WHAT'S “NEW-ISH” IN ARDS MANAGEMENT AFTER TRAUMA?

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DISCLOSURE

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OBJECTIVES

1. Understand how ARDS develops in trauma patients.
2. Understand the effects of IVFs on hypoxemia
3. Review recent trauma blood trials with a focus on hypoxemia
4. Outline ongoing/upcoming trials.
A BRIEF HISTORY OF TRAUMA RESUSCITATION

TRAUMA DEATH IS TRIMODAL

HISTORY OF TRAUMA RESUSCITATION

- Hemorrhage = 30-40% of early deaths
- Early control of hemorrhage saves lives

HEMORRHAGIC DEATH

OTHER

Pre-hospital First 24 hours After 24 hours

Percentage of deaths

Percentage of deaths
HISTORY OF TRAUMA RESUSCITATION

• The ubiquitous use of blood transfusions to injured soldiers during WWII
  - Rh blood group system discovered, 1939
  - US American Red Cross collections, 1940
  - Breakdown of plasma components, 1940
  - Plasma recommended as the primary fluid for resuscitation
  - In the end, albumin over plasma due to risk of hepatitis
• By 1945, 13 million pints collected by Red Cross

BLOOD COMPONENT THERAPY

CRYSTALLOID AS A BLOOD ADJUNCT

Shires et al (1964) and 30 dogs
  - Best replenished with balanced salt solutions (lactated ringer’s) and blood
  - Vietnam War
    - Blood + IVFs = SOP
    - Rapid helicopter transport
    - Less renal failure
    - “Da Nang Lung”

DA NANG LUNG

"Bilateral Infiltrates"

ACUTE RESPIRATORY DISTRESS SYNDROME

The Lancet · Saturday 12 August 1967

ACUTE RESPIRATORY DISTRESS IN ADULTS

Ashbaugh D et al.

Lancet. 1967;2(7511): 319-323

“STANDARD” TRAUMA RESUSCITATION PARADIGM

Crystalloid 3:1 Ratio to lost blood

- Transient or no response
- Blood
  - 6-10 units PRBC
  - FFP, platelets, cryoprecipitate
- Crystalloid
PROBLEMS WITH THE "STANDARD"

The Lethal Triad

Acidosis
Hypothermia
Coagulopathy

Death

"Cool-Aid Effect" = ARDS AFTER TRAUMA

- A “Disease of Survivorship”
- Of those who survive major trauma
  - >70% develop acute lung injury
  - 30% of those with acute lung injury die
  - The majority die within the first week
- How can we prevent ARDS development?
- When it develops, how can we mitigate its demise?


WHAT IS ARDS IN 2016?

Ranieri V et al. JAMA. 2012;307(23):2526-33
CURRENT ARDS CARE

LUNG PROTECTIVE MECHANICAL VENTILATION

- SMALLER BREATHS AND LESS PRESSURE after ARDS Dx

- ARDSnet
- 10 centers
- 12 vs. 6-8 ml/kg Vt of PBW
- Mean plateau pressures of 33 vs. 25 cm H2O
- N=861

Outcomes
1. Death prior to discharge
2. Vent-free days in 28.

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TABLE 4. MAIN OUTCOME VARIABLES.*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Group Breathing Low Volumes</th>
<th>Group Breathing Tidal Volumes</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death before discharge home and breathing without resistance (%)</td>
<td>31.0</td>
<td>39.8</td>
<td>0.067</td>
</tr>
<tr>
<td>Bacteria without assistance up to 34 days</td>
<td>44.7</td>
<td>55.6</td>
<td>0.001</td>
</tr>
<tr>
<td>No. of ventilator-free days, days 1 to 28</td>
<td>12±11</td>
<td>10±11</td>
<td>0.007</td>
</tr>
<tr>
<td>Ventilation, days 1 to 28 (%)</td>
<td>30</td>
<td>11</td>
<td>0.45</td>
</tr>
<tr>
<td>No. of days without failure of respiratory organs or systems, days 1 to 28</td>
<td>15±11</td>
<td>12±11</td>
<td>0.006</td>
</tr>
</tbody>
</table>

*Death before discharge home and breathing without resistance and Bacteria without assistance up to 34 days were not significantly different between the two groups.
**LESS CRYSTALLOID**

- ARDSnet trial
- Conservative vs liberal strategy of fluid management
- Explicit protocol for IVFs/diuresis for 7 days
- N=1000 patients
- Primary outcome
  1. 60-day death
  2. Ventilator use
  3. Organ failure

Wiedemann et al. *NEJM* 2006

**Table 1: Main Outcome Variables**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Conservative</th>
<th>Liberal</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days 0-1</td>
<td>19.0 ± 1.1</td>
<td>23.4 ± 1.8</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Days 1-7</td>
<td>1.6 ± 0.1</td>
<td>2.3 ± 0.3</td>
<td>0.01</td>
</tr>
<tr>
<td>Days 8-14</td>
<td>1.6 ± 0.1</td>
<td>2.3 ± 0.3</td>
<td>0.01</td>
</tr>
<tr>
<td>Days 15-28</td>
<td>1.6 ± 0.1</td>
<td>2.3 ± 0.3</td>
<td>0.01</td>
</tr>
<tr>
<td>Days 29-35</td>
<td>1.6 ± 0.1</td>
<td>2.3 ± 0.3</td>
<td>0.01</td>
</tr>
<tr>
<td>Days 36-42</td>
<td>1.6 ± 0.1</td>
<td>2.3 ± 0.3</td>
<td>0.01</td>
</tr>
<tr>
<td>Days 43-49</td>
<td>1.6 ± 0.1</td>
<td>2.3 ± 0.3</td>
<td>0.01</td>
</tr>
<tr>
<td>Days 50-56</td>
<td>1.6 ± 0.1</td>
<td>2.3 ± 0.3</td>
<td>0.01</td>
</tr>
<tr>
<td>Days 57-63</td>
<td>1.6 ± 0.1</td>
<td>2.3 ± 0.3</td>
<td>0.01</td>
</tr>
<tr>
<td>Days 64-70</td>
<td>1.6 ± 0.1</td>
<td>2.3 ± 0.3</td>
<td>0.01</td>
</tr>
</tbody>
</table>

Wiedemann et al. *NEJM* 2006
LESS CRYSTALLOID

CURRENT ARDS CARE

LESS CRYSTALLOID, MORE BLOOD

DAMAGE CONTROL RESUSCITATION

• DCR Definition:
  • Avoidance of crystalloid
  • Blood component therapy in ratios = whole blood
  • “1 to 1 to 1”
  • 1 unit PRBC to
  • 1 unit FFP to
  • 1 unit platelets
Transfusion related lung injury (TRALI)

- Definition: Acute lung injury that occurs within 6-72h of transfusion and is not related to other RF for ARDS.
- Mayo Clinic, retrospective eval of N=841 patients without ARDS at the time of MICU admission

Khan H et al. CHEST. 2007;131: 1308-1314.

PROMMTT TRIAL: RISK OF HYPOXEMIA


PROMMTT TRIAL: RISK OF HYPOXEMIA

PROPPR: RISK OF ARDS

<table>
<thead>
<tr>
<th>Variable</th>
<th>Univariate</th>
<th>Multivariate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>1.10 (0.89-1.35)</td>
<td>1.04 (0.86-1.26)</td>
</tr>
<tr>
<td>Sex (male)</td>
<td>1.80 (0.57-5.50)</td>
<td>0.80 (0.26-2.68)</td>
</tr>
<tr>
<td>Injury mechanism (surgery)</td>
<td>1.07 (0.88-1.30)</td>
<td>1.04 (0.82-1.32)</td>
</tr>
<tr>
<td>SAP at time of injury</td>
<td>0.12 (0.05-0.30)</td>
<td>0.18 (0.08-0.42)</td>
</tr>
<tr>
<td>ICU LOS +1st day (hrs)</td>
<td>0.88 (0.67-1.15)</td>
<td>0.89 (0.68-1.20)</td>
</tr>
<tr>
<td>Fever (°F)</td>
<td>1.08 (0.87-1.36)</td>
<td>1.07 (0.85-1.35)</td>
</tr>
<tr>
<td>ICU ARDS</td>
<td>1.08 (1.01-1.15)</td>
<td>1.03 (0.97-1.09)</td>
</tr>
<tr>
<td>Acute renal failure</td>
<td>0.96 (0.79-1.17)</td>
<td>0.98 (0.82-1.16)</td>
</tr>
<tr>
<td>Acute liver failure</td>
<td>1.12 (0.90-1.40)</td>
<td>1.09 (0.87-1.38)</td>
</tr>
<tr>
<td>WBC at time of injury</td>
<td>1.25 (0.99-1.58)</td>
<td>1.25 (0.99-1.58)</td>
</tr>
<tr>
<td>ICU ARDS</td>
<td>0.97 (0.79-1.20)</td>
<td>0.96 (0.78-1.18)</td>
</tr>
<tr>
<td>ARDS at time of injury</td>
<td>1.01 (0.88-1.15)</td>
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<tr>
<td>ICU ARDS</td>
<td>0.99 (0.85-1.15)</td>
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<td>Inotrope given at the time of injury</td>
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**2L!!

PROPPR: RISK OF ARDS

IVFs given 0-6 hours for those +/- ARDS (P<0.0001**).

WHAT’S NEW IN ARDS

PREEMPTIVE LOW TIDAL VOLUME VENTILATION
PREEMPTIVE LOW TIDAL VOLUME VENTILATION

- ARDSnet now PETAL
- Prospective, randomized trial
- “LOTUS”
- May 2017
- 48h of 6 mL/kg of PBW
- vs. standard of care
- Outcome
  1. Mortality
  2. Vent usage
- Trauma patients <10% of ARDSnet/PETAL cohort...

WHAT’S NEW IN ARDS

VITAMIN D REPLACEMENT

- Prospective, double blind control trial of Vit D replacement in those
  a. Vit D deficiency, \( \leq 20 \text{ ng/mL} \)
    - N=475 patients
  b. Severe Vit deficiency, \( \leq 12 \text{ ng/mL} \)
    - N=200 patients
- Single center study of ICU patients with low Vit D.
- Outcome
  1. Hospital LOS
  2. ICU LOS, 7 day, in-hospital, 6-month mortality

Amrein K et al. JAMA. 2014;312(15):1520-1530.
VITAMIN D REPLACEMENT

- PETAL
  - Prospective, multicenter randomized, trial
  - “VIOLET”
  - Spring 2017
  - POC Vit D testing
  - Supplementation of those with severe deficiency
  - 90 day mortality

OTHER ADJUNCTS

- Pronation therapy in severe ARDS works, probably

- PETAL – ROSE trial for early paralytics

- EOLIA trial (ECMO to rescue Lung Injury in severe ARDS) trial
 QUESTIONS?

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 SUMMARY

1. Crystalloid is bad
2. Blood is good
3. ARDS ventilation before ARDS
4. Take your vitamins (D)

 THANK YOU