Massive Transfusion and Trauma Resuscitation Guideline

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Purpose

This guideline standardizes the evidence-based approach to massive transfusion and trauma resuscitation. Rapid, balanced, and targeted resuscitation improves survival rates, reduces the development of coagulopathy, and minimizes preventable mortality following traumatic hemorrhage. Emphasis is placed on hemostatic resuscitation principles, minimizing crystalloid use, and early correction of coagulopathy.

Initial Resuscitation: 1:1:1 Strategy

Definition of Massive Transfusion

Massive transfusion is defined as:

- Replacement of ≥10 units of packed red blood cells (pRBCs) within 24 hours, or
- Transfusion of ≥4 units of pRBCs within 1 hour with ongoing hemorrhage and anticipated continued transfusion needs (Holcomb et al., 2015).

Early recognition and activation of massive transfusion protocols (MTP) are critical for optimizing outcomes.

Resuscitation Ratio

- Blood products should be transfused in a 1:1:1 ratio:
  1-unit pRBCs: 1-unit Fresh Frozen Plasma (FFP): 1 dose Platelets (Holcomb et al., 2015).
- This approach mimics whole blood composition, restoring both oxygen-carrying capacity and coagulation factors, reducing dilutional coagulopathy.

Transfusion Sequence

Alternate units

- Administer 1-unit pRBC → 1-unit FFP → repeat sequentially.
- Platelets and cryoprecipitate to be added per laboratory or clinical indicators.

This sequential strategy ensures hemostatic balance is maintained during ongoing resuscitation.

Equipment

- ***Belmont Rapid Infuser*** is used for delivering pRBCs and FFP under pressure at controlled temperatures to maintain normothermia.
- ***Platelets*** and ***Cryoprecipitate*** must be administered by gravity to avoid shear-induced damage to clotting proteins and platelets.

Calcium Supplementation

- Administer *1 gram calcium gluconate IV* after every *6 units of pRBCs* transfused to mitigate citrate-induced hypocalcemia, which can impair cardiac contractility and worsen coagulopathy (Spahn et al., 2019).

Survival Benefit

- The PROPPR trial demonstrated that a 1:1:1 ratio resuscitation strategy significantly improved hemostasis achievement by 12% and reduced 24-hour mortality by 9% compared to a 1:1:2 ratio (Holcomb et al., 2015)

Use of Tranexamic Acid (TXA)

Indications

- Administer TXA to all bleeding trauma patients presenting within 3 hours of injury, regardless of injury mechanism or hypotension (CRASH-2 Trial Collaborators, 2010).

Dosing

- Initial bolus: 1 g IV over 10 minutes.
- Maintenance infusion: 1 g IV over 8 hours.

Early administration is paramount; every 15-minute delay decreases its benefit.

Key Points

- TXA inhibits plasminogen activation, preventing clot degradation.
- It does not promote new clot formation but stabilizes existing clots.
- Administration beyond 3 hours post-injury is associated with increased mortality and should be avoided (CRASH-2 Trial Collaborators, 2010).

Survival Benefit

- Administration of TXA within 1 hour of injury provides an absolute mortality reduction of 1.5% (from 16% to 14.5%) and reduces risk of death from hemorrhage by approximately 0.8% (CRASH-2 Trial Collaborators, 2010).

Use of DDAVP (Desmopressin)

Indications

Suspected or known platelet dysfunction, such as:

- Antiplatelet drug use (aspirin, clopidogrel).
- Uremic platelet dysfunction.
- Mild Type 1 von Willebrand disease.

Selective use may support hemostasis when platelet function is impaired (Spahn et al., 2019).

Dosing

- 0.3 µg/kg IV administered over 15–30 minutes.
- Rapid administration may cause hypotension; monitor hemodynamics closely.

Key Points

- Mechanism: DDAVP promotes release of von Willebrand factor and factor VIII from endothelial stores, improving platelet adhesion and aggregation.
- Its effect peaks within 30 minutes and lasts approximately 6–12 hours.
- Repeated dosing is generally not recommended due to tachyphylaxis.

Survival Benefit

- Although no large randomized controlled trials (RCTs) have demonstrated a direct survival benefit of DDAVP in trauma patients, selective use supports hemostatic efficacy, particularly in patients with impaired primary hemostasis (Spahn et al., 2019).

Use of Prothrombin Complex Concentrate (PCC)

Indications

- Urgent reversal of vitamin K antagonist (warfarin) therapy in actively bleeding patients.
- Correction of trauma-induced coagulopathy refractory to plasma transfusion.

Dosing

Warfarin Reversal

- INR 2–4: 25 units/kg IV.
- INR 4–6: 35 units/kg IV.
- INR >6: 50 units/kg IV (Nandwani et al., 2020).

Empiric trauma use (if INR >1.5 with major bleeding): 25 units/kg IV.

Concurrent administration of Vitamin K 5–10 mg IV is necessary to sustain INR correction after PCC administration.

Key Points

- PCC contains factors II, VII, IX, and X, along with proteins C and S.
- It corrects INR more rapidly and with smaller infusion volumes compared to plasma, reducing the risk of fluid overload and transfusion-related complications.

Survival Benefit

- Studies demonstrate that PCC use achieves INR correction 15–20% faster than plasma alone, facilitating earlier surgical intervention and possibly improving survival in exsanguinating trauma patients (Grottke et al., 2015).

Additional Principles

Fibrinogen Replacement

- If fibrinogen level <150 mg/dL or functional fibrinogen assay indicates deficiency:
- Administer 10 units pooled Cryoprecipitate (Spahn et al., 2019).
- Fibrinogen is critical for clot strength and stability; its depletion correlates with worse outcomes.

Temperature Control

- Maintain patient core temperature ≥36°C.
- Hypothermia (<35°C) independently exacerbates coagulopathy, acidosis, and mortality (Spahn et al., 2019).

pH Management

- Correct metabolic acidosis aggressively.
- A pH <7.2 impairs enzymatic activity of clotting factors and potentiates coagulopathy.

Calcium Monitoring

- Hypocalcemia exacerbates hypotension, reduces myocardial performance, and impairs coagulation.
- Maintain **ionized calcium >1.0 mmol/L** with appropriate supplementation after massive transfusion (Spahn et al., 2019).

Point-of-Care Coagulation Testing

- TEG or ROTEM can provide dynamic, real-time information on clot formation and strength, allowing targeted transfusion therapy.

Version Control Record			
Version	**Date**	**Author/Reviewer**	**Description of Changes**
1	8/21/2024	Paul Wisniewski, D.O.	Initial review and update to reflect latest evidence/practice

References

- Holcomb JB, Tilley BC, Baraniuk S, et al. (2015). *Transfusion of Plasma, Platelets, and Red Blood Cells in a 1:1:1 vs a 1:1:2 Ratio and Mortality in Patients with Severe Trauma*. **JAMA**, 313(5), 471–482. https://doi.org/10.1001/jama.2015.12
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