Whole Blood Resuscitation in Trauma

HEALTH
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OVERVIEW

- Introduction
- Historical context
- Current challenges
- Importance for critical care physicians

FROM BATTLEFIELDS TO CIVILIAN CARE

FIGURE 75.—Medical care on Omaha Beach, June 1944. Note the absence of a litter.

The National WWII Museum

TRANSITION TO INDIVIDUAL COMPONENTS

- Economics of blood banking
- Specific components for cytopenias
- HIV epidemic
- ABO-specific WB mandate
- No PLT-sparing LR filter
- Question of viable cold storage PLT

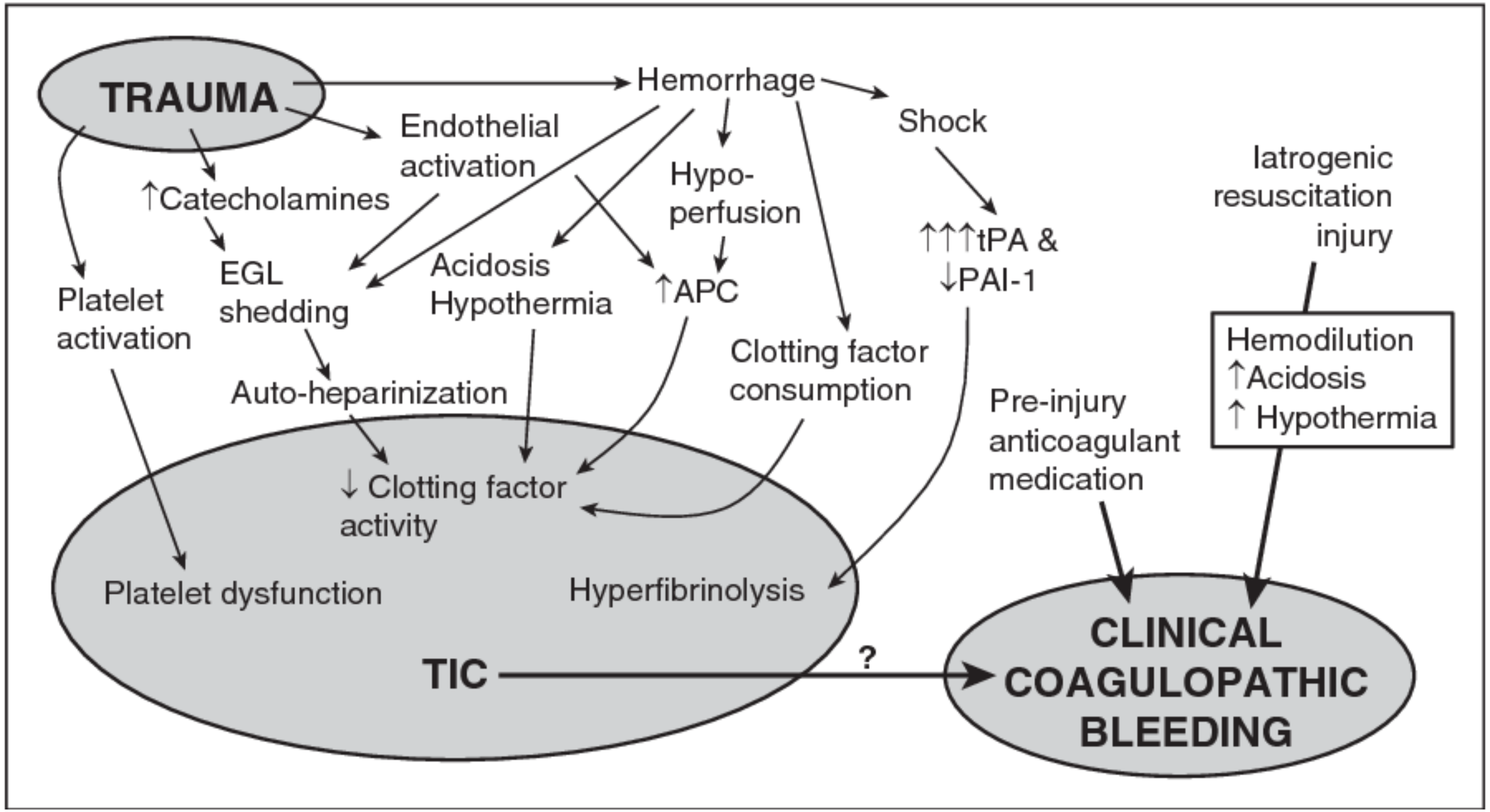
Spinella, et al. Transfusion Vol 56, 2016

TRAUMA

- Leading cause of death < age 45
- 20-40% of deaths after admission involved massive hemorrhage
  - 70% in the first 6 hours after arrival
  - Potentially preventable
- Up to 25% of bleeding trauma patients are coagulopathic on arrival

Wilderness Medicine Blog

TRAUMA-INDUCED COAGULOPATHY



Chang, et al. DOI 10.1182/blood-2016-01-636423.

DAMAGE CONTROL RESUSCITATION

- Rapid hemorrhage control
- Early use of *component therapy* (CT) to replicate WB
  - 1:1:1
- Minimize crystalloids
- US DOD made standard of care in 2004

JAMA. 2015;313(5):471-482. doi:10.1001/jama.2015.12

PROPRR TRIAL

- RCT of 680 patients comparing 1:1:1 to 1:1:2
- No mortality difference
- More 1:1:1 achieved hemostasis and fewer died due to bleeding by 24 hours

JAMA. 2015;313(5):471-482. doi:10.1001/jama.2015.12

RENEWAL OF WB INTEREST

Transfusion News

RENEWAL OF WB INTEREST

More feasible than CT in combat setting when demand > supply

Committee on Tactical Combat Casualty Care recommended WB as the optimal resuscitation product in 2014

Superior hemostatic profiles

No additional cold, acidic fluids

Hanna et al. J Trauma Acute Care Surg Volume 89, Number 2

RENEWAL OF WB INTEREST

- Lower volume
- No need to be thawed or spun
- 14-21 day shelf life at 1-6 C
- Can be given warmed
- Lower risk of admin error
- Promotes balanced resuscitation

Hanna, et al. Current Anesthesiology Reports (2022) 12:234–239

Table 1 Whole blood composition compared to component therapy

Component therapy (675 mL)	Whole blood (500 mL)
1 unit of pRBC = 335 mL with hematocrit of 55%	Hematocrit of 38–50%
1 unit of PLTs = 50 mL with 88 K platelets	Platelet count of 150–400 K
1 unit of FFP = 275 mL with 80% coagulation activity	Plasma coagulation factors = 100%
1 unit of cryoprecipitate = 15 mL with 150 mg of fibrinogen	Fibrinogen = 1000 mg
Thus, 1 unit of pRBC + 1 unit of PLTs + 1 unit of FFP + 1 unit of cryoprecipitate = 675 mL with hematocrit of 29%, platelet count of 88 K and coagulation activity of 65% compared with WB	

pRBC packed red blood cells, *PLTs* platelets, *FFP* fresh frozen plasma, *WB* whole blood.

Hanna, et al. Current Anesthesiology Reports (2022) 12:234–239

LOW TITER TYPE O WHOLE BLOOD

- Due to risk of TRALI
- Low levels of anti-A and anti-B IgM

- Rh + for males
- Rh – for females of child bearing age

Hanna, et al. Current Anesthesiology Reports (2022) 12:234–239

MILITARY OUTCOMES

- Spinella, et al.
  - Retrospective, 354 soldiers with WB vs CT
  - 95% vs 82% 30d survival ($p=0.002$)
  - MV regression OR 12.4 (1.8-80; $p=0.01$)

Spinella, et al. J Trauma. 2009;66:S69–76.

CIVILIAN OUTCOMES

- Cotton, et al. 2013
- RCT pilot; 107 patients
- No reduction in transfusion volumes

- Excluding TBI, WB reduced transfusion
  - pRBC 3 vs 6, p=0.02
  - Plasma 4 vs 6, p=0.02
  - Platelets 0 vs 3, p=0.09
  - Total 11 vs 16, p=0.02)

Cotton et al. Ann Surg Vol 258, no 4, 2013

CIVILIAN OUTCOMES

- Hanna, et al. 2020
  - Retrospective, 8,494 TQIP patients
  - WB as an adjunct to CT improved outcomes
    - reduced 24-h mortality (OR 0.78 [0.59–0.89]; $p = 0.006$)
    - in-hospital mortality (OR, 0.88 [0.81–0.90]; $p = 0.011$)
    - major complications (OR, 0.92 [0.87–0.96]; $p = 0.013$)
    - LOS (9 vs 15d, p=0.013)

Hanna et al. J Trauma Acute Care Surg. 2020;89: 329–335

CIVILIAN OUTCOMES

- Williams,et al.
- 350 patients, WB vs CT by air transport and ED
  - 53% reduction in post-ED transfusion

    (OR 0.47, 0.23-0.94; p=0.047)
  - 2x increased likelihood of survival

    (OR 2.19; 1.01-4.76; p=0.047)

Williams, et al. J Trauma Acute Care Surg Vol. 88, No 1

CHALLENGES

COST ($170K/YR)

SHIPPING & HANDLING

WASTE

FUTURE DIRECTIONS

- Childbearing age females
- Pediatrics
- Cold-stored platelets
- Efficient use
- MCTs
- Cardiac surgery, liver transplant and OB are following suit