BLOOD PRODUCT TRANSFUSIONS by Nick Mark MD

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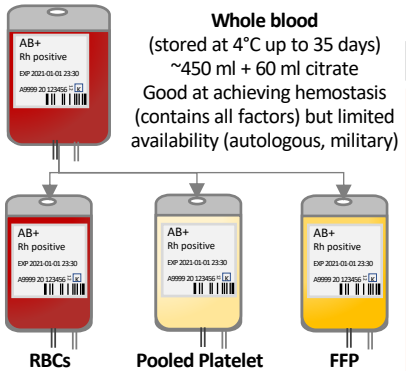
DEFINITIONS:

The goal of transfusion is to provide minimum O_2 carrying capacity (RBCs) & sufficient platelets and clotting factors to permit hemostasis. The goal is not correcting to "normal." Although RBC transfusions increase CaO_2 they might not normalize DO2 due to less efficient unloading of O_2 in transfused blood (2,3-BPG is degraded in storage).

Type and screen – determines blood type and detects antibodies in recipient (e.g., indirect Coombs test)
Treatment with anti-CD38 antibodies (daratumumab, isatuximab) can cause a false positive on screen for minor antigens for up to six months (notify blood bank).
Crossmatch – involves testing patient blood and specific donor units for compatibility. Crossmatch takes ~45 min.

In emergencies crossmatch can be skipped.
In extreme emergencies non-type specific blood can be used (e.g., O- RBCs in women, O- or O+ RBCs in men).

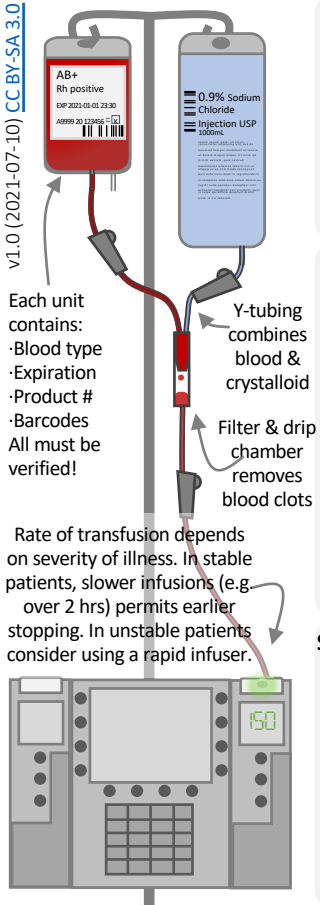


Whole blood
(stored at 4°C up to 35 days)
~450 ml + 60 ml citrate
Good at achieving hemostasis (contains all factors) but limited availability (autologous, military)

RBCs
(stored at 4°C up to 42 days)
~350 ml
↑ Hb ~1 gm/dl*

Pooled Platelet
(stored at RT up to 5 days)
~300 ml
↑ Plt by ~5-7k*

FFP
(frozen -25 °C up to 3 yrs)
~225 ml
(*in 70 kg pt)



EVIDENCE BASED TRANSFUSION THRESHOLDS:

- Restrictive transfusion strategies (Hb > 7) are comparable/superior to liberal strategies in most settings including GI bleed, septic shock, cardiac surgery, TBI, and in most ICU patients.
- Massive transfusion protocols (MTP) (e.g., trauma pts or massive GI bleed) target hemodynamic stability not a specific Hb. Among patients receiving MTP, balanced ratio (e.g., 1 RBC : 1 FFP : 1 Plt unit) is superior
- Platelet transfusion thresholds are disease dependent: For most diseases 10k is adequate, if bleeding or needing surgery 50k may be required. Limited evidence for higher targets (e.g., 100k for CNS bleed)

SPECIAL BLOOD PRODUCT TYPES:

- **Leukocyte reduced RBC**: decreases incidence of febrile rxns & prevents allo-immunization. Also makes blood CMV-safe
- **Gamma-irradiated RBC**: reduces incidence of GVHD during transfusions; important in very immunosuppressed patients
- **Volume Reduced RBC**: each unit comes in ~100 ml (instead of ~350 ml), can reduce the incidence of febrile rxns because there are fewer plasma proteins; can also be used in volume overloaded patients (though giving diuretic is probably better)
- **Washed RBC**: plasma is replaced with crystalloid; this should be done only if there was a previous allergic reaction or in IgA deficient patients (if no IgA deficient donors)
- **Single donor (apheresis) platelets**: a full unit of platelets obtained from a single donor via apheresis (in contrast to pooled platelets typically combining 5 donors). Single donor limits antigen exposure

STRATEGIES IN PEOPLE WHO DECLINE TRANSFUSION

- Discuss specific reasons/concerns, understand what tx is acceptable
- Correct coagulopathy (consider amicar, TXA, other products)
- Stop and minimize blood loss: hormonally suppress menstruation, autotransfuse with cell-saver (OR) or hemothorax/chest tube (ICU)
- Minimize iatrogenic blood loss (fewer labs, less frequently, drawn in pediatric tubes); no "routine" labs; every test should be thoughtful and drawn in pediatric tubes to minimize volume lost
- Optimize hematopoesis (IV iron infusion, folate supplementation, EPO administration)
- Consider blood substitute (poly-heme)

TRANSFUSION REACTIONS:

	REACTION	EXPLANATION	MANAGEMENT
IMMUNE MEDIATED	**Febrile Non-Hemolytic Transfusion Reaction (FNHTR)**	Most common immune reaction to transfusion. Occurs ***within 4 hours of transfusion*** due to accumulated inflammatory cytokines in the banked donor blood. May recur; 25% of patients who had FNHTR once had another reaction subsequently.	*Prevention*: APAP + H2 blockers, consider ***leukoreduced units*** *Treatment*: stop infusion, APAP, meperidine. R/o other causes. Notify blood bank.
	Acute Hemolytic Transfusion Reaction (AHTR)	Occurs ***during or shortly after transfusion***. Occurs due to mismatch of donor antigens (often ABO/Rh) & recipient antibodies leading to hemolysis & agglutination. S/sx: Fever, flank pain, dark urine, DIC, hypoTN, renal failure. Hemolysis on labs (↓haptoglobin, ↑LDH, etc)	A true emergency *Prevention*: carefully check units *Treatment*: Stop transfusion, notify blood bank, test for hemolysis & DIC, aggressive IV hydration (goal UOP > 100/hr).
	Delayed Hemolytic Transfusion Reaction (DHTR)	***Occurs 24 hours to 30 days after transfusion*** due to mismatch of minor antigens (often false negative crossmatch). 2nd exposure can be faster, more severe. May have drop in Hct, fever, minor hemolysis.	*Treatment*: Notify blood bank, repeat testing (DAT, type & screen, etc)
	Allergic reaction	Usually anaphylactoid (not IgE mediated). S/sx urticaria, maculopapular rash, pruritis, fv & hypoTN ***Occurs minutes to hours after transfusion***, due to antibodies against proteins on plts, leukocytes, or in plasma, including IgA (in recipients w/ IgA deficiency)	*Prevention*: **washed** (or IgA deficient) RBCs.Check for IgA deficiency if recurrent anaphylaxis *Tx*: epi, H2 blockers, steroids
	Post Transfusion Purpura (PTP)	***Occurs 7-10 days after transfusion***, due to anti-platelet antibodies in donor blood. Causes purpura & severe thrombocytopenia, may be life-threatening. More common in women (85%) & Caucasians.	*Treatment*: IVIG, plasmapheresis
	Transfusion Related Acute Lung Injury (TRALI)	Leading cause of transfusion related death (15% mortality). TRALI resembles ARDS, onset is ***4-6 hours after transfusion***. Most common following platelet transfusion from multi-parous female donors (due to anti-HLA or anti-HNA Ab)	*Treatment*: ventilatory support may be required (use LPV), use platelets from male donors for future transfusions.
	Transfusion Associated Graft Versus Host Disease (TA-GVHD)	***Occurs 8-10 days post transfusion***, donor leukocytes attack immunosuppressed recipient. Sx include: fever, cutaneous eruptions, diarrhea, liver abnormalities. May progresses to pancytopenia due to marrow aplasia. High mortality.	*Prevention*: use **irradiated** and **leukocyte reduced** blood in immunosuppressed recipients *Treatment*: no effective treatment
NON-IMMUNE MEDIATED	**Transfusion Associated Cardiac Overload (TACO)**	***Occurs between 0-6 hrs after transfusion***. Volume overload from transfusions, particularly in patients with CHF. Presents as dyspnea potentially progressing to severe hypoxemia.	*Prevention*: minimum # of units, volume reduced units, diuresis *Treatment*: diuresis
	Hypocalcemia Hyperkalemia	Citrate in RBCs binds to serum calcium. Blood products contain potassium from lysed cells.	*Treatment*: Replete calcium and monitor for hyperkalemia.
	Hypothermia	Due to low temp of transfused products. iatrogenic hypothermia exacerbates coagulopathy & ↑bleeding	*Prevention/Tx*: Use a blood warmer for massive transfusions
	Hypotension	People taking ACEi may develop hypotension due to inability to break down bradykinin in transfused blood	Does not require intervention. Rule out infection/hemolysis
INFECTION	Infection occurs due to ***untested*** organisms (rare), false negatives on testing (very rare), or bacterial contamination.		
	Bacterial contamination	Platelets (stored at RT) are more likely to cause infections with skin flora (GPCs). RBCs (stored at 4C), are more likely to be contaminated with GNRs. Can lead to sepsis.	
	Untested organisms	Organisms NOT tested include: Malaria, Borrellia (Lyme disease), Trypanosoma (Chagas disease), Babesiosis, & vCJD (varies by country)	
	False negative	Extremely rare: HIV 1 in 2,000,000,000, HBV 1 in 100,000,000, HCV 1 in 2,000,000, HTLV 1 in 650,000	