Whole Blood Utilization in the Trauma Population

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Relevant Disclosure

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I have no relevant financial relationships or affiliations with commercial interests to disclose.

Objectives

History of Whole Blood

Component therapy vs Whole Blood in Trauma

Current State of Whole Blood Utilization in Oklahoma

Future Goals for Oklahoma

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History of Whole Blood

For most of the last 250 years, whole blood was the only treatment option for bleeding trauma patients

- Whole blood was used as early as the 1800's
- It was used in both world wars as well as Korean and Vietnam wars

The transition from whole blood to component therapy started in the 1970's

By 1990 component therapy was almost exclusively used in trauma patients

This radical change in practice came about due to practicality

History of Whole Blood

- Component therapy brought
  - Reduced waste
  - Longer storage times
  - Tailor resuscitation
- The shift was not based on data comparing whole blood to component therapy
  - Especially in patients needing massive transfusion
- Acidosis and Coagulopathy was still a major problem
  - 1:1:1 transfusion ratio of platelets, plasma and RBCs doesn't contain the same levels of platelets, clotting factors and fibrinogen found in whole blood

History of Whole Blood

- The return to whole blood came in the 2000's by the military
  - Revisited fresh whole blood during the Iraq war
  - Found an improvement in 24 hour and 30 day mortality compared to component therapy
- Civilian use of whole blood stemmed from the military fresh whole blood implementation
  - Tactical Combat Causality Care Training

History of Whole Blood

Remote Damage Control Resuscitation (RDCR)

Military/Rural environment patients

- Modified transfusion strategy
- Different than those with scene/pre-hospital time < 30 min
- Limited resources available
- Lack of plasma/platelet availability
- 40% of the population, 60% of the trauma mortality

Current treatment options for uncontrolled hemorrhage in this environment are very limited

> 75% of combat fatalities occur in the field

History of Whole Blood

- Indications:
  - Massive Transfusion
  - Damage Control Operations
  - Thrombocytopenia or TEG indicating impaired platelet function
- Shelf life 24 hrs – Best if used within 8 hrs
- Fresh Whole blood

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Whole Blood vs Component Therapy

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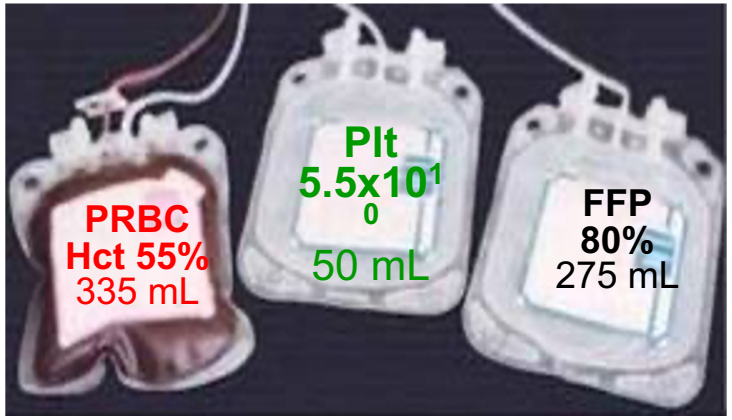
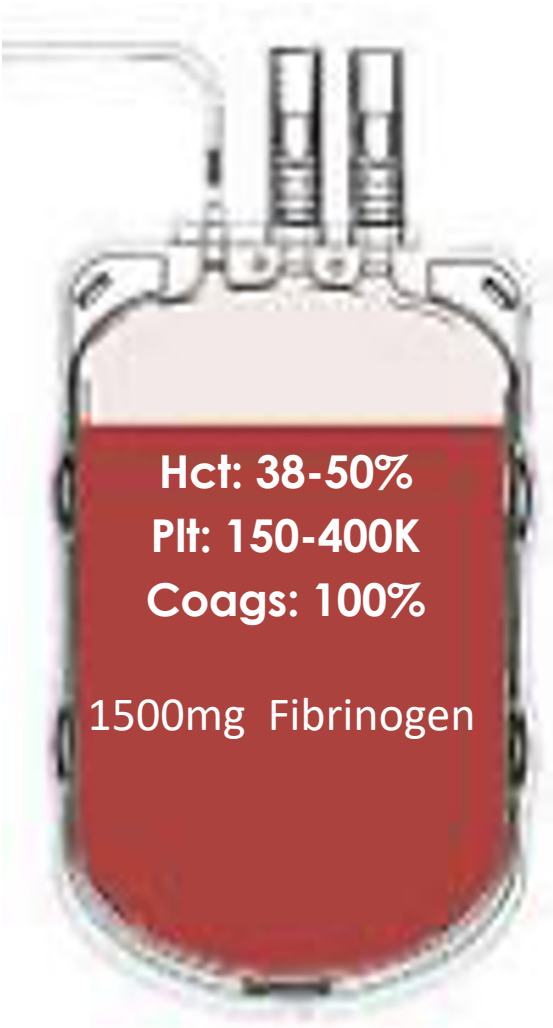
Whole Blood vs Component Therapy





Component Therapy Gives You

1U PRBC + 1U PLT + 1U FFP + 10 pk Cryo =

660 mL

Hct 29%

Coag activity 65%

750 mg fibrinogen

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Whole Blood vs Component Therapy

Giving a unit each of PRBC, FFP, platelets, and cryoprecipitate provides:

- a hematocrit of 29%, coagulation factors about 65% of normal, 80,000 platelets, and 1g of fibrinogen
- significant load of citrate and amounting to a volume of almost 700mL

500mL (1 unit) of fresh whole blood, on the other hand, has a hematocrit of 38-50%, coagulation factors at 100%, platelets at a normal range, 1g fibrinogen, and much lower amounts of citrate

- To get the equivalent amount from component therapy would require twice the volume (and twice the citrate) of components

The citrate, while useful as a preservative, binds calcium, something that is critical for both hemostasis and cardiac function

Whole Blood vs Component Therapy

Rational for whole blood:

- Coagulopathy
- The “golden hour”

Trauma Induced Coagulopathy (TIC) predicts mortality

Plasma and RBC resuscitation should occur early in the hemorrhagic/coagulopathic patient

Catchment area/Rural location provides geographic obstacles

Whole Blood vs Component Therapy

SBP > 100 mmHg, MAP > 70 mmHg

SaO2 > 92%

Normothermia

Urine output

Correction of acidosis

- Base Deficit < 2
- Serum Lactate < 2.5 mmol/L

Clinical Coagulopathy Resolved

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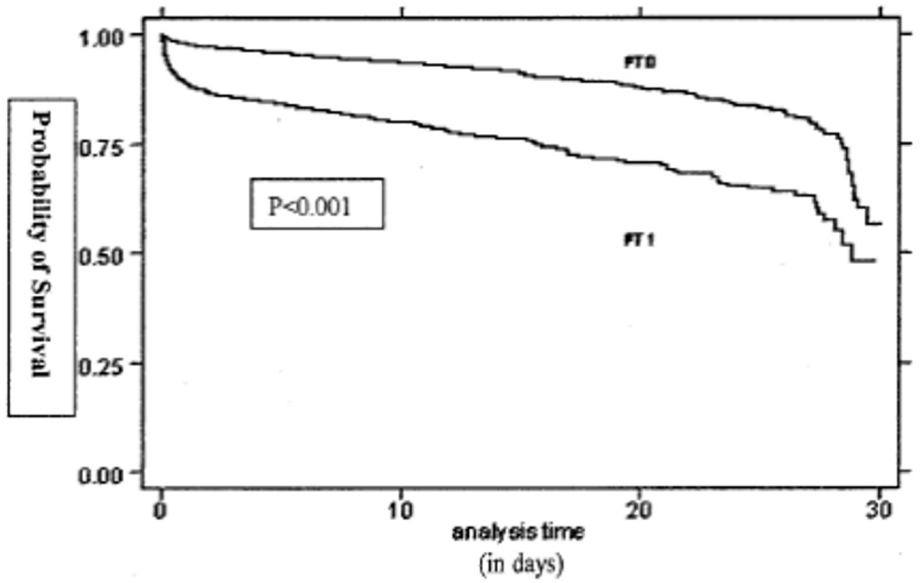
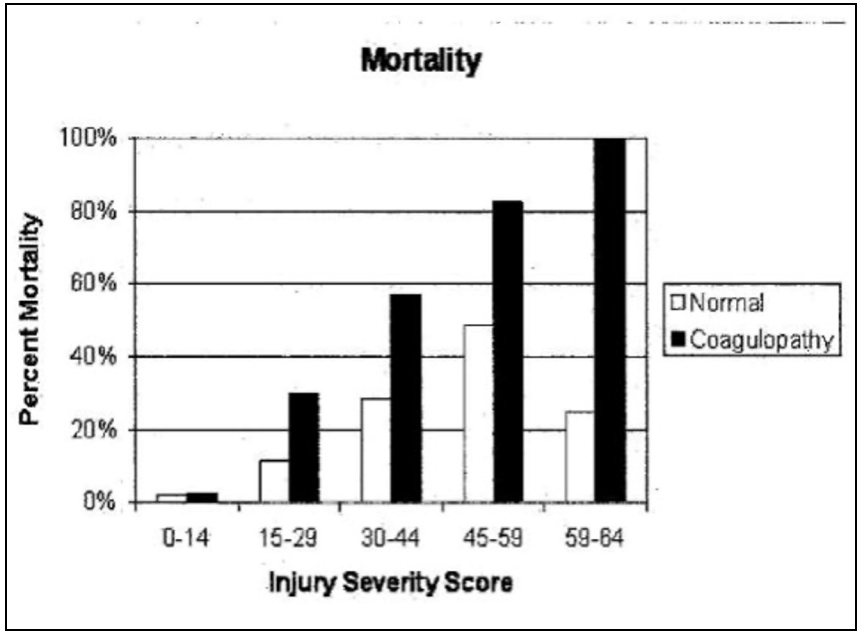
Whole Blood vs Component Therapy



Brohi K et al.
Acute Traumatic Coagulopathy
J Trauma 2003

MacLeod JBA et al.
Early Coagulopathy Predicts
Mortality in Trauma



By the time of arrival at the ED, 28% (2,994 of 10,790) of trauma patients had a detectable coagulopathy that was associated with poor outcome

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Whole Blood vs. Component Therapy

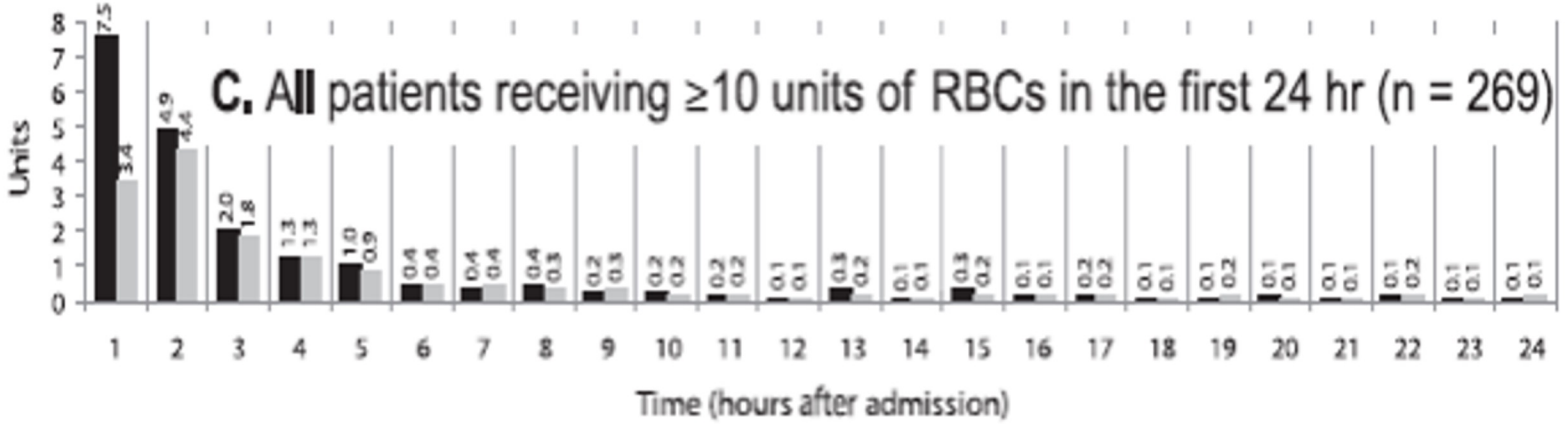

Fig. 1. Mean hourly usage of units of RBC and plasma among patients with probability of survival scores (TRISS) between 0.010 and 0.975 and categorized as (A) all patients receiving at least 5 units of RBCs in the first 24 hours, (B) patients receiving 5 to 9 units of RBCs in the first 24 hours, and (C) patients receiving more than 9 units of RBCs in the first 24 hours. (■) RBCs; (▒) plasma.

Mortality was associated with worse **Plasma Deficit**

&

The efficacy of the Plasma Repletion occurs **within hours**

de Biasi et al.
Early Coagulopathy Predicts Mortality in Trauma
Transfusion (Epub, Accepted 2010

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Whole Blood vs Component Therapy

Time to clearance clinically and statistically significantly shorter with LTO+WB than with component therapy

8 vs 13 hours

Clinical outcomes among low-titer group O whole blood recipients compared to recipients of conventional components in civilian trauma resuscitation
Seheult , Anto, Alarcon, Sperry, Triulzi, and Yazer TRANSFUSION 2018;9999;1–8.

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Whole Blood vs Component Therapy

- Unlike component therapy, whole blood has both cellular and antibody components
  - ABO compatibility very challenging
- One solution to this challenge is to transfuse only type-specific blood
  - In the military setting, where patient blood types can be readily obtained
  - “walking blood banks” of healthy volunteers can feasibly be assembled in a short time period
- Type-specific whole blood can be rapidly collected and transfused

Whole Blood vs Component Therapy

In civilian practice, this approach is impractical

- Our civilian trauma patients do not carry immediate identification of their blood type
- Waiting for blood type results before giving a transfusion would worsen hemorrhagic shock

Plasma antibody levels have been shown to vary significantly from donor to donor

- Able to select type O whole blood units with very low levels of anti-A and anti-B antibodies
- This has reduced the risk of hemolysis for incompatible recipients

The typical unit will thus be type O, low titer, and leukoreduced

- Male donors are typically chosen to reduce the risk of transfusion-related acute lung injury (TRALI)

Whole Blood vs Component Therapy

- Civilian use also mandates storage as donors are not generally available
- Storage times in civilian practice have varied from 5-15 days
  - recent statement from AABB allows storage for up to 21 days based on current literature
- Storage may however come at the cost of hemostatic function
- There is evolving evidence that, when using viscoelastic assays
  - platelet function in particular reduces over the storage period over 21 days

Whole Blood vs. Component Therapy

ISBT Science Series

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ISBT Science Series (2019) 14, 308–314

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INVITED REVIEW

Platelet functionality in cold-stored whole blood

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Whole blood is currently being reintroduced as a blood product to be used in massive bleeding situations because it affords plasma, red cells and platelets in a balanced ratio and in a logistical advantageous way. Questions concerning the haemostatic potential of the platelets have arisen, especially in cold stored whole blood, as this is the major whole blood product in use. When reviewing current knowledge on this, there is an abundance of publications demonstrating that *in vitro*, platelets in cold-stored whole blood have a haemostatic capacity up to 14 days, and even after 21 and 35 days of storage depending on type of additive solution. There is a paucity of data on clinical trials of cold-stored platelets, whereas there is an abundance of positive clinical experience with whole blood, both cold-stored and fresh, as an efficacious and safe product for use in pre- and in-hospital patients with life-threatening bleeding.

Key words: cold storage, massive transfusion, platelet function, platelets, transfusion strategy, whole blood

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Whole Blood vs Component Therapy

In addition to the improvement in 24 hour and 30 day mortality compared to component therapy proven by the military

Cotton and colleagues randomized 107 patients to either leukoreduced modified whole blood or component therapy

- Overall product use in the whole blood group was lower at 24 hours.

A recent review of transfusion practice has shown overall low rates of complications

- Including disease transmission, immune-mediated complications, and volume overload

US military experience of over 10,000 units of fresh whole blood transfusions to date have had only one reported case each

- Graft-versus-host disease
- Transmission of hepatitis C virus
- HTLV

Whole Blood vs Component Therapy

REVIEW ARTICLE

Whole blood for hemostatic resuscitation of major bleeding

Philip C. Spinella,[1,2] Heather F. Pidcoke,[2] Geir Strandenes,[3,4] Tor Hervig,[4] Andrew Fisher,[5] Donald Jenkins,[6] Mark Yazer,[7] James Stubbs,[8] Alan Murdock,[9] Anne Sailliol,[10] Paul M. Ness,[11] and Andrew P. Cap[2]

- Logistical, economic and clinical benefits of cold stored low titer type O whole blood
- Cold stored for up to 21 days
  - Platelets OK
- Improved function compared to 1:1:1

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Whole Blood vs Component Therapy

SHOCK, Vol. 41, Supplement 1, pp. 70–75, 2014

LOW TITER GROUP O WHOLE BLOOD IN EMERGENCY SITUATIONS

Geir Strandenes,[*†] Olle Berséus,[‡] Andrew P. Cap,[§] Tor Hervig,[*‖] Michael Reade,[¶] Nicolas Prat,[§] Anne Sailliol,[††] Richard Gonzales,[‡‡] Clayton D. Simon,[§§] Paul Ness,[‖‖] Heidi A. Doughty,[¶¶] Philip C. Spinella,[§***] and Einar K. Kristoffersen[*‖]**

[*]Department of Immunology and Transfusion Medicine, Haukeland University Hospital; and [†]Norwegian Naval Special Operation Commando, Bergen, Norway; [‡]Department of Transfusion Medicine, Örebro University Hospital, Örebro, Sweden; [§]US Army Institute of Surgical Research, FT Sam Houston, Texas; [‖]Institute of Clinical Science, The University of Bergen, Norway; [¶]Australian Defense Force Joint Health Command, Canberra, Australian Capital Territory; [**]French Military Medical Service, Clamart, France; [††]Commander French Military Blood Transfusion Center, Clamart, France; [‡‡]Director, US Army Blood Program and [§§]US Army Transfusion Medicine Consultant to the Surgeon General San Antonio Military Medical Center, JBSA–Fort Sam Houston, Texas; [‖‖]Transfusion Medicine Division, Johns Hopkins Medical Institutions, Baltimore, Maryland; [¶¶]NHS Blood and Transplant, Birmingham, England, United Kingdom; and [***]Division of Pediatric Critical Care, Department of Pediatrics, Washington University in St Louis, St Louis, Missouri

Conclusion: Low titer Group O is preferred alternative for emergency transfusions where safe ABO identical transfusions cannot be ensured

Whole Blood vs Component Therapy

- Component therapy emergency transfusion
  - Death rate in trauma room = 24%
  - Time to death = 1 ½ hours
  - Overall mortality 34%
- Whole blood as emergency transfusion
  - Death rate in trauma room = 11%
  - Time to death = 5 ½ hours
  - Overall mortality 27%

Whole Blood vs Component Therapy

San Antonio Experience:

Kicked off January 29, 2018

18 helicopters

- 2 units each

Mayo criteria for transfusion

Women of childbearing potential not excluded—Rh isoimmunization risk versus bleeding to death

Children 5 years and older

Whole Blood vs Component Therapy

Arizona:

"Nationwide Analysis of Whole Blood Hemostatic Resuscitation in Civilian Trauma Patients" By Kamil Hanna, MD et al (Bellal Joseph Group) out of University of Arizona

TQIP data for patients who received component therapy or whole blood within 4 hours of admission (between 2015-2016)

Whole Blood vs Component Therapy

Arizona:

8,494 patients identified

- 280 received WB + CT
- 8,214 received CT alone

WB + CT had mortality @ 24 hours of 17% vs. 25% in the CT only group

Lower in hospital mortality (29% vs 40%), complication rate (29% vs 41%) and shorter LOS

Whole Blood vs Component Therapy

Oregon:

"Massive Transfusion With Whole Blood is Safe Compared to Component Therapy", Jared Hallaher MD MPT et al (Martin Schreiber group) OHSU

Retrospective cohort analysis of CT vs WB

Whole Blood vs Component Therapy

Oregon:

Difference in 24h or 30-day mortality (22% CT vs 26% WB for 24 hour and 33% CT vs 52% WB 30 day)

No transfusion reactions

Conclusion: it is safe

Problem: it is a different product and they did not look at crystalloid use

Whole Blood vs Component Therapy

Choosing a titer

Donors with an O blood type have naturally occurring anti-A and anti-B antibodies (IgM) in their plasma

No standard for what is considered low titer

Titers can change with sensitizing events such as transfusion, pregnancy, vaccination and probiotics[3]

Things to consider:

- Cutoff
- Choosing IgG or IgM

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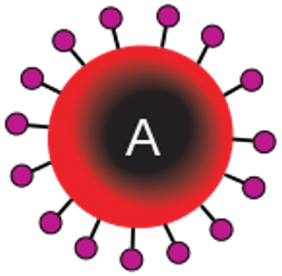
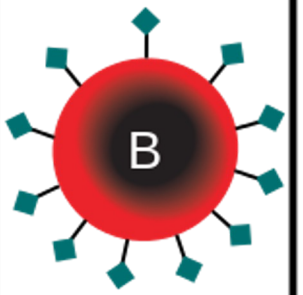
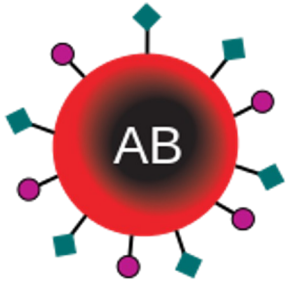
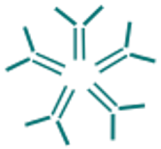
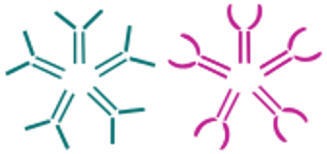
Whole Blood vs Component Therapy

	Group A	Group B	Group AB	Group O
Red blood cell type				
Antibodies in Plasma	 Anti-B	 Anti-A	None	 Anti-A and Anti-B
Antigens in Red Blood Cell	A antigen	 B antigen	 A and B antigens	None

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Whole Blood vs Component Therapy

Choosing a titer

Donors with a titer of < 256 are considered low titer

O positive, male, fixed-site donors
Donors are tested annually

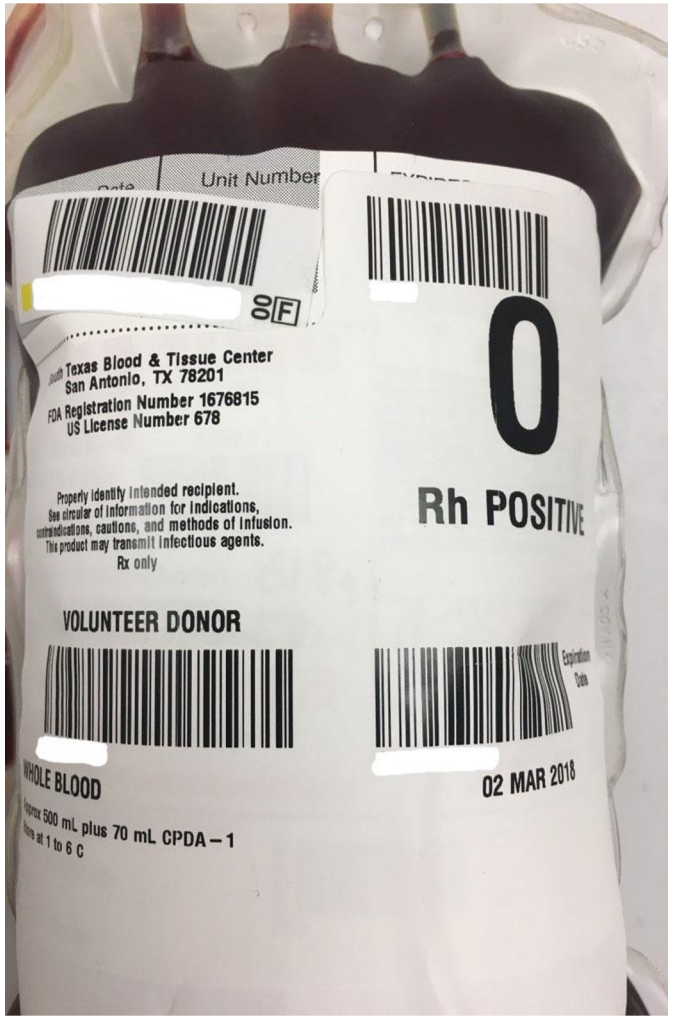
13-14% of tested donors are considered high titer

Donors were designated as low titer if testing for anti-A/anti-B isoagglutins at a titer of 256 was negative.

- A “low titer” special instruction was entered into our blood establishment computer system

Whole Blood vs Component Therapy

- Outdate
  - 21 days (CPD)
  - 35 days (CPDA-1)
- Volume 600 mLs (aprox)
- LTO+WB:
  - CPD
  - Nonleukoreduced



Whole Blood vs Component Therapy

- What is leukoreduction?
  - Removal of WBCs
  - < 5 x 10^6 WBCs in 95% of units tested
- Indications for leukoreduction:
  - Prevention of cytomegalovirus (CMV) transmission
  - Decrease febrile, non hemolytic transfusion reactions
- At risk populations include transplant and hematology oncology patients
- Does LTO+WB in massive trauma need to be leukoreduced?
  - LTO+WB- some programs do offer
  - Do the platelets work?

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Whole Blood vs Component Therapy

J Trauma Acute Care Surg. 2018 Jun;84(6S Suppl 1):S115-S119. doi: 10.1097/TA.0000000000001905.

Prehospital low-titer cold-stored whole blood: Philosophy for ubiquitous utilization of O-positive product for emergency use in hemorrhage due to injury.

McGinity AC[1], Zhu CS, Greebon L, Xenakis E, Waltman E, Epley E, Cobb D, Jonas R, Nicholson SE, Eastridge BJ, Stewart RM, Jenkins DH.

⊕ Author information

Abstract

The mortality from hemorrhage in trauma patients remains high. Early balanced resuscitation improves survival. These truths, balanced with the availability of local resources and our goals for positive regional impact, were the foundation for the development of our prehospital whole blood initiative-using low-titer cold-stored O RhD-positive whole blood. The main concern with use of RhD-positive blood is the potential development of isoimmunization in RhD-negative patients. We used our retrospective massive transfusion protocol (MTP) data to analyze the anticipated risk of this change in practice. In 30 months, of 124 total MTP patients, only one female of childbearing age that received an MTP was RhD-negative. With the risk of isoimmunization very low and the benefit of increased resources for the early administration of balanced resuscitation high, we determined that the utilization of low-titer cold-stored O RhD-positive whole blood would be safe and best serve our community.

Whole Blood vs Component Therapy

ABO and Rh status is often not known at time of transfusion

Risk of the following in those found to be RhD negative:

- Primary isoimmunization (Anti-D formation)
  - Concern in Child bearing age females & subsequent development of Hemolytic Disease of the Fetus/ Newborn
- Delayed hemolytic transfusion reaction in a patient with a preformed Anti-D

Whole Blood vs Component Therapy

- RhD negative individuals low in our population (~6%)
  - Decreased inventory availability to support O Rh Negative LTOWB
  - Low probability of isoimmunization to majority of patients upon transfusion
- Enhanced medical treatment of hemolytic disease of the fetus and newborn

Whole Blood vs Component Therapy

- Use until day 35
  - Do not convert to RBCs after 21 days due to non-leukoreduced status
- Platelet function decreased after day 14- 21
  - Decision of increased expired rate vs. platelet efficacy

Whole Blood vs Component Therapy

- Trauma Emergency Release
  - Females & Males >10 years old
  - Children <10 if received LTO+WB prehospital
- Massive Transfusion
  - All patients throughout the hospital
  - Replace 1 cooler set of components with LTOWB
- Adult (>18 y) Emergency Medicine Patients with active hemorrhage
- Abnormal placentation patients
  - Crossmatch compatible
  - Negative antibody screen

Whole Blood vs Component Therapy

Mixed Field

- Clear back front type with discernible back type= can switch to type specific components
- Mixed field with no discernible back type= O RhD+ components

Antibody Screen

- Every patient
- Determine status of antibodies and retrospective antigen typing of units for corresponding antibodies

Retrospective Crossmatch

- Prehospital transfusion
  - Only if suspected transfusion reaction
- UHS based transfusion
  - First 12 units in MTP
  - All units <12

Whole Blood vs Component Therapy

To date no hemolytic transfusion reactions due to anti-A & anti-B

Similar rates of alloimmunization and transfusion reactions compared to component based therapy

- 10 reported suspected transfusion reactions
  - 4 mild allergic
  - 2 severe allergic
  - 1 TACO
  - 2 Underlying medical condition
  - 1 delayed hemolytic/serologic transfusion reaction (Highly probable Anti-D)
- Alloimmununization
  - 8 patients; 9 antibodies
    - Anti- Lutheran a (2), Anti-Lewis a (1), Anti-E (1), Anti-Cw (1), Anti-Diego a (1), Anti-K (1), inconclusive (1), probable anti-D (1)

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Whole Blood Utilization in Oklahoma

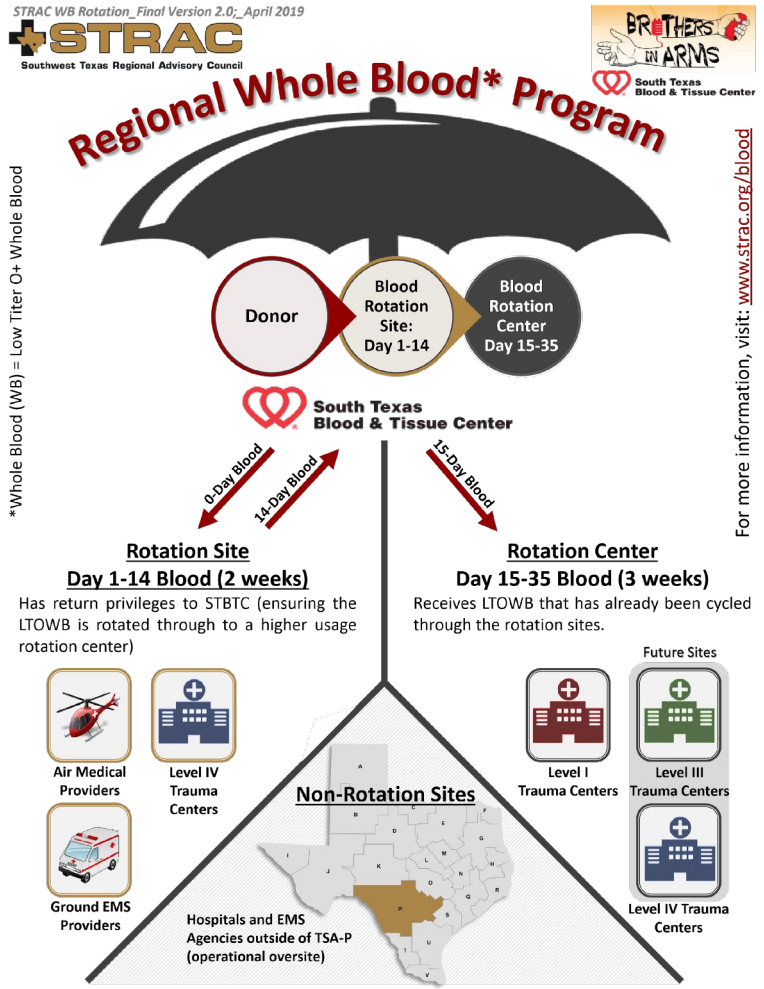
Developing a whole blood program is dependent on many factors: the logistical aspects include not only a protocol for collection, storage, and transfusion, but a ready means to offer definitive bleeding control

Practical experience from local area hospitals that have successfully implemented whole blood programs highlight the importance of institutional buy-in – this includes physicians, nurses, and allied staff in emergency medicine, surgery, and hematology/blood bank

Keeping the indications simple assists point-of-care decision making. Given the relative novelty of using this in the civilian setting, all those involved in the care of the trauma patient should be up-to-date with the evidence.

Whole blood academy in San Antonio

Whole Blood Utilization in Oklahoma: Learning from San Antonio



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Whole Blood Utilization in Oklahoma: Learning from San Antonio

- LTOWB Rotation System to push DCR capability to all geographic areas, minimize costs to EMS agencies, and be good stewards of blood administration
- Standardized transfusion criteria
- Regionally approved equipment list
- Region wide clinical documentation and data collection processes
- Develop a robust, loyal blood donor population

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Whole Blood Utilization in Oklahoma: Learning from San Antonio

Pre-hospital Rotation Sites (Air/Ground EMS)

- Issued fresh unit and maintains possession for approx. ~ 14 days (or until transfusion)

Rotation Center

Issued units returned from Rotation Sites and maintains until transfusion or expiration

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Whole Blood Utilization in Oklahoma

Every minute counts: Time to delivery of initial massive transfusion cooler and its impact on mortality

Meyer, David E. MD; Vincent, Laura E. RN; Fox, Erin E. PhD; O'Keeffe, Terence MBChB; Inaba, Kenji MD; Bulger, Eileen MD; Holcomb, John B. MD; Cotton, Bryan A. MD

Journal of Trauma and Acute Care Surgery: July 2017 - Volume 83 - Issue 1 - p 19–24
doi: 10.1097/TA.0000000000001531
EAST Plenary Paper

Abstract | Author Information | Article Outline | Article Metrics

BACKGROUND American College of Surgeons Trauma Quality Improvement Best Practices recommends initial massive transfusion (MT) cooler delivery within 15 minutes of protocol activation, with a goal of 10 minutes. The current study sought to examine the impact of timing of first cooler delivery on patient outcomes.

METHODS Patients predicted to receive MT at 12 Level I trauma centers were randomized to two separate transfusion ratios as described in the PROPPR trial. Assessment of Blood Consumption score or clinician gestalt prediction of MT was used to randomize patients and call for initial study cooler. In this planned subanalysis, the time to MT protocol activation and time to delivery of the initial cooler were evaluated. The impact of these times on mortality and time to hemostasis were examined using both Wilcoxon rank sum and linear and logistic regression.

RESULTS Among 680 patients, the median time from patient arrival to MT protocol activation was 9 minutes with a median time from MT activation call to delivery of first cooler of 8 minutes. An increase in both time to MT activation and time to arrival of first cooler were associated with prolonged time to achieving hemostasis (coefficient, 1.09; $p = 0.001$ and coefficient, 1.16; $p < 0.001$, respectively). Increased time to MT activation and time to arrival of first cooler were associated with increased mortality (odds ratio [OR], 1.02; $p = 0.009$ and OR, 1.02; $p = 0.012$, respectively). Controlling for injury severity, physiology, resuscitation intensity, and treatment arm (1:1:1 vs. 1:1:2), increased time to arrival of first cooler was associated with an increased mortality at 24 hours (OR, 1.05; $p = 0.035$) and 30 days (OR, 1.05, $p = 0.016$).

CONCLUSION Delays in MT protocol activation and delays in initial cooler arrival were associated with prolonged time to achieve hemostasis and an increase in mortality. Independent of products ratios, every minute from time of MT protocol activation to time of initial cooler arrival increases odds of mortality by 5%.

LEVEL OF EVIDENCE Prognostic, level II; Therapeutic, level III.

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Whole Blood Utilization in Oklahoma

Injury, Int. J. Care Injured 46 (2015) 822–826

Contents lists available at ScienceDirect

Injury

journal homepage: www.elsevier.com/locate/injury

Massive transfusion prediction with inclusion of the pre-hospital Shock Index

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ABSTRACT

Background: Detecting occult bleeding can be challenging and may delay resuscitation. The Shock Index (SI) defined as heart rate divided by systolic blood pressure has attracted attention. Prediction models using combinations of pre-hospital SI (phSI) and the trauma centre SI (tcSI) values may be effective in identifying patients requiring massive blood transfusions (MT).
Aim: To explore whether combinations of the phSI and the tcSI augment MT prediction.
Methods: The scores were retrospectively developed using all major trauma patients that presented to The Alfred Hospital between 2006 and 2012. The first PH and TC observations were used. To avoid exclusion of the 'sickest' patients, the SI was imputed to 2 where SBP was missing, but HR was present. We developed 4 models. (i) 'Dichotomised', defined as positive when both phSI and tcSI were ≥ 1. (ii) 'Formulaic', defined by logistic regression analysis. (iii) 'Combination', defined pragmatically based on the logistic regression. (iv) 'Trending', defined as: tcSI minus phSI.
Results: There were 6990 major trauma patients and 360 (5.2%) received MT. There were 1371 cases with either phSI or tcSI missing and were thus excluded from the analysis. The 'Dichotomised' had higher positive predictive value than the tcSI with a further 5 per 100 patients identified. The 'Formulaic' model, defined as: log Odds (MT) = 2.16 × tcSI + 0.89 × phSI − 5.42, and the 'Combination' model, defined as: phSI × 0.5 + tcSI, performed equally (AUROC 0.83 versus 0.83, $\chi^2 = 0.86$, $p = 0.35$). The 'Formulaic' performed marginally, but statistically significantly, more accurate than the tcSI alone (AUROC 0.83 versus 0.82, $\chi^2 = 6.89$, $p < 0.01$). An 'Upward Trending' SI was observed in 1758 patients, revealing a 4.6-fold univariate association with MT (OR 4.55; 95%CI 2.64–7.83), and an AUROC of 0.79 (95%CI 0.74–0.83). The 'Downward Trending' SI was protective against MT (OR 0.44; 95%CI 0.34–0.57).
Conclusion: The initial pre-hospital SI is associated with MT. However, this relationship did not clinically augment MT decision when combined with the in-hospital SI. The simplicity of the SI makes it a favourable option to explore further. Computer-assisted technology in data capturing, analysis and prognostication presents avenues for further research.

INTEGRIS HEALTH

Whole Blood Utilization in Oklahoma

Shock index as a predictor of hospital admission and inpatient mortality in a US national database of emergency departments

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Abstract

Study objectives The shock index (SI), defined as the ratio of the heart rate (HR) to the systolic blood pressure (BP), is used as a prognostic tool in trauma and in specific disease states. However, there is scarcity of data about the utility of the SI in the gen emergency department (ED)population. Our goal was to use a large national database of EDs in the United States (US) to determine whether the likelihood of inpatient mortality and hospital admission was associated with initial SI at presentation.

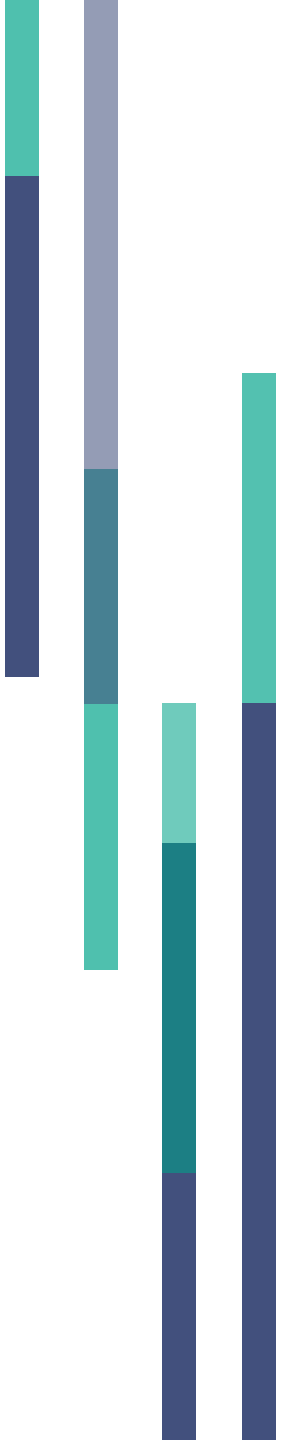
Methods Data from the National Hospital Ambulatory Medical Care Survey were retrospectively reviewed to obtain a weighte sample of all US ED visits between 2005 and 2010. All adults >18 years old who survived the ED visit were included, regardless their chief complaint. Likelihood ratios (LR) were calculated for a range of SI values, in order to determine SI thresholds most predictive of hospital admission and inpatient mortality. +LRs >5 were considered to be clinically significant.

Results A total of 526 455 251 adult patient encounters were included in the analysis. 56.9% were women, 73.9% were white 53.2% were between the ages of 18 and 44 years. 88 326 638 (15.7%) unique ED visits resulted in hospital admission and 1 9 235 (2.6%) visits resulted in inpatient mortality. SI>1.3 was associated with a clinically significant increase in both the likelihoc hospital admission (+LR=6.64) and inpatient mortality (+LR=5.67). SI>0.7 and >0.9, the traditional cited cut-offs, were only associated with marginal increases (+LR= 1.13; 1.54 for SI>0.7 and +LR=1.95; 2.59 for SI>0.9 for hospital admission and inpati mortality, respectively).

Conclusions In this largest retrospective study to date on SI in the general ED population, we demonstrated that initial SI at presentation to the ED could potentially be useful in predicting the likelihood of hospital admission and inpatient mortality, w could help guide rapid and accurate acuity designation, resource allocation and disposition.

INTEGRIS HEALTH

Thank You.



Preparing for WB Implementation

Created an auto MTP policy for component therapy MTP starting in January 2021.

- Assisted with gaining improved efficiency with obtaining blood products from blood bank
- Helped the team prepare for required process with whole blood.

Implementation of WB at OU Health

Created an auto whole blood MTP criteria

Inclusion criteria:

- Level 1 Trauma activation only
- Activated in Trauma ED only
- Transfers = trauma attending discretion
- Males >/= to 15 years old only
- Females >/= to 51 years old only

Guidelines for activation:

- SBP less than or equal to 70
- Age less than 65 shock index >/= 1.0
- Age greater or equal to 65, shock index >/= to 0.9
- ETCO2 less than or equal to 15
- Lactate greater than or equal to 5.0
- Trauma attending discretion
- Embo Now activated or pulling ERBP from HB

INTEGRIS HEALTH

January 2021

- 6 patients had auto MTP activated and received 0 product
  - 1 came in DOA and was pronounced
  - 4 were penetrating injuries that either went home or went to the floor/obs
  - 1 person didn’t get blood until the OR

February 2021

- Auto MTP Activated 35 times
  - 13 patients had auto MTP activated and received 0 product
  - On average patients received 2.04 of PRBC
  - On average patients received 2.00 of plasma
  - Platelets were given 5 times to 5 different patients receiving auto MTP
  - No wastage of blood/plasma or plts
  - 27 units out of 71 of PRBC came from the hemobank (38%)
  - 26 units out of 70 of plasma came from the hemobank (37%)
    - Most of the time patients receive blood from the HB prior to the arrival of the MTP cooler
    - 3 times all blood (over 2:2) came from HB, provider specific

February 2021

- 13 patients had auto MTP activated and received 0 product
  - 4 patients came in DOA and were pronounced
  - 6 patients were penetrating injuries that went home or admitted to floor/obs
  - 3 were admitted to the ICU (TBI)

INTEGRIS HEALTH

March 2021

- Auto MTP Activated 51 times
  - 20 patients had auto MTP activated and received 0 product
  - On average patients received 2.12 of PRBC
  - On average patients received 2.06 of plasma
  - Platelets were given 12 times to 10 different patients receiving auto MTP
  - 5/5/1 blood/plasma or plts wasted- unclear why
  - 18 units out of 108 of PRBC came from the hemobank (18%)
  - 18 units out of 105 of plasma came from the hemobank (17%)
    - Most of the time patients receive blood from the HB prior to the arrival of the MTP cooler
    - 3 times all blood (over 2:2) came from HB, provider specific
      - Adding to AutoMTP criteria- if you are pulling blood from the HB, auto activate MTP regardless of other criteria

March 2021

- 20 patients had auto MTP activated and received 0 product
  - 5 patient came in DOA and was pronounced
  - 7 was penetrating trauma that was d/c home
  - 2 had activated and didn’t receive until the OR

March 2021

- 142 Level 1's
  - 19 times AutoMTP was left blank
    - 11 of these were upgrades (need to educate the nurses to calculate shock index on upgrades)
      - 2 met criteria and ended up receiving blood from the HB
    - 8 were originally level 1's
      - 2 met criteria and 1 received blood from the HB
  - 83 No
    - 2 met criteria
      - 1 got 4L IVF and blood was given later in the OR
  - 40 Yes
    - All appropraite

April 2021

- Auto MTP Activated 24 times (up to 4/22)
  - 7 patients had auto MTP activated and received 0 product
  - On average patients received 1.98 of PRBC
  - On average patients received 2.00 of plasma
  - Platelets were given 2 times to 2 different patients receiving auto MTP
  - No wastage of blood/plasma or plts
  - 6 units out of 47 of PRBC came from the hemobank (13%)
  - 5 units out of 48 of plasma came from the hemobank (10%)
    - Most of the time patients receive blood from the HB prior to the arrival of the MTP cooler
    - 2 times all blood (over 2:2) came from HB, provider specific
      - Adding to AutoMTP criteria- if you are pulling blood from the HB, auto activate MTP regardless of other criteria

INTEGRIS HEALTH

April 2021

- 7 patients had auto MTP activated and received 0 product
  - 2 patient came in DOA and was pronounced
  - 2 was penetrating trauma that was d/c home
  - 1 had activated and didn’t receive until the OR

April 2021

- 75 Level 1's (up to 4/22)
  - 4 times AutoMTP was left blank
    - 2 of these were upgrades (need to educate the nurses to calculate shock index on upgrades)
      - 1 met criteria and ended up receiving blood from the HB
    - 2 were originally level 1's
      - 1 met criteria and 1 received blood from the HB
  - 44 No
    - 2 met criteria
      - 1 received 2:2 from the HB
  - 27 Yes
    - All appropriate

May 2021

- Auto MTP Activated 66 times
  - 32 patients had auto MTP activated and received 0 product
  - On average patients received 1.68 of PRBC
  - On average patients received 1.80 of plasma
  - Platelets were given 7 times to 6 different patients receiving auto MTP
  - No wastage of blood/plasma or plts
  - 19 units out of 112 of PRBC came from the hemobank (17%)
  - 19 units out of 118 of plasma came from the hemobank (16%)
    - Most of the time patients receive blood from the HB prior to the arrival of the MTP cooler

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May 2021

- 32 patients had auto MTP activated and received 0 product
  - 7 were activated with inappropriate SI
  - 8 no vitals given (activated appropriately need to feedback to EMS)

May 2021

- 142 Level 1's
  - 15 times AutoMTP was left blank
    - 8 were upgrades
    - 3 were "here now"
  - 79 No
    - 2 met criteria but they were falls so appropriately excluded
  - 49 Yes
    - 7 were activated with inappropriate SI
    - 1 was activated inappropriately as it was a "found down"

June 2021

Auto MTP/WB Activated 64 times (up to 6/23)

- 27 were Whole Blood activations
- 25 patients had auto MTP activated and received 0 product
  - Of those, 20 were Whole blood activations
- On average patients received 1 unit of Whole Blood
- On average patients received 1.00 of pRBC
- On average patients received 1.00 of plasma
- Platelets were given 3 times to 3 different patients receiving auto MTP
- No wastage of blood/plasma or plts
- No wastage of whole blood except the unit that was clumped

INTEGRIS HEALTH

June 2021

INTEGRIS HEALTH

June 2021

Auto MTP/WB Activated 64 times (up to 6/23)

- 24 units out of 65 of PRBC came from the hemobank (37%)
  - 9 units given prior to Arrival of MTP
  - 1 unit given and then MTP activated and no additional blood given
  - One patient was given 2 from HB, got 5 of WB, forgot to call for cooler another 3 given from HB
  - 9 units were given from the HB without auto MTP being activated at all
- 25 units out of 67 of plasma came from the hemobank (37%)
  - 11 units given prior to Arrival of MTP
  - 1 unit given and then MTP activated and not additional blood given
  - One patient was given 2 from HB, got 5 of WB, forgot to call for cooler another 3 given from HB
  - 8 units were given from the HB without auto MTP being activated at all
    - Adding to AutoMTP criteria- per James there is provider push back, some if it from the residents, need to tell James and then he can tell myself and Dr. Albrecht. DON'T ASK JUST ACTIVATE
    - 1 patient nurse documented Attending on told not to activate if fast was negative

June 2021

- 25 patients had auto MTP activated and received 0 product (20 had WB activated)
  - 1 was a Pediatric patient (component therapy activated 2nd to being 13 year old), also SI was .9 so NOT appropriate
  - 11 patients were discharged home
    - 6 were penetrating trauma that were d/c home
      - 3 appropriate SI for activation, BP low on encode
      - 1 SI was NOT appropriate for activation (.6)
      - 2 no vitals given
    - 5 were blunt trauma that were d/c home
      - 4 appropriate SI for activation, due to HR
      - 1 appropriate SI for activation, due to BP low on encode

June 2021

- 25 patients had auto MTP activated and received 0 product (20 had WB activated)
  - 4 patients were admitted to the floor/obs
    - 3 were blunt traumas admitted to the floor/obs
      - 1 SI was NOT appropriate for activation (.7)
      - 2 no vitals given
    - 1 was penetrating trauma admitted to the floor/obs
      - 1 appropriate SI for activation, BP low on encode
  - 4 patients were admitted to the ICU
    - 2 were penetrating traumas admitted to the ICU
      - 2 appropriate SI for activation, BP low on encode
    - 2 were blunt traumas admitted to the ICU
      - 1 appropriate SI for activation, BP low on encode
      - 1 no vitals given
  - 5 patients went to the OR or IR from ED
    - 3 were blunt traumas taken directly to OR or IR
      - 2 SI was NOT appropriate for activation (.4 and .5)- both received TXA prior to arrival
      - 1 (blunt) appropriate SI for activation, BP low on encode
    - 2 were penetrating traumas taken directly to OR or IR
      - 1 SI was NOT appropriate for activation (.8)
      - 1 no vitals given

June 2021

- 25 patients had auto MTP activated and received 0 product (20 had WB activated)
  - 1 patient was a Pediatric patient- ok for component therapy per our guidelines, however SI was .9 so not appropriate
    - Do we want to change component activation to 15 and older as well?
  - 5 (excluding Peds Pt discussed above) patients did not have appropriate SI for activation
    - Age < 65 then SI > 1
    - Age > 65 then SI > .9
    - These were not close either for it to be a rounding error. Thoughts? Floats?
  - 6 were no vitals given
    - Feedback to EMS of importance?

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June 2021

- 126 Level 1's (up to 6/24)
  - 9 times AutoMTP was left blank
    - 2 of these were upgrades (need to educate the nurses to calculate shock index on upgrades)
      - 1 met criteria and ended up receiving blood
    - 2 were "here now" work on triage getting vital signs?
    - 2 were Level 1's, SI was appropriate for activation
      - 1 met criteria and ended up receiving blood
    - 3 were Level 1's, SI was not appropriate for activation
  - 57 Yes
    - 16 of which were inappropriately activated
    - 5 were SI of .9, all patients were < 65 years old
      - Ages were 58, 35, 17, 26, 33
    - 3 were SI of .8
      - Ages were 33, 52, 68
    - 1 was SI of .7
      - Age was 50
    - 5 were SI of .6
    - 1 was SI of .5
    - 1 was SI of .3

June 2021

- 126 Level 1's (up to 6/24)
  - 60 No
    - 2 met criteria and were not activated
      - 1 was no vitals given (are supposed to activate those)
      - 1 was a 23 year old with SI of 1.2 (did not end up receiving blood)
    - Of note: 14 patients had no vitals given
      - 10 were activated for auto MTP per protocol
        - 6 did not receive any blood even with auto MTP activated
        - 4 did receive blood
      - 3 were left blank
        - 2 were "here now"
        - 1 was a Level 1 that met activation criteria with SI of 1.2 (did not receive blood)
      - 1 was NOT activated for auto MTP
        - Per protocol should have been activated, did not receive blood

INTEGRIS HEALTH

Future Goals

Rotational system

EMS

Flight

Outside rural hospitals

Expanding to women of child bearing age

Expanding to children 5 and older

Other patient populations

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