy



REBOA

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Intra-Aortic Balloon Occlusion to Salvage Patients With Life-Threatening Hemorrhagic Shocks From Pelvic Fractures

Thomas Martinelli, MD, Frédéric Thony, MD, Philippe Decléty, MD, Christian Sengel, MD, Christophe Broux, MD, Jérôme Tonetti, MD, PhD, Jean-François Payen, MD, PhD, and Gilbert Ferretti, MD, PhD

The Journal of **TRAUMA**® *Injury, Infection, and Critical Care* • Volume 68, Number 4, April 2010

Pelvic fractures non-responsive to resuscitation

SBP < 60 after

- 3L crystalloid,
- At least 1 U RBC,
- NE or Epi infusion

TABLE 3. Physiological Status and IABO

	Before IABO	After IABO	Level of Significance, *p*
SBP (mm Hg)	41	111	0.001
Heart rate (beats/min)	117	112	0.5836

All patients made it to angio

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Implementation of resuscitative endovascular balloon occlusion of the aorta as an alternative to resuscitative thoracotomy for noncompressible truncal hemorrhage

Laura J. Moore, MD, Megan Brenner, MD, Rosemary A. Kozar, MD, PhD, Jason Pasley, DO, Charles E. Wade, PhD, Mary S. Baraniuk, PhD, Thomas Scalea, MD, *and* John B. Holcomb, MD, *Houston, Texas*

UT Houston and Shock Trauma

RT (72) vs REBOA (24)

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Improved survival in REBOA group

Among Survivors: 77% of REBOA group went home. 71% RT group went to SNF

TABLE 4. Comparison of Survivors Between RT and REBOA

Among Survivors (n = 16)		RT Alive (n = 7)	REBOA Alive (n = 9)	*p*
Survivors	% (n)	9.7% (7)	37.5% (9)	0.003
Age	Median (P25–P75)	29 (21–51)	43 (25–59)	0.71
Male	% (n)	85.7% (6)	88.9% (8)	1.00
Blunt	% (n)	42.9% (3)	55.6% (5)	1.00
ISS	Median (P25–P75)	29 (16–34)	26 (17–29)	0.56

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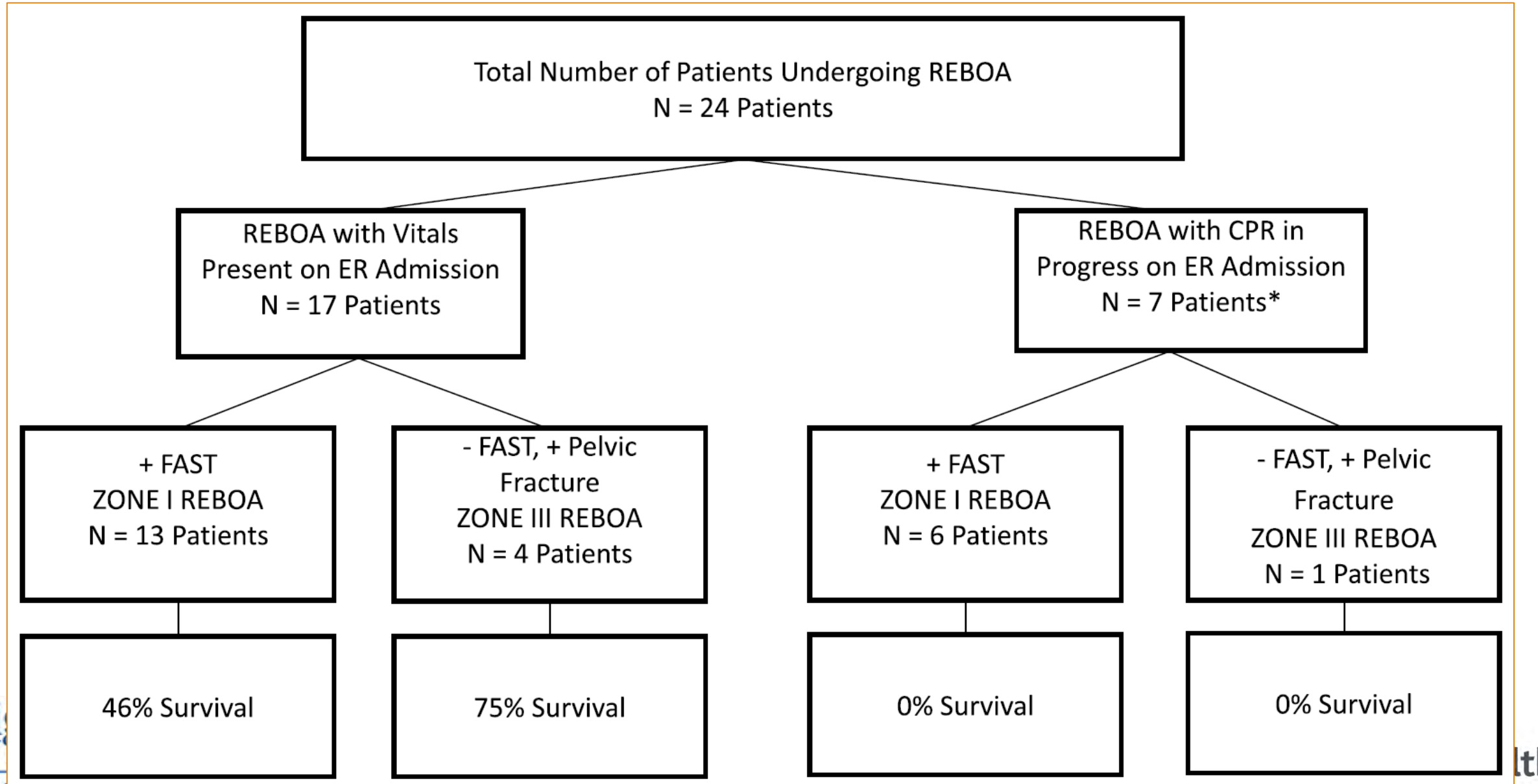
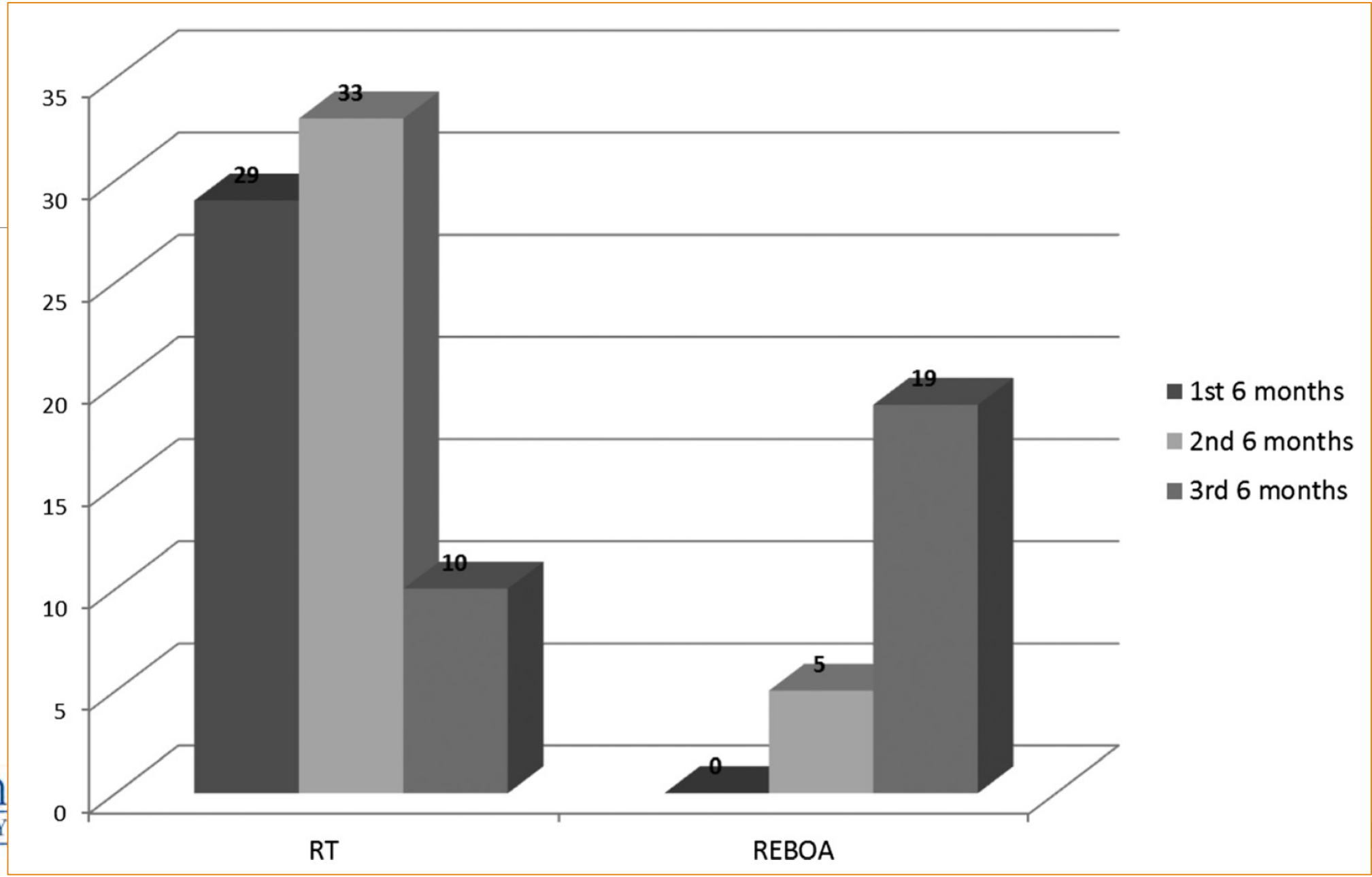

Total Number of Patients Undergoing REBOA
N = 24 Patients
REBOA with Vitals Present on ER Admission
N = 17 Patients
REBOA with CPR in Progress on ER Admission
N = 7 Patients*
+ FAST
ZONE I REBOA
N = 13 Patients
- FAST, + Pelvic Fracture
ZONE III REBOA
N = 4 Patients
+ FAST
ZONE I REBOA
N = 6 Patients
- FAST, + Pelvic Fracture
ZONE III REBOA
N = 1 Patients
46% Survival
75% Survival
0% Survival
0% Survival



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The AAST prospective Aortic Occlusion for Resuscitation in Trauma and Acute Care Surgery (AORTA) registry: Data on contemporary utilization and outcomes of aortic occlusion and resuscitative balloon occlusion of the aorta (REBOA)

Joseph J. DuBose, MD, Thomas M. Scalea, MD, Megan Brenner, MD, Dimitra Skiada, MD, Kenji Inaba, MD, Jeremy Cannon, MD, Laura Moore, MD, John Holcomb, MD, David Turay, MD, Cassra N. Arbabi, MD, Andrew Kirkpatrick, MD, James Xiao, MD, David Skarupa, MD, Nathaniel Poulin, MD, *and* the AAST AORTA Study Group, *Davis, California*

REBOA = 46

RT = 68

TABLE 2. Detail of AO and Associated Required Procedures

	Total (n = 114)	Endovascular (n = 46)	Open (n = 68)	*p* Value
Location of initial AO attempt				
Emergency department, n (%)	84/114 (73.7%)	33/46 (71.7%)	51/68 (75.0%)	0.698
Operating room, n (%)	30/114 (26.3%)	13/46 (28.3%)	17/68 (25.0%)	0.698
Active CPR ongoing during initial AO attempt, n (%)	70/114 (61.4%)	21/46 (45.7%)	49/68 (72.1%)	0.008
Aortic occlusion initiation physiology				
Systolic blood pressure, median/IQR, mm Hg	0/60	50.0/77	0/0	<0.001
Heart rate, median/IQR, beats per minute	0/87	85/123	0/40	0.001

AORTA Registry

No difference in survival

REBOA more likely to restore stability

Second attempt at occlusion more likely needed in the RT group

Similar rate of complications

RT more likely to have uncontrolled bleeding ABOVE level of occlusion (26% vs 10%)

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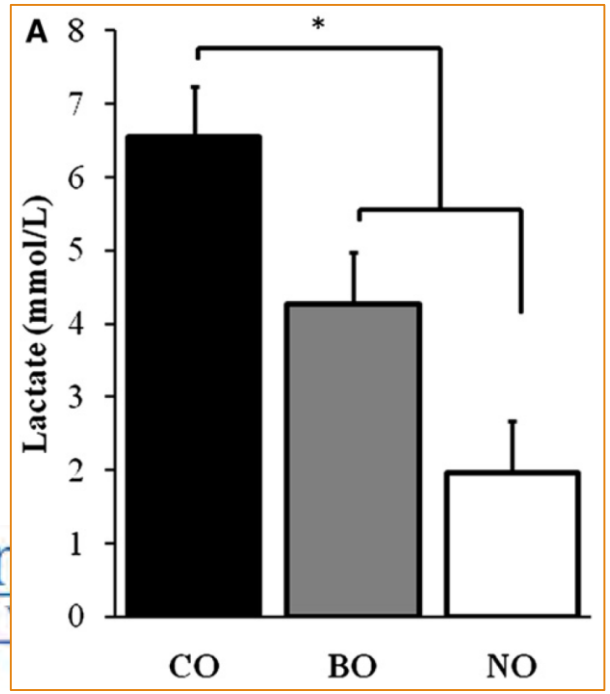
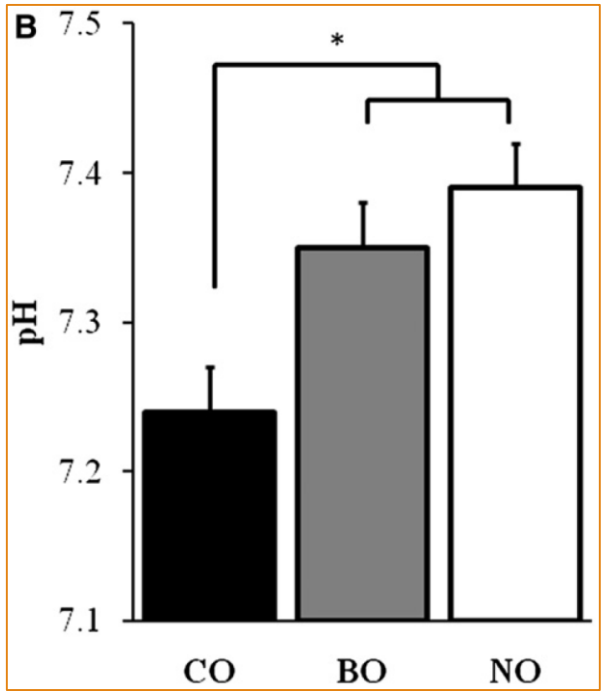
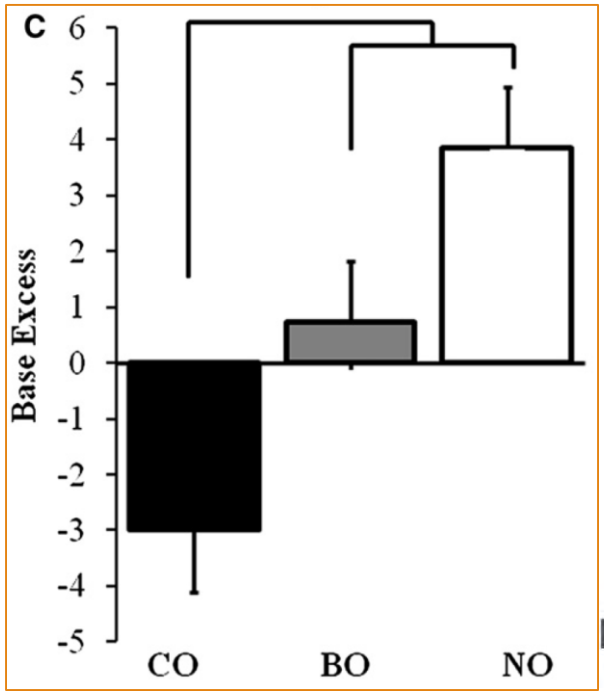
Endovascular balloon occlusion of the aorta is superior to resuscitative thoracotomy with aortic clamping in a porcine model of hemorrhagic shock

Joseph M. White, MD,[a] Jeremy W. Cannon, MD,[a,c] Adam Stannard, MRCS,[a,b] Nickolay P. Markov, MD,[a] Jerry R. Spencer, RVT,[a] *and* Todd E. Rasmussen, MD,[a,c] *San Antonio, TX, Birmingham, UK, and Bethesda, MD*

Surgery
Volume 150, Number 3







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Resuscitative endovascular balloon occlusion of the aorta or resuscitative thoracotomy with aortic clamping for noncompressible torso hemorrhage: A retrospective nationwide study

J Trauma Acute Care Surg
Volume 82, Number 5

Shotaro Aso, MD, MPH, Hiroki Matsui, MPH, Kiyohide Fushimi, MD, PhD, *and* **Hideo Yasunaga, MD, PhD**, *Tokyo, Japan*

Japan Trauma Registry

191 REBOA vs 68 RT

Propensity matched

No difference in

- ICU stay
- Mortality
- Blood transfusion

	REBOA		RT		*p*
Death, n (%)	90	(47.1)	48	(70.6)	0.0009
VFDs, n (%)					0.0116
0	105	(55.0)	52	(76.5)	
1–6	9	(4.7)	3	(4.4)	
7–13	5	(2.6)	3	(4.4)	
14–20	22	(11.5)	4	(5.9)	
21–28	50	(26.2)	6	(8.8)	

performed at admitting facility

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Resuscitative endovascular balloon occlusion of the aorta might be dangerous in patients with severe torso trauma: A propensity score analysis

Junichi Inoue, MD, Atsushi Shiraishi, MD, PhD, Ayako Yoshiyuki, MD, Koichi Haruta, MD, Hiroki Matsui, MPH, *and* **Yasuhiro Otomo, MD, PhD**, *Tokyo, Japan*

625 REBOA patients propensity matched to 625 non-REBOA patients

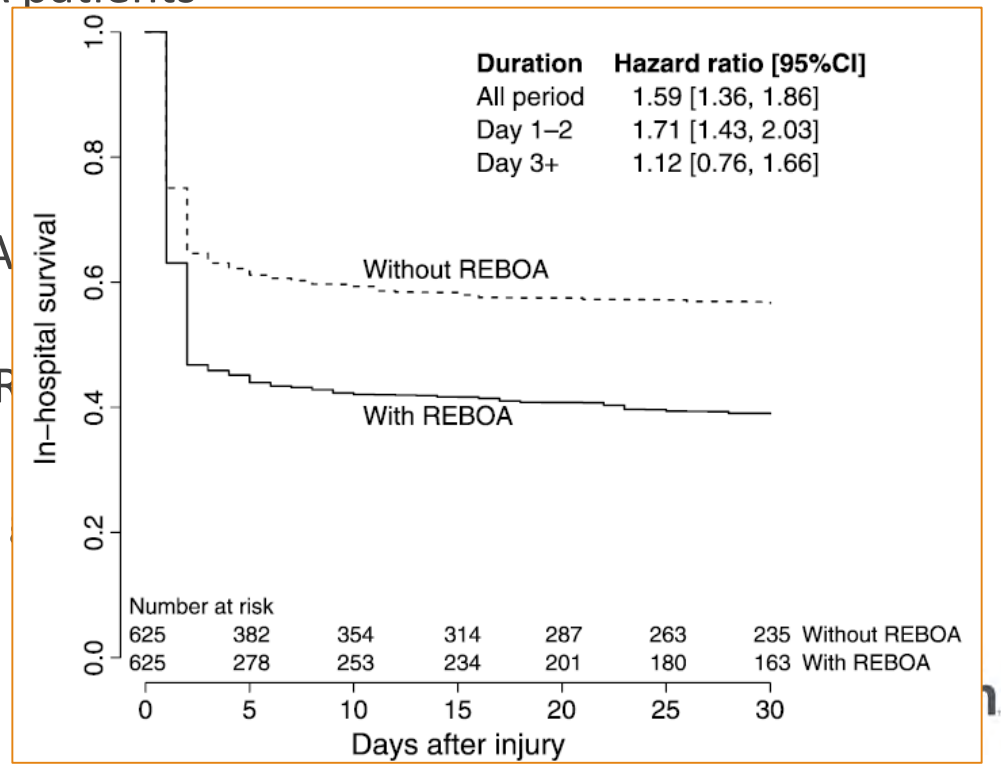
Worse outcomes with REBOA compared to without REBOA

Median time to surgical intervention: 97 minutes for REBOA

Median time to surgical intervention: 110 minutes for non-R

No difference in mortality between REBOA and non-REBOA

in less than 60 minutes.



The effect of resuscitative endovascular balloon occlusion of the aorta, partial aortic occlusion and aggressive blood transfusion on traumatic brain injury in a swine multiple injuries model

M. Austin Johnson, MD, PhD, Timothy K. Williams, MD, Sarah-Ashley E. Ferencz, MD, Anders J. Davidson, MD, Rachel M. Russo, MD, William T. O'Brien, Sr., DO, Joseph M. Galante, MD, J. Kevin Grayson, DVM, PhD, *and* **Lucas P. Neff, MD**, *Sacramento, California*

J Trauma Acute Care Surg
Volume 83, Number 1

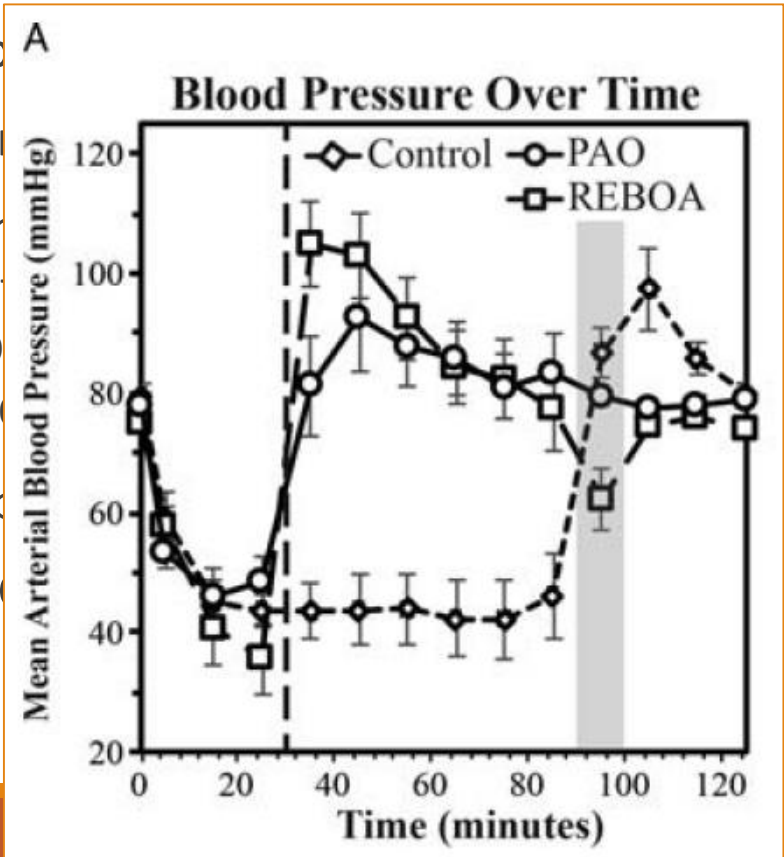
Pigs sub

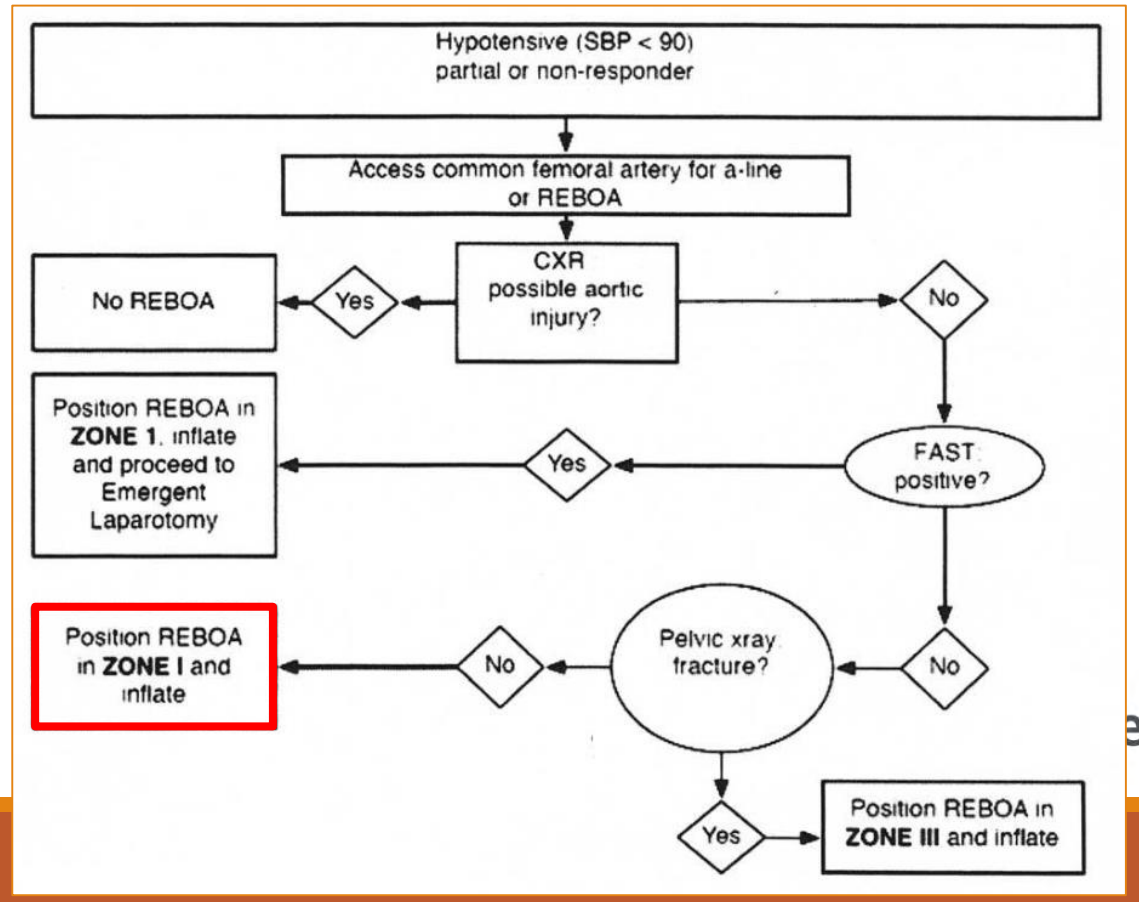
30 min

Random
- No in
- REBO
- pREB

Whole b

Critical





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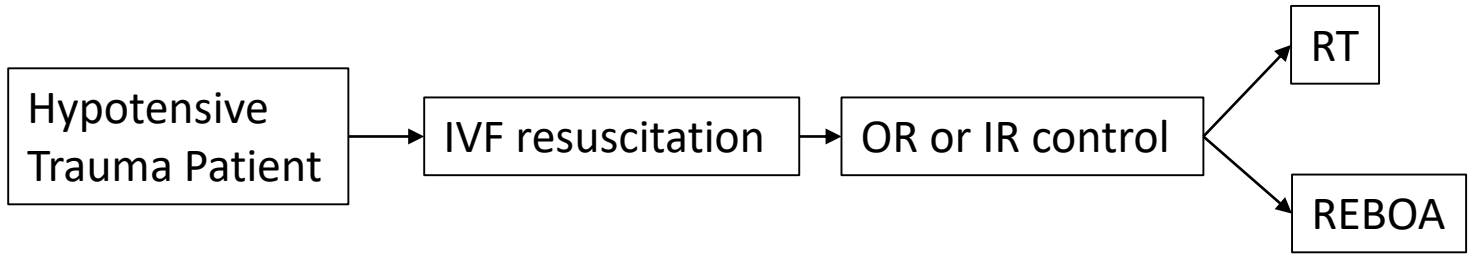
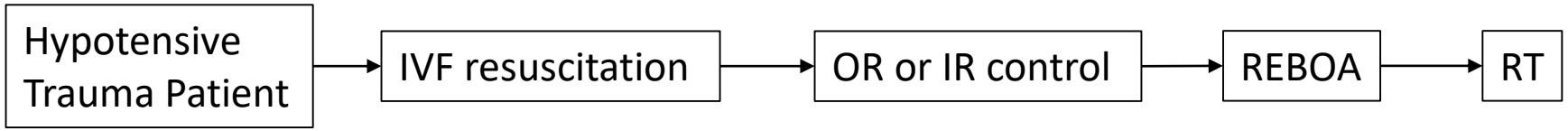
ealth

REBOA

Literature: REBOA or RT



Practice: REBOA before RT needed



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REBOA – Quest

Occlude aorta BEFORE cardiac arrest
- Patient selection

Decrease need for blood transfusion

Decrease need for surgery

Prolonged transport time

A Modern Case Series of Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA) in an Out-of-Hospital, Combat Casualty Care Setting

Justin D. Manley, MD; Benjamin J. Mitchell, MD; Joseph J. DuBose, MD; Todd E. Rasmussen, MD

Nonoperative management of hemodynamically unstable abdominal trauma patients with angioembolization and resuscitative endovascular balloon occlusion of the aorta

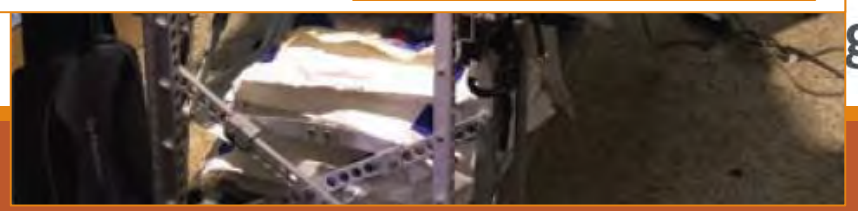
Izawa, MD,

Clinical paper

Resuscitative endovascular balloon occlusion of the aorta (REBOA) in the pre-hospital setting: An additional resuscitation option for uncontrolled catastrophic haemorrhage☆

Samy Sadek[a,*], David J. Lockey[b], Robbie A. Lendrum[c], Zane Perkins[d], Jonathan Price[e], Gareth Edward Davies[f]

Resuscitation 107 (2016) 135–138



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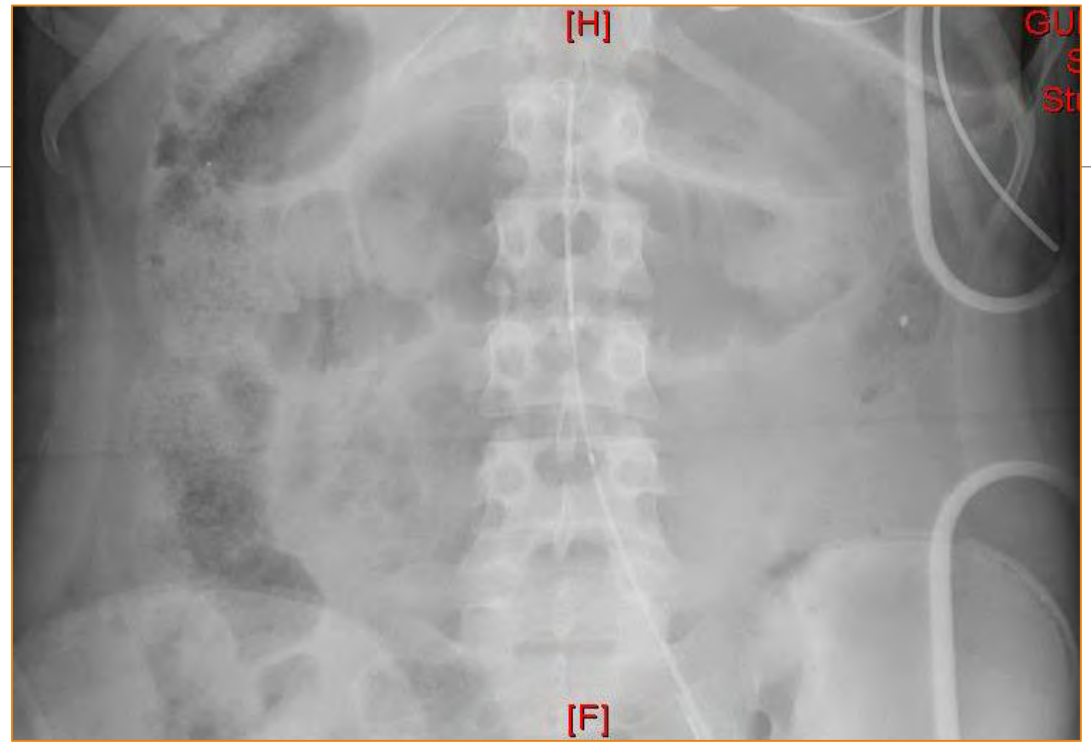
gnity Health

Conclusions

My current practice
- Pelvic fractures
- Prevent cardiac arrest

Wide open area for investigation
- Patient selection
- TBI
- Titratable aortic control (pREBOA)
- Pre-hospital use



"An instrument of the devil that sometimes saves a life."

The Tourniquet Controversy

John Navein, MRCGP, Robin Coupland, FRCS, and Roderick Dunn, FRCS

J Trauma. 2003;54:S219–S220.

Thank You