Fluid therapy and the New Evolution of Care!

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Financial Disclosure

There is no financial conflicts with this presentation.

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Mentioning a product or company does NOT represent endorsement.

Case study........

- A 53 year old 235 pound woman with a history of HTN, NIDDM, and CAD underwent an open Roux-en-Y gastric bypass procedure with combined epidural and general anesthesia.
  - A phenylephrine infusion was used to support her blood pressure.
  - Her estimated blood loss for the procedure was 500 ml, and the procedure was 3 hours long.
  - She received 4.5 L crystalloid and diuresis 250 ml.
  - Her average mean arterial pressure for the procedure was 57 mmHg.
  - Postoperatively, she became oliguric, hypotensive and azotemia & septicemic.
    - She expired on the 6th postoperative day.
  - Diuresis is helpful, but adequate perfusion pressure must be maintained (renal perfusion auto regulated between 80-180 mmHg).
    - It is easier to treat pulmonary edema compared to renal failure.
What can we do?

- Most of us practice our art in the comfort zone
- New and different ideas tend to pull people from the comfort zone to the scare zone
- Try new things
- Enhance your patient outcomes

Comfort Zone

Goal of Fluid Management

Implement a standardized, patient centered protocol

Integrate the pre-operative, intra-operative, post-operative and post-discharges phases of care to reduce LOS

Improve patient experience and satisfaction and decrease variability
Restrictive does not mean NO fluids

Like anesthetics throughout a case change, so does the fluid requirement vary and change!

Goal Directed Therapy……
- Tailored to the needs of each patient
- Goal is to maintain homeostasis
- Maintain circulatory volume
- Avoid unnecessary outcomes
**Intravenous Fluid Therapy**

Preoperative Intravenous Fluid Therapy Decreases Postoperative Nausea and Pain in High Risk Patients


Frequency of all, moderate, and severe nausea decreased

Overall incidence of PONV decreased

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**ERAS Fluids**

They start with 500 cc of 5% Albumin

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**Strube Ground Rules:**

Recognition of Problem:
Immediate Anesthesia Management:
Treatment:
Follow-up, after action review:
What did I do well?
What do I need to improve on?

Think differently: Don’t forget basics

SCIP:

Surgery Patients on a Beta Blocker Prior to Arrival That Received a Beta Blocker During the Perioperative Period
What IV solution to you choose?

NS or LR? (137 meq)

Good for what situation?

Panic attacks... oh boy?

"Lactate infusions commonly induce feeling of anxiety, and few cases of panic attack have been reported" Package insert

Measuring the Safety of Writing on Intravenous Bags

Do you write on your IV or put tape on it? ISMP also cautions against writing an expiration date directly on the bag, because volatile chemicals from the ink may leach into the solution.

http://www.accessdata.fda.gov/psn/printer.cfm?id=186

"Errors in fluid management (usually fluid excess) were the most common cause of perioperative morbidity and mortality"

Callum K et al (1999)
Perioperative Fluid Management

- Goal of perioperative fluid management:
  - Maintain adequate intravascular fluid volume,
  - LV filling pressure, oxygen delivery to tissues
- Surgical considerations:
  - Blood loss, evaporative loss, third spacing
- Other variables:
  - Preoperative fluid volume status, preexisting disease states, effects of anesthetic drugs on normal physiologic functions

Myth?

- Giving very little fluids

Restrictive does not mean NO fluids!

GOAL DIRECTED THERAPY!

Truth

- Fluid resuscitation in the patient, is driven by goal directed therapy.

NOT hypovolemia and NOT hypervolemia

Goal is to avoid both extremes
We want to start asking, how can we judge fluid administration?

**Static verse dynamic measurements**
Evaluation of Intravascular Volume

Indirect measurements
BP, heart rate, urine output
Gross estimates of organ perfusion

Invasive monitors
PA catheter, arterial line
Adequacy of intravascular volume replacement and tissue delivery to vital organs can’t be determined

Clinical evaluation of intravascular fluid volume needed
PTFSS (PTSD)

POST TRAUMATIC FRANK-STARRLING SYNDROME

WHERE AM I ONE THE CURVE?
AM I RESPONSIVE? OR
AM I NON-RESPONSIVE?

The original fluid replacement

Passive leg raise test
Cardiovascular Effects of Phenylephrine

Phenylephrine is a postsynaptic α-receptor agonist with little effect on the β receptors of the heart.

Patients do better with increased stroke volume

Systolic Pressure Variation

SPV = SBP(max) – SPB(min)

SPV, must be positive pressure ventilation and in NSR, depending on the percentage indicates a positive response to fluids or if pressors are first line.

Limitations, must be positive pressure ventilation at 8 cc/kg, and NSR.

Pulse Pressure Variation

PPV = PPV(max) – PPV(min)

Higher the number more responsive fluids, as there are wider swings in hypovolemia. New field of study, no concrete numbers, just trends.

PVI = PI (max) – PI (min)/PI (max) multiplied by 100 (closer to 100 need for fluids)
Non-cardiac surgical patients in a database of more than 33,000 patients at the Cleveland Clinic. Two main outcomes AKI and Myocardial injury

Acute Kidney Injury developed in 2478 patients
The MAP threshold where the risk was increased was less than 55mmHg

MAP less than 55mmHg for 1-5 min, 6-10 min, and 11-20 min and more than 20 min had graded increases in their outcomes.
New Technology for DYNAMIC Fluid Assessment

Stroke Volume Variation
SVV = (SV (max) – SV (min)) / SV (mean)

To optimize fluids management and oxygen delivery, can be used in both ventilated (Stockal) and non-ventilated patients, NSR. Limitations do apply.

Pros to Fluid | Cons to Fluid
---|---
Avoid Hypovolemia | Decreased gastric motility
Maintain Circulatory Stability | Development of ileus
Early time to void | Inflammation
Earlier discharge from PACU | Cellular Injury
Less nausea and vomiting | "Resuscitation injury"
| Pulmonary/Cardiac Failure

Non-invasive Monitoring

NICOM

Flow-Trac

Lidco Rapid

Vigileo EV 1000
Fluids

Introducing The New Starling™ SV Volume Management System

Measuring flow is central to what we do.

NPO--- Guidelines

<table>
<thead>
<tr>
<th>Ingested substances</th>
<th>Minimum Fasting Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear liquids</td>
<td>2</td>
</tr>
<tr>
<td>Breast milk</td>
<td>4</td>
</tr>
<tr>
<td>Infant formula</td>
<td>6</td>
</tr>
<tr>
<td>Non-human milk</td>
<td>6</td>
</tr>
<tr>
<td>Light meal</td>
<td>6</td>
</tr>
<tr>
<td>Fatty, fried foods</td>
<td>&gt; 8</td>
</tr>
</tbody>
</table>
The patient must be NPO for 8 hours.

NPO guidelines are often out of date and not evidenced based.

“While it is desirable that there be no solid matter in the stomach when chloroform is administered, it will be found very salutary to give a cup of tea or beef-tea about two hours previously.”

Lord Joseph Lister, 1882
NPO History

1946: Mendelson.
High incidence of pulmonary aspiration among OB patients receiving general anesthesia
Animal data: lung injury related to volume of aspirate and decreased pH
Recent data: Pulmonary aspiration rare.
Fasting can lead to dehydration, hypovolemia, hypoglycemia

SPECIAL ARTICLES

Practice Guidelines for Preoperative Fasting and the Use of Pharmacologic Agents to Reduce the Risk of Pulmonary Aspiration: Application to Healthy Patients Undergoing Elective Procedures

An Updated Report by the American Society of Anesthesiologists Committee on Standards and Practice Parameters

Clear liquids safe up to two hours before general anesthesia
Pre-operative PO fluid

- Fluid therapy management influences:
  - Intraoperative & postoperative morbidity and mortality
  - Adequate perfusion of vital organs

- Preoperative volume assessment
  - Bowel preparations, vomiting, diaphoresis, hemorrhage, burns, inadequate intake all can cause preop hypovolemia
  - Redistribution of intravascular volume without evidence of external loss is another cause of preop volume depletion, e.g.:
    - Sepsis, ARDS, ascites, pleural effusions, bowel abnormalities
      - Accompanied by ↑ capillary permeability & intravascular fluid → interstitial
Finding the SWEET SPOT!

Evaluation of intravascular volume

- Indirect measurements
  - BP, heart rate, urine output
    - Gross estimates of organ perfusion
- Invasive monitors
  - PA catheter, arterial line
    - Adequacy of intravascular volume replacement and tissue delivery to vital organs can't be determined
- Clinical evaluation of intravascular fluid volume needed

Fluid Resuscitation

- Blood pressure
- Jugular venous pressure
- Urine sodium concentration
- **Urine output**
  - Pre and post deficit body weight

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**Static** vs **Dynamic**

<table>
<thead>
<tr>
<th>Hypovolemia</th>
<th>Shocking</th>
<th>Renal failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dehydration</td>
<td>Heart failure</td>
<td>Nephrotic syndrome</td>
</tr>
<tr>
<td>Loss of volume</td>
<td>Left heart failure</td>
<td>Acute renal failure</td>
</tr>
</tbody>
</table>

A new avatar in DLP examination
Physical exam and lab tests

- Clinical clues to hypovolemia:
  - Skin turgor, hydration of mucous membranes, palpation of peripheral pulses, resting heart rate, BP (including orthostatic changes), urine output

- Lab data that are useful indices for intravascular volume:
  - Serial hct, ABGs, urine specific gravity or osmolality, serum Na⁺, serum creatinine-to-BUN ratio

Anesthesia techniques & volume status

- IV induction agents
  - Propofol: ↓ SVR, cardiac contractility, preload
    - BP effects less pronounced in Euvolemic pts
  - Ketamine
    - ↑ BP/HR/CO 2: stimulation of SNS & inhibition of norepinephrine reuptake
    - Direct myocardial depressant effects unmasked by exhaustion of catecholamine stores (CHF, end-stage shock) → paradoxical ↓ BP

- Neuromuscular blockers
  - Generally lack direct C-V effects
    - Atracurium produces histamine release w/ ↓ SVR & venous pooling 2: ↓ muscle tone

- Inhalation anesthetics
  - Isoflurane, desflurane and sevoflurane all ↓ SVR & depress myocardial contractility
  - Positive pressure ventilation reduces preload & ↓ BP in hypovolemic pts

- Regional anesthesia
  - Neuromuscular blocks produce sympathetic blockade
    - Innervation of vascular smooth muscle
    - Causes vasodilation, pooling of blood, ↓ SVR
Perioperative fluid therapy

- Replacement of preexisting fluid deficits
- Replacement of normal losses or maintenance requirements
- Replacement of surgical wound or "third space" losses, including blood loss
- 80 kg by rules for 10 hrs NPO—1.2 liters down

Preexisting fluid deficits

Deficit is proportionate to the duration of fasting time

Can be estimated by multiplying normal maintenance rate by length of fast

The "4-2-1" Rule to Calculate Deficit Replacement

<table>
<thead>
<tr>
<th>Up to 10 kg</th>
<th>4 ml/kg/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>11-20 kg</td>
<td>2 ml/kg/hr</td>
</tr>
<tr>
<td>21 kg &amp; above</td>
<td>Add 1 ml/kg/hr</td>
</tr>
</tbody>
</table>

For example, a 70kg adult needs

- 4 cc/kg for the first 10 kg = 40cc
- 2 cc/kg for the next 10 kg = 20 cc
- 1 cc/kg for the remaining kg = 50 cc

Total = 2640 cc/day or 110 cc/hr
For example, a 70 kg adult needs:

- 1st 10 kg x 100 cc/kg per day = 1,000
- 2nd 10 kg x 50 cc/kg per day = 500
- 3rd 50 kg x 20 cc/kg per day = 1,000

Total = 2,500 cc/day or 104.1667 cc/hour

<table>
<thead>
<tr>
<th>Degree of Tissue Trauma</th>
<th>Additional Fluid Requirement (Beyond Deficit Replacement)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimal (Herniorrhaphy)</td>
<td>2-4 ml/kg/hr</td>
</tr>
<tr>
<td>Moderate (Cholecystectomy)</td>
<td>4-6 ml/kg/hr</td>
</tr>
<tr>
<td>Severe (Bowel Resection)</td>
<td>6-8 ml/kg/hr</td>
</tr>
</tbody>
</table>

(May need more. Desired endpoint is at least 0.5 ml/kg/hr urine output)

Abnormal fluid losses

- Result from:
  - Vomiting, diarrhea, preoperative bleeding
  - Occult losses:
    - Ascites, infected tissues
  - Insensible losses:
    - Fever, sweating, hyperventilation

- Include estimated abnormal fluid losses in calculation of preop fluid deficits
  - Need to minimize hypotension/hypoperfusion
  - Fluid used for replacement should be similar in composition to fluid lost
**Maintenance requirements**

- Maintenance fluid required in fasting result due to:
  - Continued urine formation
  - G-I secretions
  - Insensible losses from skin & respiratory tract

- Maintenance fluid requirements calculated and replaced w/crystalloid solutions intraoperatively

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**Blood loss**

**Estimating blood loss**

- Sponges + suction – irrigation = EBL

**Data to calculate EBL:**

- Measurement of blood (minus irrigation) in the surgical suction canister
- Occult bleeding into wound
  - Hard to estimate
- Bleeding under or on surgical drapes
  - Regular visual scanning of surgical field is an important part of vigilance

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**Blood loss**

- Surgical sponges & laparotomy pads ("laps")
  - Fully soaked sponge ("4 x 4") holds 10 ml of blood
  - Fully soaked "lap" holds 100-150 ml
  - Exact blood loss volume determined by weighing sponges, which is typically only done during surgery on infants & small children
  - Remember to account for irrigation solution used

- EBL often underestimated
How do I calculate this?

Clinical signs such as tachycardia are insensitive and nonspecific re volume status.

Late signs of inadequate tissue perfusion:
- ↓ u.o., ↓ pH, ↑ base deficit
  - Manifested only when tissue hypoperfusion moderate to severe
- Visual estimation of continual blood loss is mandatory to guide fluid replacement & transfusion

Replacement ratios:
- Crystalloid: blood = 3 ml crystalloid : 1 ml blood
- Colloid: 1 ml colloid (packed cells, albumin, Hespan) : 1 ml blood

How do you calculate this?

Blood loss
Other losses
- Fluid shifts or loss from the operative site
- Evaporative losses most apparent with large wounds
- Considerable amount fluid can be lost through lungs with mechanical ventilation unless humidifier is used

Internal fluid redistribution
- Also known as “third spacing”
- Can cause large fluid shifts and severe intravascular fluid volume depletion
  - Especially during major abdominal or thoracic surgery
- Traumatized, inflamed or infected tissue can sequester large amount of fluid in the interstitial space
  - Replacement of evaporated and “third-spaced” fluids is necessary to avoid organ hypoperfusion, especially renal insufficiency

Resuscitation Debate
- Osmotic Pressure
  - Movement of fluid between the ICF and ECF compartments is primarily a function of osmotic forces: plasma proteins pull water back into the vascular space at the venous end of the capillary bed
Four Types of Fluids

Blood
Dextrose – limited use in anesthesia – PONV
Crystalloid
Colloid

Lactated ringer’s solution, saline & ECF

<table>
<thead>
<tr>
<th></th>
<th>Dextrose</th>
<th>Na⁺</th>
<th>Cl⁻</th>
<th>K⁺</th>
<th>Ca²⁺</th>
<th>pH</th>
<th>mOsm/L</th>
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<tbody>
<tr>
<td>ECF</td>
<td>90-110</td>
<td>140</td>
<td>108</td>
<td>4.5</td>
<td>5</td>
<td>7.3</td>
<td>290</td>
</tr>
<tr>
<td>LR*</td>
<td>-</td>
<td>130</td>
<td>109</td>
<td>4</td>
<td>3</td>
<td>6.6</td>
<td>273</td>
</tr>
<tr>
<td>NS</td>
<td>-</td>
<td>154</td>
<td>154</td>
<td></td>
<td>5.6</td>
<td>308</td>
<td></td>
</tr>
</tbody>
</table>

*LR contains lactate 28 mEq/ml (ECF lactate = 5 mEq/ml)

The battle is between fluids and between
Inpatient and Outpatient……..
Colloids and Crystalloids

Intravenous fluids may be divided into

Crystalloid solutions - clear fluids made up of water and electrolyte solutions; Will cross a semi-permeable membrane e.g. Normal, hypo and hypertonic saline solutions; Dextrose solutions; Ringer’s lactate and Hartmann’s solution.

Colloid solutions – Gelatinous solutions containing particles suspended in solution. These particles will not form a sediment under the influence of gravity and are largely unable to cross a semi-permeable membrane. e.g. Albumin, Dextran, Hydroxyethyl starch [HES].

Colloids

More effective for volume resuscitation in moderate-severe blood loss

Examples:
- Albumin (5% and 25%)
- 10% Dextran 40 and 6% Dextran 70
- Hetastarch (hespan)
- 10% Pentastarch (hetastarch derivative)

Colloid versus crystalloid

Long-standing controversy regarding merits of crystalloid versus colloid for fluid resuscitation

Numerous studies

None have unequivocally demonstrated distinct advantages in terms of pulmonary complications or survival with either therapy

IN ERAS, ALBUMIN IS PREFERRED!

Colloids more expensive & don’t have same safety profile as crystalloids
Hard to justify their use unless rapid volume expansion needed
Less hemodilution w/colloids than crystalloids
Joachim Boldt: is a German anesthesia provider who used to be considered a leading researcher into colloids. He has been stripped of his professorship and is under criminal investigation for possible forgery of up to 98 research studies.

FDA Safety Communication: Boxed Warning on increased mortality and severe renal injury, and additional warning on risk of bleeding, for use of hydroxyethyl starch solutions in some settings—November 25, 2013

Hespan

Black Box WARNING....

Hydroxyethyl starch

- Hetastarch in synthetic colloid that is 6% solution in 0.9% NS (Hespan)
- Doses > 20 ml/kg → ↓ Factor VIII, prolonged PTT
- Hextend is colloid w/similar molecules
  - 6% hetastarch in solution that contain physiologic electrolyte concentrations
  - Effects on Factor VIII not clear
- Pentastarch: lower molecular mass hetastarch, under study
Coagulation abnormalities

Bleeding associated w/synthetic colloids widely reported

Dextran produces dose-related ↓ platelet aggregation & adhesiveness

Plasmalyte???

Hetastarch can lead to ↓ factor VIII & von Willebrand factor, impaired platelet function & prolonged PTT

Coag studies & bleeding times not affected by infusions of up to 1L
  o Best avoided in pts w/known coagulopathy
  o Voluven: short half life, less ↓ in coag factors

The battle! Fact or Bias?

2011. Colloid or Crystalloid: Any Differences in Outcomes?
Tong J. Gan, M.D., M.H.S., F.R.C.A. Professor and Vice Chair, Department of Anesthesiology, Duke University Medical Center, Durham, NC in the International Anesthesia Research Society Journal.

"In summary, the choice of fluid administration in the perioperative period can affect postoperative outcomes. Colloid results in a more effective plasma volume expansion compared to crystalloid and hence lower volumes are required. Crystalloid is an essential part of perioperative fluid regimen for replenishing insensible and interstitial fluid loss. However, large volumes of crystalloid are associated with gastrointestinal dysfunction and delay bowel recovery. Balanced salt solutions appear to provide better postoperative outcomes than normal saline."

Plasma-Lyte/Normosol $6.49

- PLASMA-LYTE 148 Injection (Multiple Electrolytes Injection, Type 1, USP) administered intravenously has value as a source of water, electrolytes, and calories.
- One liter has an ionic concentration of 140 mEq sodium, 5 mEq potassium, 3 mEq magnesium, 98 mEq chloride, 27 mEq acetate, and 23 mEq gluconate.
- The osmolality is 294 mOsmol/L (calc).
  - Normal physiological osmolality range is approximately 280 to 310 mOsmol/L.
  - Administration of substantially hypertonic solutions may cause vein damage.
- The caloric content is 21 kcal/L.
**Dextrose**


**Intravenous dextrose administration reduces postoperative antiemetic rescue treatment requirements and postanesthesia care unit length of stay.**


October 20, 2009 (New Orleans, Louisiana) — The simple intravenous (IV) administration of dextrose following surgery significantly reduces the occurrence of postoperative nausea and vomiting (PONV) and the need for antiemetic medication in the postoperative anesthesia care unit (PACU), investigators reported here at the American Society of Anesthesiologists 2009 Annual Meeting.

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**Colloid Albumin——$125**

- Albumin is purified from human plasma & commercially available as 5% or 25% solution.
- Since it is a blood product, Jehovah’s Witnesses may object to receiving it for religious reasons.
- Half life of albumin in plasma = 16 hrs
  - About 90% of dose remains in intravascular space
  - 2 hrs after administration

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**Albumin’s Role in F/E Balance**

- Reabsorption prevents too much fluid from leaving the capillaries.
- Albumin is a large molecule and will not pass through the capillary membrane.
- When fluid filters through the capillary, the protein albumin remains behind.
- When the concentration of albumin increases, fluid begins to move back into the capillary wall by osmosis.
- The pulling force of albumin in the intravascular space is called plasma colloid osmotic pressure.
Voluven – Is Hespan a thing of the past?

- A new colloid – used to treat hypovolemia
- What is the benefit?? What about Hespan?
- Remember Hespan has a max dose of 20cc/kg to a max of 1000cc’s
- Voluven has a max dose of 50cc/kg
- Initial dose should be 10-20cc (not per kg) and observe for signs of a reaction

Voluven---$53.33

- Contraindications:
  - Hypersensitivity; fluid overload; CHF; renal failure; dialysis; hypernatremia; hyperchloremia; intracranial bleeding
- Watch for dilution of blood products
  - “Monitor the coagulation status of patients undergoing open heart surgery in association with cardiopulmonary bypass as excess bleeding has been reported with HES solutions in this population. Discontinue use of Voluven if the first sign of coagulopathy.”
- Adjust for renal and hepatic patients
- Number one side effects is pruritus
- Watch for Anaphylactoid and hypersensitive reaction

Mizzi et al (2017)
Safety profiles

- Colloids exhibit similar effectiveness in maintenance of colloid oncotic pressure but have different safety profiles
- Hypersensitivity reactions, including anaphylaxis have been reported with albumin, hetastarch & dextran
  - Dextran 1 (Promit) given before Dextran 40 or Dextran 70 to prevent anaphylaxis
    - Acts as hapten and binds any circulating dextran antibodies
  - Pruritis seen with hetastarch in dose-dependent fashion

Dogma?

Dogma is a principle or set of principles laid down by an authority as incontrovertibly true. It serves as part of the primary basis of an ideology or belief system, and it cannot be changed or discarded.

INTRODUCTION

HISTORY
Massively transfused casualties (>10 RBC units in 24 hours) have a high mortality rate (33%) and have the greatest potential to benefit from appropriate transfusion strategies.

Large retrospective cohort studies of casualties requiring mass transfusions during OIF and OEF demonstrate a significant benefit for the massively transfused when RBCs, fresh frozen plasma, and platelets are transfused at a 1:1:1 ratio.
US Military Death Distribution
4,596 Combat Deaths (2001-11)

- 90% of combat deaths occur before reaching Role 2
  - PRE-HOSPITAL
- 25% of pre-hospital deaths are preventable
  - 90% of these are due to hemorrhage, mostly truncal

MASSIVE TRANSFUSION

- Early Recognition of Massive Transfusion (MT) Patients
  - Most patients requiring emergency unmatched blood in ED will need MT
  - Predictors (3/4 70% 4/4=85% of MT)
    - SBP <110 mmHg
    - HR > 105
    - HCT <32
    - pH < 7.25

1:1:1
Lessons Learned

- Straight crystalloid doesn't work and causes other problems
  - Acid Base and electrolyte disorders
  - Dilutes clotting factors and oxygen delivery
  - Large volumes led to other medical problems
    - Abdominal Compartment Syndrome
    - Multiorgan Dysfunction
    - Death
- Packed Red Cells
  - Help replace lost oxygen delivery
  - Dilutes clotting factors
  - Less effective the older it is
When somebody says whole blood just can’t be done

- Royal Caribbean Cruise Liners
  - 100,000 guests plus 37,000 crew at sea in 34 different ships each day
  - Many guests, elderly, over-weight, over-eating and on anticoagulants
    - High risk of GI bleeding
  - Often weeks 24 hours from any port
  - Operationalized a Fresh Whole Blood Transfusion Program
  - Recurrent training and education of 250 medical personnel
  - Screening questionnaires, rapid ABO typing and infectious disease testing

- 40 months there were 40 whole blood emergent transfusions
  - 1-6 Units per patient
  - One allergic reaction, no infectious complications

Fluid Resuscitation for Hemorrhagic Shock in Tactical Combat Casualty Care

TCC Guidelines Change 14-01

28 June 2014

Conclusions

1. The preferred fluids for resuscitation of casualties in hemorrhagic shock descending order of preference, are:
   - Whole blood
     - 1:1:1 plasma, RBCs, and platelets
     - 1:1 plasma and RBCs
     - Reconstituted dried plasma, liquid plasma, or thawed plasma alone or RBCs alone
     - Hextend
     - Lactated Ringers or Plasma-Lyte A
Blood therapy

- **Indication is for inadequate oxygen carrying capacity/delivery & correction of coagulation deficits**
- Provides additional intravascular volume
- Have to determine blood types of recipient and donor
  - Typing determines antigens (A, B, Rh) on RBC membranes
  - Naturally occurring antibodies (anti-B, anti-A) are formed whenever RBCs lack A/B/both antigen(s)
  - These antibodies can rapidly destroy RBCs that carry the corresponding antigen

Type and screen---$50-$170

- Denotes blood that has been typed for A, B and Rh antigens & screened for common antibodies
- This is done when scheduled surgery unlikely to require transfusions (hysterectomy, cholecystectomy) but is one in which blood should be available
- Type & screen is more cost-effective since blood is available to > 1 patient
- Chance of significant hemolytic reaction to use of type & screen is 1:10,000

Cross-match---$200

- Donor RBCs are incubated w/recipient plasma
  - Major cross-match also checks for IgG antibodies (Kell, Kidd)
- Incubation of donor plasma w/recipient RBCs is a minor cross-match
- Agglutination occurs if either major or minor cross match is incompatible
- Type-specific blood:
  - Only ABO-Rh type has been determined
  - Chance of significant hemolytic reaction to transfusion of type-specific blood – 1:1,000
Blood components: packed RBCs: $343-$510

- Volume: 250-300 ml
- Hct: 70-80%
- 1 unit RBCs ↑ hgb by 1 gm
- Treatment of anemia 2o surgical blood loss

Goal: ↑ O₂ carrying capacity of blood
- RBCs ↑ blood volume, but so do crystalloids and colloids like Hespan or albumin

Platelet concentrates: $600

- Allow treatment of thrombocytopenia w/out unnecessary blood components
- Intraop platelets probably not needed unless platelet count < 50K cells/mm³
- 1 unit platelet concentrate will ↑ platelet count by 5,000-10,000

Fresh frozen plasma: $100

- Fluid portion obtained from single unit whole blood
  - Frozen w/in 6 hrs of collection
- All coagulation factors, except platelets, are present in FFP
  - Rationale for component therapy, e.g., platelets + FFP, when hemorrhage related to coag factor deficiencies
- Intraop FFP only necessary w/ PT, PTT 1.5 longer than normal
- You will find platelets & FFP are sometimes given empirically
Cryoprecipitate---$1080

- Fraction of plasma precipitated when FFP thawed
- Unresponsive to desmopressin
  - Contains high concentrations of Factor VIII in small volume
- Also useful for hyperfibrinogenemia induced by packed RBCs
  - Contains more fibrinogen than FFP

Cryoprecipitate is prepared from plasma and contains fibrinogen, von Willebrand factor, factor VIII, factor XIII and fibronectin. Cryoprecipitate is the only adequate fibrinogen concentrate available for intravenous use.

Thank You
pstrube3000@yahoo.com

Questions??