



Fluid Resuscitation: How far have we come?

JOSHUA DAMIAN, MD

BURN & RECONSTRUCTIVE SURGERY, TRAUMA &
SURGICAL CRITICAL CARE, GENERAL SURGERY
FLAGSTAFF SURGICAL ASSOCIATES

1

DISCLOSURES: None

2

Learning Objectives

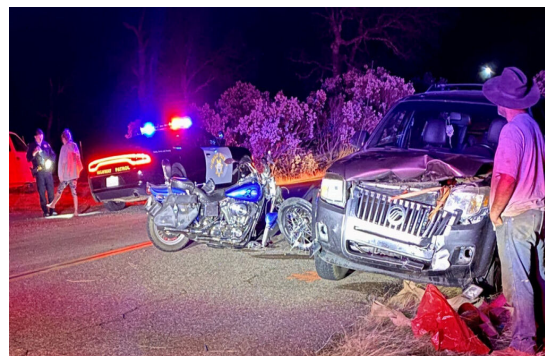
- ☐ Understand the historical significance of resuscitation of the medical/trauma patient
- ☐ Review historical resuscitation methods and compare with present-day approaches
- ☐ Identify similarities and differences in resuscitation methods
- ☐ Identify the paradigm shift in resuscitation and extrapolate to future advances in the field

3

The Real World

38 year old female who presents as a Trauma CRITICAL activation after being involved in a motorcycle accident. She was a helmeted passenger when a SUV pulled out in front of the bike, causing the motorcycle to T-Bone the vehicle. Both riders were ejected. Driver was a trauma CODE on scene and declared on EMS arrival. Patient complaining of back, pelvic, and bilateral arm pain – notable deformities to the bilateral wrists with open fractures appreciated by EMS crew. Hypotension noted in the field – pelvic binder placed. Placed in C-collar, arms splinted, and patient strapped to backboard and brought in by air.

- ☐ Trauma Bay Arrival
 - ☐ GCS 15
 - ☐ BP 90/40
 - ☐ HR 118
 - ☐ RR 25
 - ☐ SP02 93% on 2 LPM nasal cannula
 - ☐ 1 L NS 0.9% given in the field



4

What do we mean by "fluid resuscitation"?

Resuscitation = to revive or restore back to prior state (a return to)

In the context of medicine, resuscitation refers to restoring normal hemodynamic and homeostatic mechanisms.

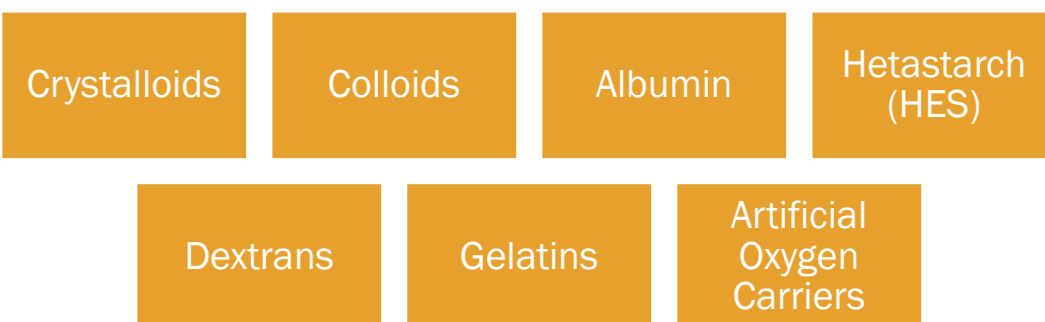
Specific to trauma and critical illness, resuscitation slightly changes its definition to also become focused on PREVENTION of the lethal triad of trauma and subsequent secondary injury.

So...

Fluid resuscitation = utilization of various fluids to restore the body's physiology to homeostasis and normal function, while preventing subsequent secondary injury

5

Fluid Types – Which to choose?



6

A Short History of Fluid Resuscitation

7



8

William Brooke O'Shaughnessy

- ❑ Irish physician
- ❑ 1831: First documented case of repletion of patient's intravascular volume via IV
- ❑ Inciting event: CHOLERA OUTBREAK



Noted loss of large volume water, sodium chloride, and bicarbonate in patient stools, and postulated that repletion of these components could occur only through: "absorption, by imbibition, or by the injection of the aqueous fluid into the veins."

9

Early Pioneers (up to 1930)



- 1831: First documented case of repletion of patient's intravascular volume via IV; Irish physician, Dr. William Brooke O'Shaughnessy
- 1883: Lactated ringers solution created by Sydney Ringer; first "balanced" solution
- 1896: NS (current form) created from Joseph Hamburger, Dutch physiologist
- 1930: LR solution modified to current form by Alexis Hartmann

10

The Era of Burns

- 1906: Haldor Sneve, MD demystifies burn "toxemia" → burn hypovolemia
- 1921: Rialto Theater fire, New Haven, Conn → Dr Frank Underhill & the concept of prevention of secondary injury after inhalation burns
- 1931: Alfred Blalock → lab experiments in burns demonstrating insensible fluid losses and quantified these based on %TBSA
- 1942, Jan 7 → National Research Council meeting to originate burn-size-based resuscitation formulas and traumatic resuscitation formulas
 - Drs Cope and Moore develop first burn resuscitation formula based on surface area* (hallmark of all burn formulas developed after)
- 1953: Brooke formula for Burn Resuscitation, G. Tom Shires

11



1968: Parkland formula developed by Baxter and Shires @ UTSW

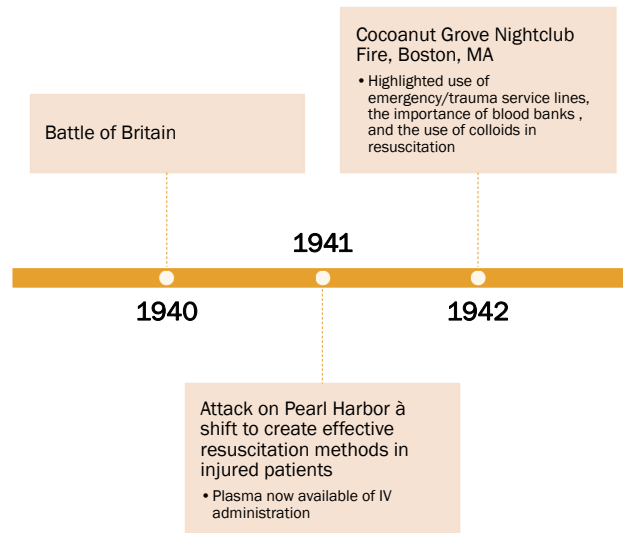
*Most significant contribution of direct fluid resuscitation efforts in Burn and Trauma world

12

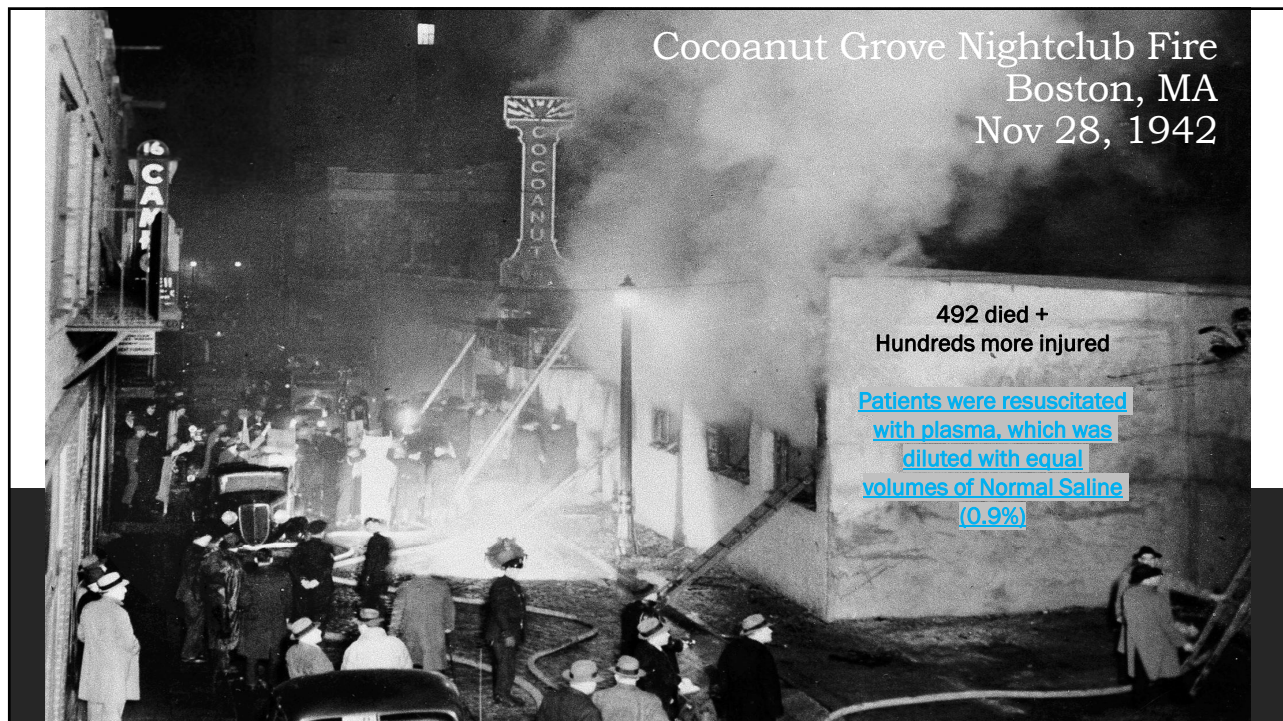
Wartime Advancement

Mass casualty events drive medical science forward with innovation

Fluid resuscitation was no different during these times...



13



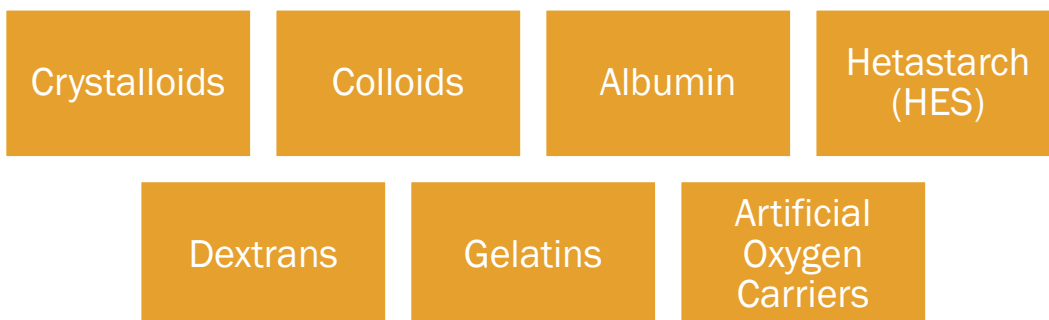
14

Trauma & Critical Care

- 1994: Bickell and Colleagues demonstrated the benefits of restricted fluid resuscitation;
Precursor to damage control resuscitation
- 1994 - 2011: Damage control resuscitation formalized and refined
 - Dutton, J Trauma 2002
 - Morrison, J Trauma 2011

15

Fluid Types – Which to choose?



16

Fluid Choice – A Controversial Topic

Balanced crystalloids (LR or PlasmaLyte)	Normal Saline	Colloids/HES/Albumin/Dextrans/Etc.
<ul style="list-style-type: none">• Most commonly used solutions• PROS<ul style="list-style-type: none">• Readily available, inexpensive• PlasmaLyte = osmolality closer to serum, and instead of lactate, has gluconate and acetate• Negligible benefit of electrolytes in solution• CONS<ul style="list-style-type: none">• Not replacing what is lost in hemorrhagic shock with like	<ul style="list-style-type: none">• PROS<ul style="list-style-type: none">• Cheap, also readily available• Great in prehospital settings• CONS<ul style="list-style-type: none">• May decrease renal blood flow and GFR resulting in worsening AKI• Large volumes result in hyperchloremic metabolic acidosis• Not replacing what is lost in hemorrhagic shock with like	<ul style="list-style-type: none">• Physiologic defense for use = Starling equation to increase plasma oncotic pressure• CONS<ul style="list-style-type: none">• RCTs have not demonstrated an overall improvement in mortality• HES solutions = too many negative side effects• Cochrane review & AKI risk/CRRT• European Medicines Agency declaration in 2013

17

RCT Data

1. SPLIT Trial (Young & colleagues; JAMA 2015)

Compared NS versus PlasmaLyte use on AKI in ICU patients) → equivalent use

Results:

****No difference in inflammation, impaired renal function, increased pressor reqs, increased transfusion reqs, or increased mortality***

2. CRISTAL Trial (Crystalloids versus colloids for resuscitation in ICU patients with hypovolemic shock) (Annane, et al; JAMA 2013)

Results:

****Resuscitation with colloids appears not to reduce the risk of death, compared to resuscitation with crystalloids.***

****Furthermore, the use of hydroxyethyl starch appears to increase mortality.***

18

Modern-day Resuscitation Strategies

19

Fluid-Responsiveness	Fluid-Tolerant	Damage-Control	Hemostatic
<ul style="list-style-type: none">• AIM: 10-15% increase in patient's cardiac output (Bentzer, JAMA 2016)• Most commonly used by anesthesia• Fluid bolus based	<ul style="list-style-type: none">• Holistic approach• AIM: use patient's history, current presentation, and adjuncts (such as bedside US) to determine whether patient will benefit or be harmed with IVF	<ul style="list-style-type: none">• Morrison, J Trauma 2011), (Dutton, J Trauma 2002), (Bickell, NEJM 1994)• AIM: maintain the minimal BP to continue end organ perfusion until hemorrhage control is achieved• RCT Results = IMPROVES OVERALL SURVIVAL	<ul style="list-style-type: none">• AIM: maintain intravascular volume, O2 carrying capacity, and normal coagulation through early use of blood products that approximates ongoing losses• PROPPR Trial (Holcomb, et al, JAMA 2015)

20

So which resuscitation strategy is
BEST?



21

The Answer is...

BEST PRACTICES:

*Frequent reassessment and use of IVF and adjuncts as a **BRIDGE**
until definitive control of patient's source of shock can be
addressed is safest and most effective approach*

*There is evidence of harm associated with aggressive IVF resuscitation, so best to avoid

22

Wrapping Up

Where do we go from here?

- ❑ Continuous reevaluation and ongoing investigations using new biomedical adjuncts and new technologies
- ❑ Studies in ICU patients, Trauma, and Sepsis dominate
- ❑ Follow the data

A photograph showing a tall wooden post covered in numerous small, colorful directional signs pointing in various directions. The signs are made of wood and painted in bright colors like red, yellow, green, blue, and black. Some signs have text such as "ACAPULCO", "LA JALISA", "BRASIL", "GRECIA", "COLOMBIA", and "XOLO". The post is situated on a rocky beach with waves crashing against the rocks in the foreground. In the background, there's a clear blue sky and the ocean horizon.

- [illegible]

Thank you!

Questions/ Comments?

*Please send to Suzanne Tackitt
(Suzanne.Tackitt@nahealth.com)*

References

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6. Annane D, Siami S, Jaber S, et al, for the CRISTAL Investigators. Effects of fluid resuscitation with colloids vs crystalloids on mortality in critically ill patients presenting with hypovolemic shock. JAMA 2013;310(17):1809-1817.