

Advances in Trauma Resuscitation: Implications for the Nurse Anesthetist

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Trauma Resuscitation

- Brief History
- The “Golden Hour”
- Surgical Advances
- Anesthesia Advances
- Resuscitation Advances
 - Pre-Hospital
 - Technological
 - Systems

Trauma Resuscitation

- Team Approach
- Level of Care
- Roles and Responsibilities
- Organization
- We do this all the time
- “Blah-Blah-Blah Ginger”



What I would like to talk about

- Trauma Team
- Diagnostic Advances
 - CT Scanning, Radiology, FAST
- Technology
 - Pre-Hospital Communication
 - Fluid Warming and Delivery
 - Laboratory Analysis
- Fluid Resuscitation
- Critical Care

Communication

- Pardon my soapbox but listen...
- If we just communicate then we can do this!
- Why does the patient always look different?
- Why is the surgeon keeping “it” a secret?
- Improved patient outcomes with NPs on the trauma service...HMMM!

Trauma Team

- The “New” Trauma Team
- Anesthesia is now a critical member
- Depending on the center where you work...
 - Cook County-Chicago, IL
 - San Francisco General-San Francisco, CA
 - R Adams Cowley Shock Trauma Center-Baltimore, MD
- May respond to trauma patient initially or NOT
- Airway **and** Resuscitation Skills

Diagnostic Advances

- **CT Scanning**
 - Improved Technology
 - Need the updated hardware and software
 - CT Resuscitation Stretcher
 - Non-Contrast Head CT in 90 seconds
- **Plain X-rays**
 - Full-Body x-ray scan for gross fractures
 - 3 Minutes allows focus areas when stable
 - Computer Generated Images
 - Wireless view in multiple locations or PDA

FAST

- Focused Abdominal Sonography in Trauma
- Ultrasound Exam
 - Multiple Technologies
 - “Big” Machine
 - Hand Held/Portable
 - Don’t need a Radiologist
 - Man, they really hate that!
- Fast, as in quick...see blood...

FAST

- ...See blood...see doctor run...see anesthesia work harder...no time to set-up room
- With rapid diagnostic tools, prep time is greatly decreased
- Room set-up strategies
 - All Trauma
 - Emergency OR easily reconfigured

TEE

- Coming to a Trauma Center near you
- Direct assessment of volume and pressure
- Cardiac Dysfunction
- Guide Volume
- “Easy” to use
- Real Time assessment of interventions

Technologies

- Consciousness Monitoring
- Depth of Anesthesia
- Awareness Monitoring
 - BIS Monitor
 - PSA 4000
- Implications in Trauma
 - “No” Anesthesia Given...well then what did I do for the last 5 hours?

Technologies

- T-line
 - Tensys Medical Inc., San Diego, CA
- TL-100 Tensymeter
- “Enabling non-invasive beat-to-beat arterial blood pressure monitoring for early detection and treatment in hemodynamically unstable patients”

T-line

- Transdermal system designed for placement over the radial artery
- Beat-to-beat monitoring
- Check it out
- Utilize the new technologies and see if they meet your standard

Pre-Hospital Communication

- HA! HA! HA! HA! HA! HA! HA! HA!
 - Tell Hawaii Air-Ambulance Story
- Clear communication with scene providers
 - Get the big picture
 - Begin treatment
 - Do **not** stay and play
 - Shock-Trauma “Go Team”
 - Airway Management in the field
 - Head Injury
 - Pediatric Head Injury Outcome

Warming Technologies

- Ambient Room Temperature
 - Really it does make a difference
 - Trauma Prep
 - Naked and wet!
 - Knees, face and feet are covered
 - The only people who are warm are the OR personnel
 - Better than nothing?
 - We will have to wait on a definitive study
 - AORN does have a position statement

Warming Technology

- Belmont Technology
- FMS 2000
- Warmer
- Infuser Technology
- Air detector
- Ease of use
- Set-up time
- Push Button
- Smart Alarms



Warming Technology

- Infuses at 500 ml/min with the touch of one button

RATE= 500 $\frac{\text{ml}}{\text{min}}$	T= 37.5°C		
VOL= 1301 ml	P= 130mmHg		
INFUSE RATE ▲	MAX. RATE	BOLUS 200ml	STOP
INFUSE RATE ▼		RECIRC	

- Touch Screen
- Choose amount of bolus
- Does not require a perfusionist
- Even your Attending can run it!!
 - Only Kidding...

FMS 2000



Warming Technology



- Hot Line
- Ease of use
- OOPS! It will pee on the floor if you disengage warming tubing without turning off unit first!

Warming Technology



- Level-One Rapid Infusor
- Ranger Fluid Warmer
- Pressure Bag
- Medical Solutions in Virginia has a new product to warm bags and give date and time
- JCAHO regulations

Warming Technologies

- A Laboratory Evaluation of the Level 1 Rapid Infusor (H1025) and the Belmont Instrument Fluid Management System (FMS 2000) for Rapid Transfusion
 - Comunale, M.E. Anesth Analg 2003;97:1064-1069
- Warming capabilities similar at flow rates of 500mL/min
- FMS 2000 superior air-detection and elimination capabilities

Infusion Technologies

- New Products
- Incorporate Warming and Controlled infusion with ability for rapid infusion
 - Medical Solutions
 - Zoll Medical purchased Infusion Dynamics and their product, Power Infuser
 - Disposable cartridge
 - 1-AAA Battery
 - Well suited for pre-hospital
 - HMMM...maybe we can't break it!

Hypothermia

- A core body temperature $< 36^{\circ}$ C
- Most trauma patients arrive with a CBT lower than this, so we start behind already
- Increases length of stay
- Coagulopathy
- Morbid cardiac events
- Delayed wound healing
- Increased incidence of infection
- Extended PACU stay

LABS



- “Send some labs”
 - Oh, what a great idea, I am sorry I didn’t think of it!
- Point of care testing
 - ABG, HGB, HCT, GLU, LYTES, ACT, TEG
 - “STAT” Labs, OR Lab
 - Tell Cook County Story
 - Tell SFGH story

Labs

- What do you really need
- Success of intervention
- Resuscitation Endpoint
 - Lactate
 - Base Deficit
 - Coagulation Status
 - CBC



Resuscitation Endpoints



- Treat perfusion-related dysoxia
- Global Markers
- Regional Markers
- Biochemical Markers
- Functional Markers

Resuscitation Endpoints

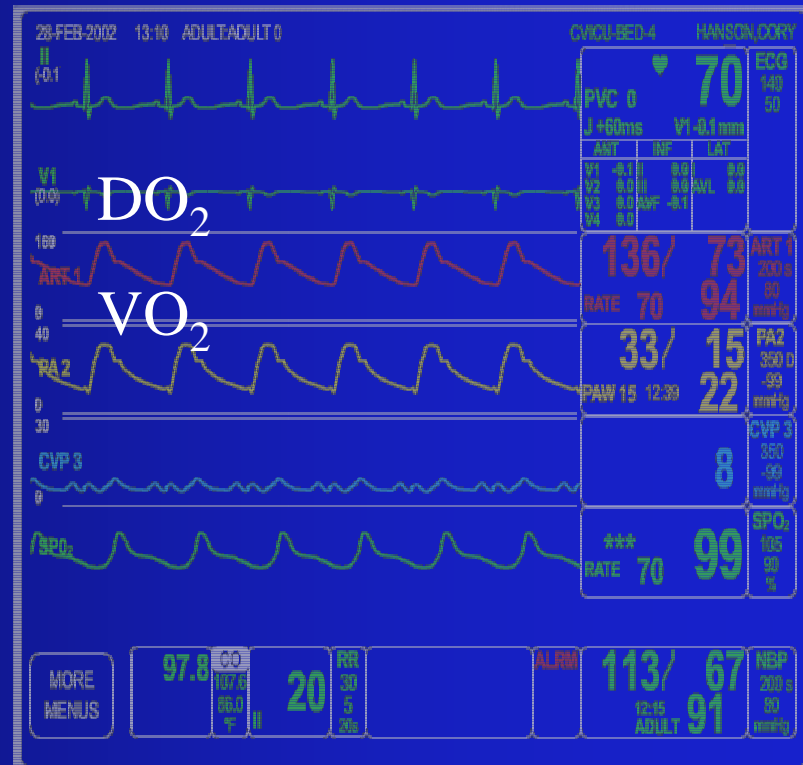
- Our initial resuscitation is more than just getting “them” out of the OR or Interventional Unit
- Sepsis and MOF are responsible for >60% of trauma deaths
 - These complex secondary events are usually a consequence of the initial tissue hypoxia related to acute hemorrhage.
- Recognize and correct perfusion deficits as **early** and **fully** as possible

Endpoints

- Base Deficit
- Lactate
 - Easily measured
 - Arterial blood sample or chemistry tube for lactate
 - Easy to trend
 - Help guide resuscitation

Endpoints

- DO_2
- VO_2
- Oxygen consumption and delivery are excellent markers and assist in guiding treatment and evaluation of success but technically difficult during active resuscitation
 - Technical limitations

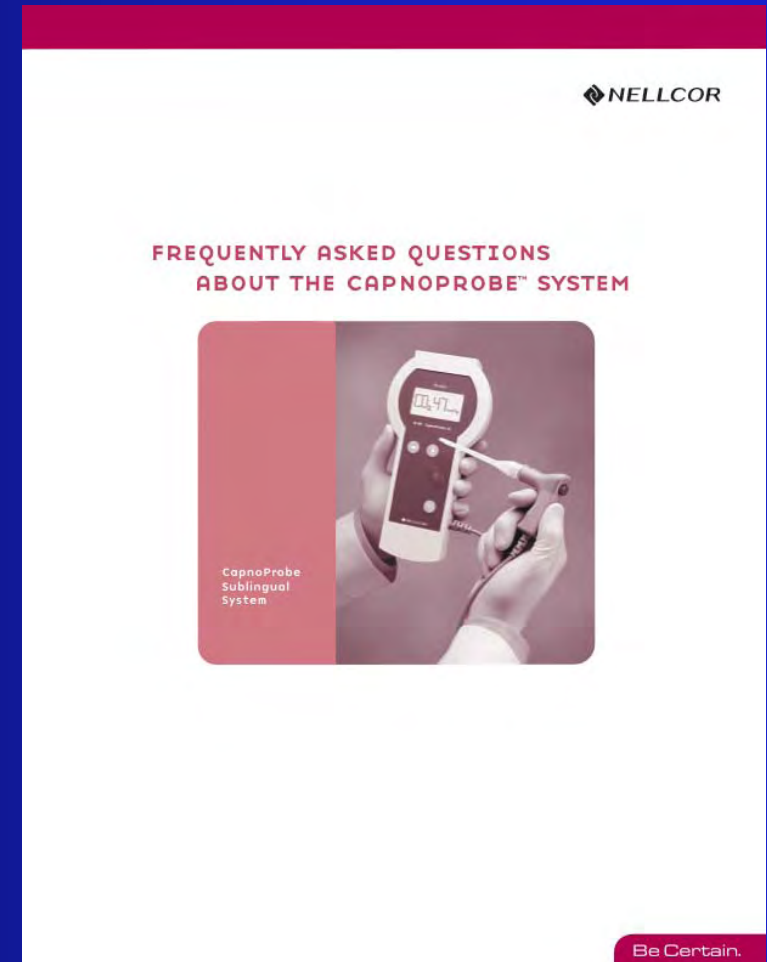


Gastric Tonometry

- CO₂ present within the gastric mucosa is in equilibrium with the blood
- PCO₂ across the mucosal layer of the stomach into its lumen
- Intramucosal pH---pHi
- Henderson-Hasselbach Equation substitution
 - $pH_i = 6.1 + \log_{10} \left(\frac{\text{arterial } HCO_3^-}{P_gCO_2 \times K} \right)$

Sublingual Capnometry

- Proximal gastric intestinal mucosa (under the tongue)
- Esophageal tissue pCO₂ mirrors that of the stomach



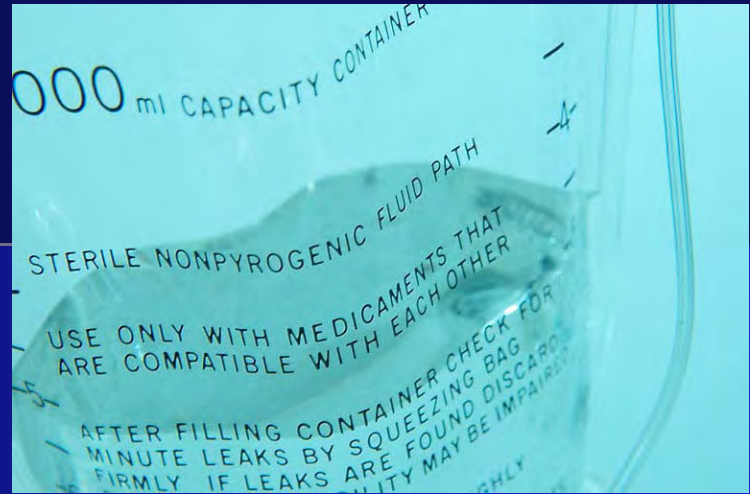
Fluid Resuscitation



Fluid Resuscitation

- Controversy
- Has been going on for a long time
- Tell Maddox Fluid Study story-Houston
- Crystalloid-Colloid-Blood
- How much and when?
- Research
- Geographical and Institutional differences

Crystalloids



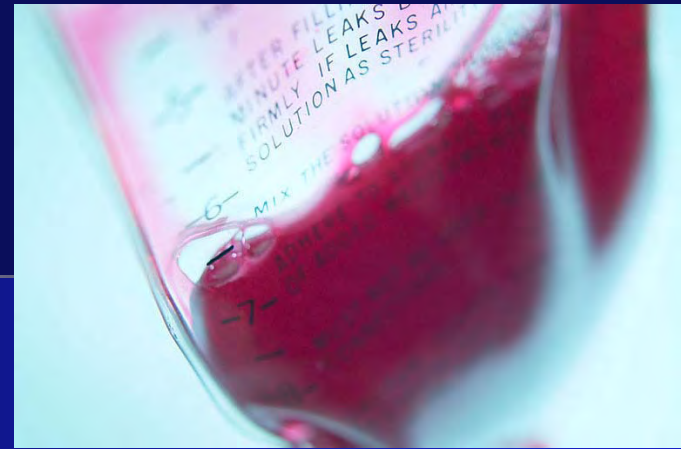
- LR, NS, PLYTE
- Readily available
- Inexpensive
- No associated adverse reactions*
- Large volumes required
- Over-expands interstitial space

Colloids



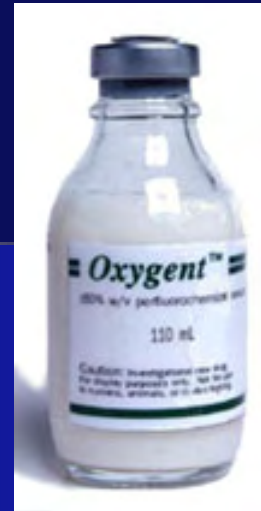
- Mostly readily available
- Expensive
- Associated risk of adverse reactions
- Smaller volumes required
- Minimal effect on interstitial space

Human Blood Products



- Type: Whole blood, PRBCs, FFP, Clotting factors
- Availability
- Expensive
- Associated risk of adverse reactions
- Rapid & Volume availability

Oxygen Carrying Solutions



- Availability-??
- Expensive
- No risk of adverse reactions-??
- Volume expansion

The Center for Bloodless Medicine & Surgery
AT PENNSYLVANIA HOSPITAL



PolyHeme: An alternative to blood transfusion

Since the early 1990s, when the fears of contracting diseases such as HIV and Hepatitis C through donated blood were so widespread, many companies began searching for a safe alternative to donated blood. Currently, PolyHeme-an experimental blood substitute-is being evaluated for use in trauma situations for the treatment of acute blood loss.

PolyHeme developed by Northfield Laboratories, Inc uses hemoglobin that researchers separate, filter and chemically modify. After undergoing modifications, the “naked,” or stripped, hemoglobin cell can be transfused into any individual, regardless of his or her blood type. PolyHeme lasts in the body for only 72 hours, but could serve as a temporary solution for critically injured patients who do not have immediate access to stored blood, or who refuse to receive standard blood transfusions. PolyHeme has a shelf life of approximately 100 days, which is more than half the shelf life of donated blood.

Recently, the Food and Drug Administration (FDA) approved clinical trials for PolyHeme, to be used in cases of “urgent blood loss when blood is not immediately available.”

-The Center for Bloodless Medicine & Surgery Fall 2003 Newsletter

Perfect Fluid Replacement

- Volume expansion with prolonged vascular effect
- Oxygen carrying capacity
- Universal blood compatibility
- No adverse effects
- Possess a long shelf life
- Stable at extreme temps
- Low infused volume



Critical Care

- Sicker patients being maintained in ICU for longer periods.
- We are getting really good and they just WON'T die (only kidding)
- Tell the standing Exploratory Lap and Craniotomy at Shock-Trauma
- Anesthesia for sicker patients
- Damage Control Surgery re-dos

Impact of New Technologies

- TIME
- COST
- OUTCOME
- Examine the research
- Try it out on your population
- Is it just a toy or will it change practice

- Keep up to date

Finally...



- Trauma is FUN
- Trauma is not rocket science
- Rocket science is helping trauma patients survive
- Thank you for what you do
- Trauma is no accident...the life you save may be your own!