Major Hemorrhage

Massive transfusion · damage-control resuscitation · stop the bleeding, do not just replace it

TXA < 3 h
and blood, not saline

ACTIVATE EARLY, AND ON CLINICAL GROUNDS

Loss of one blood volume in 24 h, 50% in 3 h, bleeding faster than 150 mL/min, or transfusion needed to stay alive. Do not wait for a hemoglobin: the initial value is normal in brisk bleeding because the patient has not yet hemodiluted, so a reassuring number early means nothing. **Activating the protocol is what gets balanced products to the bedside** instead of sequential single units, and under-activation is far more damaging than over-activation.

FIRST MOVES *control the source while you resuscitate; these run in parallel*

STOP THE BLEEDING

Direct compression, tourniquet, hemostatic packing, pelvic binder. Definitive control by surgery, interventional radiology or endoscopy is the actual treatment: transfusion only buys the time to get there. **Call surgery, IR and hematology at activation**, not once products are running.

TXA WITHIN 3 HOURS

Tranexamic acid 1 g IV over 10 min, then 1 g over 8 h (CRASH-2, Lancet 2010; CRASH-3, Lancet 2019 for head injury). **Earlier is better and the benefit decays fast. Given beyond 3 h it is associated with harm**, so the time of injury, not the time of arrival, is what counts.

RESTRICT CRYSTALLOID

Give blood, not liters of saline. Crystalloid **dilutes clotting factors, worsens acidosis and drops the temperature**, feeding the lethal triad. **Permissive hypotension to a systolic of about 80 to 90** until bleeding is controlled, so you do not pop a fresh clot. **The exception is traumatic brain injury**, where the injured brain needs perfusion: target a **MAP of at least 80**.

TRANSFUSE *empiric ratio first, then goal-directed once numbers are back*

Target	Aim	If not met
Empiric ratio	**RBC : FFP : platelets = 1 : 1 : 1** in fixed packs until labs return	PROPPR, JAMA 2015 compared 1:1:1 with 1:1:2. **Its primary endpoints, 24-h and 30-day mortality, were negative.** The 1:1:1 group achieved more hemostasis and fewer deaths from exsanguination at 24 h, which were **secondary** findings, and that is the honest basis for the balanced ratio.
Hemoglobin	**7 to 9 g/dL** during active bleeding	Transfuse red cells. Do not chase a normal hemoglobin while still bleeding.
Platelets	**> 50**, and **> 100** for CNS or eye injury, or ongoing bleeding	One adult pool.
Fibrinogen	**> 1.5 to 2.0 g/L**	**Cryoprecipitate or fibrinogen concentrate. Fibrinogen falls first and fastest of all the clotting factors**, so it is the one most often left uncorrected.
PT / aPTT	**< 1.5 × normal**	FFP 15 to 20 mL/kg, or **PCC if on warfarin**.
Ionized calcium	**> 1.1 mmol/L**	**IV calcium chloride or gluconate. Stored blood is citrated and citrate chelates calcium**, so massive transfusion reliably causes hypocalcemia. **Calcium is required for the clotting cascade and for myocardial contractility**, making this a cause of both refractory coagulopathy and refractory hypotension. Check it early and repeatedly.

THE LETHAL TRIAD *each element worsens the other two, so all three are treated at once*

HYPOTHERMIA

Clotting enzymes are temperature-dependent and slow markedly below 34 °C, so a cold patient is coagulopathic whatever the numbers say. **Warm the patient, the fluids and the blood**, use forced-air warming, and stop exposing them once the survey is done.

ACIDOSIS

Acidosis impairs the clotting cascade and blunts the response to vasopressors. The fix is **restoring perfusion and stopping the bleeding**, not bicarbonate. Follow lactate and base deficit as resuscitation markers.

COAGULOPATHY

Trauma-induced coagulopathy is present on arrival in a substantial minority, before any dilution. **Balanced ratio plus TXA plus calcium**, then **viscoelastic testing (ROTEM or TEG)** to target the specific defect once available.

BY SETTING, AND WHAT TO REVERSE

Setting	Additional measures
Trauma	**Damage-control resuscitation and damage-control surgery**: control contamination and bleeding, then return once resuscitated rather than completing a long operation on a cold, acidotic patient. **Pelvic binder, early CT or straight to the operating room, TXA early.**
Obstetric	**Uterotonics, bimanual compression, balloon tamponade, and the operating room. TXA early.** Obstetric hemorrhage is frequently underestimated because young patients compensate until they crash.
GI	**Endoscopy or interventional radiology**; in variceal bleeding add **octreotide and ceftriaxone**. Surgery if uncontrolled.
Reverse anticoagulants	**Warfarin: 4-factor PCC plus vitamin K. DOACs: idarucizumab for dabigatran, andexanet alfa for factor Xa inhibitors**, or PCC if unavailable. **Ask what they take at activation**, since this changes the products you need.

MONITOR, AND KNOW WHEN TO STOP *over-transfusion has its own harms*

WHAT TO REPEAT, AND HOW OFTEN

Full blood count, coagulation screen, fibrinogen, blood gas (lactate and base deficit) and ionized calcium every 30 to 60 min during active bleeding. **Numbers drawn an hour ago describe a patient who no longer exists**, which is why viscoelastic testing at the bedside is preferred once available.

DE-ESCALATE ONCE CONTROLLED

Stand the protocol down deliberately and tell the blood bank, or products keep arriving. **Over-transfusion causes TACO, TRALI, hyperkalemia and thrombosis**, and the balanced ratio that was right during exsanguination is wrong once bleeding has stopped. **Then switch to VTE prophylaxis**, which these patients need sooner than instinct suggests.

PEARLS & PITFALLS

- **Blood in a balanced ratio, and TXA within 3 hours.** Crystalloid dilutes clotting factors and cools the patient.
- **A normal initial hemoglobin means nothing** in brisk bleeding. Activate on clinical grounds.
- **Check ionized calcium early and repeatedly.** Citrate chelates it, and low calcium causes both coagulopathy and hypotension.
- **Definitive control is the treatment.** Transfusion only buys time to reach the operating room, IR suite or endoscope.

References: European guideline on management of major bleeding and coagulopathy following trauma · CRASH-2 collaborators, *Lancet* 2010 · CRASH-3 collaborators, *Lancet* 2019 · Holcomb et al, PROPPR, *JAMA* 2015 · ACS TQIP massive transfusion guidance.

Educational aid; verify doses against local protocol, renal function, and patient factors.

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