



# Life Saving Prehospital Trauma Interventions

PROBLEMS

T-CPR

HEAMORHAGE

PAÏN MAN.

DIAGNOSE

ADVANCED

- Problems
- T-CPR (airway management, pericardiocentesis, torax interventions, stabilization of the pelvis etc.)
- HEAMORHAGE CONTROL
  - ACCES
  - BLOOD STOPERS
  - INTERVENTIONS
- PAÏN MANAGEMENT
- POINT OF DIAGNOSTIC
- ADVANCED PROCEDURES
  - ECMO
  - REBOA

WHO reported that road traffic injuries accounted for 59% of deaths in adults age 15 years to 44 years

Despite the importance of interventions, studies and guidelines instruct that "initiation of transport of critically injured trauma patient should never be delayed



Vital signs and physical examination can not assess accurately the injury severity of trauma patients

More than half of all traumatic deaths happen in prehospital settings

Resource and expertise needed to rapidly diagnose and initiate prehospital lifesaving interventions LSI



T-CPR

# Needle thoracostomy

- ▶ In patients with traumatic cardiac arrest (tCA), a tension pneumothorax (TP) must be ruled out as the cause of circulatory arrest.
- ▶ If a TP is suspected, immediate treatment is mandatory.

PROBLEMS

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DIAGNOSE

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- ▶ Thoracic injuries may be a contributing factor in up to 60% of deaths in the setting of multisystem trauma.
- ▶ The majority of life threatening injuries to the thorax cannot be treated in the prehospital setting; however, tension pneumothorax, which can lead to death within minutes, can be temporized by the use of needle thoracostomy (NT).
- ▶ NT is also one of the few interventions that has been shown to make a difference in outcomes for prehospital traumatic cardiac arrest

PROBLEMS

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## NEEDLE THORACOSTOMY IN THE PREHOSPITAL SETTING: A RETROSPECTIVE OBSERVATIONAL STUDY

Lori Weichenthal, MD, FACEP, Desiree Crane, DO, Luke Rond, DO

### ABSTRACT

**Background:** The use of needle thoracostomy (NT) is a common prehospital intervention for patients in extremis or cardiac arrest due to trauma; however, controversy surrounds its use. The purpose of this study is to compare outcomes, effectiveness, and complications of NT in an Emergency Medical Services (EMS) system that includes urban, rural, and wilderness environments. **Methods:** This is a retrospective observational study of all patients who had NT performed in a four county EMS system with a catchment area of greater than 1.6 million people. All prehospital records where NT was performed were queried for demographics, mechanism of injury, initial status, and clinical changes fol-

No complications from NT were reported. **Conclusions:** NT can safely be performed by paramedics in an EMS system that includes urban, rural, and wilderness settings. Its efficacy does not differ between patients suffering from blunt versus penetrating trauma; however, it appears most beneficial for patients who are unstable but still have vital signs. **Key words:** prehospital; needle thoracostomy; tension pneumothorax

PREHOSPITAL EMERGENCY CARE 2016;20:399-403

### INTRODUCTION

The purpose of this study is to compare outcomes, effectiveness, and complications of NT in an Emergency Medical Services (EMS) system

This is a retrospective observational study

- A total of 169 patients were included
- mortality rate was 77% in the blunt trauma group; and 83% in the penetrating group
- There was a significant difference in survival between patients who were initially presented as a stat trauma versus as a trauma arrest (52% versus 99%,  $p > 0.001$ ).
- The multivariate model with regard to survival supported that reported clinical change after NT ( $p = 0.001$ ) and status ( $p=0.0001$ ) are important indicators of survival.
- No complications were reported

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- **Conclusions:** NT can safely be performed by paramedics in an EMS system that includes urban, rural, and wilderness settings.
- it appears most beneficial for patients who are unstable but still have vital signs.

- Needle decompression is the simplest method for relieving intrathoracic pressure.
- The American College of Surgeons Committee on Trauma's Advanced Trauma Life Support recommends placing a large-gauge, 5cm long catheter in the second intercostal space at the midclavicular line. Recent studies advocate the use of needle decompression in the fifth intercostal space anterior to the midaxillary line because the chest wall is thinner in this area
- Patients treated with needle decompression should be handled very carefully during transport because catheter kinking or occlusion may cause the TP to recur

American College of Surgeons. ATLS Student Course Manual, 9th ed. Chicago, IL: American College of Surgeons; 2012.

Inaba K, Ives C, McClure K, Branco BC, Eckstein M, Shatz D, et al . Radiologic evaluation of alternative sites for needle decompression of tension pneumothorax. Arch Surg 2012; 147:813–818.

# HEAMORHAGE CONTROL and ACCES



PROBLEMS

T-CPR

HEAMORHAGE

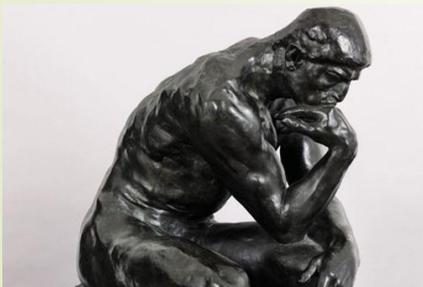
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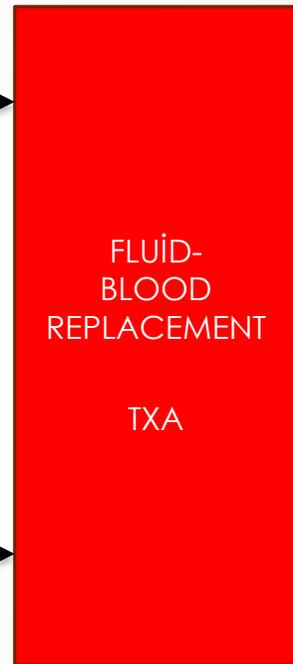
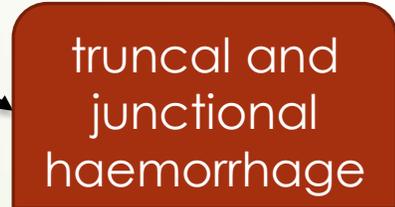
DIAGNOSE

ADVANCED

- ▶ Hemorrhage is an etiologic factor of mortality in 30–40% of trauma patients, and many of these deaths happen before the patient reaches the hospital.
- ▶ Advanced trauma life support recommends the prehospital assessment of a patient's circulation status and resuscitation with intravenous fluids.

Which fluid?  
What amount?  
When?



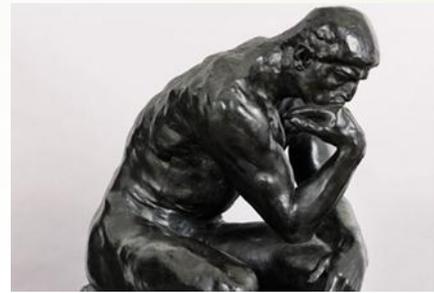


- Prehospital control of bleeding from the torso and junctional area's remains challenging but offers a great potential to improve survival rates

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Intravenous (IV) access has an essential role in the care provided for trauma patients, allowing for transfusion of blood products, fluids, and drugs.

is it really necessary



### Intravenous access in the prehospital settings: What can be learned from point-of-injury experience

Roy Nadler, MD, Sami Gendler, MD, Avi Benov, MD, Avi Shina, MD, Erez Baruch, MD, Gilad Twig, MD, PhD, and Elon Glassberg, MD, MHA, Ramat Gan, Israel

Success rates for IV access were 86%, 68%, 63%, 50%, 20% for the first, second, third, fourth, and fifth attempts, respectively

The first and second attempts accounted for 96% of the successful procedures.

Decisions should be made regarding the necessity of IV Access while considering cost-benefit of the procedure in terms of delayed evacuation times.

<b>BACKGROUND:</b>	Intravenous (IV) access has an essential role in the care provided for trauma patients, allowing for transfusion of blood products, fluids, and drugs. Decisions should be made regarding the necessity of IV access while considering cost-benefit of the procedure in terms of delayed evacuation times.
<b>METHODS:</b>	A retrospective review of all trauma patients in whom at least one attempt at IV access was performed were reviewed. Data were abstracted from the Israeli Defense Force Trauma Registry.
<b>RESULTS:</b>	Of 7,476 patients, 1,082 patients who had at least one documented attempt at IV access between January 1997 and April 2013 were included in this study. Overall cumulative success rate at IV access was 82%. Success rates for IV access were 86%, 68%, 63%, 50%, 20% for the first, second, third, fourth, and fifth attempts, respectively. The first and second attempts accounted for 96% of the successful procedures. Mortality in patients for whom IV access was successful was 13%; mortality in patients for whom IV access was not successful was 35%.
<b>CONCLUSION:</b>	The success rate of IV access declined with each subsequent attempt. There was minimal improvement of overall success rate seen after the second attempt. Our findings suggest that the inability to obtain peripheral venous access is associated with severe injuries. These findings support a policy of limiting the number of venous access attempts to two attempts, followed by a reevaluation of need for parenteral access. Improved training of combat medics and paramedics might marginally increase the success rates of IV access. Point-of-injury data, used for ongoing learning and research, form the ground for improving combat casualty care and thus help saving lives. ( <i>J Trauma Acute Care Surg.</i> 2015;79: 221–226. Copyright © 2015 Wolters Kluwer Health, Inc. All rights reserved.)
<b>LEVEL OF EVIDENCE:</b>	Therapeutic study, level IV.
<b>KEY WORDS:</b>	Peripheral; intravenous; access; success; prehospital.

# Hypertonic saline

- ▶ Hypertonic saline, whose composition of solutes is higher than that of the human body, has been hypothesized to exert a dual physiological role of increasing circulatory volume with minimal volumes of fluid, and muting the pro-inflammatory response of the body to injury and illness

Rossaint R, Bouillon B, Cerny V, Coats TJ, Duranteau J, Fernandez-Mondejar E, et al. The European guideline on management of major bleeding and coagulopathy following trauma: fourth edition. Crit Care. 2016;20:100.

Kobayashi L, Costantini TW, Coimbra R. Hypovolemic shock resuscitation. Surg Clin North Am. 2012;92(6):1403–23.

Bunn FR IG, Tasker R, Trivedi D. Hypertonic versus near isotonic crystalloid for fluid resuscitation in critically ill patients. Cochrane Database Syst Rev. 2009;4

RESEARCH ARTICLE

Open Access



# The effectiveness of prehospital hypertonic saline for hypotensive trauma patients: a systematic review and meta-analysis

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## Abstract

**Background:** The optimal prehospital fluid for the treatment of hypotension is unknown. Hypertonic fluids may increase circulatory volume and mute the pro-inflammatory response of the body to injury and illness. The purpose of this systematic review is to determine whether in patients presenting with hypotension in the prehospital setting (population), the administration of hypertonic saline (intervention), compared to an isotonic fluid (control), improves survival to hospital discharge (outcome).

**Methods:** Searches were conducted in Medline, Embase, CINAHL, and CENTRAL from the date of database inception to November, 2016, and included all languages. Two reviewers independently selected randomized control trials of hypotensive human participants administered hypertonic saline in the prehospital setting. The comparison was isotonic fluid, which included normal saline, and near isotonic fluids such as Ringer's Lactate.

Methods: Searches were conducted in Medline, Embase, CINAHL, and CENTRAL from the date of database inception to November, 2016. The comparison was isotonic fluid. Secondary outcomes were reported for fluid requirements, multi-organ failure, adverse events, length of hospital stay, long term survival and disability.

All studies administered a fixed 250 ml dose of 7.5% hypertonic saline

Two studies used normal saline, two Ringer's Lactate, and one Ringer's Acetate as control

Five studies were included in the meta-analysis (n=1162 injured patients) with minimal statistical heterogeneity (I<sup>2</sup> = 0%)

There was no significant difference in important clinical outcomes for hypotensive injured patients administered hypertonic saline compared to isotonic fluid in the prehospital setting

PROBLEMS

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DIAGNOSE

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PROBLEMS

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DIAGNOSE

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- ▶ In spite of promising animal and pre-clinical data, a systematic review and meta-analysis published in 2009 by the Cochrane Collaboration that included prehospital and hospital based studies of patients presenting with hypovolemia did not reach any definitive clinical conclusions on the impact of hypertonic saline
- ▶ These findings also align with another meta-analysis conducted in 2014

Bunn FR IG, Tasker R, Trivedi D. Hypertonic versus near isotonic crystalloid for fluid resuscitation in critically ill patients. Cochrane Database Syst Rev. 2009;4

Wang JW, Li JP, Song YL, Tan K, Wang Y, Li T, et al. Hypertonic saline in the traumatic hypovolemic shock: meta-analysis. J Surg Res. 2014;191(2):448–54.

- 
- 
- ▶ The use of hypertonic saline may be particularly useful for teams operating in austere and remote conditions (e.g., tactical or wilderness EMS, etc.) where there are limitations to equipment availability and the time to definitive care is long.

# TOURniQUeTS

- ▶ The best evidence for tourniquet use in the prehospital environment comes from the experience of military hospitals.
- ▶ A prospective study analyzing 428 tourniquets placed on 309 injured limbs showed that early tourniquet use before the onset of shock was associated with a 90% survival rate versus 10% survival if the application was delayed until the casualty was in shock

# HEMOSTATIC AGENTS

- ▶ The use of topical hemostatic agents in combination as an adjunct to surgical bleeding control has been identified as a grade 1B recommendation in European guidelines

Which one is best?



- Currently approved topical hemostatic agents can be categorized under four functional categories:

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Mechanism	note	brand
biologically active agents,	indicated for minor bleeding and oozing	
fibrin sealants	do not depend on patients' intrinsic clotting mechanism	
mechanical barrier agents	block blood flow and create thrombogenic surfaces	
flowable sealants (thrombin plus a mechanical barrier)	paste-like mixture and combine thrombin with a mechanical hemostatic agent.	

- The HemCon bandage consists of freeze-dried chitosan, which appears to strongly adhere to wet tissues and seal injured vessels.
- QuikClot functions as a mineralbased hemostatic agent. The zeolite minerals cause rapid water absorption which may concentrate clotting proteins and cells into the wound. The newer generation mineral-based hemostatic agents QuikClot Combat Gauze (Z-Medica Corp., Wallingford, CT, USA) and Celox (MedTrade Products Ltd., Crewe, UK) have shown improved hemostatic efficacy over previous topical hemostatic dressings

# AORTIC OCCLUSION

PROBLEMS

T-CPR

HEAMORHAGE

PAIN MAN.

DIAGNOSE

ADVANCED



## Bi-manual proximal external aortic compression after major abdominal-pelvic trauma and during ambulance transfer: A simulation study

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<sup>c</sup>Department of Critical Care Medicine, University of Alberta Hospital, Edmonton, Alberta, Canada

### ARTICLE INFO

#### Keywords:

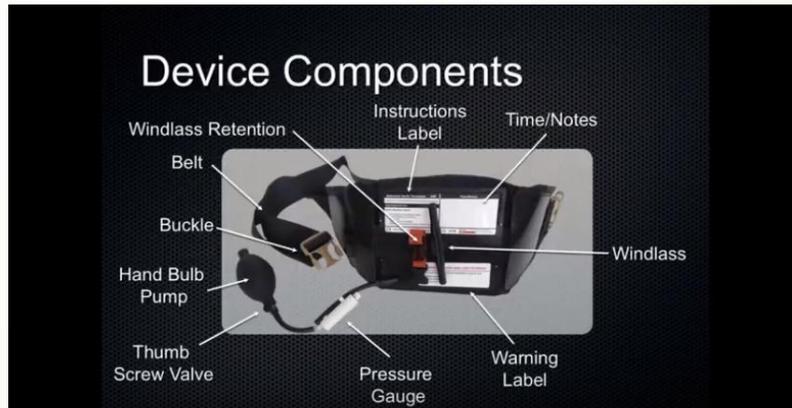
Noncompressible torso hemorrhage  
Junctional hemorrhage  
Prehospital care

### ABSTRACT

**Background:** Applying manual pressure after hemorrhage is intuitive, cost-free, and logistically-simple. When direct abdominal-pelvic compression fails, clinicians can attempt indirect proximal-external-aortic-compression (PEAC), while expediting transfer and definitive rescue. This study quantifies the sustainability of simulated bi-manual PEAC both immediately on scene and during subsequent ambulance transfer. The goal is to understand when bi-manual PEAC might be clinically-useful, and when to prioritize compression-devices or endovascular-occlusion.

**Methods:** We developed a simulated central vessel compression model utilizing a digital scale and Malbrain intra-abdominal pressure monitor inside a cardiopulmonary resuscitation mannequin. Twenty prehospital health care professionals (HCPs) performed simulated bimanual PEAC i) while stationary and ii) inside an 80 km/h ambulance on a closed driving-track. Participants compressed at "the maximal effort they could maintain for 20 min". Results were measured in mmHg applied-pressure and kilograms compressive-weight. The Borg scale of perceived-exertion was used to assess sustainability, with <16 regarded as acceptable.

**Results:** While stationary all participants could maintain 20 min of compressive pressure/weight: within five-percent of their starting effort, and with a Borg-score <16. Participants applied 88–300 mmHg compressive pressure; (mean 180 mmHg), 14–55 kg compressive-weight (mean 33 kg), and 37–66% of their bodyweight (mean 43%). In contrast, participants could not apply consistent or sustained compression in a moving ambulance: Borg Score exceeded 16 in all cases.



Abdominal aortic  
tourniquet(AAT)

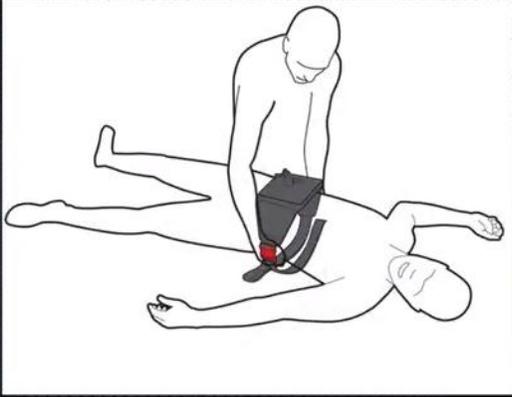


Fig. 1 CROc™. <https://combatmedicalsystems.wordpress.com/2013/05/06/combat-ready-clamp-croctm-makes-tactical-medicine-history/>

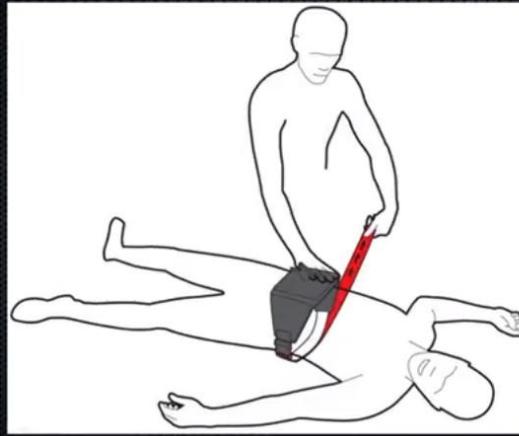
- ▶ Abdominal aortic tourniquet (AAT) occluded common femoral artery flow in 15 of 16 healthy volunteers without harmful sequelae and arrested popliteal artery flow (at 114 mm/Hg) in 13 of 13 healthy volunteers



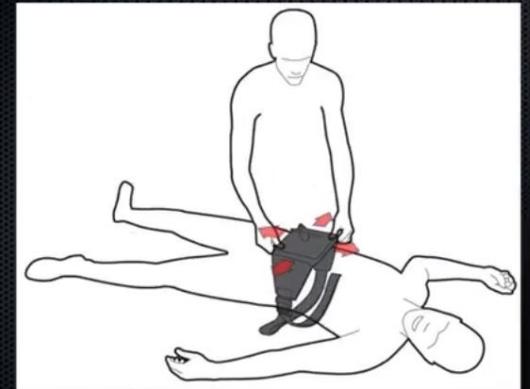
Buckle the device around the patient's waist



Tighten Belt



Position bladder over the patient's umbilicus



PROBLEMS

T-CPR

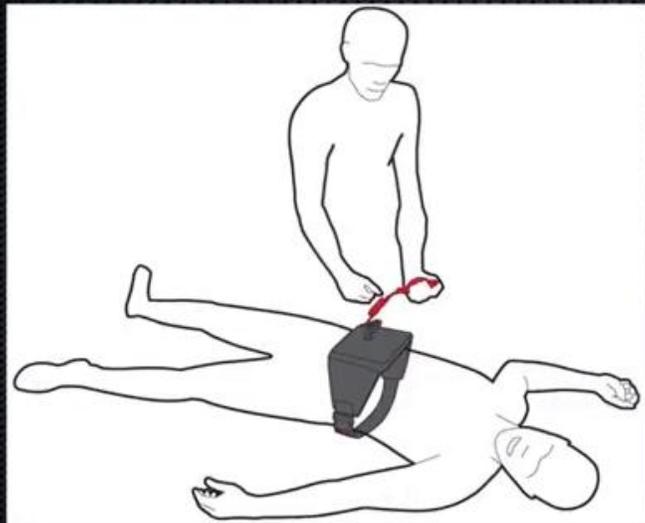
HEAMORHAGE

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DIAGNOSE

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Inflate bladder until green indicator shows



## Inflating the Bladder

- Continue to squeeze the 5 oz. hand bulb until the pressure gauge shows green
- GREEN: 250-300 mm Hg
- RED: > 300 mm Hg



PROBLEMS

T-CPR

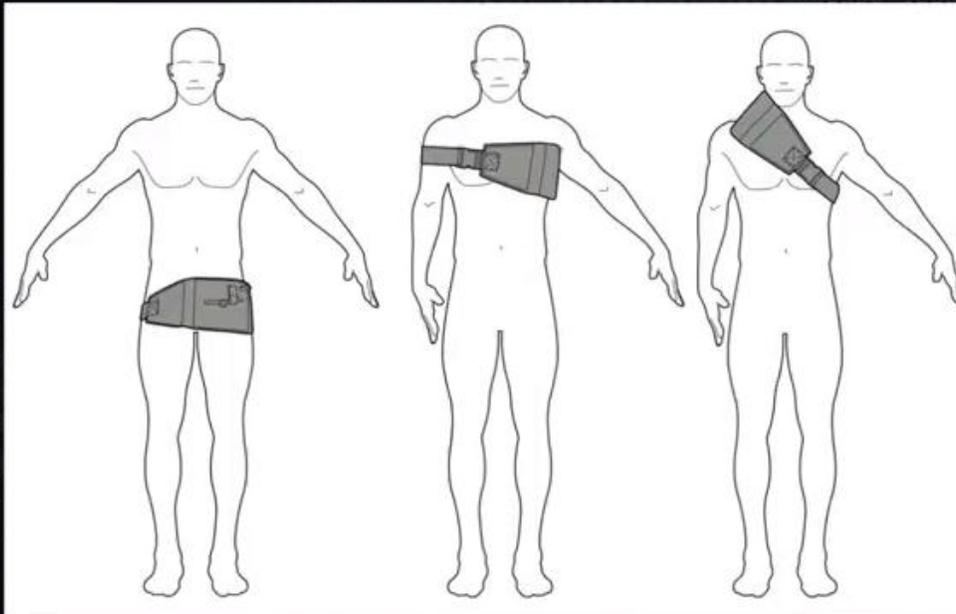
HEAMORHAGE

PAİN MAN.

DIAGNOSE

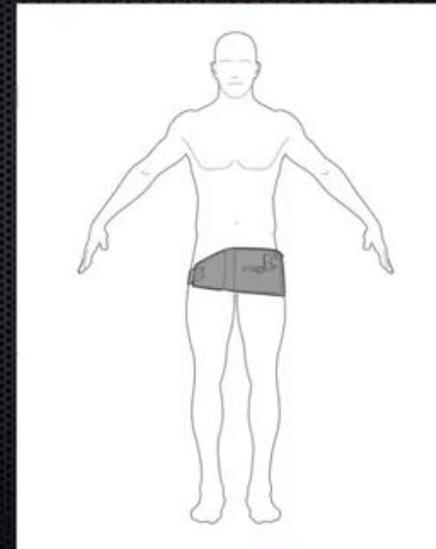
ADVANCED

## New Application Sites



## Single Groin Application

- Isolated groin injury
- Single leg amputation
- Quick application time
- Safer than mechanical compression
- More comfortable than mechanical compression
- More stable during transport



PROBLEMS

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HEAMORHAGE

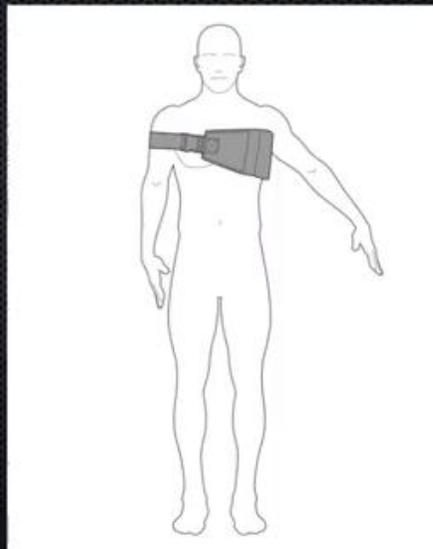
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DIAGNOSE

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# Axilla Application

- Axilla injury
- Single arm amputation
- Quick application time
- Pneumatic compression displaces a large amount of tissue
- Can be anchored around contralateral upper arm or the neck



PROBLEMS

T-CPR

HEAMORHAGE

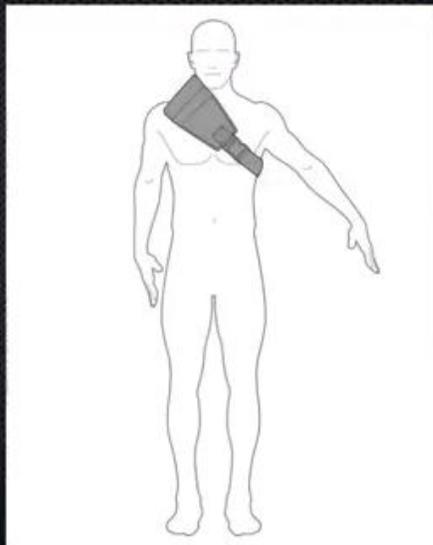
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DIAGNOSE

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# Base of Neck Application

- Base of neck or subclavian injury
- Difficult to control area
- Quick application time
- Safer than mechanical compression
- More comfortable than mechanical compression



**Larry B. Mellick, MD**

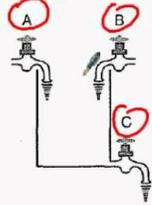
Professor of Emergency Medicine

Georgia Regents University



# BLOOD PRODUCTS

## Örnek - 5



Şekildeki boş havuzun tamamını tek başına A musluğu tek başına 10 saatte, B musluğu tek başına 15 saatte doldurmaktadır. C musluğu dolu havuzu tek başına 30 saatte boşaltmaktadır.

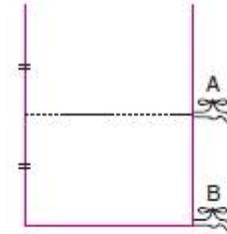
Buna göre, bu üç musluk havuz boşken birlikte açıldığında havuzun tamamının kaç saatte dolacağını bulalım.

$$\frac{1}{A} + \frac{1}{B} - \frac{1}{C} = \frac{1}{x}$$

$$\frac{1}{10} + \frac{1}{15}$$

blood loss from the body is similar to pool-filling (rate of work) problems

But in prehospital settings this IS more problematic!(you can't fill the tank)



Yukarıdaki şekilde verilen havuz, dipteki B ve havuzun yarısında bulunan A musluğu aynı anda açıldığında 9 dakikada boşalmaktadır.

A ve B muslukları özdeş olduğuna göre, B musluğu dolu havuzu kaç dakikada boşaltır?

- A) 10      B) 12      C) 14      D) 16      E) 18

- ▶ A “1:1” transfusion ratio of fresh frozen plasma (FFP) and red blood cells (RBCs) has been shown to reduce mortality in military literature
- ▶ But propably whole blood strategy have more benefits. A randomized control trial demonstrated that cool whole blood in children requiring cardiac surgery reduced bleeding and had improved platelet function compared with blood components in a 1:1:1 unit ratio

Manno CS et al. Comparison of the hemostatic effects of fresh whole blood stored stored whole blood and components after open heart surgery in children. Blood 1991;77:930-936

Curry N, Davis PW. What's new in resuscitation strategies for the patient with multiple trauma? Injury (2012) 43(7):1021–8.  
doi:10.1016/j.injury.2012.03.014

- Cold stored Low titer group 0 whole blood (LTOWB) well tolerated and efficacious alternative to reconstituted whole blood (1:1:1)
- LTOWB;
  - Low risk of bacterial contamination
  - Lower risk of hemolysis
  - Can be transfused to a patient of any ABO blood type
  - Can store duration of up to 21 days (logistic benefit)

## Prehospital administration of freeze-dried plasma, is it the solution for trauma casualties?

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<b>BACKGROUND:</b>	Hemorrhage is the leading cause of possible preventable death in the battlefield. There is an increasing evidence for the effectiveness of blood component therapy in general, and plasma infusion in particular but their use is less applicable in the prehospital setting due to logistic difficulties. Israeli Defense Force has implemented the use of freeze-dried plasma (FDP) at the point of injury (POI), this adoption of FDP use entailed doubts regarding the feasibility and effectiveness of this practice. In this article, we present our experience with the use of FDP at the POI and prehospital setting regarding the feasibility, safety, adverse reactions, and adherence to clinical practice guidelines.
<b>METHODS:</b>	This is a descriptive retrospective cohort study based on all casualties receiving FDP during January 2013 to June 2016. The study describes the injury, treatment, and outcome characteristics from POI until hospital discharge.
<b>RESULTS:</b>	During the study period, 109 casualties received FDP. The majority were men, aged 18 years to 35 years. Multiple severe injuries were found in almost half of the casualties, 78% had penetrating injury, and more than half were involved in a multicasualty event. Eighty-three percent were treated with one unit of FDP, 13% with two units, and 4% casualties with three units, nine patients (8.2%) were also treated in the prehospital setting with packed red blood cells. Fifty-seven percent fulfilled at least one criterion for the administration of FDP. Lifesaving interventions were required in 64%. In five (4.6%) cases, there were difficulties with FDP administration. Side effects were reported in one female patient.
<b>CONCLUSION:</b>	This study supports the usage feasibility of FDP at the POI and in the prehospital setting. Further adjustment of the clinical practice guidelines is required basing it not only on pathophysiologic parameters but also on clinical judgment. Further investigation of the available data is required to learn about the effectiveness of FDP at POI. ( <i>J Trauma Acute Care Surg.</i> 2017;83: 675-682. Copyright © 2017 Wolters Kluwer Health, Inc. All rights reserved.)
<b>LEVEL OF EVIDENCE:</b>	Retrospective case series study, level IV.
<b>KEY WORDS:</b>	Freeze dried plasma, prehospital, hemorrhagic shock.

Hemorrhage, both compressible and noncompressible, is the leading cause of preventable death on the battlefield<sup>1,2</sup> and effective treatment is needed to minimize casualty mortality.<sup>3</sup> Many fluid resuscitation protocols have been developed over the years;<sup>4,5</sup> these protocols include administration of crystalloids, colloids, and the use of blood products, such as packed red blood cells (PRBCs), fresh frozen plasma (FFP), platelets, and

There is an increasing evidence for the effectiveness of plasma infusion but their use is less applicable in the prehospital setting due to logistic difficulties

Freeze dried plasma (FDP) has various comparative advantages over crystalloids and other colloids;

- CAN restore intravascular volume
- Provides replacement of consumed clotting factors
- can store 15 months in room temperature
- it can be reconstituted quickly and dissolved in a small volume of solvent (200 ml normal saline)

PROBLEMS

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DIAGNOSE

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# POINT OF DIAGNOSTIC



PROBLEMS

T-CPR

HEAMORHAGE

PAIN MAN.

DIAGNOSE

ADVANCED

## PROSPECTIVE EVALUATION OF PREHOSPITAL TRAUMA ULTRASOUND DURING AEROMEDICAL TRANSPORT

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Deborah del Junco, PhD,‡ and John B. Holcomb, MD‡

\*Department of Emergency Medicine, University of Texas Medical School at Houston, Houston, Texas, †Department of Internal Medicine, University of Texas Medical School at Houston, Houston, Texas, and ‡Department of Surgery and The Center for Translational Injury Research, University of Texas Medical School at Houston, Houston, Texas

Reprint Address: Gregory M. Press, MD, Department of Emergency Medicine, University of Texas Medical School at Houston, 6431 Fannin, JLL 450E, Houston, TX 77030

□ **Abstract—Background:** Ultrasound is widely considered the initial diagnostic imaging modality for trauma. Preliminary studies have explored the use of trauma ultrasound in the prehospital setting, but the accuracy and potential utility is not well understood. **Objective:** We sought to determine the accuracy of trauma ultrasound performed by helicopter emergency medical service (HEMS) providers. **Methods:** Trauma ultrasound was performed in flight on adult patients during a 7-month period. Accuracy of the abdominal, cardiac, and lung components was determined by comparison to the presence of injury, primarily determined by computed tomography, and to required interventions. **Results:** HEMS providers performed ultrasound on

were 50% (95% CI 22.3%–58.7%) and 99.8% (98.6%–100%), respectively. The positive likelihood ratio for laparotomy was 10.7 (95% CI 5.5–21) and for thoracostomy 235 (95% CI 31–1758), and the negative likelihood ratios were 0.4 (95% CI 0.2–0.7) and 0.5 (95% CI 0.3–0.8), respectively. Of 240 cardiac studies, there was one false-positive and three false-negative interpretations (none requiring intervention). **Conclusions:** HEMS providers performed EFAST with moderate accuracy. Specificity was high and positive interpretations raised the probability of injury requiring intervention. Negative interpretations were predictive, but sensitivity was not sufficient for ruling out injury. © 2014 Elsevier Inc.

Study sought to determine the accuracy of trauma ultrasound performed by helicopter emergency medicine (HEMS) providers. Trauma ultrasound was performed on adult patient during a 7 month period .accuracy was determined Sensivity and specificity for hemiperitoneum was %46 (%95 confjdens interval 27.1%-94.1%) and 94.1% ( (%95 CI 89.2%-97%) For pneumothorax were 18.7%( 95% CI 8.9%-33.9%) and 99.5%(95%CI 98.2%-99.9%)

- 
- 
- ▶ HEMS provider performed EFAST with moderate accuracy
  - ▶ Specificity was high , it can determine injuries requiring interventions
  - ▶ But sensitivity was not sufficient for ruling out injury

## Novel prehospital monitor with injury acuity alarm to identify trauma patients who require lifesaving intervention

Robert M. Van Haren, MD, MPH, Chad M. Thorson, MD, MPH, Evan J. Valle, MD, Alexander M. Busko, BS, Jassin M. Jouria, MD, Alan S. Livingstone, MD, Nicholas Namias, MD, MBA, Carl I. Schulman, MD, PhD, and Kenneth G. Proctor, PhD, Miami, Florida

**BACKGROUND:** A miniature wireless vital signs monitor (MWVSM, [www.athena.gtx.com](http://www.athena.gtx.com)) has been designed according to US Special Operations Command specifications for field monitoring of combat casualties. It incorporates an injury acuity algorithm termed the *Murphy Factor* (MF), which is calculated from whatever vital signs are available at the moment and changes in the last 30 seconds. We tested the hypothesis that MF can identify civilian trauma patients during prehospital transport who will require a lifesaving intervention (LSI) upon hospital admission.

**METHODS:** From December 2011 to June 2013, a prospective trial was conducted in collaboration with prehospital providers. The MWVSM detects skin temperature, pulse oximetry (SpO<sub>2</sub>), heart rate (HR), pulse wave transit time, and MF. LSIs included: intubation, tube thoracostomy, central line insertion, blood product transfusion, and operative intervention. Prehospital MWVSM data were compared with simultaneous vital signs (SaO<sub>2</sub>, systolic blood pressure (SBP), and HR) from a conventional vital signs monitor. Sensitivity, specificity, negative predictive value, positive predictive value, and area under the receiving operating characteristic curves were calculated.

**RESULTS:** Ninety-six trauma patients experienced predominantly blunt trauma (n = 80, 84%), were mostly male (n = 79, 82%), and had a mean ± SD age of 48 ± 19 years and an Injury Severity Score (ISS) of 10 (17). Those who received an LSI (n = 48) had similar demographics but higher ISS (18 vs. 5) and mortality (23% vs. 0%) (all p < 0.05). The most common LSIs were intubation (n = 24, 25%), blood product transfusion (n = 19, 20%), and emergency surgery (n = 19, 20%). Compared with HR > 100 beats/min, SBP < 90 mm Hg, SaO<sub>2</sub> < 95% alone or in combination, MF > 3 during the entire transport time had the largest area under the receiving operating characteristic curves (0.620, p = 0.081). MF greater than 3 had a specificity of 81%, sensitivity of 39%, positive predictive value of 68%, and negative predictive value of 57% for the need for LSI.

**CONCLUSION:** A single numeric value has the potential to summarize overall patient status and identify prehospital trauma patients who need an LSI. Prehospital monitoring combined with algorithms that include trends over time could improve prehospital care for both civilian and military trauma. (*J Trauma Acute Care Surg.* 2014;76: 743–749. Copyright © 2014 by Lippincott Williams & Wilkins)

**LEVEL OF EVIDENCE:** Prospective observational, level II.

**KEY WORDS:** Wireless vital signs; lifesaving interventions; forward surgical teams.

A miniature wireless vital signs monitor (MWVSM, [www.athena.gtx.com](http://www.athena.gtx.com)) has been designed for field monitoring of combat casualties.

It incorporates an injury acuity algorithm termed the *Murphy Factor* (MF), which is calculated from whatever vital signs are available at the moment and changes in the last 30 seconds. We tested the hypothesis that MF can identify civilian trauma patients during prehospital transport who will require a lifesaving intervention (LSI) upon hospital admission.

The MWVSM detects skin temperature, pulse oximetry (SpO<sub>2</sub>), heart rate (HR), pulse wave transit time, and MF.

LSIs included: intubation, tube thoracostomy, central line insertion, blood product transfusion, and operative intervention.

PROBLEMS

T-CPR

HEAMORHAGE

PAIN MAN.

DIAGNOSE

ADVANCED

PROBLEMS

T-CPR

HEAMORHAGE

PAİN MAN.

DIAGNOSE

ADVANCED

- The most common LSIs were intubation (n= 24, 25%), blood product transfusion(n=19,20%),and emergency surgery(n=19,20%).
- Compared with HR>100 beats/min, SBP < 90 mm Hg, SaO<sub>2</sub> < 95% alone or in combination, MF > 3 during the entire transport time had the largest area under the receiving operating characteristic curves (0.620, p = 0.081).
- **MF greater than 3 had a specificity of 81%, sensitivity of 39%, positive predictive value of 68%, and negative predictive value of 57% for the need for LSI.**
- **A single numeric value has the potential to summarize overall patient status and identify prehospital trauma patients who need an LSI**

# Point of care coagulopathy tests

- ▶ We can not use aPTT and INR (international normalized ratio) in prehospital settings for predicting coagulopathy
- ▶ Thromboelastography (TEG) or thromboelastometry (ROTEM) are facilitate coagulation status



# ADVANCED PROCEDURES

PROBLEMS

T-CPR

HEAMORHAGE

PAIN MAN.

DIAGNOSE

ADVANCED

- Advanced procedures in the field in retrieval medicine can be time consuming and is not without risk of complication.
- Minimizing time in the field can lead to better outcomes for patients who are seriously medically ill or traumatically injured.

# REBOA

PROBLEMS

T-CPR

HEAMORHAGE

PAİN MAN.

DIAGNOSE

ADVANCED

The patients who had fallen 15 meters suffered catastrophic internal hemorrhage associated with pelvic fracture

They insert REBOA balloon catheter at the scene to control bleeding, Emergency angio embolization and subsequent surgery was performed in hospital  
**HE was discharged neurologically normal after 52 days.**



Clinical paper

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



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Non-compressible torso haemorrhage

### ABSTRACT

This report describes the first use of Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA) in the pre-hospital setting to control catastrophic haemorrhage. The patient, who had fallen 15 meters, suffered catastrophic internal haemorrhage associated with a pelvic fracture. He was treated by London's Air Ambulance's Physician-Paramedic team. This included insertion of a REBOA balloon catheter at the scene to control likely fatal exsanguination. The patient survived transfer to hospital, emergency angio-embolization and subsequent surgery. He was discharged neurologically normal after 52 days and went on to make a full recovery. The poor prognosis in catastrophic torso haemorrhage and novel endovascular methods of haemorrhage control are discussed. Also the challenges of Pre-Hospital REBOA are discussed together with the training and governance required for a safe system.

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

Muzafer 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

**BACKGROUND:** Torso hemorrhage is the primary cause of potentially preventable mortality in trauma. Resuscitative endovascular balloon occlusion of the aorta (REBOA) has been advocated as an adjunct to bridge patients to definitive hemorrhage control. The primary aim of this study was to assess whether contrast-enhanced ultrasonography can improve the accuracy of REBOA placement in the infrarenal aorta (Zone III).

**METHODS:** A fluoroscopy-free “enhanced” Zone III REBOA technique was developed using a porcine cadaver model. A “standard” over-the-wire Seldinger technique was used, which was enhanced with the addition of a microbubble contrast medium to inflate the balloon, observed with ultrasonography. Following this, attending- and resident-level physicians were randomized into two groups. They were taught either the enhanced with ultrasonography guidance (Group A) or the standard measuring length of catheter insertion (Group B) technique as part of a human cadaver trauma skills course. Outcomes assessed included time (seconds) from insertion to inflation, accuracy, and missed targets. All results were benchmarked against three endovascular experts.

**RESULTS:** There were 20 participants who performed REBOA with Group A (51 [31]) being significantly faster than Group B (90 [63]) ( $p = 0.003$ ) and more accurate ( $p = 0.023$ ) with no missed targets. Group B had five missed targets, the most common error being inflation within Zone II.

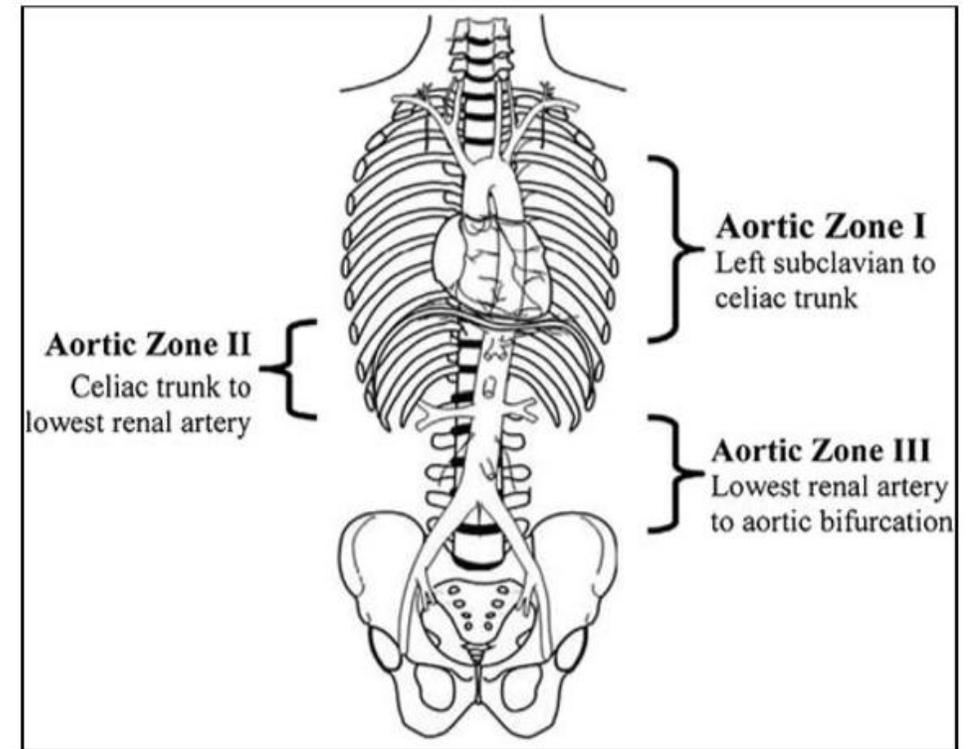
**CONCLUSION:** For Zone III REBOA, contrast-enhanced ultrasonography technique is faster and more accurate than the standard technique. This may have value in time-critical and austere environments. Clinical studies are now required to evaluate this approach further. (*J Trauma Acute Care Surg.* 2016;80: 89–94. Copyright © 2016 Wolters Kluwer Health, Inc. All rights reserved.)

**KEY WORDS:** Ultrasound; REBOA; prehospital care; hemorrhage control; swine.

The standard REBOA technique consisted of inserting the guidewire followed by the Coda balloon catheter. To ensure inflation in Zone III, the catheter had been measured from the point of insertion to just beyond the umbilicus.

An enhanced REBOA technique consisted of the standard technique with the addition of ultrasonography guidance and a balloon contrast medium.

The contrast agent used in this study was Sonovue microbubbles approved for use in the European Union since 2001



The proximal Zone III landmark was where the left renal vein crossed the aorta, and the inferior border was at the aortic bifurcation

PROBLEMS

T-CPR

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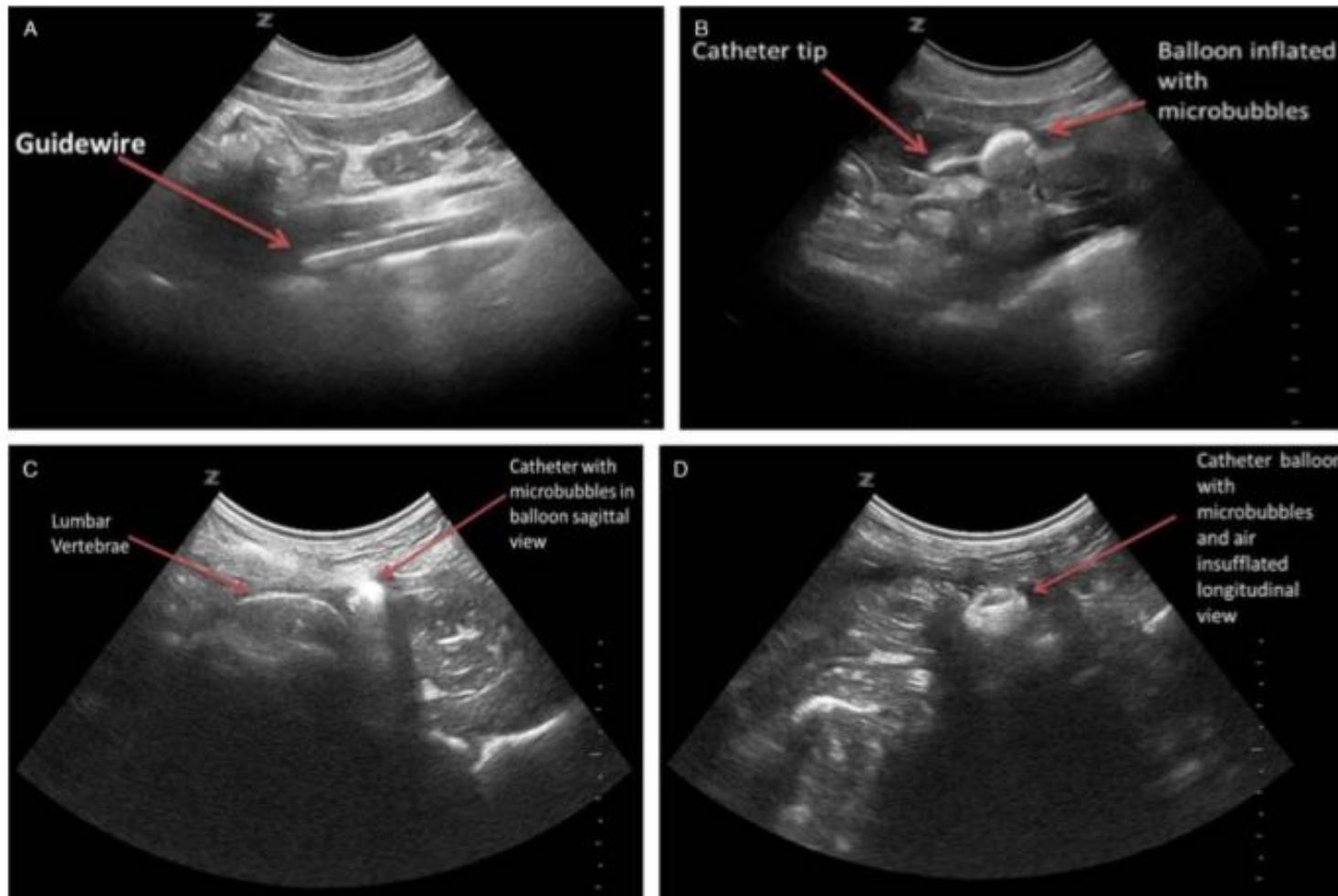
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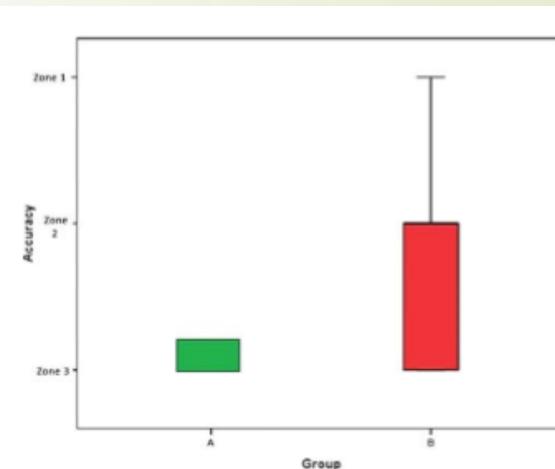
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# Results

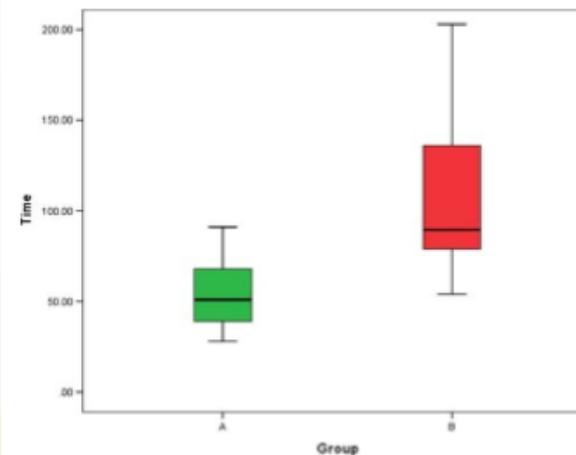


**Figure 3.** Ultrasonography images of guide wire and catheter. *A*, Guide wire visualized under ultrasonography longitudinal view within Zone III of the aorta. *B*, Longitudinal view of Coda catheter tip and balloon inflated with microbubbles within Zone III. *C*, Sagittal view of Coda catheter tip and balloon inflated with microbubbles within Zone III. *D*, Contrast-enhanced ultrasonography longitudinal view of balloon inflated with microbubbles and air within the aorta.

Refence:



**Figure 5.** Accuracy of balloon placement within Zone III Group A versus Group B.



**Figure 4.** Time (in seconds) to perform REBOA Group A versus Group B.

PROBLEMS

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- Use of REBOA has been shown to improve hemodynamics, increase survival as compared to historical controls who underwent thoracotomy (21.1% versus 7.4%), and preserve neurological outcome in survivors (38).

DuBose JJ, Scalea TM, Brenner M, Skiada D, Inaba K, Cannon J, et al. The AAST prospective Aortic Occlusion for Resuscitation in Trauma and Acute Care Surgery (AORTA) registry. *J Trauma Acute Care Surg* (2016) 81(3):409–19.  
doi:10.1097/TA.0000000000001079

# ECMO

ECMO was performed in 7 patients who had refractory cardiac arrest by a prehospital ECMO team

- ECMO flow was established in all patients
- ECMO was started 22 min (+-6) after the incision and 57 min (+-21) after onset of advanced cardiac life support
- One patient survival without sequelae, three patients developed brain death
- Prehospital ECMO performed by non-surgeons is safe and feasible

PROBLEMS

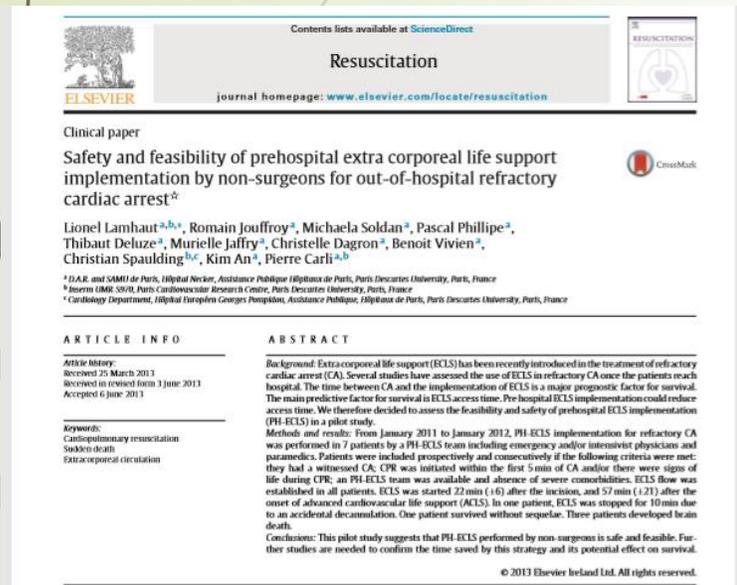
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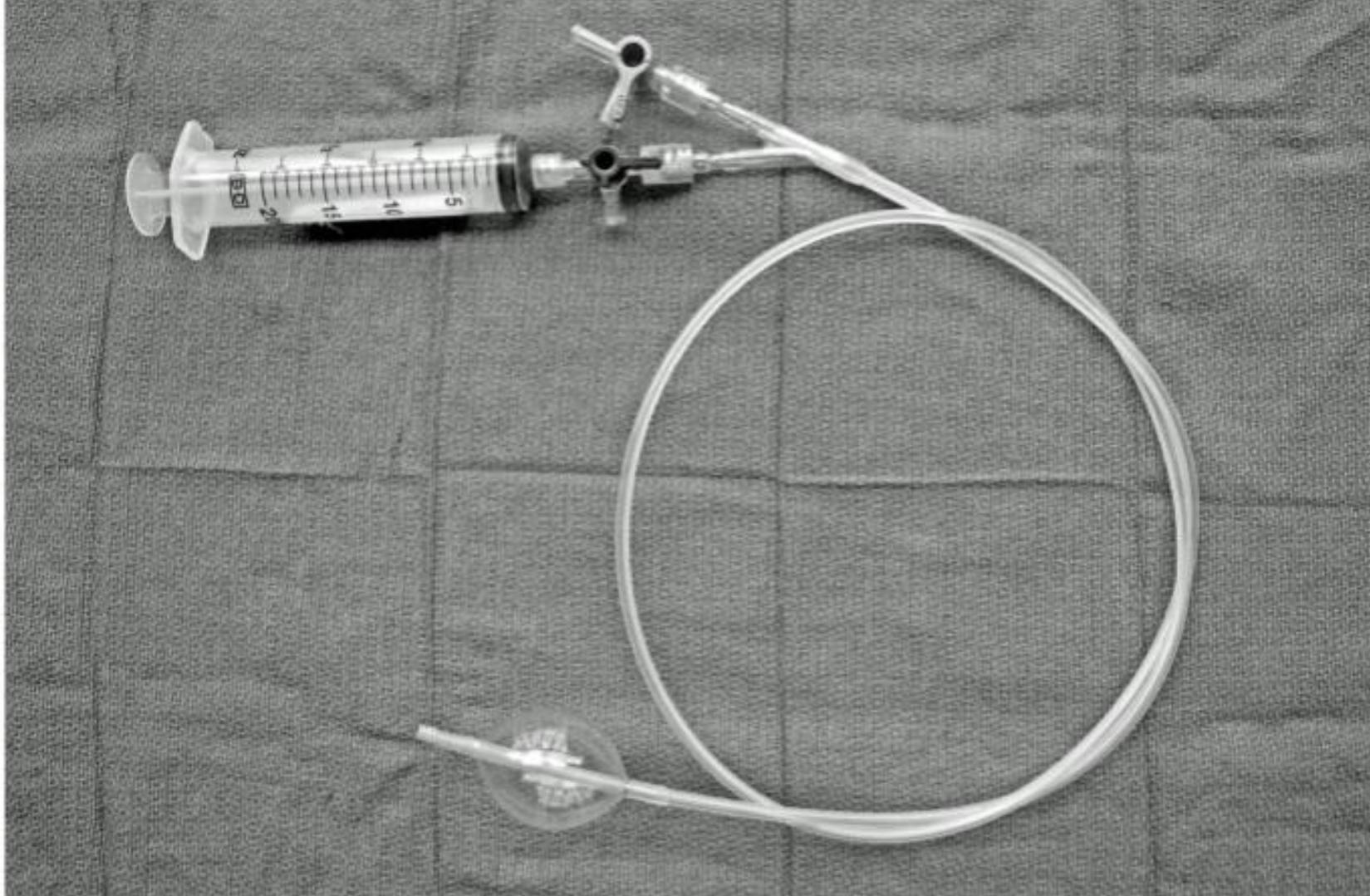
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**Fig 1. SAAP catheter (photograph by EGB Barnard).** To determine the efficacy of SAAP in resuscitating NCTH-induced TCA compared to REBOA, we modified an existing large swine translational model of NCTH. [16] We hypothesized that in this translational model of NCTH-induced TCA, SAAP would significantly increase ROSC and 60-min survival (a surrogate for prehospital survival) as compared to REBOA, and that SAAP efficacy requires oxygen carrying capacity in the resuscitation fluid infused. NCTH, noncompressible torso hemorrhage; REBOA, Resuscitative Endovascular Balloon Occlusion of the Aorta; ROSC, return of spontaneous circulation; SAAP, Selective Aortic Arch Perfusion; TCA, traumatic cardiac arrest.

<https://doi.org/10.1371/journal.pmed.1002349.g001>

PROBLEMS

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DIAGNOSE

ADVANCED

The END

➔ *I wish healthy (non-traumatic) days*

