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Trauma Services

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PERMISSIVE HYPOTENSION IN TRAUMA

Prehospital medicine has held to mainly non-scientific, tradition based treatment protocols regarding fluid resuscitation of acutely injured hemorrhagic patients.

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CURRENT PREHOSPITAL EDUCATION AND PRACTICE

Current Prehospital Education and Practice

Prehospital medicine has held to mainly non-scientific, tradition based treatment protocols regarding fluid resuscitation of acutely injured hemorrhagic patients.

The National Standard curriculum currently provides only fundamental training in trauma and pathophysiology at varying levels of EMS practice. National curriculum lags significantly behind best science practice.

Traditional EMS treatment models for acute hemorrhagic shock usually include:

1. Control of bleeding through use of direct pressure, pressure points and occasional use of tourniquets.
2. Two peripheral large bore IVs
3. Wide open fluid resuscitation using normal saline (NS) or lactated ringer's (LR) solutions.
4. Maintenance of "normotensive blood pressures" generally above 100 systolic.
5. Limited use of hemostatic non-exothermic compresses and or powders.
6. No internal bleeding control mechanisms such as clamping.
7. No use of colloidal agents such as FFP, Blood and or blood products.
8. No use of antifibrinolytic medications such as tranexamic acid.

EMS should consider the importance of changing trends in prehospital fluid resuscitation in hemorrhagic shock and the effect on positive patient outcomes.

Multiple national and international studies have been conducted in the past several years, investigating permissive hypotension. These findings are relevant to prehospital paramedic practice and should drive some important evidence based changes in paramedicine.

THE STUDIES

Matter for debate--Fluid resuscitation in pre-hospital trauma care: A consensus view

Greaves I, Porter KM, Revell MP
Selly Oak Hospital,
Birmingham, B29 6JD, UK

J.R.Coll.Surg.Edinb. 2002 April;47:2, 451-457

SUMMARY

Fluid administration for trauma in the pre-hospital environment is a challenging and controversial area. There is, as yet no equivocal answer or view, which can be supported by clear, well-documented and reliable evidence. Nevertheless, a careful evaluation of what evidence is available does allow some provisional conclusions to be drawn. We believe that the following represent the best possible current expert consensus on pre-hospital fluids in trauma. As future evidence brings clarity to this area, these guidelines can be modified, and further consensus statements will be issued taking into account such information.

When treating trauma victims in the pre-hospital setting:

- Cannulation should take place en route, where possible
- Only two attempts at cannulation should be made
- Transfer should not be delayed by attempts to obtain intravenous access
- Entrapped patients require cannulation at the scene
- Normal saline is recommended as a suitable fluid for administration to trauma patients
- Boluses of 250 ml fluid may be titrated against the presence or absence of a radial pulse (caveats; penetrating torso injury, head injury, infants)

The effect of vigorous fluid resuscitation in uncontrolled hemorrhagic shock after massive splenic injury.

Solomonov E, Hirsh M, Yahiya A, Krausz MM.

Department of Surgery A, Rambam Medical Center, Haifa, Israel.

Critical Care Medicine. 2000 Mar;28(3):749-54.

Editorial:

Regardless of origin, uncontrolled hemorrhage is uncontrolled hemorrhage

Tisherman SA.

Critical Care Medicine. 2000 Mar;28(3):892-4

OBJECTIVE: Using a standardized massive splenic injury model of uncontrolled hemorrhagic shock, we studied the effect of vigorous fluid resuscitation on the hemodynamic response and survival time in rats. **DESIGN:** Randomized, controlled study. Duration of follow-up was 4 hrs.

SETTING: University research laboratory.

SUBJECTS: Adult male Sprague-Dawley rats, weighing 240-430 g.

INTERVENTIONS: Standardized massive splenic injury was induced by two transverse incisions in the rat's spleen. The animals were randomized into four groups: group 1 (n = 8) underwent sham operation; in group 2 (n = 15), massive splenic injury was untreated; in group 3 (n = 15), massive splenic injury was treated with 41.5 mL/kg 0.9% sodium chloride (large-volume normal saline); and in group 4 (n = 15), massive splenic injury was treated with 5 mL/kg 7.5% sodium chloride (hypertonic saline).

MEASUREMENTS AND MAIN RESULTS: The hemodynamic and metabolic variables in the sham-operated group 1 were stable throughout the experiment. Mean arterial pressure in group 2 decreased from 86.5 +/- 4.0 to 50.3 +/- 6.3 mm Hg (p < .001) in the first 15 mins after massive splenic injury. Mean survival time in group 2 was 127.5 +/- 17.0 mins; total blood loss was 33.8% +/- 2.6% of blood volume; and the mortality rate at 1 hr was 13.3%. Bolus infusion of large-volume normal saline after 15 mins resulted in an early increase in mean arterial pressure from 48.6 +/- 7.4 to 83.3 +/- 7.2 mm Hg (p < .01); it then rapidly decreased to 24.6 +/- 8.6 mm Hg (p < .001) after 60 mins. The mean survival time (95.3 +/- 16.4 mins) was significantly lower than in group 2 (p < .01); total blood loss (48.0% +/- 4.3%) was significantly higher than in group 2 (p < .01); and mortality rate in the first hour was 33.3% (p < .05). Bolus infusion of hypertonic saline also decreased survival time to 93.3 +/- 20.3 mins (p < .01), but total blood loss was 35.2% +/- 3.0%, which was not significantly different from the blood loss in group 2. The mortality rate in the first hour (60.0%) was significantly higher than in group 2 (p < .005).

CONCLUSIONS: Vigorous infusion of normal saline after massive splenic injury resulted in a significant increase in intra-abdominal bleeding and decreased survival time. The hemodynamic response to crystalloid infusion in blunt abdominal trauma is primarily dependent on the severity of injury and the rate of blood loss.

Effects of traditional versus delayed resuscitation on serum lactate and base deficit.

Baron BJ, Sinert RH, Sinha AK, Buckley MC, Shaftan GW, Scalea TM.

Department of Emergency Medicine, SUNY Health Science Center at Brooklyn,
New York, NY 11203, USA.

Resuscitation. 1999 Dec;43(1):39-46.

OBJECTIVE: To test the hypothesis that delayed resuscitation of hemorrhagic shock produces a less severe shock insult than traditional resuscitation, characterized by repeated episodes of alternating hypotension and normotension.

METHODS: Female pigs were divided into three groups. Sham operated controls (C) (n = 4), sustained hypotension (SS) (n = 6), and hypotension with multiple cycles of shock and resuscitation (SR) (n = 6). SS and SR animals were bled to a mean arterial pressure (MAP) of 50 mmHg. SS animals were maintained at an MAP of 50 mmHg for 65 min and then resuscitated to baseline blood pressure with normal saline and shed blood. SR animals were initially bled and maintained at an MAP of 50 mmHg for 35 min, resuscitated to baseline BP, and subsequently bled and resuscitated twice more. The total period of shock was the same in both SS and SR.

RESULTS: Following hemorrhage, there was a significant increase in lactate and base deficit in SS as compared to C and SR.

CONCLUSION: Delayed resuscitation produces a more profound shock insult than traditional resuscitation.

Prehospital Fluid Administration for Thoracic Trauma

Hyde AJ, Graham TR,

Pre-Hospital Immediate Care, 1999 June ;3:99-101

Fluid administration is an established component of resuscitation in cases of trauma. Often this occurs as part of a set protocol, and little thought is given to the pathophysiology of the underlying injury. This approach is often beneficial, particularly in hypovolaemic patients, and in the majority of cases will be harmless. Unfortunately, there are certain instances, particularly with thoracic trauma, when such an indiscriminate policy can be detrimental and even fatal. This has recently brought into question the whole issue of fluid resuscitation, and the concept of hypotensive resuscitation has been introduced. This relies on fluid resuscitation only to the point of critical organ perfusion, and not beyond. Unless specifically indicated, fluids may be withheld until assessment in the emergency room. This policy not only prevents the potential for disastrous consequences of over transfusion, but reduces time spent at scene, and therefore expedites transfer.

Limited volume resuscitation in penetrating thoracoabdominal trauma.

de Guzman E. Shankar MN. Mattox KL.
Trauma Services, Ben Taub General Hospital,
Houston, TX 77030, USA.

AACN Clinical Issues. 1999 Feb;10(1):61-8.

Trauma is the leading cause of death in young adults. Development of trauma centers in urban settings including emergency medical services has contributed greatly to the improved quality of trauma patient care. Based on animal experiments performed 3 decades ago, the traditional management of hypovolemic hemorrhagic shock includes adequate circulatory volume with aggressive initial infusion of crystalloid solution. However, in several recent animal studies, investigators have found that aggressive treatment with fluids before control of bleeding results in a higher mortality rate, especially if blood pressure is elevated. This notion has been supported by findings in a recent prospective, randomized study involving patients with penetrating injuries to the torso. This article discusses briefly the pathophysiology of shock and hemostasis and the current literature on fluid resuscitation, with emphasis on limited volume resuscitation in patients with penetrating thoraco-abdominal injuries.

Central and regional hemodynamics during crystalloid fluid therapy after uncontrolled intra-abdominal bleeding.

Riddez L, Johnson L, Hahn RG.

J Trauma 1998 Mar;44:433-439

OBJECTIVE: To study the effect of graded crystalloid fluid resuscitation on central hemodynamics and outcome after intra-abdominal hemorrhage.

METHODS: Ten minutes after a 5-mm long laceration was produced in the infrarenal aorta, 32 pigs were randomized to receive either no fluid or Ringer's solution in the proportion 1:1, 2:1, or 3:1 to the expected amount of blood lost per hour (26 mL kg⁻¹) over 2 hours. The hemodynamics were studied using arterial and pulmonary artery catheters and four blood flow probes placed over major blood vessels.

RESULTS: During the first 40 minutes after the injury, the respective blood flow rates in the distal aorta were 39% (no fluid), 41% (1:1), 56% (2:1), and 56% (3:1) of the baseline flow. Fluid resuscitation increased cardiac output but had no effect on arterial pressure, oxygen consumption, pH, or base excess. Rebleeding occurred only with the 2:1 and 3:1 fluid programs. Survival was highest with the 1:1 and 2:1 programs.

CONCLUSIONS: Crystalloid fluid therapy improved the hemodynamic status but increased the risk of rebleeding. Therefore, a moderate fluid program offered the best chance of survival
Reviewer's note: The authors wanted to test the "low fluid hypothesis" of transport. Limited

volume resuscitation was more likely to result in survival than fluid therapy at the standard 3 litres given:1litre of lost blood ratio. (Then) standard resuscitation caused a higher bleeding rate.

Reappraising the prehospital care of the patient with major trauma.

Pepe PE, Eckstein M.

Department of Emergency Medicine, Allegheny University of the Health Sciences,
Pittsburgh, Pennsylvania, USA.

Emerg Med Clin North Am. 1998 Feb;16(1):1-15.

Recent research efforts have demonstrated that many long-standing practices for the prehospital resuscitation of trauma patients may be inappropriate, particularly in certain circumstances. Traditional practices, such as application of antishock garments and IV fluid administration, may even be detrimental in certain patients with uncontrolled bleeding. Endotracheal intubation, although potentially capable of prolonging a patient's ability to tolerate circulatory arrest, may be harmful if overzealous ventilation further compromises cardiac output in such severe hemodynamic instability. If these procedures delay patient transport, any benefit they may offer could be outweighed by delaying definitive care. To improve current systems of trauma care, future trauma research must address the different mechanisms of injury, the anatomic areas involved, and the physiologic staging in a given patient.

Resuscitation from severe hemorrhage.

Shoemaker WC, Peitzman AB, Bellamy R, Bellomo R, Bruttig SP, Capone A, Dubick M, Kramer GC, McKenzie JE, Pepe PE, Safar P, Schlichtig R, Severinghaus JW, Tisherman SA, Wiklund L.
Department of Emergency Medicine, King/Drew Medical Center,
Los Angeles, CA 90059, USA.

Critical Care Medicine 1996 Feb;24(2 Suppl):S12-23

The potential to be successfully resuscitated from severe traumatic hemorrhagic shock is not only limited by the "golden 1 hr", but also by the "brass (or platinum) 10 mins" for combat casualties and civilian trauma victims with traumatic exsanguination. One research challenge is to determine how best to prevent cardiac arrest during severe hemorrhage, before control of bleeding is possible. Another research challenge is to determine the critical limits of, and optimal treatments for, protracted hemorrhagic hypotension, in order to prevent "delayed" multiple organ failure after hemostasis and all-out resuscitation. Animal research is shifting from the use of unrealistic, pressure-controlled, hemorrhagic shock models and partially realistic, volume-controlled hemorrhagic shock models to more realistic, uncontrolled hemorrhagic

shock outcome models. Animal outcome models of combined trauma and shock are needed; a challenge is to find a humane and clinically realistic long-term method for analgesia that does not interfere with cardiovascular responses. Clinical potentials in need of research are shifting from normotensive to hypotensive (limited) fluid resuscitation with plasma substitutes. Topics include optimal temperature, fluid composition, analgesia, and pharmacotherapy. Hypotensive fluid resuscitation in uncontrolled hemorrhagic shock with the addition of moderate resuscitative (28 degrees to 32 degrees C) hypothermia looks promising in the laboratory. Regarding the composition of the resuscitation fluid, despite encouraging results with new preparations of stroma-free hemoglobin and hypertonic salt solutions with colloid, searches for the optimal combination of oxygen-carrying blood substitute, colloid, and electrolyte solution for limited fluid resuscitation with the smallest volume should continue. For titrating treatment of shock, blood lactate concentrations are of questionable value although metabolic acidemia seems helpful for prognostication. Development of devices for early noninvasive monitoring of multiple parameters in the field is indicated. Molecular research applies more to protracted hypovolemic shock followed by the systemic inflammatory response syndrome or septic shock, which were not the major topics of this discussion.

Fluid resuscitation of the trauma patient: how much is enough?

Hamilton SM; Breakey P. From the Department of Surgery, University of Alberta Hospitals, University of Alberta, Edmonton, Alta.

Canadian Journal of Surgery, 1996 Feb; 39(1): 11-16

Patient management in the prehospital resuscitative phase after trauma is vitally important to the outcome. Early definitive care remains the essential element in improving morbidity and mortality. In Canada, where a large proportion of trauma occurs at sites distant from a trauma centre, the prehospital resuscitative phase is long and has even greater potential to affect outcome. Conventional teaching about the end points of resuscitation has promoted the concept of normalization of hemodynamic parameters with maintenance of end-organ perfusion, as measured by the hourly urine output. Recent work in patients with a closed head injury and in patients with penetrating torso trauma challenge the notion that trauma patients are homogeneous with respect to these end points. In the Canadian setting of blunt injury, where a closed head injury is usually suspected and often present, the evidence from clinical studies suggests that an aggressive approach to maintaining blood pressure is warranted. In penetrating torso injury in an urban setting, there is evidence to suggest that delaying resuscitation until hemorrhage is controlled is beneficial. More Canadian clinical trials are required in this area. In the meantime, the priorities of resuscitation must be carefully assessed for each patient and pattern of injury.

Improved outcome with fluid restriction in treatment of uncontrolled hemorrhagic shock.

Capone AC, Safar P, Stezoski W, Tisherman S, Peitzman AB.

Department of Surgery, University of Pittsburgh Medical Center, PA.

Journal of the American College of Surgeons. 1995 Jan;180(1):49-56

BACKGROUND: Recent studies have challenged current guidelines for prehospital fluid resuscitation. However, long-term studies evaluating the consequences of fluid restriction in uncontrolled hemorrhagic shock are lacking. This study was done to examine the long-term effects of deliberate hypotension in the treatment of uncontrolled hemorrhage.

STUDY DESIGN: Uncontrolled hemorrhagic shock was produced in 40 rats by a preliminary bleed (3 mL per 100 g) followed by 75 percent tail amputation. Experimental design consisted of three phases: a "prehospital phase" (90 minutes of uncontrolled bleeding with or without treatment with lactated Ringer's [LR] solution), followed by a "hospital phase" (60 minutes, including control of hemorrhage and fluid resuscitation including blood), and a three-day observation phase. Forty rats were studied in four treatment groups (ten rats per group). Group 1 consisted of untreated controls (no resuscitation). Group 2 had no fluid during the prehospital phase. Group 3 had prehospital resuscitation to a mean arterial pressure (MAP) of 40 mm Hg with LR, and group 4 had prehospital resuscitation to MAP of 80 mm Hg with LR. Groups 2, 3, and 4 received fluid and blood to MAP of 80 mm Hg and hematocrit of 30 percent in the hospital phase.

RESULTS: All rats in group 1 (untreated) died within 2.5 hours. Five rats in group 2 (no prehospital FR) survived 90 minutes; however, only one survived three days. In group 3, all ten rats survived 2.5 hours and six survived three days. In group 4, eight rats died within 90 minutes, but none survived long-term. Blood loss (mL per 100 g) for each group was 3.75 0.6 for group 1, 3.35 0.1 for group 2, 4.15 0.8 for group 3, and 8.45 0.6 for group 4, ($p < 0.05$, group 4 compared with groups 1, 2, and 3).

CONCLUSIONS: Attempts to achieve normal MAP during uncontrolled bleeding increased blood loss, hemodilution and mortality. Hypotensive resuscitation resulted in less acidemia and improved long-term survival. Reviewer's Note: Improved outcome with fluid restriction in treatment of uncontrolled hemorrhagic shock- mortality at 90 min was least in the hypotensive resuscitation group.

The effects of prehospital fluids on survival in trauma patients.

Kaweski SM, Sise MJ, Virgilio RW.

Trauma Research and Education Foundation, San Diego, California

J Trauma 1990;30(10):1215-1218 Comment in: J Trauma 1991 Sep;31(9):1325

The effect of prehospital intravenous fluids upon survival was studied in 6,855 trauma patients. Mean prehospital time was 36 minutes in both the group of patients who received fluids and the group that did not. The volume of fluid administered was not significantly different in the group who survived compared to those who died. Eighty-five per cent of the patients had an Injury Severity Score (ISS) less than 25 and the mortality rate in the 56% of patients in this group who received fluids was similar to that of the patients who did not receive fluids (0.7% vs. 0.5%). Twelve per cent of the patients had an ISS between 25 and 50. Sixty per cent of these patients received fluids and the mortality rates were similar to the patients who received fluids compared to those who did not (23% vs. 22%). Three per cent of patients had an ISS of greater than 50 and the mortality rate was highest in this group but was not influenced by the administration of fluids (90% vs. 86%). Comparison of groups with similar probability of survival according to the TRISS methodology also failed to show an influence of fluid administration on survival. The mortality rate in patients with an initial systolic blood pressure (BP) of 90 torr or greater was compared to the rate in patients with an admission BP less than 90 torr. Although hypotension was associated with a significantly higher mortality rate, the administration of fluids had no influence on this rate.

BEST PRACTICE PREHOSPITAL GUIDELINES

Best Practice Prehospital Guidelines

GENERAL INSTRUCTIONS

1. The guidelines below obviously do not reflect the uniquenesses and varying capabilities of different agencies and systems; they will therefore need to be adapted to your individual system's needs and capabilities.
2. Each subsequent level of licensure capability adds to all previous level's recommendations and build upon each other. (i.e. EMR/EMT guidelines should be followed before Advanced EMT guidelines are applied.
3. Should you need assistance with implementation of these guidelines in the form of draft protocols or suggestions on equipment use, please contact us for assistance.

EMR/EMT

- 1) Assess and support ABC's: Hypotension identified (defined as SBP < 90 and/or HR >110 with suspected hemorrhage from trauma.
- 2) CONTROL HEMMORHAGE!
- 3) Activate Full Trauma Alert and rapid transport to closest appropriate trauma center for stabilization.
- 4) Tag and assign Trauma Band to patient
- 5) Discuss issues related to trauma if suspected TBI is present.
- 6) Position supine
- 7) Keep pt. NPO
- 8) Administer supplemental oxygen as needed to maintain SPO2 above 94%
- 9) Identify if external source of blood loss (open wound)
 - a) If open wound, apply pressure – consider combat gauze dressing at the wound site and to pack a deep wound where gauze would be able to be extracted. Use hemostatic agent gauze if available.

If wound on extremity bleeds despite direct pressure and pressure dressings, immediately place tourniquet(s) proximal to wound.

ADVANCED EMT

- 1) Oregon Intermediate EMT

INTERMEDIATE EMT

1. If peripheral IV is unsuccessful, place IO in unaffected limb and humeral I/O if bleeding is suspected at or below the pelvis.
2. Cardiac monitoring/prefer 12-lead

BEST PRACTICE PREHOSPITAL GUIDELINES

3. Evaluate and treat dysrhythmias

PARAMEDIC

- 1) Consider tension pneumothorax
- 2) Best if administered in FIRST hour. CONTRAINDICATED after 3 hours.
- 3) Infuse 1GM TXA in 100 mL NS over 10 minutes if any of the following are present:
 - a) Penetrating wound
 - b) Wound that is actively bleeding despite direct pressure
 - c) Blunt thoracic wound with suspected internal bleeding
- 4) Extremity wound that requires tourniquet application

TANEXAMIC ACID PHARMACOLOGY

Tanexamic Acid Pharmacology

ACTIONS

1. Definition: Tranexamic Acid is a fibrinolytic inhibitor, preventing the breakdown of blood clots.
2. Function: To help stabilize clot formation and decrease bleeding associated with traumatic hemorrhagic shock.

INDICATIONS

1. Suspected hemorrhagic shock in a trauma patient with mechanism AND
2. Systolic BP < 90mmHg AND
3. Injury occurred less than 3 hours

CONTRAINDICATIONS

1. Pediatric patients less than 12 years of age.
2. Time since injury exceeds 3 hours
3. Isolated Traumatic Brain Injury
4. Patients with known, active intravascular clotting (DVT or PE)
5. Hypotension and/or shock due to non-hemorrhagic, non-traumatic cases

SIDE EFFECTS

1. Serious reaction: Vision change, thromboembolism, ureteral obstruction, seizure, hypotension, hypersensitivity reaction.
2. Common reaction: nausea, vomiting, diarrhea, giddiness, dizziness.

ADULT

1. TXA Bolus (IV/IO): Mix 1 gram in 100ml of NS and infuse over 10 minutes before other IV fluids if possible.
2. Document any noted side effects
3. Document time, dose, amount of medication, route of administration and indication for use
4. Document any change in patient physical assessment, clinical presentation and vital signs.

PEDIATRIC

1. Contraindicated in patients less than 12 years of age.

TRANEXAMIC PROTOCOL

Tranexamic Protocol

I. Description and Purpose:

- A. Definition: Tranexamic Acid is a fibrinolytic inhibitor, preventing the breakdown of blood clots.
- B. Function: To help stabilize clot formation and decrease bleeding associated with traumatic hemorrhagic shock.
- C. TXA administration is time-sensitive, and therefore should be given within the first hour of injury, when possible, for the most benefit. Administration past three hours can have negative effects, and be potentially harmful.

II. Indications:

- A. Suspected hemorrhagic shock in a trauma patient with mechanism AND
- B. Systolic BP < 90mmHg **AND**
- C. Injury occurred less than 3 hours.

III. Contraindications:

- A. Pediatric patients less than 12 years old.
- B. Time since injury exceeds 3 hours.
- C. Isolated Traumatic Brain injury.
- D. Patients with known, active intravascular clotting (**DVT** or **PE**).
- E. Hypotension and/or shock due to non-hemorrhagic, non-traumatic causes

IV. Side Effects:

- A. **Serious Reaction:** Vision change, thromboembolism, ureteral obstruction, seizure, hypotension, hypersensitivity reaction.
- B. **Common Reaction:** nausea, vomiting, diarrhea, giddiness, dizziness.

V. Procedure:

- A. TXA Bolus (IV/IO): Mix 1 gram in 100ml of NS and infuse over 10 minutes before other IV fluids if possible.
- B. Best if administered in FIRST hour. CONTRAINDICATED after 3 hours.
- C. Document any noted side effects
- D. Document time, dose, amount of medication, route of administration and indication for use
- E. Document any change in patient physical assessment, clinical presentation and vital signs.