SCHOOL OF HEALTH PROFESSIONS
UT HEALTH SCIENCE CENTER
DEPARTMENT OF EMERGENCY HEALTH SCIENCES

Prehospital Treatment of Hypotension

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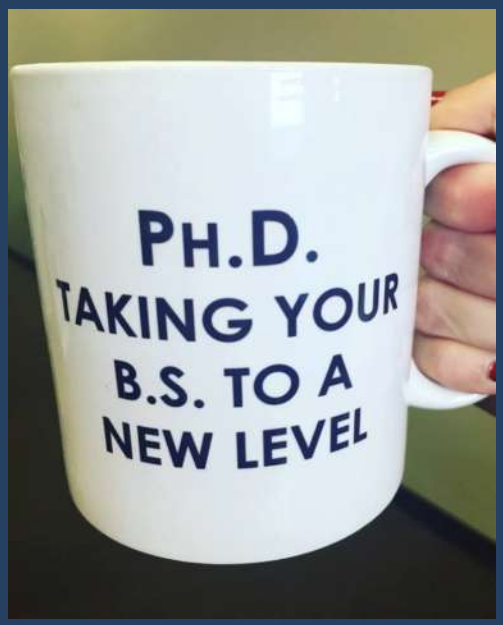


Disclosures

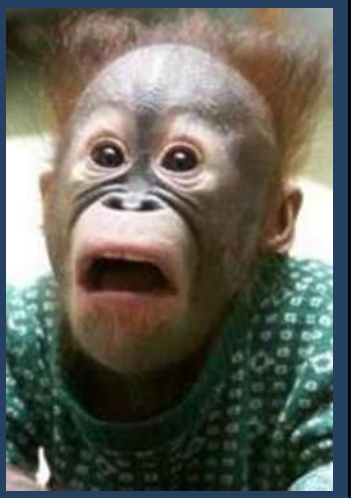
- No personal financial conflict
- DoD grant to study the effectiveness of the Impedance Threshold Device in hypotensive patients.

Hypotension

- Is it low blood pressure?
- Is it poor perfusion?
- Is it shock?

Causes of Shock

- **Three Causes**
  - Not enough fluid
  - Too much space
  - Not enough pump



Causes of Shock

- **Hypovolemic** – not enough Fluid
- **Sepsis** – not enough fluid, too much space
- **Anaphylaxis** – Too much space
- **Cardiogenic** – Not enough pump
- **Neurogenic** – Too much space

Treatment of Shock

- If the Tank is low
  - Fill the tank
- If the Tank is too big
  - Make the tank smaller
- Not enough pump
  - Make the pump work better

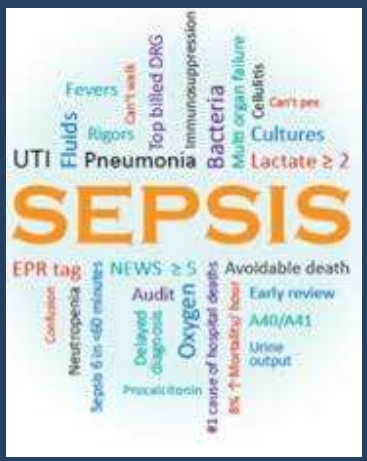
Anaphylaxis

Therapy Goals

- Antihistamine
  - Diphenhydramine
  - Famotidine
- Epinephrine
  - Vasoconstriction
  - Increased Heart rate and contractility
  - Bronchodilation
  - Reduced cytokine production

Sepsis

- Fluids
  - Lots
- Antibiotics
  - Early
- Vasopressors
  - Early



Cardiogenic Shock

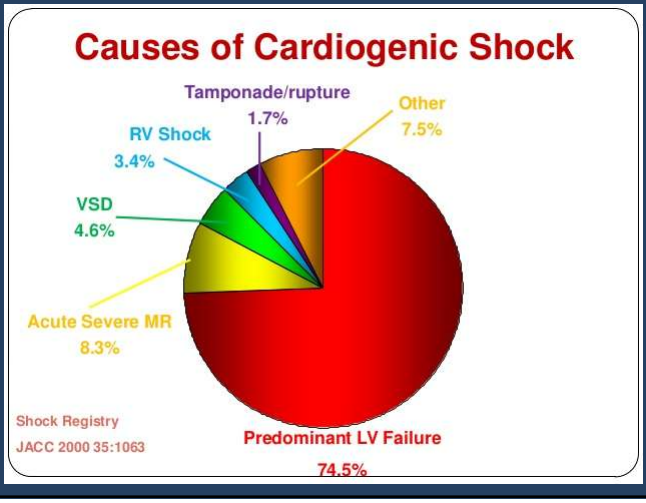
- Multifactorial -

Diastolic Heart Failure

Systolic Heart Failure

Structural

Rate related



Trauma

Common Cause of Shock

Keys to Survival

- Air must go in and out.
- Blood must go round and round.
- For Blood to work it must be on the inside not the outside

Another Myth

- Large volume resuscitation with isotonic crystalloids (3:1)
- Extracellular fluid redistributes during shock into both intravascular and intracellular spaces
- Optimal resuscitation corrects the extra-cellular deficit

….dogma that has stood unchallenged for over 40 years…

Leaky Buckets

The Problem:

Salty water neither clots nor carries oxygen

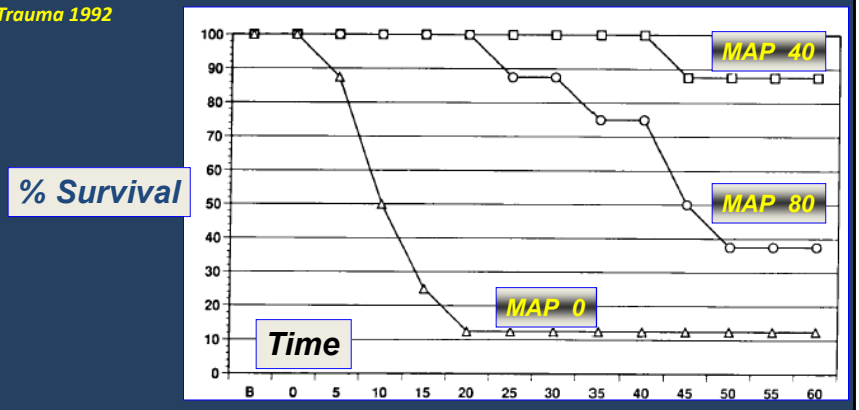
Permissive Hypotensive Resuscitation

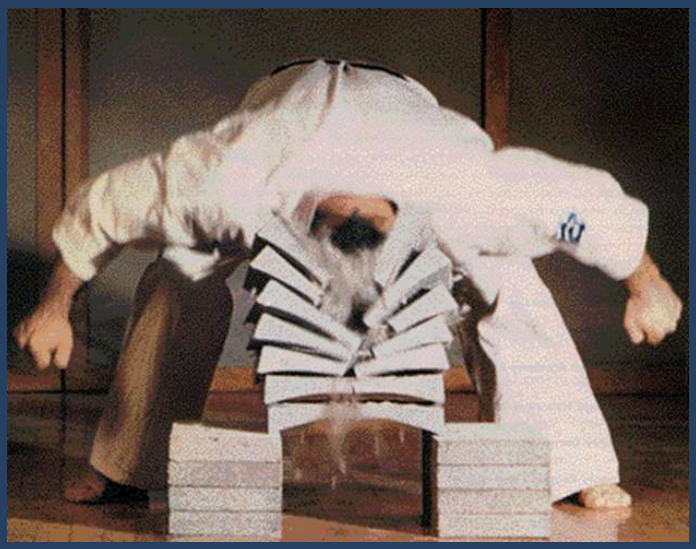
- How high must the systolic pressure be to perfuse adequately?
- Resuscitate to lower pressures slowing the rate of blood loss while still perfusing vital tissues.

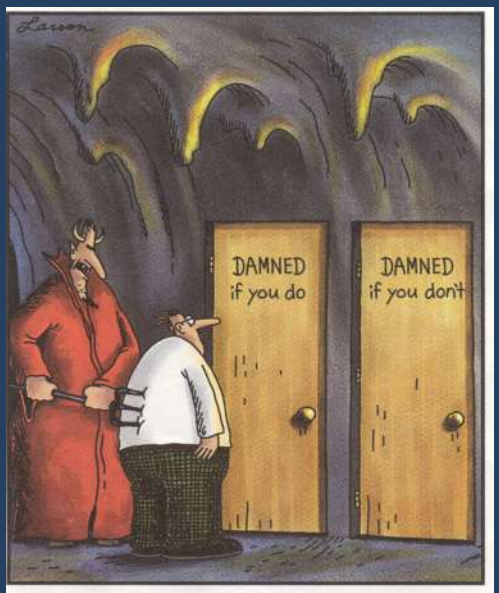
IMPROVED OUTCOME WITH HYPOTENSIVE RESUSCITATION OF UNCONTROLLED HEMORRHAGIC SHOCK IN A SWINE MODEL

Terry Kowalenko, MD, Susan Stern, MD, Steven Dronen, MD, and Xu Wang, MD

- Saline infusion to maintain MAP in pigs; MAP of 40, 80, & 0 with survival rate 87.5%, 37.5% & 12%; attempts to normalize BP increased mortality, and increased hemorrhage.
  - *J Trauma 1992*







"C'mon, c'mon—it's either one or the other."

B

TREATMENT OF HYPOTENSION

Maintaining adequate blood flow to vital organs is the key to patient survival and quality of life!

- **Traditional Therapies:**
  - Positioning (e.g. Trendelenburg)
  - Vasopressors
  - Fluids
  - Anti-shock garments (e.g. MAST)

These therapies are NOT always practical, beneficial or even effective in treating hypotension.

Novel Therapies

TXA – CRASH 2 Study Lancet Online Article 2010

Effects of tranexamic acid on death, vascular occlusive events, and blood transfusion in trauma patients with significant haemorrhage (CRASH-2): a randomised, placebo-controlled trial

CRASH-2 trial collaborators*

- Prospective, randomized controlled trial
- Over 20,000 patients
- TXA significantly reduced all causes mortality from 16.0% to 14.5%
- TXA significantly reduced death from bleeding from 5.7% to 4.9%

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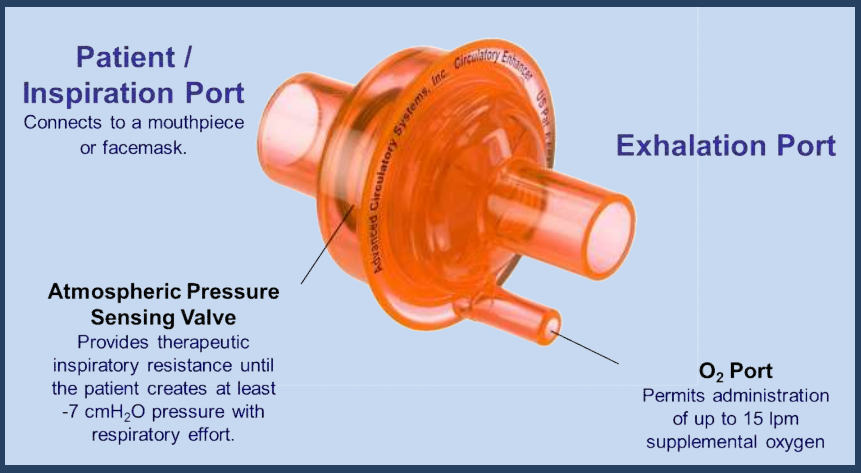
Intrathoracic Pressure Regulation

Impedance threshold Device

ResQGARD™

- FDA Approved Impedance Threshold Device
- Research Protocol to analyze improvements on SAFD patient population
- Spontaneously breathing
  - Dehydration
  - Sepsis
  - Trauma (Military funding the project – specific interest in trauma)
  - Orthostatic intolerance
  - Severe allergic reaction
- See improvement quickly (3-4 breathes)

IPR for Hypotension: ResQGARD ITD

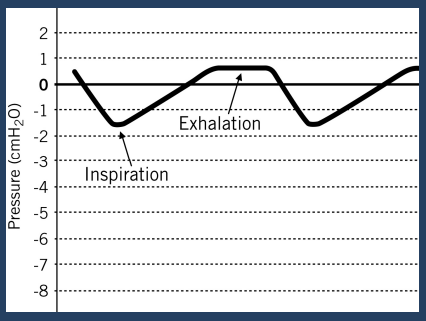


ResQGARD on Facemask or Mouthpiece

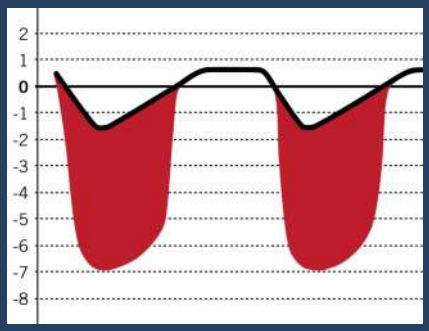
Important: Maintain Tight Seal!

ResQGARD Impact

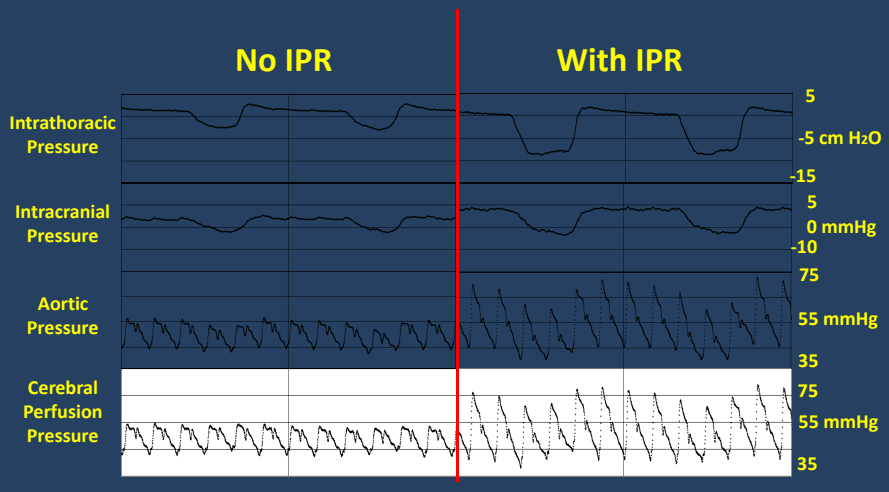
Normal Breathing



Inhalation with ResQGARD



Impact of IPR on Pressures



Animal Model with 40% bleed and no intervention

2 Seconds per Division

Convertino et al. Resp Care 2011;56:846-857.

Application: Spontaneously Breathing Hypotensive Patients

- Trauma
- Sepsis
- Dehydration
- Orthostasis
- Dialysis
- Heat exhaustion

When Not to Use

- If you would use CPAP, don't use the ResQGARD as the effects are the opposite
  - Pulmonary edema/congestive heart failure
  - Bronchospasm
- Also:
  - Shortness of breath
  - Loss of intact chest wall (trauma)
  - Pneumothorax

Use of an impedance threshold device in spontaneously breathing patients with hypotension secondary to trauma: An observational cohort feasibility study

David Wampler, PhD, LP, Victor A. Convertino, PhD, Shannon Weeks, EMT-P, Michael Hernandez, EMT-P, Jacob Larrumbide, *and* Craig Manifold, DO, *San Antonio, Texas*

- Study Design
  - All Patients Treated by SAFD EMS
  - Hypotension from all causes (exclusions)

Setting

- Quick Facts about SAFD
- Population served:
  - Fire: 1,352,906
  - EMS: 1,367,521
- Square Miles:
  - Fire: 469
  - EMS: 483
- Response Volume: Fire: 100,894
  EMS: 141,427

SAFD Emergency Medical Services

- 387 Paramedic Personnel (4 Shifts)
  - 32 Fulltime "Medic Units"
    - Up to 7 Peak Period Units
  - Each Medic Unit is staffed with 2 Paramedics (Nationally Registered and/or State Certified)
- 22 Command/Supervisory Personnel:
  - Medic Chief
  - Medic Executive Officer
  - 4 Medic Shift Commanders
  - 16 Medic Officers
- Medical Special Operations Unit (MSOU)
- 2 Fulltime Medical Directors
  - 4 BCEM Associate Medical Directors
  - EMS Fellowship
  - EMS Research

UT Health Science Center
PREHOSPITAL RESEARCH

Disclaimer: No EMS Fellow, Paramedic or Accountant were harmed during the production of this video – Physically harmed anyway.

Data Collection

- Closed call rule
  - Paramedics could not complete PCR of any hypotensive patient without addressing device intervention

Time	Treatment	Who performed	Comments
14:42	ResQGARD Evaluation	[redacted]	
	ResQGARD Used?=Yes	If NO, Why?=Other	
	Was it Removed?=No	What Time Removed?=0000	
	Why was it removed?=Other	Paramedic Comfort?=Easy	
	Patient Comfort?=Easy	Patient Tolerance?=Easy	

- Benefits:
  - Two patient populations
    - Hypotensive with device
    - Hypotensive without device (quasi control group)

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TABLE 1. Primary Impressions of the Patients Who Were Treated With the ITD

	All Patients (n = 200)	
Primary Impression	**n**	**%**
Altered mental status	13	7
Chest/abdominal complications (nontraumatic)	22	11
Diabetic complications	4	2
Dizziness	20	10
Generalized weakness	34	17
Primary dehydration	4	2
Sepsis	6	3
Syncopal episode	18	9
Toxic ingestion/stings	6	3
Blunt and penetrating trauma	29	15
Undifferentiated hypotension	24	12
Other	20	10

Of the 29 subjects with trauma, 3 were treated although their SBP was higher than 95 mm Hg, and there were 3 subjects who had incomplete data in this subgroup.

TABLE 2. Mechanism of Injury for Trauma Patients Treated With the ITD

	Trauma Subgroup (n = 23)	
Primary Impression	**n**	**%**
Motor vehicle collision	6	26
Fall	10	43
Shooting/stabbing	5	22
Laceration	2	9

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All Hypotensive patients treated with the ITD.

TABLE 3. Vital Signs for All Patients

	Systolic, mm Hg	Diastolic, mm Hg	MAP, mm Hg	Pulse (per minute)	Respirations (per Minute)	SaO_2, %
Before ITD Use						
Mean	78	51	60	87	19	97
SD	13	13	10	25	7	3
Median (Q1–Q3)	80 (71–86)	52 (45–59)	62 (62–67)	86 (68–101)	18 (16–20)	98 (96–100)
After ITD Use						
Mean	97	63	70	85	18	99
SD	19	15	15	22	4	2
Median (Q1–Q2)	93 (84–107)	60 (53–70)	68 (63–81)	84 (69–99)	18 (16–20)	100 (98–100)
p	<0.001	<0.001	<0.001	0.07	0.31	0.28

SaO_2, arterial oxygen saturation.

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All Hypotensive **Trauma** patients treated with the ITD

TABLE 4. Vital Signs for Trauma Patients

	Systolic, mm Hg	Diastolic, mm Hg	Pulse (per minute)	Respirations (per Minute)	SaO_2, %
Before ITD Use					
Mean	79	54	90	18	97
SD	14	13	29	4	3
Median (Q1–Q3)	78 (69–88)	55 (46–62)	84 (71–102)	18 (14–20)	98 (96–99)
After ITD Use					
Mean	101	70	83	18	99
SD	23	19	20	4	2
Median (Q1–Q2)	100 (89–108)	66 (59–76)	83 (69–98)	18 (16–22)	99 (98–100)
p	<0.001	<0.001	0.26	0.18	0.01

SaO_2, arterial oxygen saturation.

Intrathoracic Pressure

High

- Continuous Positive Airway Pressure (CPAP)
- Lower Cardiac Output
- Risk of Hypotension
- + 5 – 25 cmH_2O
- Therapy for Pulmonary Edema

Low

- Impedance Threshold Device
- Increased Cardiac Output
- Therapy for Hypotension
- - 7 – 10 cmH_2O
- Risk of Pulmonary Edema

Acknowledgments

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- Dr. Brian Eastridge
- Dr. Keith Lurie

QUESTIONS?