Taking the Pressure Off
Hypotensive Resuscitation in Traumatic Injuries

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Blood Pressure

- Arterial blood pressure is the pressure exerted by the moving blood on the walls of the blood vessels.

- Effected by:
  - Rate
  - Volume
  - Resistance
  - Viscosity
How do we measure BP?
Blood
Clot Formation
Blood Clot
While there is still a hole in a named blood vessel, what is the *best fluid resuscitation strategy* to keep the victim alive until hemostasis can be achieved, and to promote intact survival?
History of Saline in Resuscitation

- Cholera pandemic of 1831
- Saline Injections
- O’Saughnessy
  - Lancet publication
  - Victim’s blood “lost a large portion of its water”
  - Return blood to its “natural specific gravity” and “replace its deficient saline”
New Developments in Fluid Resuscitation

• Vietnam War era (Shires, Moyer, Moss)
  • Aggressive crystalloid resuscitation
  • 3:1 Replacement (as high as 8:1 for significant shock)

• Intensive Care (Shoemaker)
  • Oxygen debt
  • “Maximizing or supernormalizing” Cardiac Output

ATLS Sets Current Precedents

Effect of Blood Pressure on Hemorrhage Volume

- Surgically created hemorrhage
- Stepwise increase in blood pressure with aggressive crystalloid resuscitation
  - MAP 40, 60, 80 mmHg

Conclusions:

Attempts to restore blood pressure with crystalloids resulted in increase hemorrhage volume and higher mortality

Houston Trial: Delayed Fluid Resuscitation

- 598 adults
- Penetrating injuries
  - SBP < 90 mmHg
- Randomized by odd or even day
- Improved survival in delayed resuscitation

Blood Pressure at which Rebleeding Occurs

- Surgically created hemorrhage
  - Aortotomy
  - Resuscitation at 5, 15, 30 minutes
  - Rebleeding MAP 64, Systolic 94

Sondeen et al. Journal of Trauma May 2003, S110 - 117
Is Permissive Hypotension: A New Concept?
The Nature and Treatment of Wound Shock and Allied Conditions

Cannon et al. JAMA (1918) 607-21
Tactical Combat Casualty Care

Despite widespread use, the benefit of prehospital fluid resuscitation in trauma has not been established

- 22 references
Tactical Combat Casualty Care

Animal data clearly establishes aggressive fluid resuscitation in unrepaired vascular injury is either of no benefit or results in an increase in blood loss and mortality

• 18 references
Tactical Combat Casualty Care

Two Studies were found to suggest fluid resuscitation may be of benefit in uncontrolled hemorrhage

• Rat-tail amputation
• 2 references
Crystalloids cannot replace lost blood and only serves to dilute what's left.
Resuscitation Outcomes Consortium
Subject Selection

Inclusion Criteria

• Blunt or penetrating injury
• Prehospital SBP ≤90 mmHg
• Age >15 y/o
  ▪ Or ≥50 kg, if age unknown
• Absence of severe head injury
  ▪ Or GCS >8

Exclusion Criteria

• Severe head injury with GCS ≤8
• >250 ml intravenous fluid given*
• Any CPR by First Responders
• Known prisoners
• Known/suspected pregnancy
• Drowning or hanging
• Burns >20% TBSA
• Time from dispatch >4 hrs
• Prehospital SBP >90 mmHg
• Age <15
  ▪ Or <50 kg, if age unknown

*Patient can receive up to 250 ml of fluid and still be eligible for enrollment.
Study Fluids

Box will contain either 1 x 1000 ml saline or 2 x 250 ml + dummy weight
Labels

Hypotensive Fluid

**ATTENTION**
ONLY 0.9% Sodium Chloride IV during first 2 hours in ED

>> Hang 250ml bag <<

- Check radial pulse or SBP
- Radial pulse **PRESENT** or SBP ≥ 70 mmHg
- TKVO
- Give 250ml

**Stop intervention**
2 hours after ED arrival or at hemorrhage control, whichever is earlier.

**Hemorrhage control means bleeding stopped by:**
- Ligate vessel
- Embolize vessel
- Pack lacerated solid organ
- Remove lacerated solid organ

Blood product transfusions may be given at any time

Standard Fluid

**ATTENTION**
ONLY 0.9% Sodium Chloride IV during first 2 hours in ED

>> Hang 1000 ml bag <<

- Administer up to 2000 ml
- Check SBP
- SBP ≥ 110 mmHg
- TKVO
- Give fluid (as necessary)

**Stop intervention**
2 hours after ED arrival or at hemorrhage control, whichever is earlier.

**Hemorrhage control means bleeding stopped by:**
- Ligate vessel
- Embolize vessel
- Pack lacerated solid organ
- Remove lacerated solid organ

Blood product transfusions may be given at any time
Chasing Numbers...

What else can we use?

- Prehospital Lactate Measurements
- BLAST study

![Lactate Pro device](image)
To raise new questions, new possibilities, to regard old problems from a new angle, requires creative imagination and marks real advance in science. **Albert Einstein**