

Permissive Hypotension: Changing Tide of Trauma Fluid Resuscitation

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Objectives:

- ❖ Describe the history of fluids in trauma resuscitation
- ❖ Understand the pathophysiology of hemorrhagic shock
- ❖ Understand the rationale for limiting IV fluids during trauma resuscitation

History of Fluid Resuscitation:

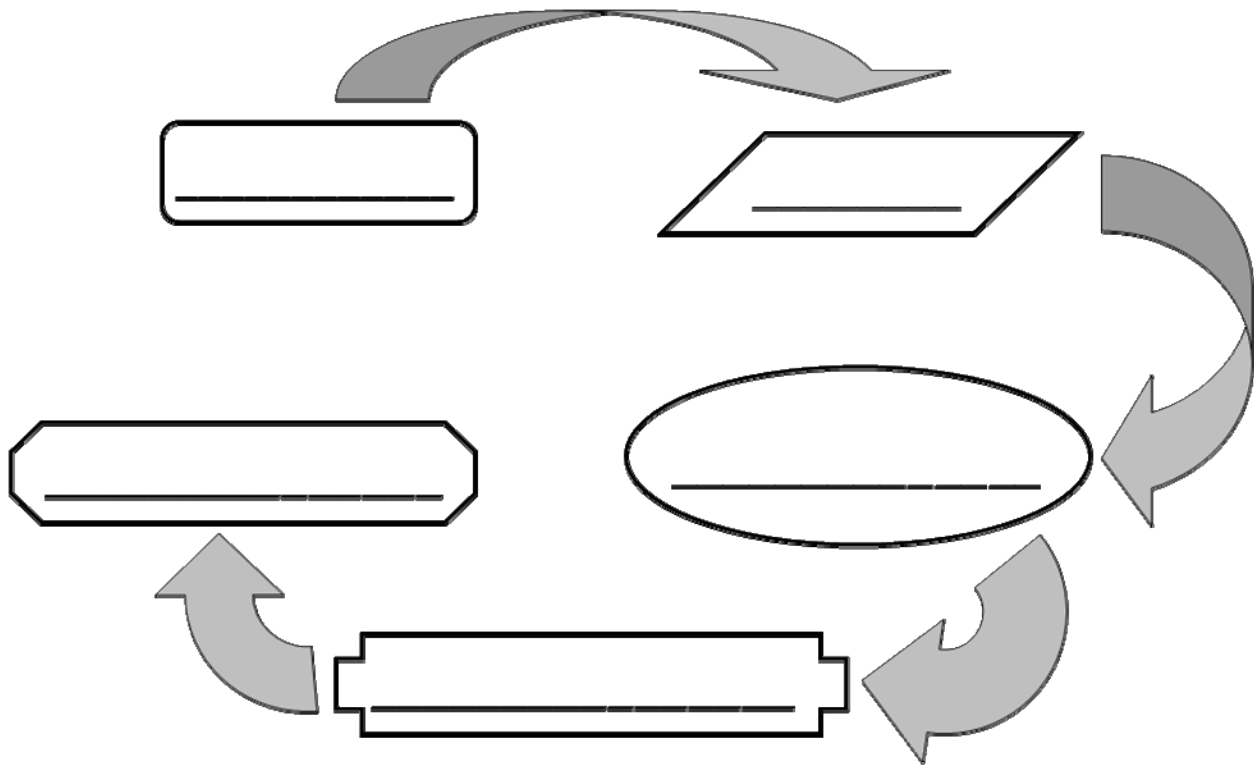
- ❖ Traditional resuscitation guidelines
 - 2 large bore IVs
 - Infusion of 2 liters normal saline or lactated ringers
- ❖ Hypotension in Trauma occurs in _____ of both blunt and penetrating trauma victims. The civilian rate is approximately _____ and the recent military rate is _____
 - Approximately _____ of victims of trauma who are hypotensive die early, either _____ or _____ and are _____.
 - This rate has been stable since the Crimean War and is not affected by trauma system development*
 - Approximately _____ of victims of trauma who are hypotensive are hypotensive from _____ causes. These causes include:
 - _____
 - _____
 - _____
 - _____
 - _____
 - _____
 - Approximately _____ of victims of trauma who are hypotensive are hypotensive secondary to _____ and are the focus of the discussion.
- ❖ Cannon, Fraser, Cowell. *Preventative treatment of wound shock*. JAMA 1918 noted poor outcomes with IV Fluid resuscitation

- “Inaccessible or uncontrolled source of blood loss should not be treated with intravenous fluids until the time of surgical control”
- ❖ Beecher. Resuscitation & anesthesia for wounded men, 1949 found adequate hemodynamics for surgery with limited fluid resuscitation.
 - “The young, healthy organically sound battle casualty will tolerate his wound and the strain of surgery without replacement of all blood lost.” p121
 - “A further principle that we established is that if surgery cannot be undertaken at once...the patient will not suffer as long as the systolic pressure is 80 mmHg and the skin warm and of good color. Neither will he lose as much hemoglobin as he will if plasma, say, is used to raise the blood pressure higher than necessary during the waiting period.” p125
- ❖ This early work suggested that hypotension in the setting of hemorrhagic shock may be protective. These findings were forgotten until later in the century.
- ❖ In the 1950s and 1960s much trauma research focused on _____. These studies were based on animal models of _____ hemorrhage, and thus did not translate to actual clinical conditions.
- ❖ During the Vietnam conflict, high volume resuscitation was used for hypotensive wounded soldiers. Many went on to develop what was called “Da Nang Lung”, which was _____. This was found to have been caused by an _____ that took place in the lungs. This phenomenon had not been observed in prior conflicts.
- ❖ In the 1980s, the concept of limited fluid resuscitation returned. Animal models focused on _____, a more realistic model.
- ❖ First clinical study was performed by Bicknell, Wall, Pepe, et. al. in Houston reported in 1994. This study focused on _____ and concluded that limited fluid resuscitation _____.

Pathophysiology of Hemorrhagic Shock:

❖ Hemorrhagic Shock is _____

❖ What happens when we hemorrhage?



❖ The body has several compensatory mechanisms in response to hemodynamically significant hemorrhage. All of these mechanisms lead to _____ and involve:

- Vasoconstriction & Venoconstriction
 - _____
 - _____
 - _____
- Preferential _____ & _____ circulation
- Increased _____ blood flow
- Decreased _____ blood flow occurs last

- ❖ Specific Compensatory Mechanisms
 - Baroreceptors are located in the _____ & _____
_____ and sense central arterial _____.
Their function is to _____ and increase _____.
 - Circulating vasoconstrictors consist of _____ and others and cause an _____.
 - The _____ of capillary pressure causes a fluid shift from the _____ into the _____ to help restore volume.
 - Stimulation of the thirst mechanism _____ and causes the kidneys to absorb _____ & _____.
 - Chemoreceptors are Important when MAP drops below _____ mmHg. These receptors are stimulated by _____ and _____. When activated, chemoreceptors produce _____ and _____.
 - Cerebral ischemia occurs when the MAP falls below _____ mmHg. Cerebral ischemia causes an _____ and is a last ditch effort to increase perfusion.
 - Hematopoiesis is the production of _____ and is a _____ mechanism not helpful in acute hemorrhage.
- ❖ These compensatory mechanisms work well, however at some point the patient will decompensate. When this happens, the following occurs:
 - Cardiogenic shock occurs due to _____ and _____. Myocardial dysfunction causes _____ and _____, worsening perfusion.
 - The loss of sympathetic activity has significant systemic effects. Decreased vascular tone results in _____, _____ and _____.

Increased capillary pressure will cause _____ to _____
from _____ and worsening hypovolemia.

- Once the sympathetic burst caused by cerebral ischemia finishes firing, there is a _____.
- At some point, Systemic inflammatory response syndrome (SIRS) begins. _____ are released causing _____, _____ and _____, all of which contribute to the worsening hypotension.

Permissive Hypotension: *The Concept of limited fluid resuscitation*

- ❖ Hypotension is protective because the decreased blood pressure _____. Hypotension is considered helpful in other conditions where bleeding is not controlled, including _____ and _____. In _____, controlled resuscitation decreased lung injury.
- ❖ The coagulation cascade is activated by _____. A _____ forms which attracts additional circulating _____. This clot transforms to a rigid plug in ____ – ____ minutes.
- ❖ A dilutional coagulopathy is caused when IV fluids (saline or lactated ringers) are infused, causing the concentration of platelets and clotting factors to drop. This can occur with an infusion as little as _____ ml of crystalloid infusion. The dilutional coagulopathy is worsened by the _____ that is incited by the crystalloid infusion.
- ❖ Raising the blood pressure rapidly places additional fluid stresses on the clot. Based upon several uncontrolled hemorrhage animal studies (pigs, rats, dogs), the hemostatic plug will rupture at an SBP of _____ mmHg or an MAP of _____ mmHg. In one study, there was a _____% re-bleed rate when the SBP increased above _____ mmHg. As opposed to the controlled hemorrhage model used in the 1950s and 1960s, the animals were bled and the hemorrhage continued for a realistic period of time after resuscitation began. Most recent research has focused on varying fluid treatment regimes including normal saline,

lactated ringers, hypertonic (3% and 7%) saline, hetastarches, dextrans and combinations of these fluids.

- ❖ As you have surmised by this point in the discussion, there are several consequences to fluid administration. These include:
 - Hemodilution causing a drop in _____ and _____.
 - A rapid rise, then fall in blood pressure, resulting in _____ & _____, loss of _____ and a reversal of _____.
 - Cytokine activation occurs with all types of crystalloid fluids, setting off the _____ which may result in _____ and _____.
 - Coagulopathy occurs from dilution and from the cytokine activation, leading to _____, impaired coagulation factor function and _____.
 - The inflammatory process also causes increased _____ which not only can cause _____ but allow a pathway for _____.
 - High volume fluid administration also has an effect at the cellular level. The cellular environment becomes _____ and large _____ occur which _____.
- ❖ The only controlled prospective study that has been performed was in Houston Bickell, Wall, Pepe, et.al. They enrolled 598 patients who sustained penetrating torso trauma who were hypotensive between November 1, 1989 and December 22, 1992. Patients on even days were in the immediate resuscitation group and received standard (at the time) prehospital and ED fluid resuscitation to normalize blood pressure. Patients on odd days were in the delayed resuscitation group and received no intravenous fluids until in the operating room and then only enough to maintain an SBP ~90mmHg.
- ❖ The results:
 - Immediate fluids group
 - 62% survival to D/C
 - 30% with complications
 - Delayed fluids group
 - 70% survival to D/C
 - 23% with complications
 - Shorter hospitalization

- ❖ The “Permissive Hypotension” camp has the following recommendations:
 - If normotensive administer _____.
 - If hypotensive, administer controlled IVF (_____ – _____ ml boluses) until goal of:
 - _____
 - _____
 - MAP _____ mmHg (SBP _____ mmHg)

❖ Controversy Remains:

- Permissive Hypotension:
- ✓ Don't pop the clot!
 - ✓ Hypotension can be tolerated until surgical control

- Standard Fluid Resuscitation:
- ✓ Organ ischemia bad!
 - ✓ Optimize organ perfusion



It is a question of balance...

- ❖ But what about patients who have sustained a head injury? We know from good research that _____ and _____ is bad for the brain. An MAP above _____ mmHg is needed to provide an adequate cerebral perfusion pressure (CPP = MAP – ICP). Normal ICP is between 5 and 15 mmHg.
- ❖ In the case of head injury, studies suggest _____ but also caution against over resuscitation.
- ❖ In reality, what is lacking are clinical trials. These type of trials are logistically difficult to perform. Most of this information is extrapolated from animal models.
- ❖ Open areas in question include:
 - Is permissive hypotension appropriate for patients who have received blunt trauma? The Bicknell study focused on penetrating trauma.
 - What are the balanced resuscitation goals in patients with a head injury?
 - Does permissive hypotension work in the pediatric & geriatric populations who do not have the compensatory mechanisms young adults have?
 - Patients with near morbid severe hypotension verses those with mild hypotension

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One Minute Evaluation

Session: Permissive Hypotension

Date: July 2009

Please complete and place face down on the table by the door.

List 2 – 3 core ideas that have emerged for you as important during the session:

1.

2.

3.

List 2 – 3 questions that have surfaced for you relevant to the content presented. Were they answered during the session?

1.

2.

3.

List 2 – 3 things the presenter(s) did well during the session:

1.

2.

3.

List 2 – 3 things that could be improved about the session:

1.

2.

3.

THANK YOU!