

Transfusion in the Trauma Setting: Prehospital Transfusion and MTP controversies









Providing Blood Products for Emergency Transport

DISCLOSURES

- Dr. Nancy Van Buren and I are Medical **Directors at Memorial** Blood Centers, Nebraka Community **Blood Centers and Community Blood** Center of Greater Kansas City, in addition to Children's and HCMC, both of which are competing level one pediatric trauma centers!
- No relevant financial relationships



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EDUCATIONAL OBJECTIVES

At the conclusion of this talk, participants should be able to:

- Cite findings supporting pre-hospital transfusion
- Identify Controversies in MTP including:
 - Fixed ratios of various components
 - Role of Whole Blood
- Future options for plasma transfusion in this setting

OUTLINE OF PRESENTATION

Why: Transfusion during emergency transport increases survival in severely injured patients

What: MBC provides 2 units of O negative RBCs per helicopter at regional air ambulance sites to Lifelink III, North Memorial Aircare,

Where: 12 locations in Minnesota; 2 in Wisconsin

How: By calling folks who are O neg during dinner to come in really, really often...

Mayo: Serves much of Southern MN and Northern Iowa +







TRANSFUSION DURING EMERGENCY TRANSPORT REDUCES MORTALITY IN SEVERELY INJURED PATIENTS



Brown JB, Ann Surg 2015; 261(5):997-1005



REMOTE DAMAGE CONTROL RESUSCITATION (RCDR)

Focus of THOR (Trauma Hemostasis and Oxygenation Research) Network

- Reduce morbidity and mortality from trauma
- Why RDCR makes a difference:
 - Trauma: leading cause of death in the civilian setting for people between 1 and 44 years old; half caused by hemorrhage
 - Of the estimated ~30K deaths/yr in the US that are preventable with optimal care, ~20K due to hemorrhage
- Goals of RDCR:
 - Control bleeding, restore volume, manage complications (including electrolyte imbalance, acidosis, hypothermia)
 - Reduce risk of early trauma-induced coagulation (ETIC)
 - High incidence (16-24%) due to coagulopathy
 - Dilutional effects of IV fluids
- Paradigm shift:
 - Early use of blood components, permissive hypotension,
 - limiting volume of crystalloid fluid



PROVISION OF BLOOD DURING AIR TRANSPORT

What do we know about the safety of uncrossmatched blood?

Most blood currently transfused in hospitals is computer crossmatch, but only after documentation of negative antibody screen.

Low risk of hemolytic transfusion reaction from Group O uncrossmatched RBCs when ABO/Rh type is unknown

• (2 studies involving 161 and 262 patients: 0-0.4%)

Rh(D) negative for females

Bottom line:

 Life-saving units of uncrossmatched blood should not be withheld from transfusion during emergency transportation in trauma patients



PROVIDING 2 UNITS OF O-NEGATIVE BLOOD FOR EACH OF THE AIR AMBULANCE SITES

Maximize O-negative collections

- (Does it really need to be O neg, given that most dumb things resulting in hemorrhage are done by men?!)
- Rotating blood to sites
- Validation of shipping containers
- Procedures for ensuring acceptable temps maintained for return or reissue of blood
- Replacement strategies when units transfused
- Documentation of transfusion



LOGISTICS OF BLOOD DELIVER TO AIR AMBULANCES

Documentation of the process for receipt and storage of blood











WORKFLOW WHEN BLOOD TRANSFUSED: DOCUMENTATION OF TRANSFUSION

UNCROSSMATCHED

LIFE LINK III STOCKED PRBCs

CALL YOUR BLOOD BANK FOR FURTHER TESTING

RUN#

LIFE LINK III 1-800-283-4025 Nurses in ED to send all blood bags with attached tags to the Transfusion Service/Blood Bank

EMS staff document disposition on forms

- EMS instructs hospital/ED RN send with empty bag to Transfusion Service, where crossmatch is performed
- After return to air base, EMS documents on tracking log
- Two replacement units of O negative RBCs obtained from MBC

IN AIR DOCUMENTATION OF TRANSFUSION



AABB 31ST STANDARDS REVISION EFFECTIVE APRIL 1, 2018

5.27.1

Recipients whose ABO group is not known or has not been confirmed shall receive group O Red Blood Cells or **Iow-titer group O Whole Blood**...

5.27.2

If blood is issued before completion of compatibility testing, recipients whose ABO group has been determined... by the transfusing facility shall receive only ABO group-specific Whole Blood, **Iow-titer group O Whole Blood**, or ABO group-compatible Red Blood Cell components.

WHAT'S ON THE HORIZON FOR TRAUMA HEMOSTASIS AND REMOTE DAMAGE CONTROL RESUSCITATION?

AABB Standards 31st ed. for Low-titer whole blood (Standard 5.15.1 and Standard 5.27.1)

Platelet-sparing filters

Cold-stored platelets

cWB vs RBCs + plasma

Use of TXA, ECMO



USE OF COLD-STORED WHOLE BLOOD (CWB)

Advantages:

- Less dilution of cellular and plasma components because of lower additive and anticoagulant solution volume
- Fewer donor exposures
- Simplification of logistics
- Additional hemostatic benefits (some plasma and functional platelets without agitation)

Barriers:

- Implementation of cWB
- What is "low titer" ?
- Determination of filter and additive solution
- Definition of "platelet sparing"
- IT development of cWB order at hospitals
- Incompatible plasma guidelines
- Returning cWB units and conversion to RBCs

WHAT ABOUT PREHOSPITAL PLASMA TRANSFUSION?

The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812

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VOL 179 NO.4

Prehospital Plasma during Air Medical Transport in Trauma Patients at Risk for Hemorrhagic Shock

J.L. Sperry, F.X. Guyette, J.B. Brown, M.H. Yazer, D.J. Tnulzi, B.J. Early-Young, P.W. Adams, B.J. Daley, R.S. Miller, B.G. Harbrecht, J.A. Claridge, H.A. Phelan, W.R. Witham, A.T. Putnam, T.M. Duane, L.H. Alarcon, C.W. Callaway, B.S. Zückerbraun, M.D. Neal, M.R. Rosengart, R.M. Forsythe, T.R. Billiar, D.M. Yealy, A.B. Peitzman, and M.S. Zenati, for the PAMPer Study Group*

CONCLUSIONS

In injured patients at risk for hemorrhagic shock, the prehospital administration of thawed plasma was safe and resulted in lower 30-day mortality and a lower median prothrombintime ratio than standard-care resuscitation. (Funded by the U.S. Army Medical Research and Materiel Command; PAMPer ClinicalTrials.gov number, NCT01818427.) Conversely a land ambulance trial conducted at a single site in Denver categorically failed to show any benefit to prehospital plasma transfusion. (Moore, HB Lancet 2018) Over 125 patients included 65 treated and 60 ctl. 28d mortality was 15% in treated and 10% in ctl, not statistically different.

So does prehospital transfusion of plasma matter?

Perhaps it comes down to "it depends." One clear difference between these two studies is transport time. The transport times were under 20 minutes on average in the Denver trial and 40-50 minutes in the NEJM trial. In subset analysis, the outcome difference was only observed in the longer transports in the NEJM trial. One possible explanation is: If you have time to bleed to death, better hemorrhage control is better.

MASSIVE TRANSFUSION: RBC TO PLASMA RATIOS



Early Massive Trauma Transfusion:

Current State of the Art



Hypothermia and acidosis exacerbate coagulopathy



- J Trauma (2009) 67:202-8
 - Hypothermia and acidosis inhibit coagulation by different mechanisms
 - Hypothermia impairs initiation of clot forming
 - Acidosis accelerates fibrinogen degradation
- •J Trauma (2008) 65:951
 - $pH \le 7.1$, BE < -12.5, T< 34°C all impair clotting

RATIO OF RBC TO PLASMA IN MASSIVE TRANSFUSION

- Soldiers in middle East conflicts have fared better with rapid emergent whole blood transfusion
- Studies comparing fresh whole blood to fresh components should no difference in outcome
- Many with military experience have brought home a belief in superiority of a "balanced" (meaning 1RBC to 1unit FFP to 1 WB platelet equivalent) transfusion ratio
- Retrospective studies showing better outcome as ratio approaches 1:1 may be affected by survival bias. Only those who live long enough to have time to thaw FFP, receive a ratio approaching 1:1.



MORTALITY BY PLASMA : RBC RATIO N = 252 MT'S (2003-2004)





IMPACT OF FWB ON OVERALL MORTALITY



RBC: Plasma ratio, not whole blood vs. components correlates with overall mortality



Group O Whole Blood

"What's so great about Whole Blood again?" Jed B. Gorlin MD, MBA





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WHOLE BLOOD CONSIDERATIONS

Immunologic

- Isohemagglutinins and hemolysis
 - Titers-What do they mean?
- Immunomodulation
- TRALI mitigation
 - Further reduces supply by practically limiting to male donors

Logistics

- Are outcomes really better with whole blood?
- Platelet sparing??
- What happens if not used after X weeks?



ISOHEMAGGLUTININ AND WHOLE BLOOD HEMOLYSIS

Historic: US Military Vietnam Walking donor program

- In their review of military program, Bahr and Yazer (Trans. Med. (2016) 26(6) 406-14) state, "To date, over 10,000 U of FWB transfusions have safely occurred in both recent Iraq and Afghanistan conflicts." and give 4 citations
 - May I respectfully point out that one of the four citations (Gilsted) is titled "*Fatal* transfusion-associated graft-versus-host disease with concomitant immune hemolysis in a group A combat trauma patient resuscitated with group O fresh whole blood."!!!
 - That said, Hess Transfusion (2003) Reviewing military Transfusion in Vietnam: "Universal donor RBCs were another widely used field expedient. More than 100,000 group O un-cross-matched, universal donor transfusions were given without a single fatal hemolytic transfusion reaction. All nine reported fatal hemolytic transfusion reactions that occurred during the war followed the administration of misidentified cross-matched blood."



SHOULD THE SAFETY OF GIVING GROUP A PLASMA IN EMERGENCIES BE REASSURING FOR GROUP O PLASMA?

Median anti-A or anti-B titer in group O donor is either 1:32 or 1:64

In contrast median anti-B (Table from Mayo article should say anti-B) peaks at 1:16





Care State Real	

	TABLE 1.	Anti-A titer	s in male bl	ood donors	: Mayo Clini	c Blood Dor	nor Center		
Titer value	≤2	4	8	16	32	64	128	256	512
Number of donors Percent of donors	11 9.2	8 6.7	21 17.5	32 26.7	22 18.3	16 13.3	5 4.2	4 3.3	1 0.8

Immunologic: What can we learn from plasma incompatible apheresis group O platelets?

Hemolysis: whole blood and apheresis platelets have a similar volume of plasma

- Incompatible plasma can cause hemolysis, but it is both rare and generally associated with quite high anti-A,B titers in group O plasma Bersus: Transfusion (2013) 53:114S
 - 25 case reports of hemolysis(1975-2009) with Tx of group O platelets to non-group O recipients, including 2 fatalities in cancer patients. All cases of lesser volume included titers >1:1000.





CORRELATION OF EITHER TITERS OR HEMOLYSIN TEST WITH ACTUAL HEMOLYSIS IS POOR!

- Landim: Revista Braslieria de Hematologia e Hemoterapia (2015) 37(4) 217-22
 - Isohemagglutinin titer and qualitative hemolysin test did not correlate. Routine implementation of hemolysis test would significantly increase % of units not acceptable for transfusion. Even units negative on hemolysis test, did not prevent red blood cell sensitization. Poor correlation with clinical hemolysis.
 - Castilho editorial: "The finding that none of the methods (iso titer & hemolysin test) is guaranteed to eliminate the risk of passive hemolysis supports the concept that there are combinations of factors influencing hemolysis due to plasmaincompatible platelets."



TRALI MITIGATION: GROUP O WHOLE BLOOD

- Requirement for all Male donors means availability of group O neg RBC cut in half:
 - Either use all male donors or
 - Use female donors whose anti-HLA antibodies have been screened and below a cutoff level.
 - While the latter may be practical for frequent female platelet donors, it is a logistical challenge for tracking in whole blood donors.



OUTCOMES: IS OUTCOME WITH WHOLE BLOOD BETTER?

Cotton Ann Surg (2013) 258(4):527-32

- Randomized >100 patients to whole blood vs. components.
- No difference in any PRESPECIFIED outcome
 - (post hoc analysis excluding some of the sickest patients (TBI) may show decrease blood product use)



Low ratio of Plasma/RBC correlated with higher Mortality, but no difference observed between component and whole blood

WHAT HAPPENS TO THOSE PRECIOUS O NEG RED CELLS IF NOT USED IN FIRST SEVERAL WEEKS?

Current platelet sparing whole blood leukoreduction filter configuration only allows 121 day storage: [Yazer: "How do I implement a whole blood program..." in Transfusion (2018) 58:622-8], then you use the platelet sparing collection bag, collected into CPD and have a 21 day unit.

Currently ~80% of units distributed to our air ambulance sites get recycled (brought back to our trauma centers) and outdate there is virtually 0%.

Instead we propose to simply express off plasma and convert to O neg RBC if we can use a CPDA collection bag and sterile dock filter at collection.

RBC % returned	Calendar Year 2013	Calendar Year 2014	Calendar Year 2015	Calendar Year 2016	Calendar Year 2017
NM Air Care	100%	95%	70%	67%	54%
Life Link	88%	87%	79%	86%	66%

ARE "PLATELET SPARING" WB FILTERS REALLY SPARING?

In vitro Analysis of the Hemostatic Properties of Whole Blood Products Prepared with a Platelet-Sparing Leukoreduction Filter

Zielinski MD, Stubbs JR Journal of Thrombosis and Circulation. J Thrombo Cir 2018, 4:1

Background: A leukoreduction filter that maintains platelet count while eliminating white blood cells has been developed but its effect on platelet function is unknown.

Results: Filtration was successful at removing white blood cells (5.5 \pm 1.2 vs. 0.3 \pm 0.3 \times 106 /L) while retaining an adequate platelet count (172.0 \pm 47.0 to 166.0 \pm 42.3 \times 109 /L) and hemoglobin concentration (13.7 \pm 0.5 vs. 13.0 \pm 0.7 g/dL).

 Rotational Thromboelastography (ROTEM) results revealed a similar clotting time (CT) before and after filtration (64.9 ± 5.1 vs. 64.1 ± 6.8 s) but a decreased maximum clot firmness (MCF) (58.6 ± 4.2 vs. 54.9 ± 4.6 mm). Platelet aggregation decreased substantially (28.8 ± 6.7 vs. 9.3 ± 2.1 ohm) immediately after filtration. CWB function continued to diminish over time.

Conclusion: CWB holds great promise as a surrogate for WFWB, but use of a platelet-sparing LR filter diminishes platelet function almost immediately after filtration.

COLD PLATELETS: ARE THEY REALLY "HOT STUFF" AND FRANKLY, ARE THEY STILL THERE?

We intend to provide whole blood for our 14 air ambulance sites, but many are quite distant from our distribution site and currently are on a q 2-3 week rotation schedule.

Many studies show decreased to no platelet activity after 14 days cold storage



I suspect I had cold platelets that day....certainly the rest of me was frozen Note: My spouse beat me by ~30 min in 24K race

EARLY CORRECTION OF COAGULOPATHY CORRELATES WITH BETTER OUTCOME

- Fresh frozen plasma should be given earlier to patients requiring massive transfusion Gonzalez et al J Trauma (2007) 62:112
- Patients admitted to ICU with coagulopathy often remained coagulopathic and used greater amounts of blood. Earlier correction led to superior outcome. (Their working protocol did not replace ANY FFP until after 6 units RBC were transfused. They have since changed this requirement.)



EMERGENCY RELEASE GROUP A PLASMA

For patients requiring emergent plasma transfusion who can't wait for ABO typing, more centers are relying upon pre-thawed group A plasma to spare the very limited supply of AB plasma from male donors (to minimize TRALI risk).

Studies at Univ. of Massachusetts and Mayo trauma programs document hundreds of safe uses of group A plasma in untyped patients, dozens of whom were subsequently determined to be B or AB

Studies of isohemagglutinin titers in group A individuals shows median of 1:8 and rarely >1:64 in contrast to group O plasma.



CONFLICTING PRE-HOSPITAL PLASMA TRANSFUSION STUDIES

- Sperry: NEJM 2018 documented imporved outcome in patients receiving pre-hospital plasma transfusion when transported by air ambulance.
- Moore: Lancet 2018 failed to find benefit during prehospital plasma transfusion in land ambulances in Denver.
- One clear difference in these studies was transport time which was 3-5 times longer in the air transport study.
 - (<16 min vs. 39-52 in air transport)
- "If you have the time to bleed to death, then better hemorrhage control is better!"



FREEZE DRIED PLASMA

Freeze dried plasma as produced by Netherlands and French blood programs have a growing track record of efficacy and safety.

Currently, we are the largest provider of plasma for BARDA (defense department research program) to produce freeze dried plasma. Currently it is not pooled and ABO type specific.

Eventually it may be produced in pools and type independent (either by depleting isohemagglutanins or neutralization by combing

French FDP

plasma ABO group plasma)



Freeze-dried Plasma

U.S. - Based FDP



FIXED TRANSFUSION RATIOS

May be helpful for transfusion at remote sites or where lab tests are not immediately available

- Postpartum hemorrhage: 6 units O-, 4 units FFP, 1 unit apheresis platelets
 - Goodnough Transfusion (2007) 47: 1564
- May deplete availability of O neg and over/undertransfuse. If low fibrinogen may need cryoprecipitate.



Ratio of Blood Products Transfused Affects Mortality in Patients Receiving Massive Transfusions in a Civilian Hospital



Fig. 9. The significance of the U-shaped curve is emphasized by the importance of separating transfusion ratios. When 1:1 and 1:2 ratios were combined, the U-shaped curve is lost, resulting in a linear relationship of FFP:RBC ratio to mortality.

J Trauma. 2008;65:261-271.

CANADIAN NATIONAL ADVISORY COMMITTEE ON BLOOD AND BLOOD PRODUCTS - MASSIVE TRANSFUSION CONSENSUS CONFERENCE 2011:

Questions addressed:

- ratio-based blood resuscitation in trauma patients;
- survivorship bias in current research conclusions;
- the value of non-plasma coagulation products;
- the role of protocols in urgent transfusion;
- traditional labs vs. TEG/ROTEM
- opportunities for future research.



CANADIAN CONSENSUS KEY FINDINGS

lack of evidence to support the use of 1:1:1 blood component ratios as the standard of care

importance of early use of tranexamic acid,

the importance of an organized response plan

integrated approach including antifibrinolytics, rapid release of RBCs, and a foundation ratio of blood components adjusted by either traditional coagulation tests or TEG/ROTEM



PROPPR OR IMPROPPR TRIAL DESIGN? 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: THE PROPPR RANDOMIZED CLINICAL TRIAL

Objective Transfusing patients with severe trauma and major bleeding using plasma, platelets, and red blood cells in a 1:1:1 ratio compared with a 1:1:2 ratio.

Interventions Blood product ratios of 1:1:1 (338 patients) vs 1:1:2 (342 patients) during active resuscitation



PROPPR RESULTS

The 1:1:1 group received more plasma (median of 7 U vs 5 U, P < .001) and platelets (12 U vs 6 U, P < .001) and similar amounts of red blood cells (9 U) over the first 24 hours,

No differences between the 2 groups were found for the 23 pre-specified complications, including acute respiratory distress syndrome, multiple organ failure, venous thromboembolism, sepsis, and transfusion-related complications.

Conclusions and Relevance Among patients with severe trauma and major bleeding, early administration of plasma, platelets, and red blood cells in a 1:1:1 ratio compared with a 1:1:2 ratio <u>did not result in significant differences in</u> <u>mortality at 24 hours or at 30 days</u>. However, more patients in the 1:1:1 group achieved hemostasis and fewer experienced death due to exsanguination by 24 hours.



INTERPRETING PROPPR TRIAL: CHALLENGES

Trial Design

- In the 1:1:1 arm, each container, provided within 10 minutes of arrival had 6 RBC, 6 thawed plasma and an apheresis platelet or it's equivalent in pooled platelets, with the platelets infused first!
- The 1:1:2 arm had two cooler configurations
 - Initial Cooler (and all subsequent odd # coolers) had 3 plasma, 6 RBC, no platelets, with the intent to give 2 RBC and one plasma with each transfusion
 - Second (and all subsequent even #) cooler had platelets in addition to the 3 plasma and 6 RBC, with the intent that the platelet was transfused first.

No outcome specified BEFORE the trial started showed statistical difference. Only analysis after the fact identified early bleeding. Given that the 1:1 group got 40% more plasma but 100% more platelets can one really ascribe the lower rate of early hemorrhage deaths in 1:1 group to extra plasma?



HCMC MASSIVE TRANSFUSION POLICY

Blood bank works with staff to monitor patient

Don't wait for coagulopathy to develop

- After 4u RBC are released in < 1h, staff ask if MTP
- 4 units group A plasma thawed at all times

Cooler based (Initial ratio was 4 RBC: 4 thawed plasma in 1st cooler, followed by 4R/2F)

- Apheresis platelet (~6 WB) every other cooler
- Obtain labs/cooler: Hct/Hgb, plt, coags inc. fibrinogen
- Need dedicated runner

Need surgeon/MD to order MTP! (labs/consult)



2016 HCMC ~160 MTP CASES

Category	# of Cases	% of Total MTPs
GSW/Stabbing	45	28%
Trauma- Motorized Vehicle	42	26%
Trauma- other	11	7%
TOTAL Trauma	98	62%

Category	# of Cases	% of Total MTPs
GI Bleed	24	15%
Other	17	11%
Cardiovascular	14	9%
OB	5	3%
Burn	1	1%

NOTE: 51 trauma MTP activated in 2015 (103 total MTP in 2015)



2016 TRAUMA MTP: BLOOD PRODUCTS USED

# of RBC used	# of cases	% of total trauma MTP cases
0-4	44	45%
5-10	41	42%
11-20	10	10%
>20	3	3%

Of MTP Trauma Cases Using ≥5 RBCs 30 (56%) Maintained a ratio of ≤2:1 RBC:FFP

HCMC: JAN 13, 2015

MTP cooler based protocol went live:

- 4 RBC and 2 FFP in every cooler
- 1 PLT (apheresis) every other cooler
- Pooled cryo as indicated by labs

Results: Initial Ratio Data 01-13-15 to 09-21-15

- All MTP
 - 42 (57%) Maintained a ratio of ≤2:1 RBC:FFP
- Trauma MTP
 - 17 (53%) Maintained a ratio of ≤2:1 RBC:FFP
 - 10 (56%) MTP cases using ≥5 RBC maintained a ratio of ≤2:1 RBC:FFP



SEPT 21, 2015

Process Improvement Change Goal

- Increase % Receiving ≤2:1 RBC:FFP
- Extra FFP to Account for Emergent Release RBC prior to MTP activation

Coolers:

- 4 RBC/4 FFP initial cooler / 4 RBC & 2 FFP thereafter
- 1 PLT (apheresis) every other cooler
- Pooled cryo as indicated by labs

Outcome of Change

- Trauma MTP
 - 41 (61%) Maintained a ratio of ≤2:1 RBC:FFP
 - 28 (64%) MTP cases using ≥5 RBC maintained a ratio of ≤2:1 RBC:FFP
- Since MTP cooler based go live:
 - FFP wastage increased from 6.6% to 9.3%
 - PLT wastage increased from 3.1 to 7.0%



AUG 15, 2016

Process Improvement Change

Goal

- Decrease Blood Product Wastage
- Decrease Turnaround Time to First Cooler
- Quicker Transfusion of Platelet

Coolers:

- 2 RBC and 2 FFP on initial cooler
- 4 RBC and 2 FFP all remaining coolers
- 1 PLT (apheresis) every other cooler
- Pooled cryo as indicated by labs



AUG 15, 2016 (2 RBC 2 FFP FIRST COOLER)

Outcome of Change

	Baseline*	Post Change**
n (# of coolers in analysis)	29	22
Avg TAT to cooler ready	0:09	0:05
Avg TAT to cooler pick-up	0:12	0:08

*Calculated from data collected real time on initial MTP coolers of 4 RBC and 4 FFP from 05-01-16 to 08-14-16 **Calculated from data collected real time on initial MTP coolers of 2 RBC and 2 FFP from 08-15-16 to 11-30-16

Trauma MTP

33 (67%) Maintained a ratio of \leq 2:1 RBC:FFP 11 (48%) MTP cases using \geq 5 RBC maintained a ratio of \leq 2:1 RBC:FFP

	Baseline ⁺	Post Change [#]	
n (# of coolers in analysis)	45	44	
Avg TAT to cooler ready	0:09	0:07	
Avg TAT to cooler pick-up	0:11	0:09	
# of Platelets Transfused	10	19	
# of Products Returned			
RBC	82	32	
FFP	69	25	
PLT	4	5	
CRYO	0	0	
# of Products Wasted			
RBC	6	1	
FFP	12	6	
PLT	2	0	

+Calculated from data collected real time on MTP coolers from 05-01-16 to 08-14-16 ++Calculated from data collected real time on MTP coolers from 08-15-16 to 11-30-16



JAN. 1, 2017 (2 RBC 2 FFP ALL COOLERS)

Process Improvement Change

Goal

- Increase % Receiving 2:1 RBC:FFP
- Maintain decreased FFP wastage, decrease turnaround time to first cooler, and quicker transfusion of platelet

Coolers:

- 2 RBC and 2 FFP on all coolers
- 1 PLT (apheresis) every other cooler
- Pooled cryo as indicated by labs





CONTINUOUS LEARNING

In a majority of cases not meeting 2:1 ratio or lower:

- Prior receipt of RBC only (1st hospital, in transit, ER frig)
- FFP/PLT products returned but RBC transfused
- Specific requests from clinical team for RBCs only

Order for MTP in EHR is important

- TXA ordered automatically
- Emergency labs: (missed ~30% of trauma MTP orders in EHR in 2016)
 - Green Cards are important to getting labs back quickly

Coolers must be requested; do not come at defined intervals



EMERGENCY RELEASE FRIG HCMC ER





HCMC MTP ADULT & PEDIATRIC FLOW SHEET

(HELPS TRANSFUSING CLINICIANS TRACK WHAT HAS GONE IN)



TXA 1 gram loading 1 gram/8 hours



Blood Product Adm	inistration
PRBC	20 ml/Kg
FFP	10 ml/Kg
Platelets	4 ml/Kg (apheresed)
Cryoprecipitate	4 ml/Kg

TRANEXAMIC ACID (TXA) Loading Dose: 15 mg/Kg (max 1000mg) Infusion: 2 mg/Kg/Hr x 8 hours (max rate 125 mg/Hr) (max total 1000 mg)



PEDIATRIC MASSIVE TRANSFUSION SIMULATION

Simulation goal was to distinguish the difference between requests for emergency release and activation of the MTP which would result in coolers of various products Note: Sriracha makes a great "blood substitute"



ECMO INITIATION SIMULATION AT MPLS CHILDREN'S

ECMO simulation helped identify bottlenecks in having team prepared for initiating ECMO during failed resuscitation in delivery room area. Note: staff checking units. Realistic infant manikin has exposable vessels to

practice cannulation!

