Trapped Driver Resuscitation

Taking the Lessons from the Track and Applying them to the Road

Jamie Syrett, MD, FACEP

Pulsecheck 2013

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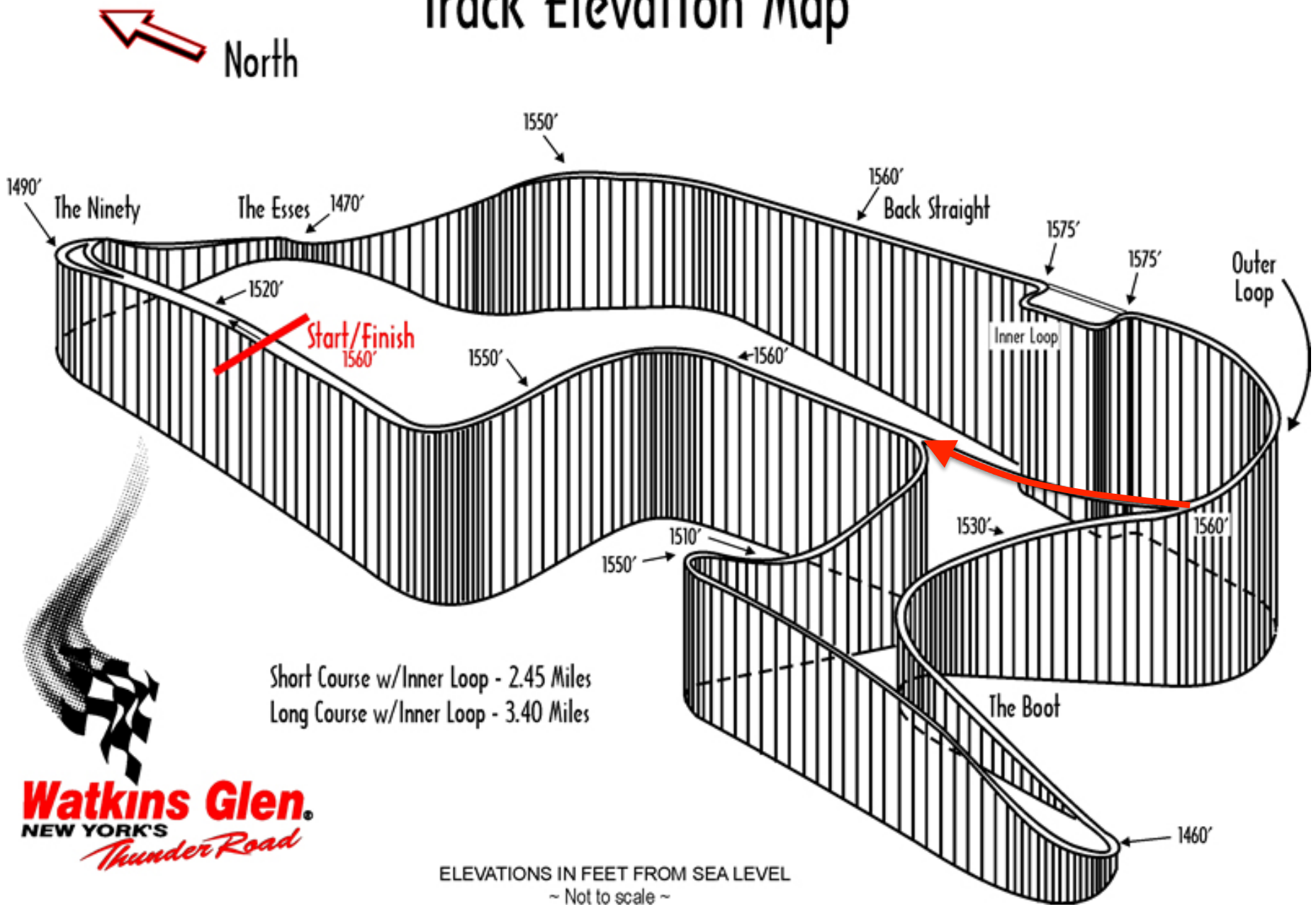
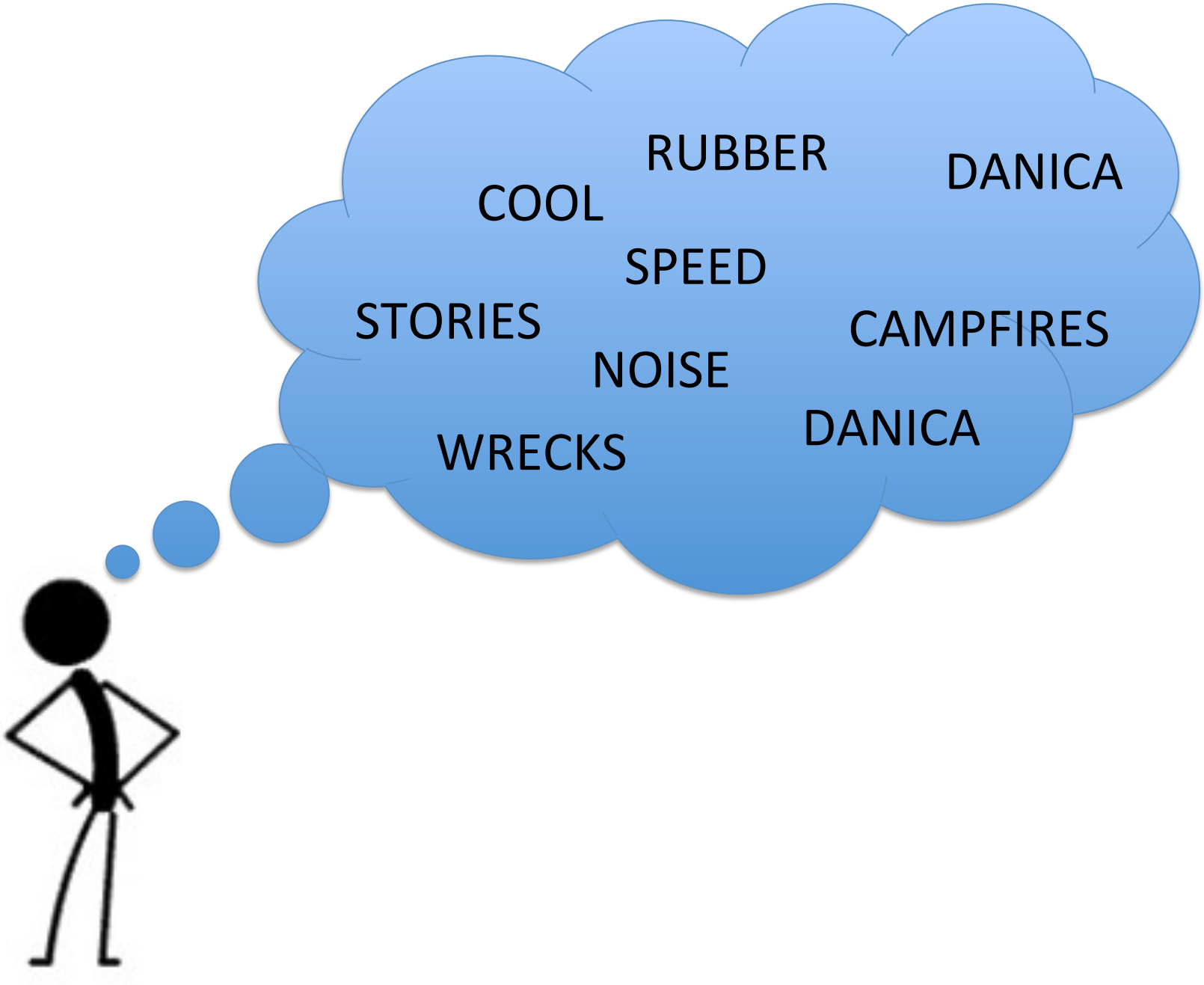
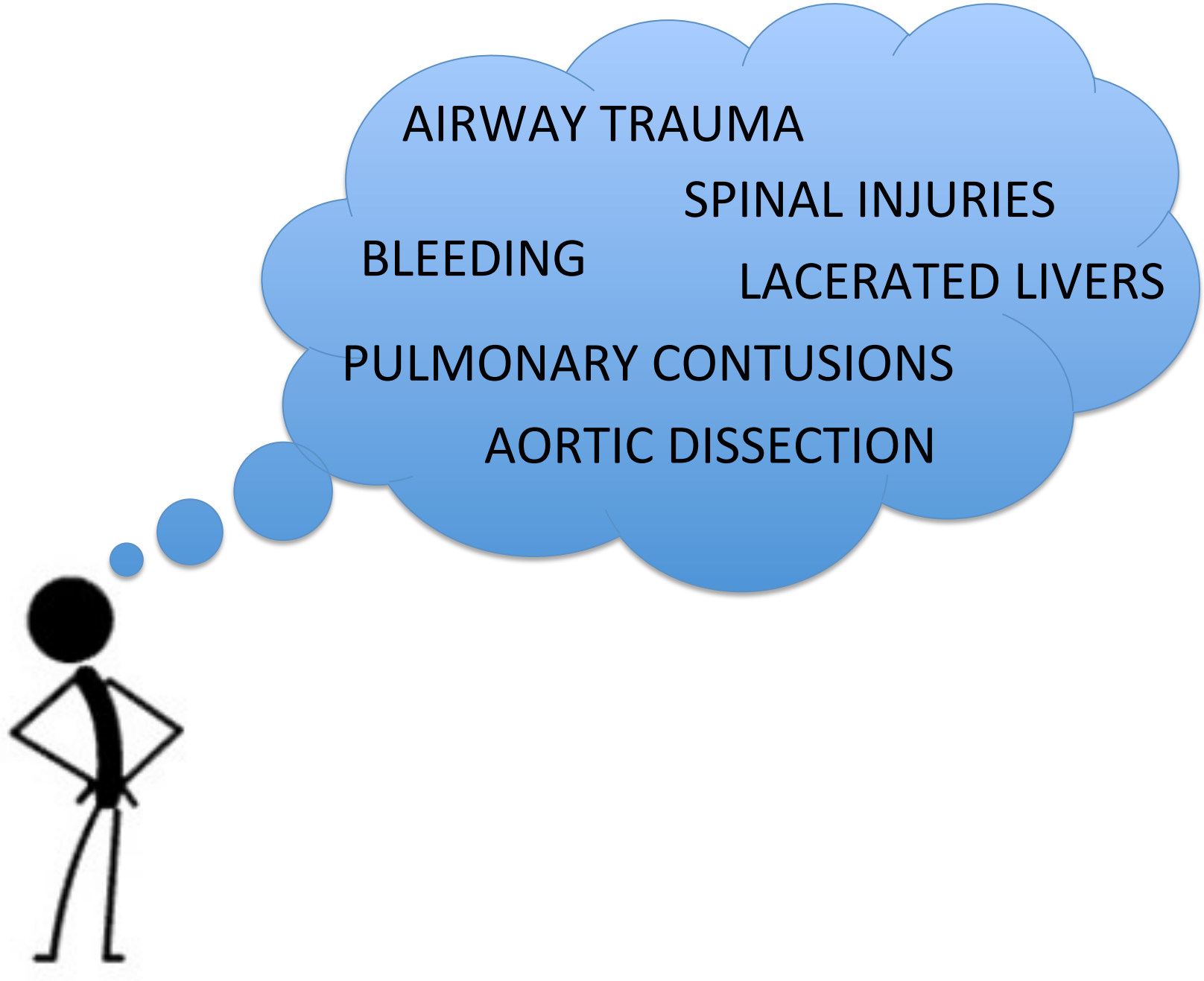
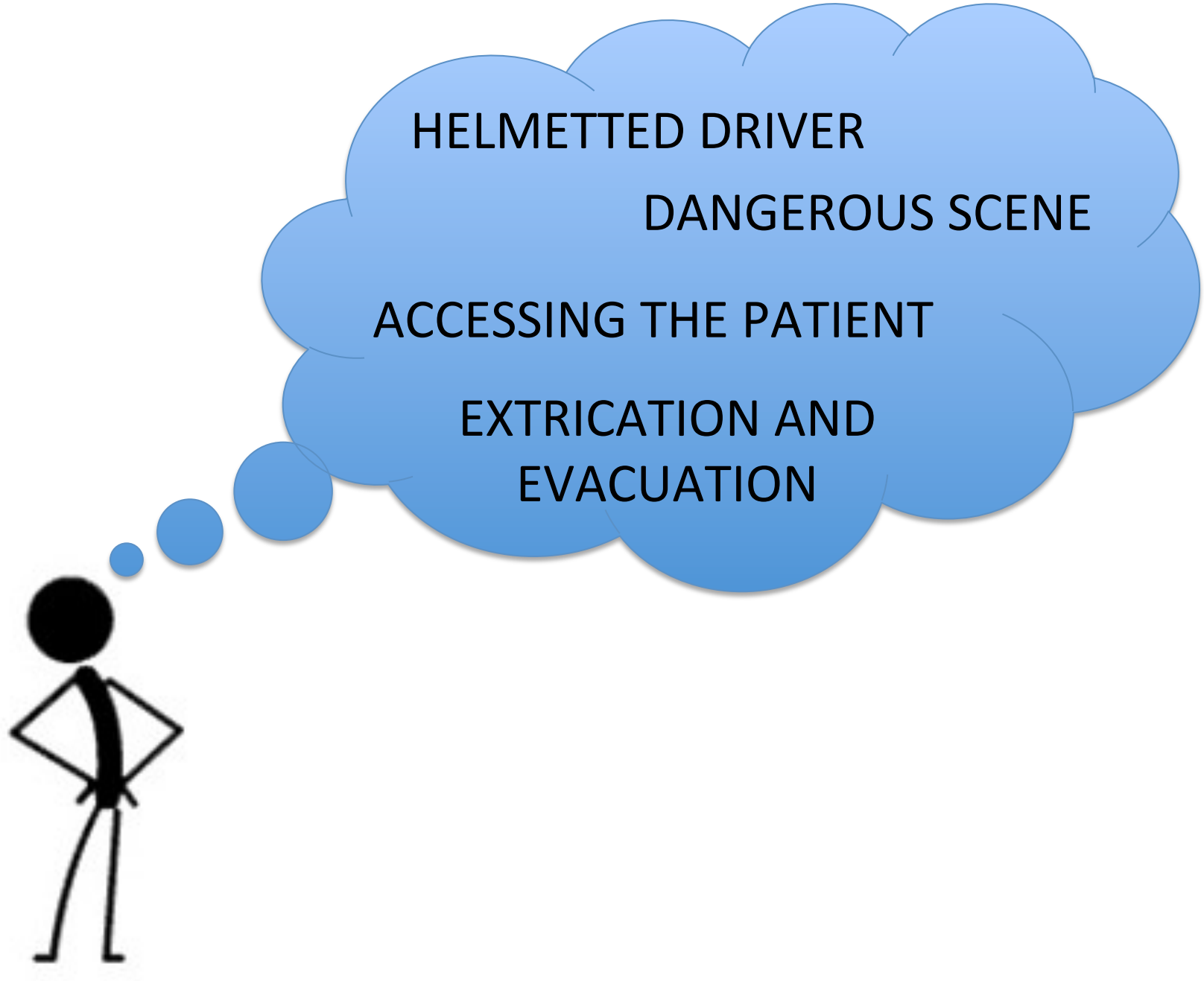
Track Elevation Map



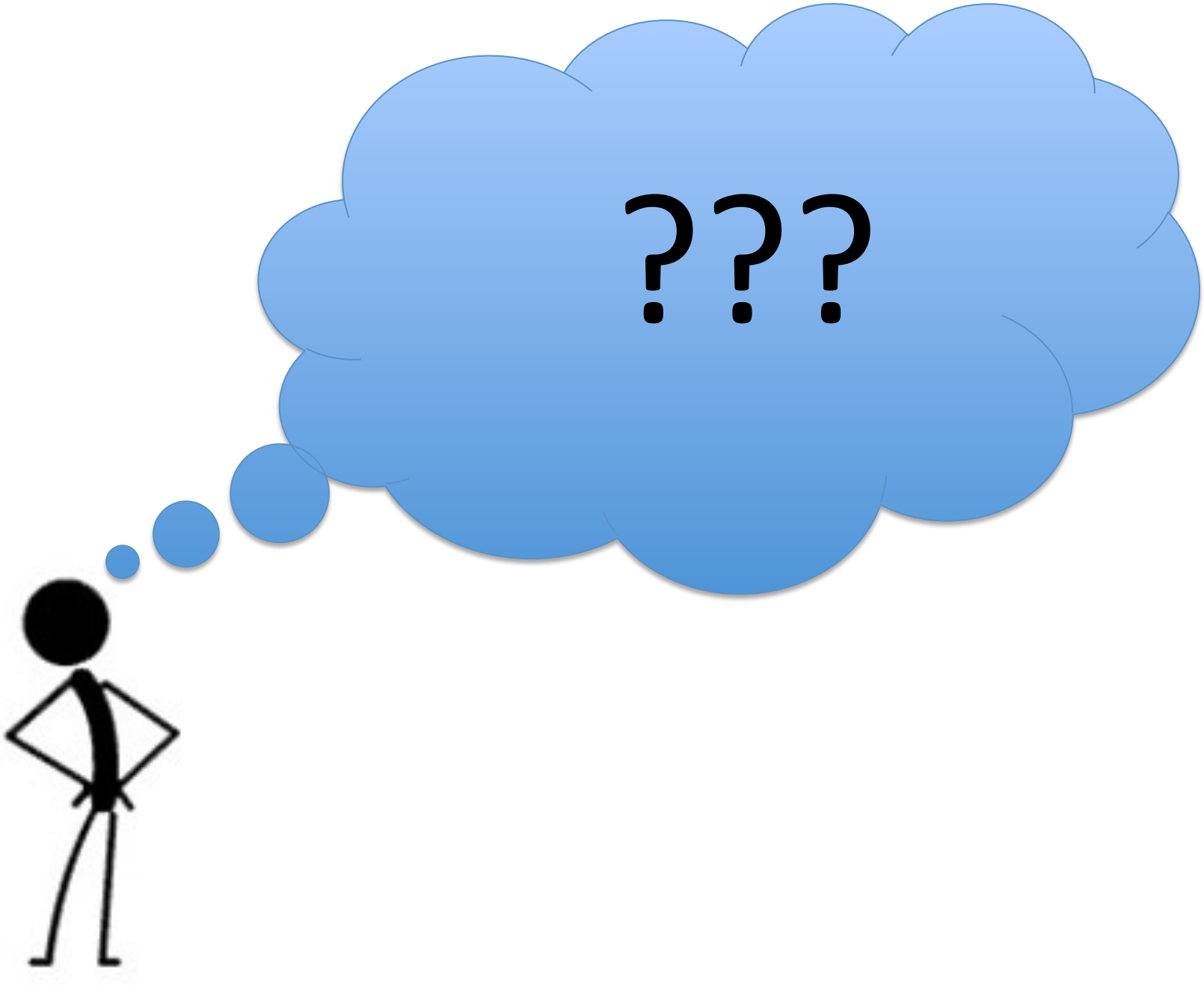

RUBBER
DANICA
COOL
SPEED
STORIES
CAMPFIRES
NOISE
DANICA
WRECKS


WRECKS!

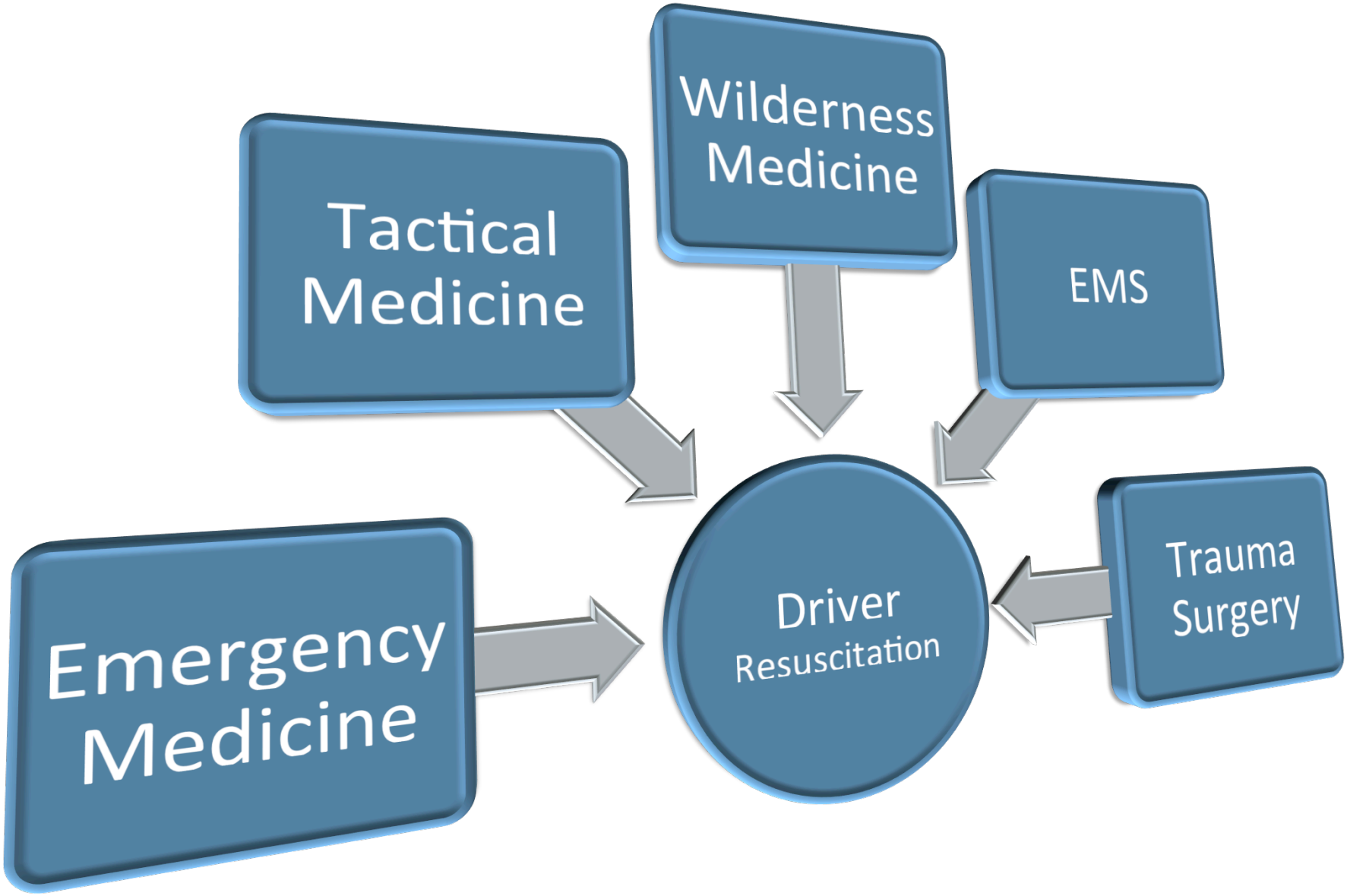

AIRWAY TRAUMA
SPINAL INJURIES
BLEEDING
LACERATED LIVERS
PULMONARY CONTUSIONS
AORTIC DISSECTION


HELMETTED DRIVER
DANGEROUS SCENE
ACCESSING THE PATIENT
EXTRICATION AND EVACUATION


G-FORCE



How would you resuscitate an unconscious driver involved in a high energy impact who remains in the vehicle?


Tactical Medicine
Wilderness Medicine
EMS
Emergency Medicine
Driver
Resuscitation
Trauma Surgery

Challenges

- Austere Environment
  - Heat and Fire
  - Chemicals
  - Sharp edges/awkward angles
- Driver is “trapped” and hidden
  - Restraint devices/helmet
  - Communications/Environmental connections
  - No door
- Access is limited to the driver
  - Working thru the window
- Coordination of Service that may have competing goals
  - Rapid extrication vs rapid treatment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Every time a Race Car Driver sits in the vehicle, they become trapped!
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The Helmet prevents access to the mouth, nose and neck
BELL

Trauma Priorities

Airway (with C-spine control) – Breathing – Circulation

From Tactical Combat Casualty Care –

"Hemorrhage is the most common cause of preventable death in combat and thus takes priority over airway management."

C.R.I.T.I.C.A.L

- C – Control the environment
- R – Rapidly identify and control massive hemorrhage
- I – Inspect and Ensure a patent airway
- T – Treat life threatening torso injuries
- I – Inspect for bleeding, gain IV access, manage shock
- C – Control pain, prevent infection
- A – Aid the litter team
- L – Lead a coordinated evacuation

Driver Resuscitation

1. Control the environment
2. Control massive hemorrhage

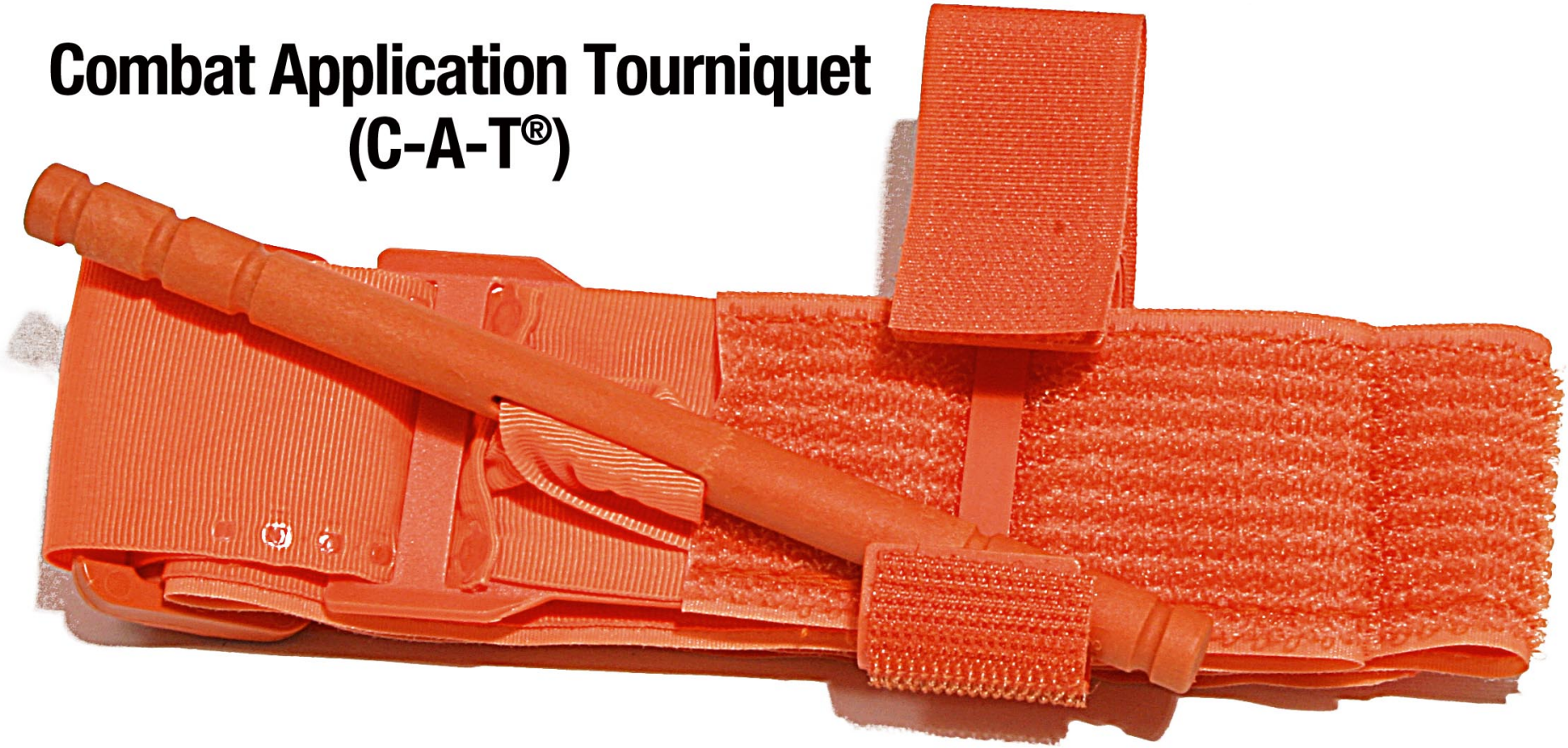
Massive Hemorrhage

- Massive hemorrhage is defined as 150ml blood loss/min (5oz)

Car Side Resuscitation

- Managing Massive Hemorrhage
  - Reach in and apply **Direct Pressure** to torso/neck bleeds
  - Tourniquets applied to extremity bleeding

CAT1 Tourniquet



C-A-Tourniquet

Arm Application


© Kam 2010

Driver Resuscitation

1. Control the environment
2. Control massive hemorrhage
   - Direct pressure
   - CAT1 application as proximal as possible
3. Assess and secure an airway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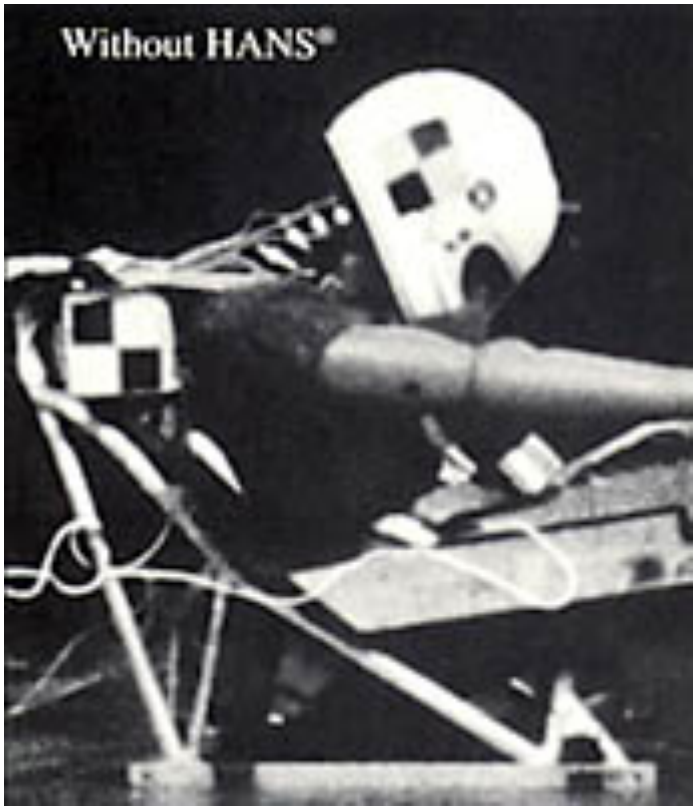
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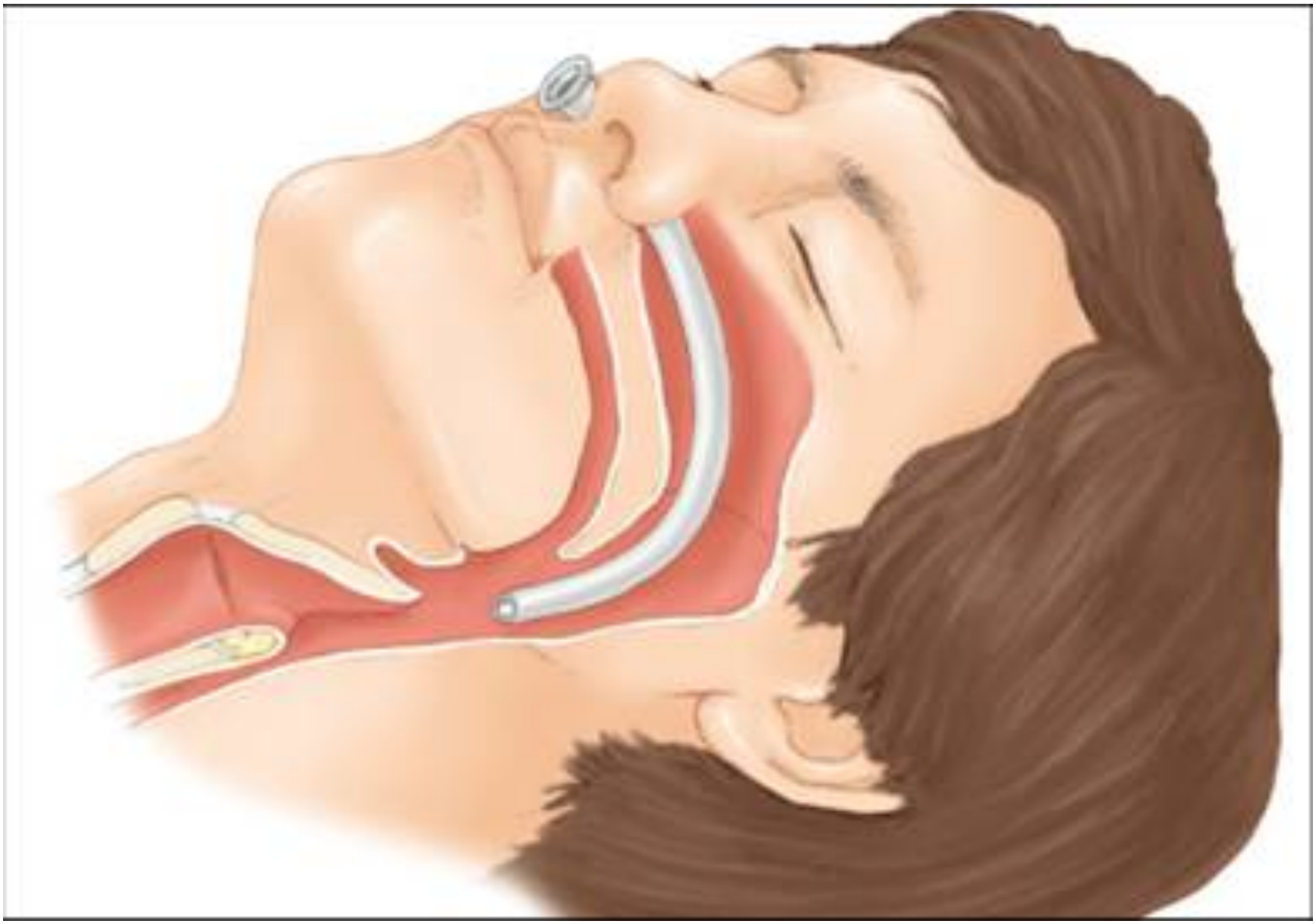
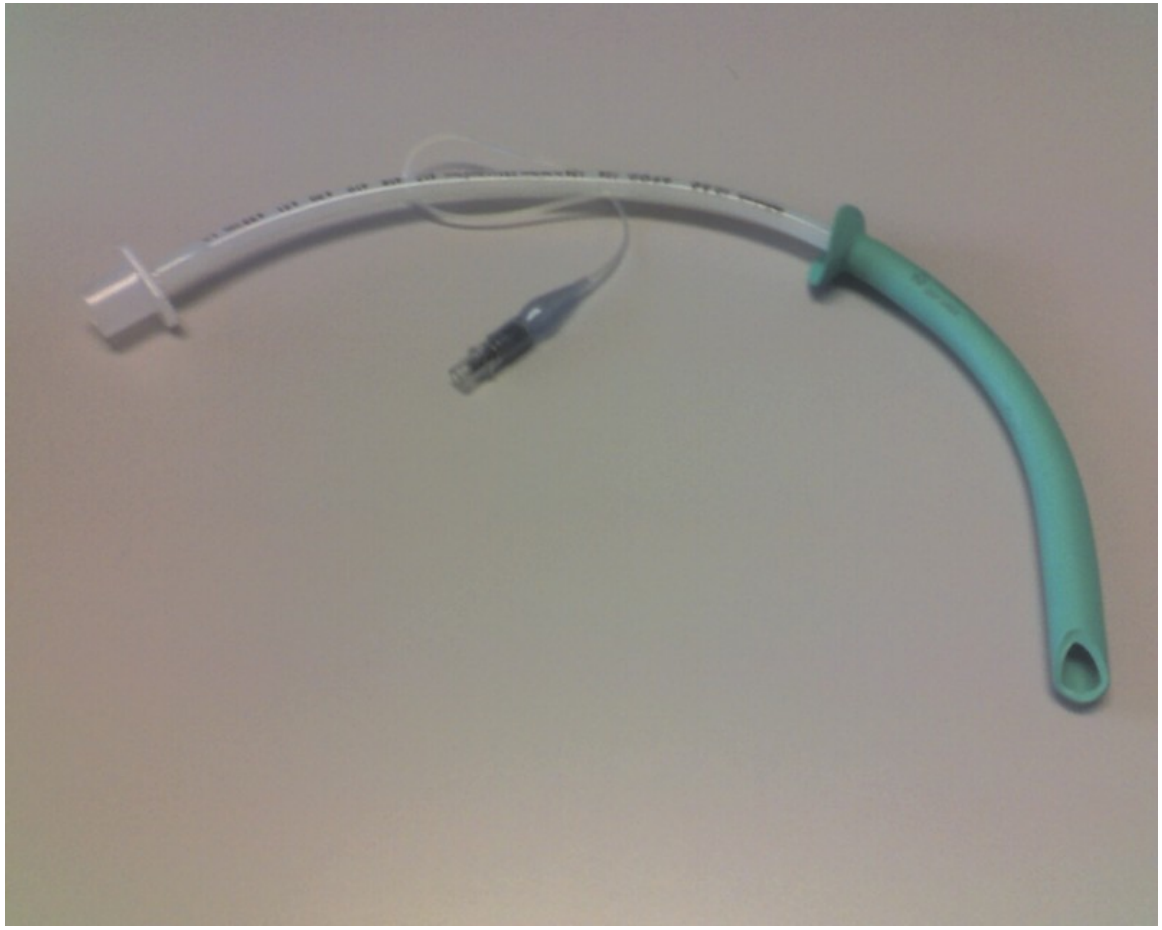




32F Nasopharyngeal Airway + 5.0 Endotracheal Tube

NASCAR Airway

- Insert the NPA
- Thru the NPA push the ETT

- Variable placement
  - Pharyngeal
  - Tracheal

- Ventilate by keeping the mouth and non-intubated nare

In-car Airway Options for NASCAR Drivers

Jonathan Q. Dyreyes, MD; Jeff Grange, MD; Dustin Smith, MD; Peter Jin, MS; Greg Guldner, MD
Loma Linda University Medical Center, Loma Linda,CA

Western Journal of Emergency Medicine, 9(1)

Results: No method other than the TAD could be implemented due to a lack of access to the oropharynx. The TAD could be placed but did not produce significant chest rise.

Conclusion: The trumpet airway device may help oxygenate such drivers, however, adequate ventilation using this device should be further studied. Motorsports medical personnel should focus on basic airway maneuvers and rapid extrication with helmet removal rather than wasting valuable time attempting more advanced airways in drivers with full face helmets trapped in their race cars.

Wilderness Medicine Solution

Drip chamber airway – “Spike Crich”

Rapid procedure
Definitive airway
Can be done “blind”
Requires minimum “equipment”

Eric Weiss - If the spike is used, "you don't even have to make an incision through the skin: This spike is so sharp, you just plunge that right into the cricothyroid membrane. You have the fastest cricothyroidotomy the world has ever seen."

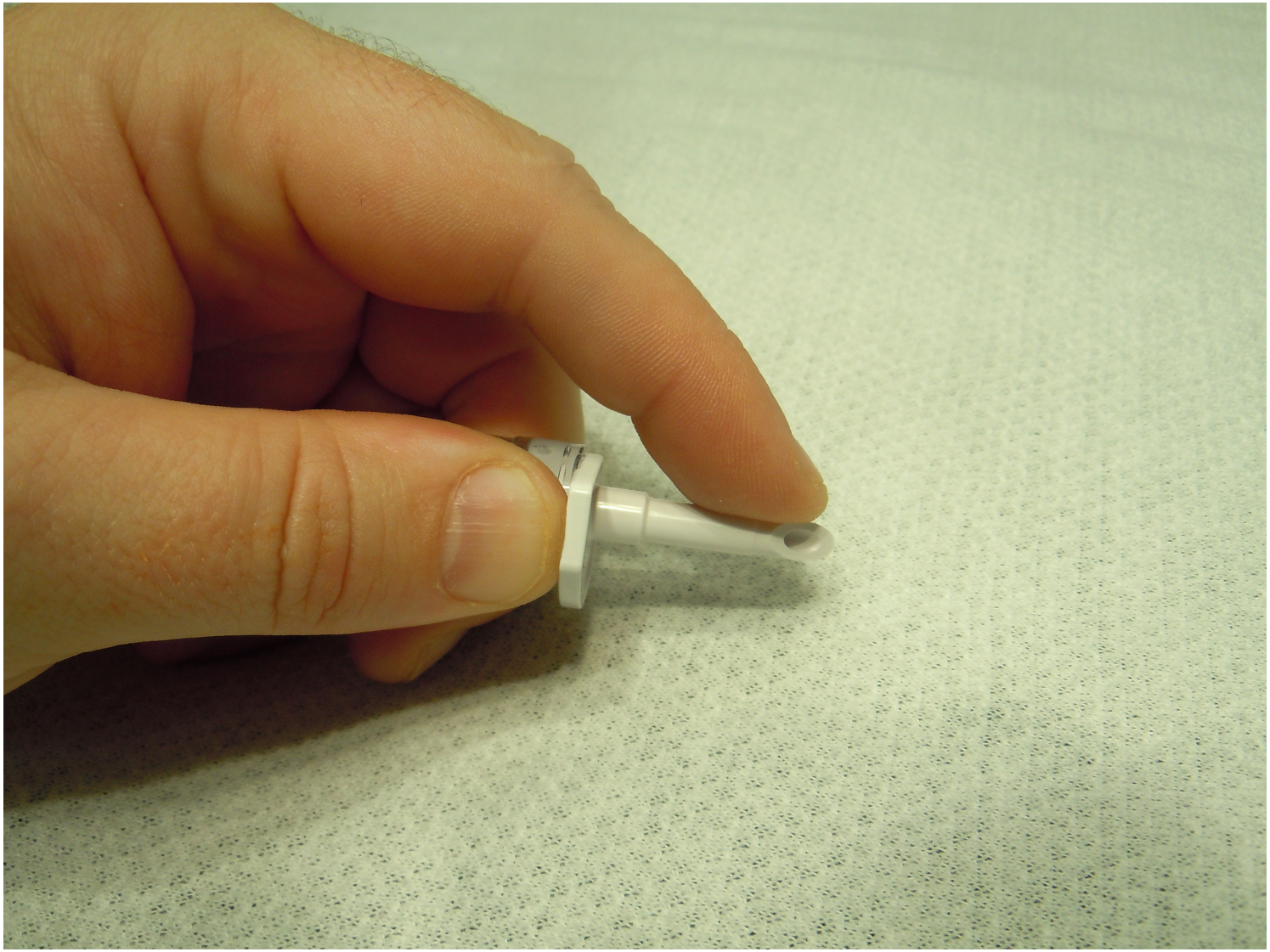
Spike Crich


WARNING:
TO PREVENT FREE-FLOW,
CLOSE ROLLER CLAMP
WHEN SAFETY CLAMP
IS OPEN.

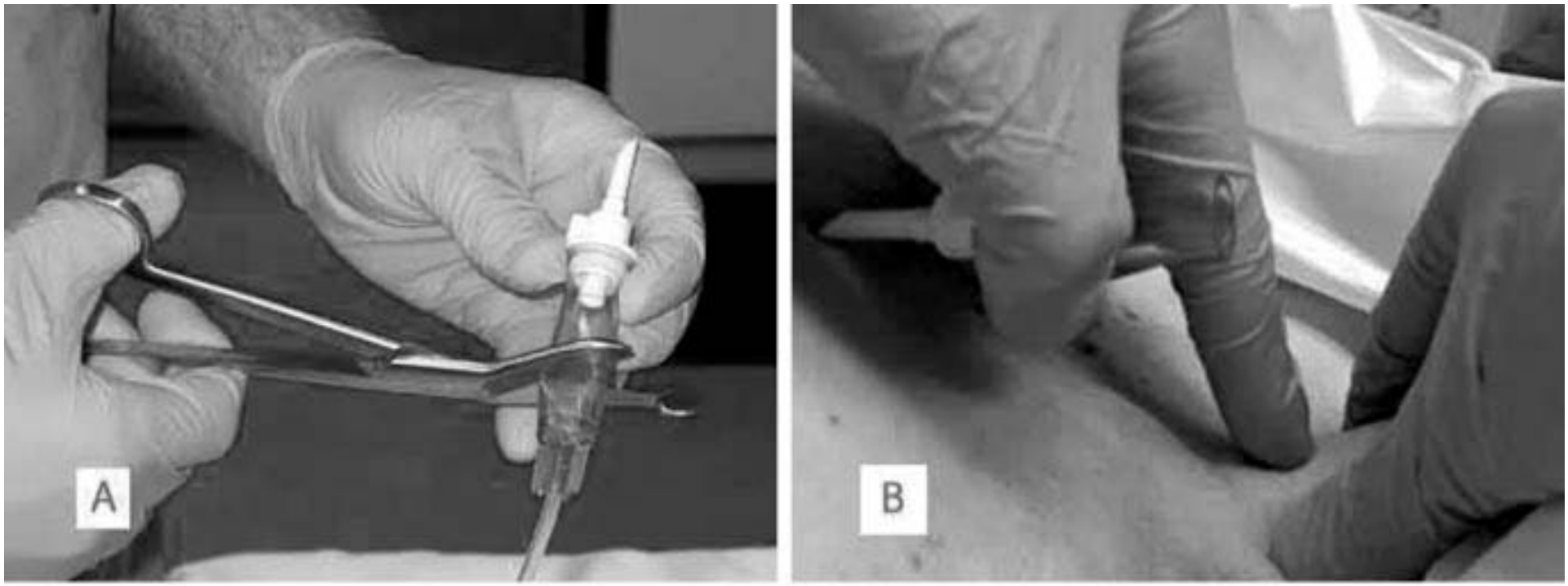
Spike Crich

Spike Crich

Spike Crich



Spike Crich



Spike Crich

Driver Spike Crich Method

- Neck is maximally exposed – right arm on helmet
- Drip Chamber is loaded into the left hand with the index finger shadowing the spike
- Index finger is run up the midline of the neck to find the cricothyroid membrane
- Once located the spike is driven thru the membrane shaded towards the head
- Stabilize the spike and connect to the BVM system

Wilderness and Environmental Medicine, **17**, 81–86 (2006)

ORIGINAL RESEARCH

Improvised Cricothyrotomy Provides Reliable Airway Access in an Unembalmed Human Cadaver Model

Timothy F. Platts-Mills, MD; Matthew R. Lewin, MD, PhD; Jesse Wells, MD; Philip Bickler, MD, PhD

From the Department of Emergency Medicine, University of California, San Francisco, Fresno, Fresno, CA (Dr Platts-Mills); the Division of Emergency Medicine, University of California, San Francisco, San Francisco, CA (Dr Lewin); the Department of Emergency Medicine, Alameda County Medical Center, Highland Campus (Dr Wells); and the Department of Anesthesia, University of California, San Francisco, San Francisco, CA (Dr Bickler).

How does it work

1. The majority of airway resistance is upper resistance
2. Oxygen/air will flow from an area of high pressure to an area of low pressure

Driver Resuscitation

1. Control the environment
2. Control massive hemorrhage
   - Direct pressure
   - CAT1 application as proximal as possible
3. Assess and secure an airway
   - NASCAR airway (breathing)
   - Spike crich (apneic)

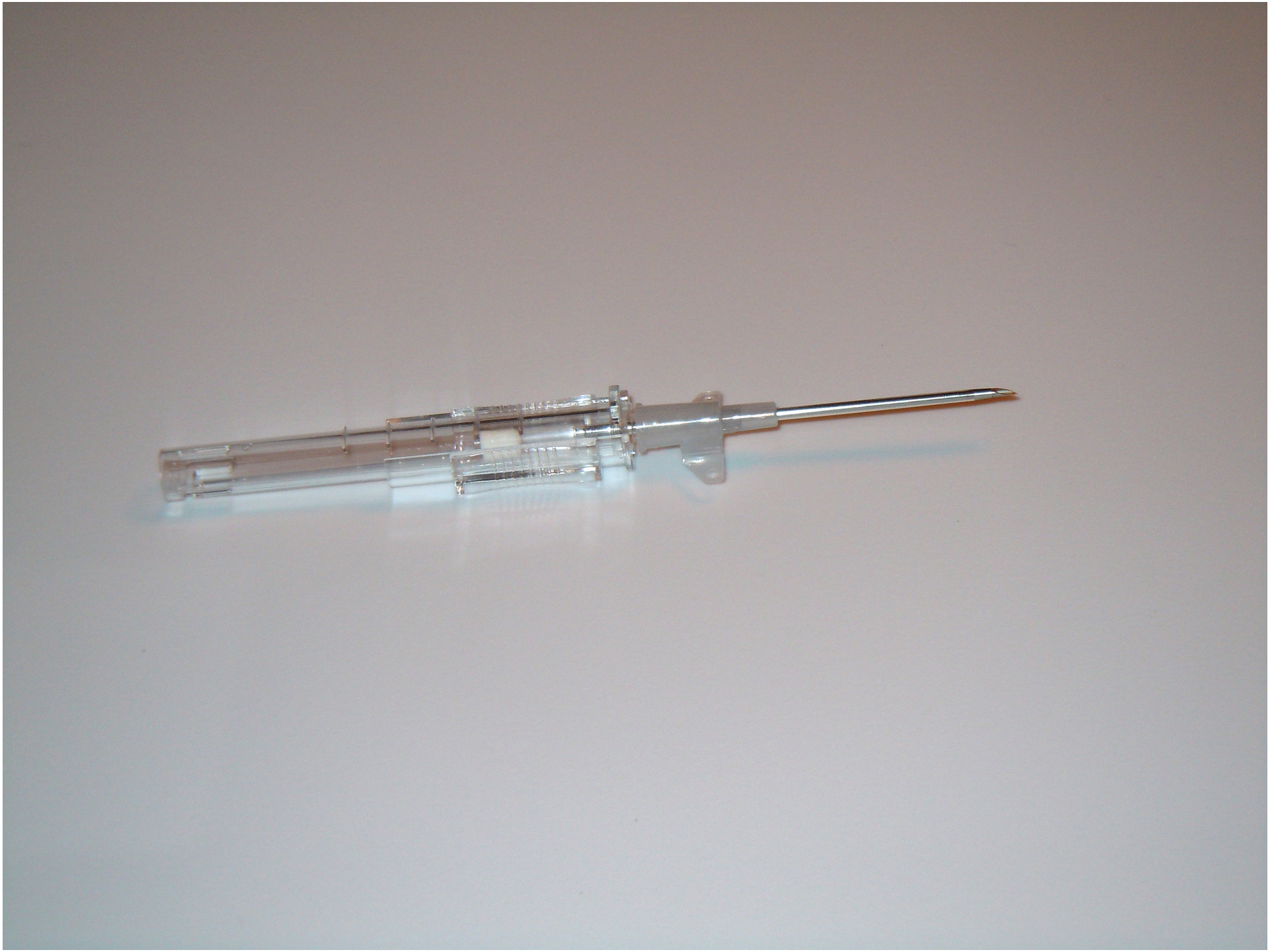
Torso Injuries

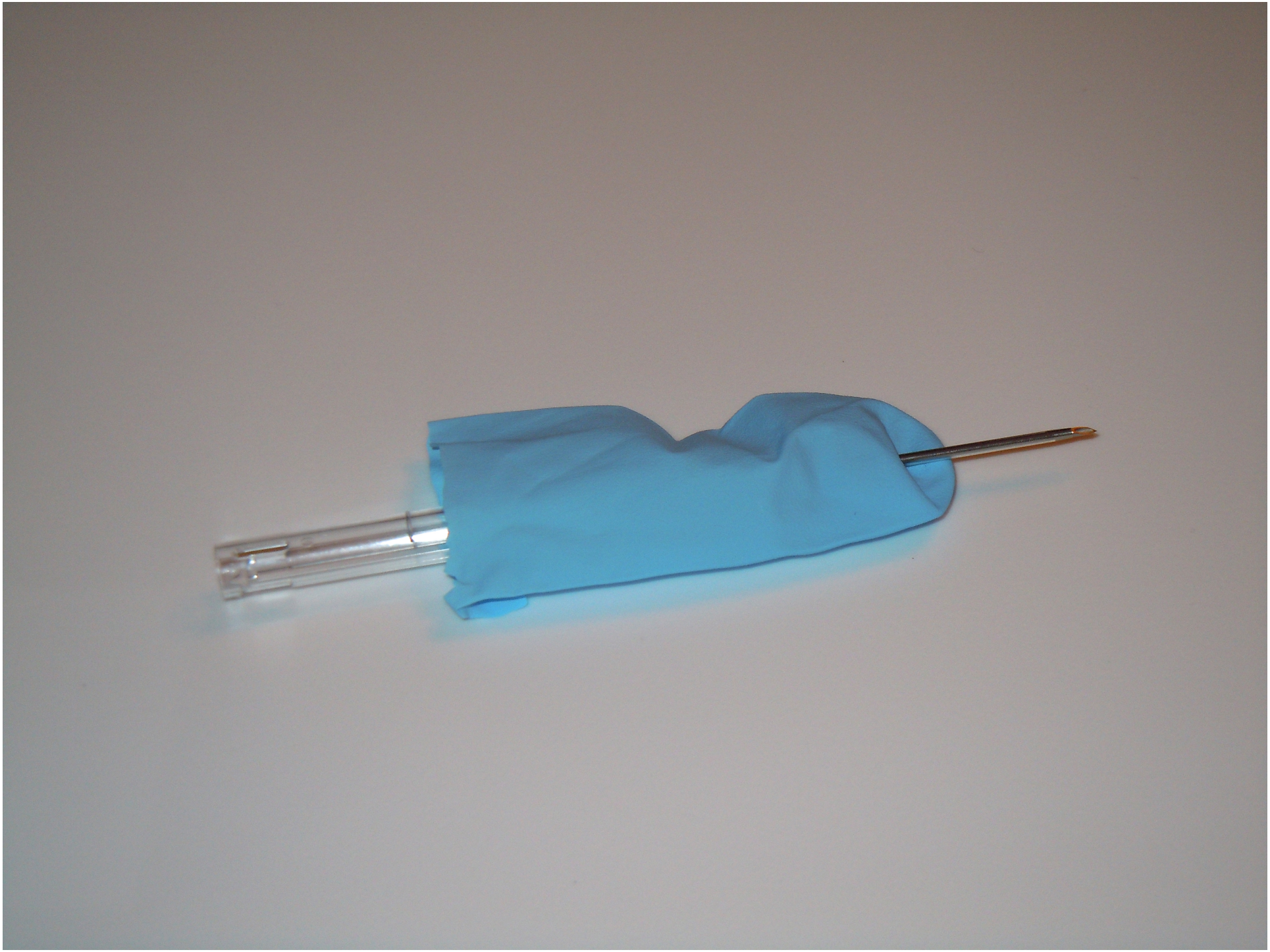
- Conditions that most often compromise ventilation
  - **Tension Pneumothorax**
  - Massive hemothorax
  - **Open pneumothorax**
  - Flail chest

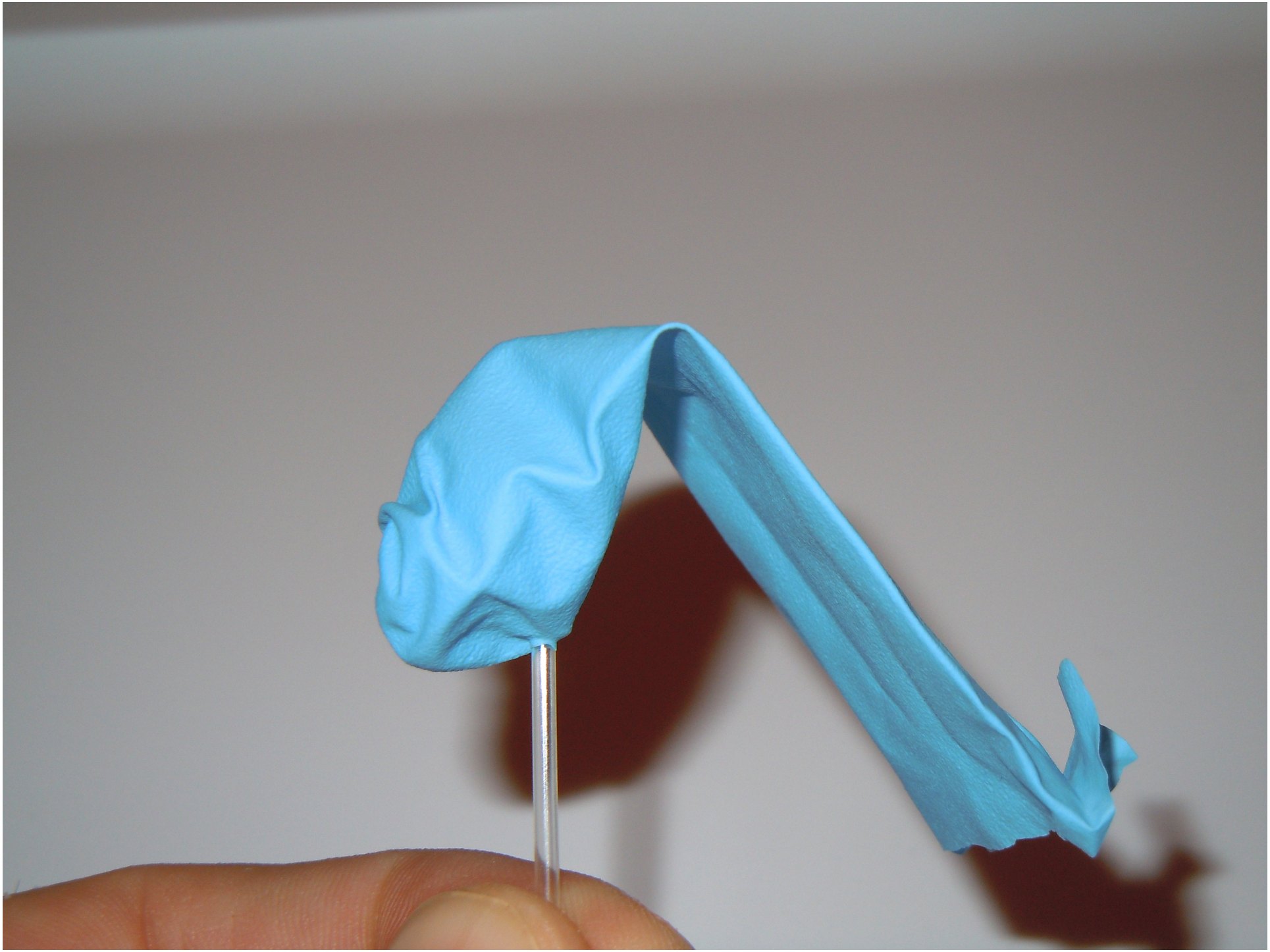
- In the event of respiratory distress or apnea
  - Immediately needle decompress the side of the injury
  - In the event that the side is unclear, needle decompress both sides
  - In the event of a sucking chest wound
    - place occlusive dressing

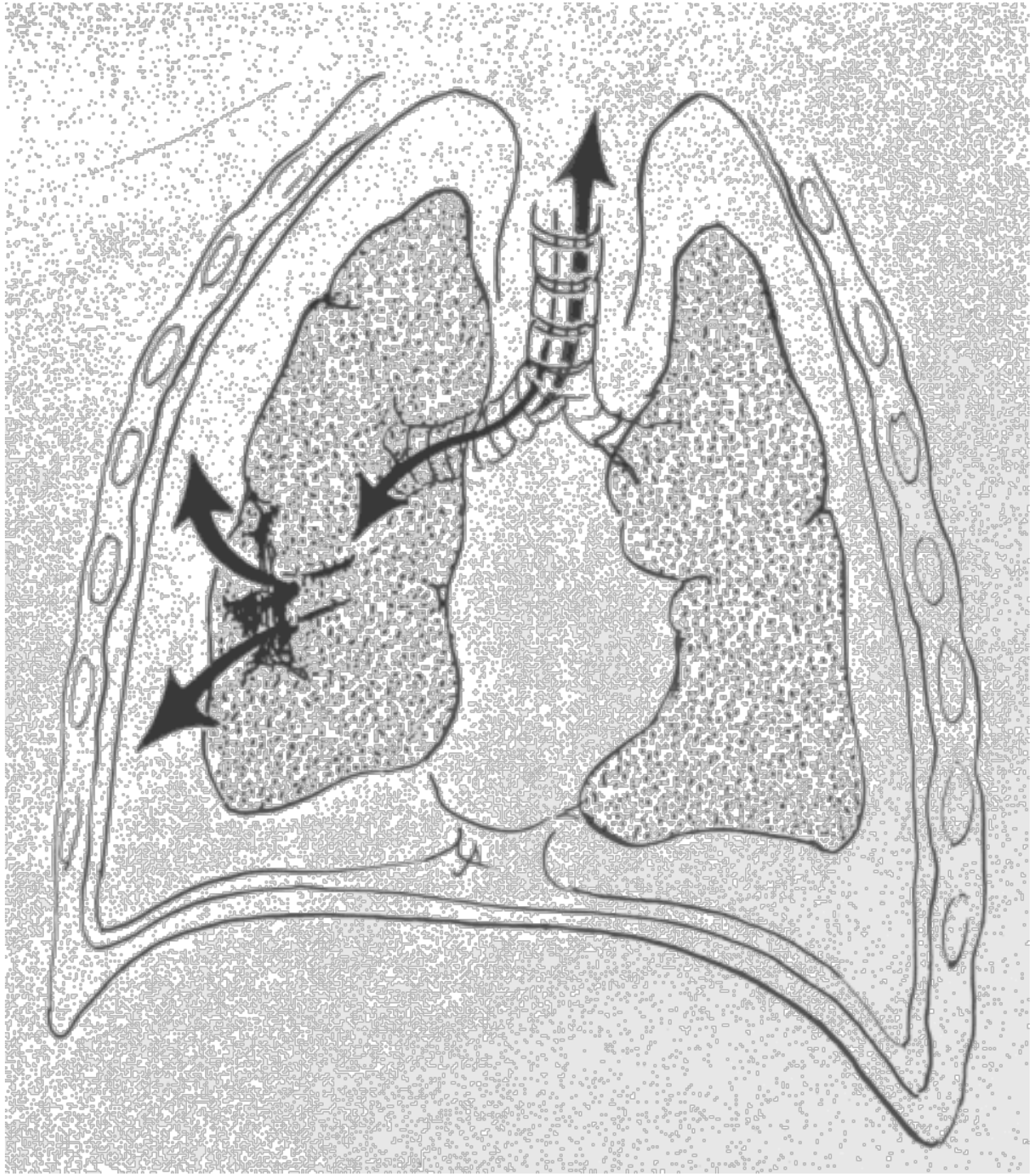
Tactical Field Care
Needle Decompression

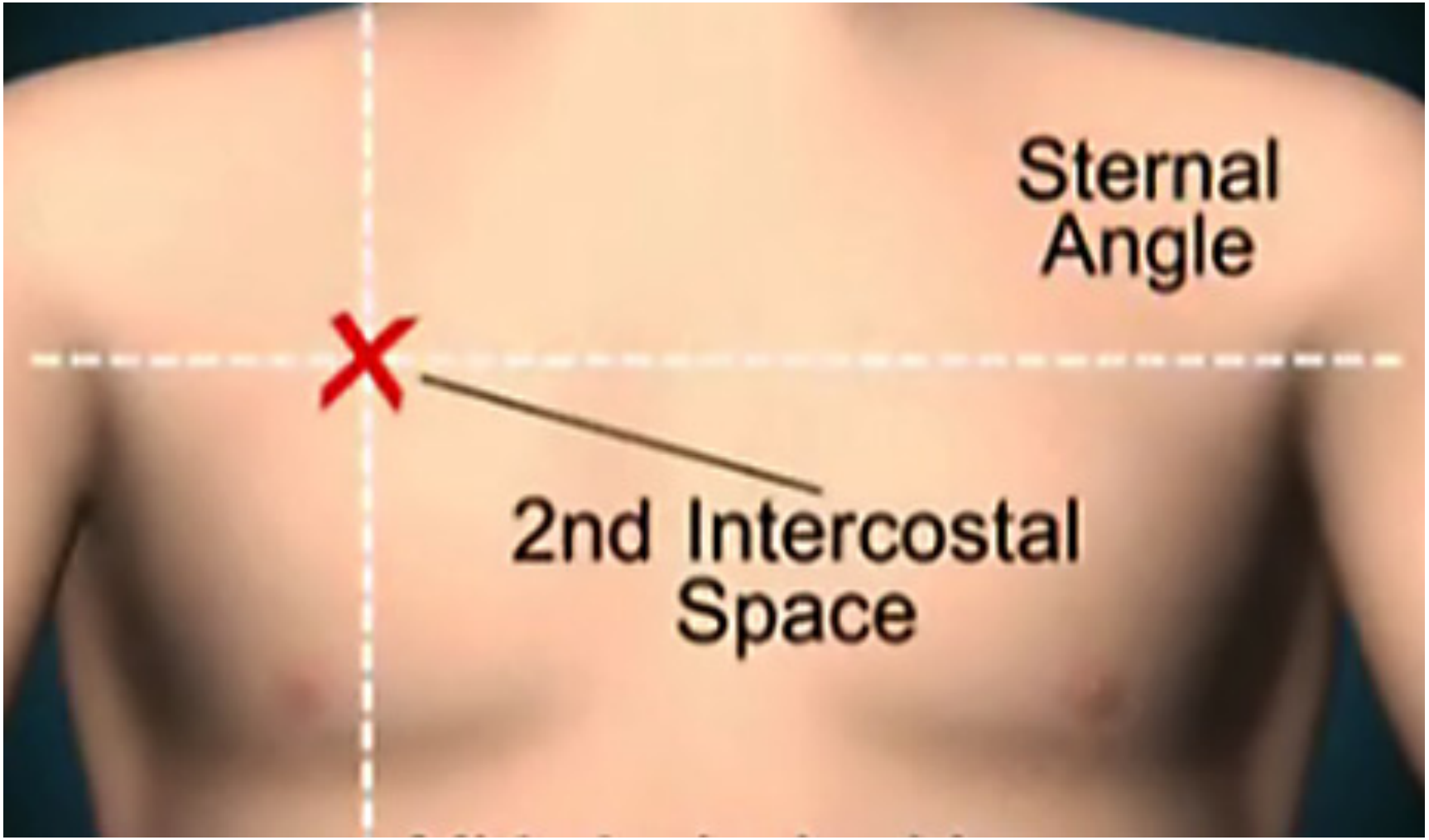
- Use IV catheter with the largest gauge available
- ~~Catheter is pushed thru the finger of a glove and then~~
  - ~~2nd/3rd intercostal space in the mid-clavicular line or~~
  - ~~5th intercostal space in the mid-axillary line~~










Sternal
Angle
2nd Intercostal
Space

Driver Resuscitation

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   - Spike crich (apneic)
4. Treat life threatening torso injuries

IV access/Manage Shock

- Goal is to initiate resuscitation management in the car then allow extrication followed by continued resuscitation
- Problem is that there is an unknown extrication time

- Is there anything that can rapidly be done to prevent driver decline during extrication

- Life threats addressed so far
  - Massive hemorrhage, airway/apnea, torso trauma
- Life threats to be suspected and addressed
  - Intra-abdominal bleeding
  - Shock

Intravascular Access Options

- Intravenous – traditional method
  - Can take time to obtain
  - Difficult to site in a driver with potential limb injuries
  - Requires securing

- Newer option – Intra-osseous access
  - Traditional placement – Proximal tibia
  - Army placement – Sternal
  - Newest placement site – Proximal humeral

A Comparison of Proximal Tibia, Distal Femur, and Proximal Humerus Infusion Rates Using the EZ-IO Intraosseous Device on the Adult Swine (*Sus scrofa*) Model

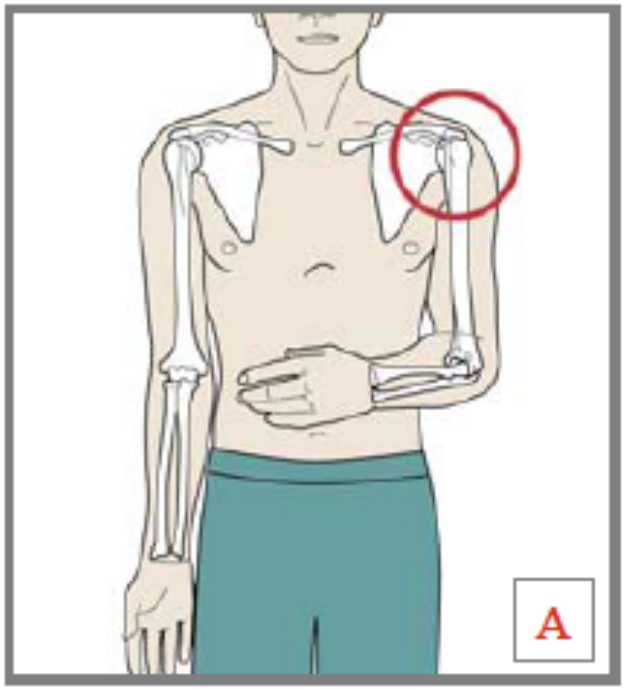
Julio Lairet, DO, Vikhyat Bebarta, MD, Kimberly Lairet, MD, Robert Kacprowicz, MD, Christopher Lawler, DO, Rebecca Pitotti, RN, MSN, Anneke Bush, ScD, MSH, James King, MD

- From PEC (April/June 2013)
  - Peak infusion rates
    - Humerus – 213ml/min ($p<0.001$)
    - Distal femur – 138ml/min
    - Prox tib – 103ml/min

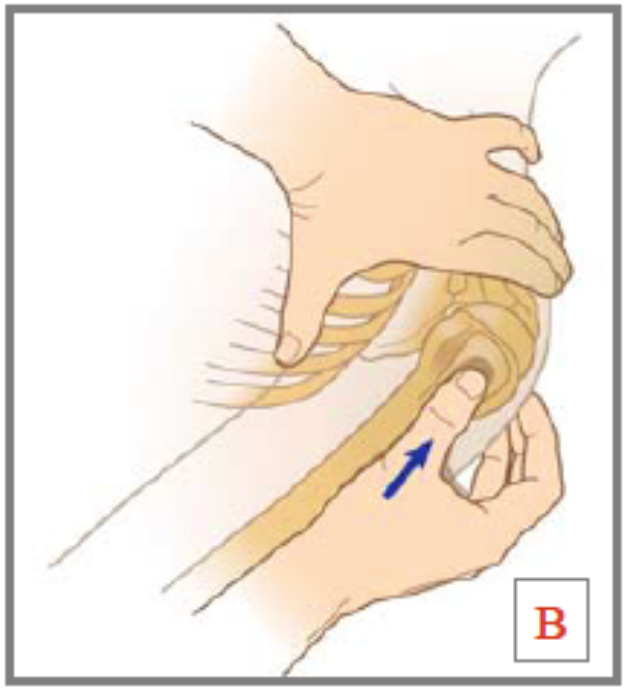
Humeral IO access

- Utilize a mechanical IO device (EZ-IO)
- Expose the driver left shoulder
- Place the IO

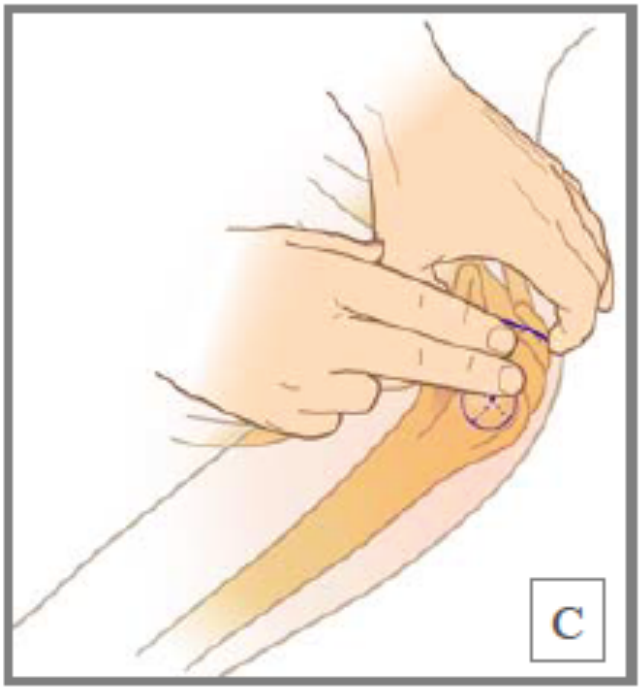
Placement



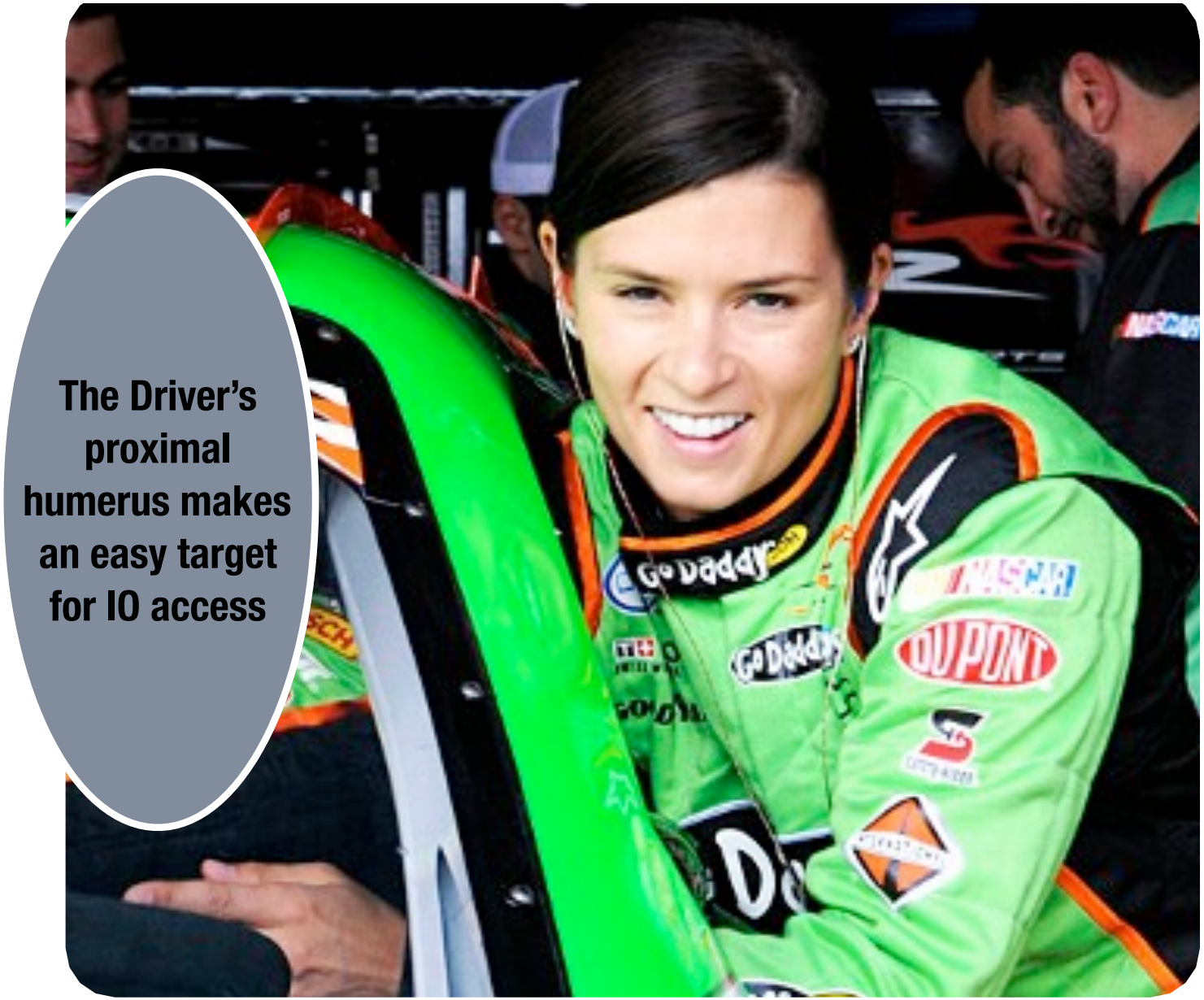
Orient Arm



Preferred Approach



Alternate Approach



The Driver's proximal humerus makes an easy target for IO access

Driver Resuscitation

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4. Treat life threatening torso injuries
5. Obtain IO access

Bleeding

- How to stop bleeding
  - Apply direct pressure
  - Encourage clotting
  - Decrease the flow
- Easy for bleeding you can see, difficult for bleeding you cannot

Traditional ATLS

- “2 lines and 2 liters” - Theory was dilute down the blood but restore the preload to allow the heart to pump - more is better

- 2005 AHA stated “aggressive fluid resuscitation is no longer indicated in trauma and resuscitation should focus on maintaining a SBP at 90mmHG”.

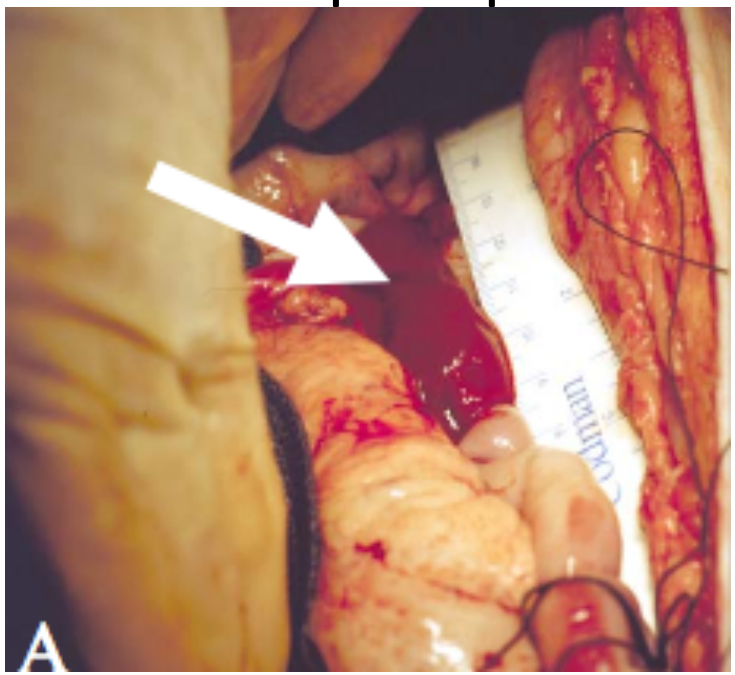
1994 - Bickell

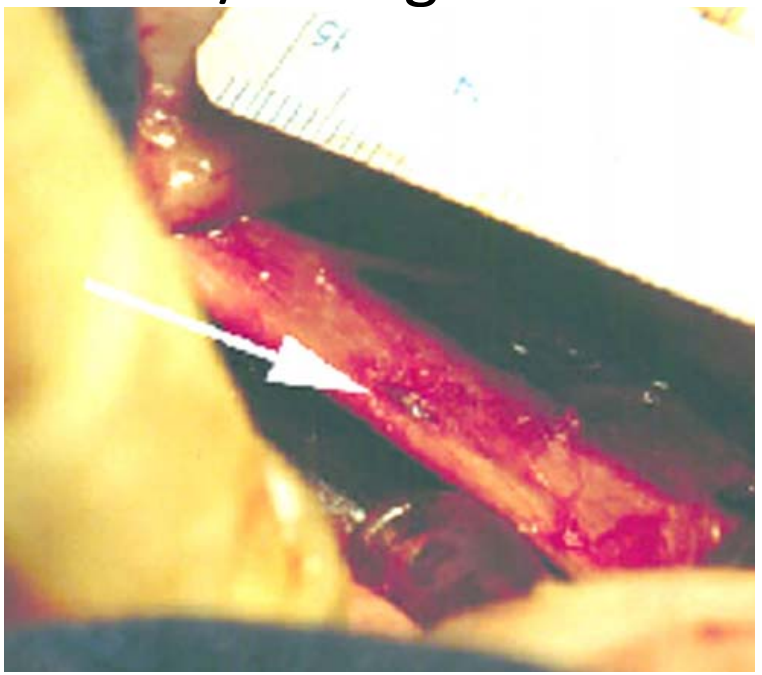
- Houston 1994
- Every other day randomization
- Penetrating trauma to torso + hypotension
  - Group 1 - 2 lines and IV fluid bolus
  - Group 2 - 2 lines and low volume fluids

- In the low volume resuscitation group
  - 8% lower mortality (p=0.04)
  - 7% lower complication rate (p=0.08)
  - Average volume infused was EMS (92 vs 870cc) and ER (283 vs 1608cc)

US Army – “pop off pressure”

- US Army study in pigs
  - 2mm hole in the aorta, infusion rates of 100-300cc/min after 5, 10 or 15 minute delay
  - Pop off pressure was 94/45 regardless of method





US Army

- Continued resuscitation led to 4 times more bleeding but no survival benefit from stopping fluids
- Best survival was in the do nothing group - suggesting any amount of rebleeding is bad

- Saline was initiating a coagulopathy
- Saline was increasing blood pressure and blowing off clots that had formed

- US Army wish list – a solution that enhances coagulation that can then be followed by fluid resuscitation

Coagulants

- Many options were tried
  - Recombinant factor VII – Increased pop-off to 85mmHg
  - Very expensive
- New direction utilizing TXA (Tranexamic Acid)
  - MATTERS study – Military patients – 293 of most severely injured patients got TXA. Did as well as lesser injured patients. 50% less deaths in TXA group when matched.
  - CRASH2 study – Civilian patients – 274 hospitals in 40 countries, >20,000 patients. In patients getting TXA within 1 hour of injury death rate was 5.3% (vs 7.7% $p<0.001$)

TXA

- Given as a 1g IV/IO bolus followed by an infusion
- Should be given ASAP after injury
- Very cheap – total treatment about $45

- Action is to stop clot breakdown

Internal Bleeding

- Most likely bleeding from intra-abdominal source or orthopedic source

- Is there any way to divert blood flow away from the organs that are bleeding
  - Bones – Positioning and tourniquets
  - Intra-abdominal organs - ????

Vasopressin

- Also known as ADH
- Used in cardiac arrest
  - Does not increase myocardial oxygen demand
  - Works in an acidotic environment

- Vasopressin, acting via V1 receptors, reduces portal blood flow
- Diverts blood away from the intra-abdominal organs
- Now being used in penetrating abdominal trauma to divert blood from the abdomen

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   - Spike crich (apneic)
4. Treat life threatening torso injuries
5. Obtain IO access, give TXA bolus, give vasopressin

Where are we now?

- Addressed
  - Massive hemorrhage
  - Airway
  - Torso injury
  - Intravascular Access
  - Diverted blood away from abdominal organs
  - Encouraged blood to clot

- Not Addressed
  - Pelvic fracture
  - (Femur fracture)

Pelvic Fractures

- Common fracture in driver injury
- Potential for high volume of blood loss

- Only effective EMS treatment is pelvic compression

- Can only be applied after driver is out of the vehicle

- Suggest the backboard being used for transport be prepared with a pelvic compression device

- Step back/allow the extrication to occur

Pelvic Compression Devices

Pelvic Compression Devices

- Pelvic fractures present a difficult pre-hospital and hospital treatment challenge and have a very high mortality rate.
- There is a great diversity in mortality rate secondary to pelvic trauma; studies demonstrate a mortality rate of 5% to 50%.
- The major reason for this high mortality rate is significant hemorrhage that may occur in the pelvis with minimal external signs.
- The significant bleeding that occurs with pelvic fractures is mainly due to the presence of numerous major blood vessels that are in the pelvis and the high vascularity of the organs that are in the pelvis.

Pre-application
of ***T-POD®***

Post-application
of ***T-POD®***


FERNO


FERNO

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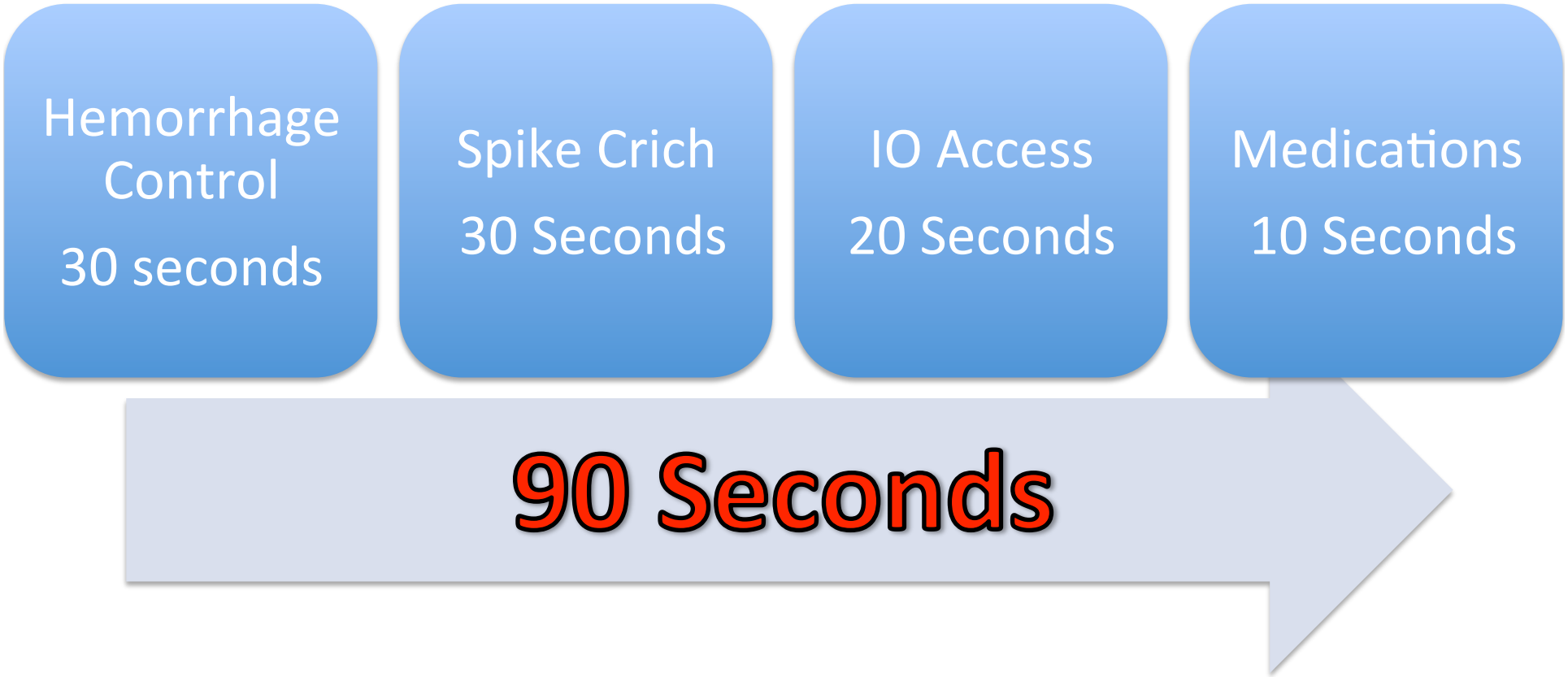
4. Treat life threatening torso injuries
5. Obtain IO access, give TXA bolus, give vasopressin
6. Extricate
7. Pelvic compression
8. Evacuate


Hemorrhage Control
30 seconds
Spike Crich
30 Seconds
IO Access
20 Seconds
Medications
10 Seconds
90 Seconds

For EMS – Consider MARCH

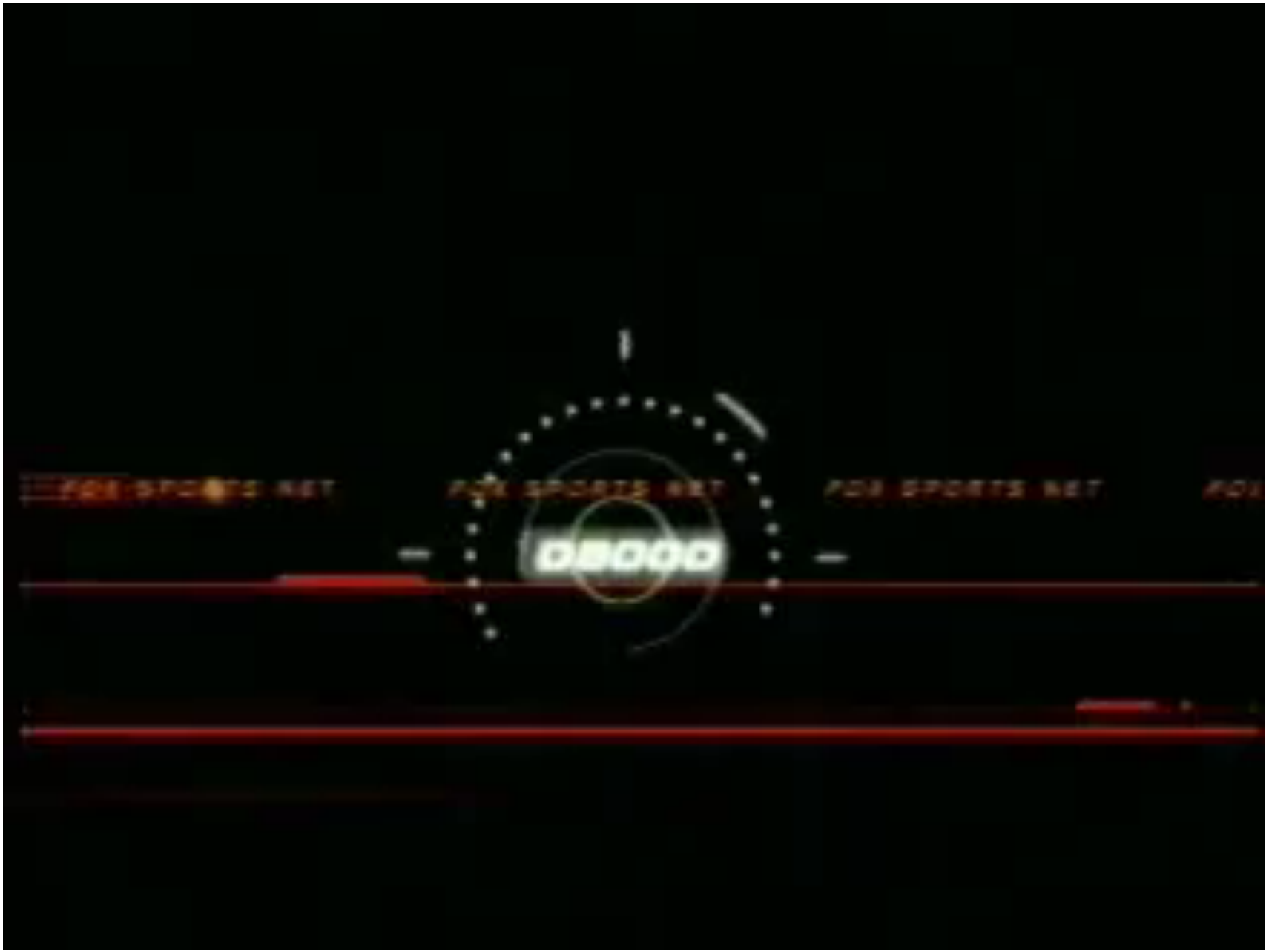
- Massive hemorrhage
  - CAT1 tourniquets
  - Wound packing
- Airway
  - LMA/Combitubes/King
  - Surgical is a good option
- Respirations
  - Needles to chest
  - AED pads to sucking wounds
- Circulation
  - TXA is on the way
  - Vasopressin orders in trauma already being given
  - Move away from large saline boluses
- Hypothermia

For EMS

- Airway options
  - Lateral approach
    - King airways
    - NPA with NRB
  - To intubate
    - Anterior approach skyhook – very inefficient unless you straddle steering column and roof is removed
    - Over the top – again needs roof removed

For EMS – Short Board Systems

Yates Spec Pack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