

A Guide to Pediatric MTP

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Disclosure

I have no financial disclosure or conflicts of
interest with the presented material in this
presentation

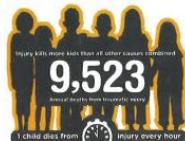
Objectives

Learners will be able to identify blood components, products, and volumes used during pediatric massive transfusion

Learners will be able to identify ways to review pediatric MTP and identify opportunities for PI projects.

Pediatric Trauma

Macro Facts:



For each child (age 1-18) who dies each year from the PI:

Cause	# of Deaths
Heart Disease	2
Cancer	6
Trauma	34

Common Injuries

- Motor Vehicle
- Drowning
- Poisoning
- Fire/Burn
- Rec/Sports
- Firearms
- Falls

System Facts:

Where it work needed: 5,700 hospitals nationwide

30% of kids in the U.S. cannot reach trauma center within the golden hour

The Golden Hour: The time between a traumatic injury and getting medical treatment can make the difference between life and death.

25% Treatment at a trauma center improves chance of survival by 25 percent

Noteable Facts:

- 71% of all severe and moderate pediatric trauma deaths were among males
- 50% of all deaths and moderate/severe pediatric trauma deaths were among males
- 30.5% of all of all pediatric deaths in the U.S. are trauma-related
- 62% of sports-related injuries occur during practice rather than in games
- 90% of sports-related fatalities occur when they are treated in a hospital
- 90% of sports-related fatalities occur when they are treated in a hospital

Key Takeaways:

- Pediatric trauma is severe injury to children that requires hospitalization and care.
- Annually, more children die from traumatic injury than all other causes combined.
- Pediatric trauma is not a disease; therefore, the readiness of our trauma system is critical to save injured children.
- More funding to advance research and education programs that improve treatment is required.
- Your advocacy to support the pediatric system of care is crucial.

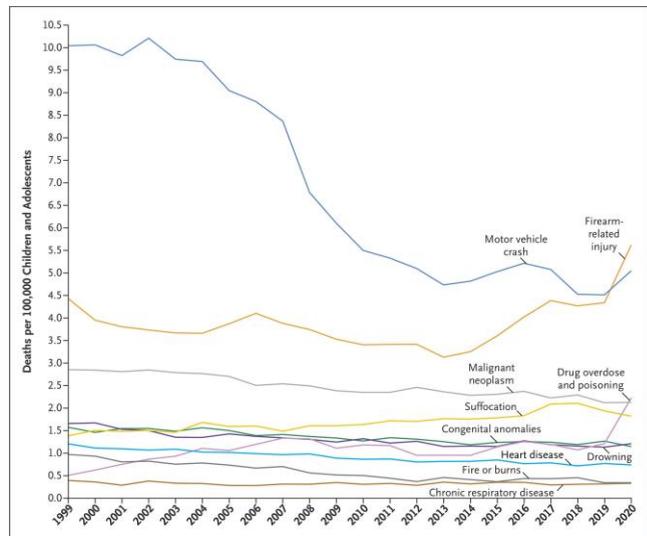
To learn more visit SAVEINJUREDKIDS.org




Trauma is #1 cause of death for children 0-18

Landscape is changing

- Historically, MVCs were #1 cause of injury in kids
 - Focus on Blunt Trauma
- As of 2020, Firearm-related injury has taken over as #1
 - More likely to need MTP than blunt trauma (*68% of MTPs at our center were from penetrating trauma)



Why?

Hemorrhagic shock after trauma is the most common cause of preventable death in children.



Adult vs. Kid? Is it different?

Yes!
They are not just “little adults”

But also, No!
Let's talk about why...



Goals of Initial Trauma Evaluation

- M** • Massive Hemorrhage
- A** • Airway
- R** • Respirations
- C** • Circulation
- H** • Hypothermia and Head injury



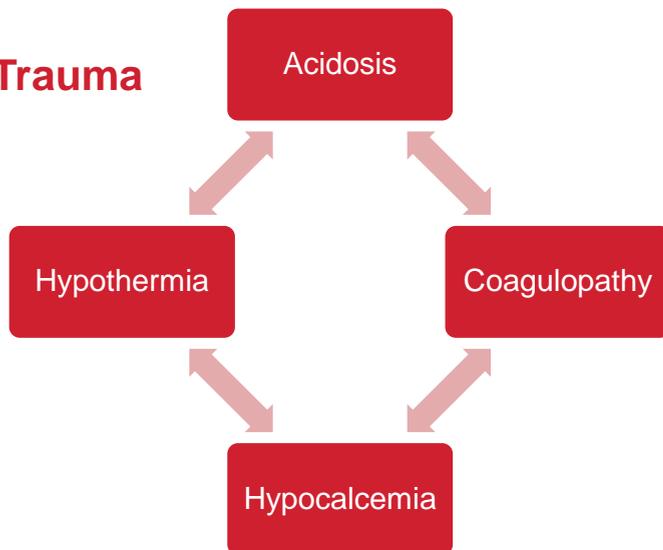
- A** • Airway
- B** • Breathing
- C** • Circulation
- D** • Disability
- E** • Exposure



Lethal Diamond of Trauma

Historically the Triad of Death
Hypocalcemia has become a recognized factor and should be addressed during resuscitation

Do your protocols have adjuncts to address these four factors?



Damage Control Resuscitation

Overall management strategy used in trauma to rapidly restore physiologic stability, while mitigating hypothermia, coagulopathy, and acidosis

Three Core Concepts:

- Acute Coagulopathy of Trauma

- Permissive Hypotension*

- Massive Transfusion and Hemostatic Resuscitation

Kids can compensate for up to 45% of total blood volume loss before becoming hypotensive

What is estimated total circulating blood volume in a pediatric patient?

75-80 ml/kg TCBV



Quiz time!!

In a 10 kg infant, how much blood loss would need to occur for a patient to progress to hypovolemic shock?

~300-360 ml



MTP in Adults

No universal definition but is generally considered:

- Transfusion of >10 units of packed red blood cells within a 24-hour period OR
- Transfusion of >4 units of packed red blood cells within 1 hour, with anticipation of requiring more transfusion within the next 24 hours



What is Massive Transfusion in pediatrics?

Table 1

Definitions of Massive Transfusion in Pediatric Literature^{3,16,17,19-21}

Author	Population	Definitions	Strengths	Limitations
Edwards et al 2012 ³	Iraqi and Afghani children admitted to a military facility with injuries from an explosive device	Any transfusion versus no transfusion, lack of definition for massive transfusion	Detailed description of blast injury patterns that increased mortality in children and adults	Only evaluated blast injured adults and children. This is an uncommon mechanism of pediatric injury in developed countries
Nosanov et al 2013 ¹⁶	Pediatric trauma patients who received blood within 24 hours	Greater than or equal to 50 percent of patient's blood volume transfused within 24 hours	Relatively large cohort identified over several years at a large, United States pediatric trauma center	Includes head injured children which can obscure any mortality benefit from transfusion
Neff et al 2015 ¹⁶	Department of Defense Joint Theater Trauma Registry	Transfusion greater than or equal to 40 milliliters per kilogram of all blood products in 24 hours	Burns, drowning, isolated head injuries and those without an injury severity score were excluded	Combat injured children with blast and penetrating trauma predominating; 24 hour totals of blood products
Horst et al 2016 ²⁰	Survey of forty six pediatric massive transfusion protocols	Institution Based, examples are greater than 40 milliliters per kilogram in 2 hours, more than 50 percent of blood volume in 2 hours and continued need for transfusion	Broad Response, Multiple Variables including ratios, hemostatic agents, massive transfusion protocol activation and compliance	Limited response from surveyed institutions by a variety of individuals with varying pediatric massive transfusion protocol experience
Cannon et al 2017 ²¹	Department of Defense Joint Theater Trauma Registry	Transfusion greater than or equal to 40 milliliters per kilogram in 24 hours	Burns, drowning and isolated head injuries and patients eighteen and over were excluded	Combat injured children were the only ones reviewed. The mechanism of injury is not as applicable in developed countries
Cunningham et al 2019 ¹⁷	Pediatric Trauma Quality Improvement Program data	Transfusion greater than or equal to 40 milliliters per kilogram in 24 hours	Large cohort, multi-institution data set; burns, dead on arrival and non-survivable injuries excluded	Retrospective, limited by data in the Trauma Quality Improvement Program database



What components are in Pediatric MTP?

Traditional MTP

- PRBCs
- Plasma
- Platelets
- Cryoprecipitate

Recent updates for our center

- Whole Blood
- Tranexamic Acid
- Calcium



May 2018

Use of Uncrossmatched Cold-Stored Whole Blood in Injured Children With Hemorrhagic Shock

Christine M. Leeper, MD, MS^{1,2}; Mark H. Yazer, MD³; Franklyn P. Cladis, MD⁴; et al

» Author Affiliations | Article Information

JAMA Pediatr. 2018;172(5):491-492. doi:10.1001/jamapediatrics.2017.5238

> *J Trauma Acute Care Surg.* 2021 Oct 1;91(4):573-578. doi: 10.1097/TA.0000000000003306.

Whole blood hemostatic resuscitation in pediatric trauma: A nationwide propensity-matched analysis

Tanya Anand¹, Omar Obaid, Adam Nelson, Mohamad Chehab, Michael Ditillo, Ahmad Hammad, Molly Douglas, Letitia Bible, Bellal Joseph

Affiliations + expand

PMID: 34086658 DOI: 10.1097/TA.0000000000003306

Multicenter Study > *Am Surg.* 2023 Jul;89(7):3058-3063. doi: 10.1177/00031348231157864.

Epub 2023 Feb 15.

Whole Blood Resuscitation is Safe in Pediatric Trauma Patients: A Multicenter Study



So now we know what to give, where do we go next?



Traditional Massive Transfusion

- Weight based... to an extent
- Dose 10 ml/kg
- Most Pediatric MTPs are defined in “< kg and > kg”
- We know with children, volume is extremely important

Children <10 kg: Blood products are to be physician order specific for any child <10kg.

Product	MTP Pack 1	MTP Pack 2	MTP Pack 3	MTP Pack 4
PRBC	25ml/kg	25ml/kg	25ml/kg	25ml/kg
FFP	20ml/kg	20ml/kg	20ml/kg	20ml/kg
PLT	10ml/kg	10ml/kg	10ml/kg	10ml/kg
Cryo.	4ml/kg	4ml/kg ²	4ml/kg ²	4ml/kg ²
		² Ca++? ⁴ rFVIIa?	² Ca++?	² Ca++?

Children 11 – 25kg:

Product	MTP Pack 1	MTP Pack 2	MTP Pack 3	MTP Pack 4
PRBC	2 Units	2 Units	2 Units	2 Units
FFP	2 Unit	2 Unit	2 Unit	2 Unit
PLT	1 Pack	1 Pack	1 Pack	1 Pack
Cryo.	2.5 Units (1/2 bag) (100mL)	2.5 Units (1/2 bag) ^{2,3,4} (100mL)	2.5 Units (1/2 bag) ^{2,3} (100mL)	2.5 Units (1/2 bag) ^{2,3} (100mL)
		² Ca++? ⁴ rFVIIa?	² Ca++?	² Ca++?

Children 26 kg and up:

Product	MTP Pack 1	MTP Pack 2	MTP Pack 3	MTP Pack 4
PRBC	4 Units	4 Units	4 Units	4 Units
FFP	4 Unit	4 Unit	4 Unit	4 Unit
PLT	1 Pack	1 Pack	1 Pack	1 Pack
Cryo.	5 Units (1 bag)	5 Units (1 bag) ^{2,3,4}	5 Units (1 bag) ^{2,3}	5 Units (1 bag) ^{2,3}
		² Ca++? ⁴ rFVIIa?	² Ca++?	² Ca++?

Weight based... to an extent... notify the Blood Bank.

Children ≤ 20 kg)

MTP Pack 1	MTP Pack 2	MTP Pack 3	MTP Pack 4	MTP Pack 5
1 U PRBCs	1 U PRBCs	1 U PRBCs	1U PRBCs	1 U PRBCs
1 U FFP	1 U FFP	1 U FFP	1 U FFP	1 U FFP
Blood Bank to				

Children > 20 KG

Pack 3	Pack 4
2 units PRBC	2 units PRBC
2 unit	2 unit
1/2 SDP	1/2 SDP

Pack 1	Pack 2	Pack 3	Pack 4
4 units PRBC	4 units PRBC	4 units PRBC	4 units PRBC
4 unit FFP	4 unit FFP	4 unit FFP	4 unit FFP
1 SDP	1 SDP	1 SDP	1 SDP

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MASSIVE TRANSFUSION PROTOCOL

March 2021

Children 10-20 kg

Blood Product Tracking Tool

This tracking tool does not obviate the need to appropriately record blood product administration in the patient's medical record.

Instructions for Use:

1. Refer to blood product release pathway based on patient weight.
2. Begin with the 1st MTP series (left column) and check off blood products as administered.
3. Sign, date and time the bottom of the form to indicate your use of this form.
4. During patient handoff communicate the use of this form to the practitioner assuming responsibility for continued blood product administration.
5. Provide a copy of this form to DCMC Transfusion Services Department upon deactivation of MTP.

1st MTP series	2nd MTP series	3rd MTP series	4th MTP series	5th MTP series
<input type="checkbox"/> 1 unit PRBCs	<input type="checkbox"/> 1 unit PRBCs	<input type="checkbox"/> 1 unit PRBCs	<input type="checkbox"/> 1 unit PRBCs	<input type="checkbox"/> 1 unit PRBCs
<input type="checkbox"/> 1 FFP	<input type="checkbox"/> 1 unit FFP <input type="checkbox"/> 1 unit platelets	<input type="checkbox"/> 1 unit FFP <input type="checkbox"/> 1 unit platelets	<input type="checkbox"/> 1 unit FFP <input type="checkbox"/> 1 unit platelets	<input type="checkbox"/> 1 unit FFP <input type="checkbox"/> 1 unit platelets
Consider TXA within 3 hours of injury		<input type="checkbox"/> 1st Cryoprecipitate	<input type="checkbox"/> 1st Cryoprecipitate	<input type="checkbox"/> 1st Cryoprecipitate
		<input type="checkbox"/> 2nd Cryoprecipitate	<input type="checkbox"/> 2nd Cryoprecipitate	<input type="checkbox"/> 2nd Cryoprecipitate

Our Project

A little about our center...

- Located in downtown St. Louis, MO
- 174 bed Pediatric Hospital
- Level I Pediatric Trauma Center
- 30 bed ED (4 Trauma Bays)
 - 60,000 ED visits/year on average
- Over 600 pediatric trauma admission per year
- 350+ GSWs in the last 4 years



Why did we start our project?

- Physical space – Refrigerators became available in our ED and OR, and core blood bank moved outside the building
- Several patients who had MTP activated were getting unbalanced resuscitation as well as over-resuscitated
 - Patient received 12,080 mL PRBC and 4,832 of plasma – we knew we had an opportunity
 - 11 yo MVC, ultimately received 23 L of blood products during her resuscitation
- MTP is low frequency, but high acuity – making it very difficult to keep staff competent and proficient in the process



First Intervention (2020)



MTP GUIDE

1. Give 1 U Whole Blood or PRBCs. Administer 2nd U if needed then proceed to Pack 1

1a. TXA – 15 mg/kg up to 1g – give over 10 minutes on pump at onset of MTP

1b. Calcium Chloride – 20 mg/kg – Give after 1st u WB or PRBCs then after trauma sets 1,3,5,etc.

****Do not give CaCl in same line as blood products****

2. Start MTP Pack 1 based upon patient weight. Alternate Plasma and PRBC

(1 u plasma, 1 u PRBC, 1 u plasma, etc. etc.)

Children < 30 kg				Children > 30 kg			
Component	PACK 1 Fridge 2 "TRAUMA SETS"	PACK 2 Fridge 2 "TRAUMA SETS"	ALL OTHER PACKS Can do Pack 3 and 4 from fridge, all others from BB	Component	PACK 1 Fridge 4 "TRAUMA SETS"	PACK 2 Fridge 4 "TRAUMA SETS"	ALL OTHER PACKS SLU BB
Plasma *Rapid Infuser*	2 units	2 units	2 units	Plasma *Rapid Infuser*	4 units	4 units	4 units
PRBCs *Rapid Infuser*	2 units	2 units	2 units	PRBCs *Rapid Infuser*	4 units	4 units	4 units
Platelets *Hand push*	½ unit SLU BB	½ unit SLU BB	½ unit SLU BB	Platelets *Hand push*	1 unit SLU BB	1 unit SLU BB	1 unit SLU BB
Cryo *Hand push*	NONE	2 units SLU BB	2 units SLU BB	Cryo *Hand push*	NONE	5 units SLU BB	5 units SLU BB

MTP Activation

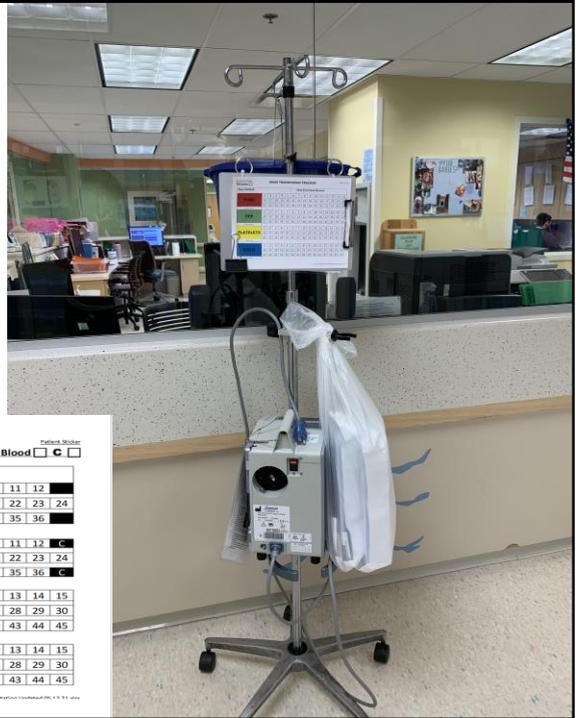
Call Blood Bank at ext. 1358

<30kg >30kg Male Female

Attending Name: _____

- Write time on **EACH** pack used in permanent marker attached to Belmont
- Save bags in red basket for charting after MTP ends/patient transferred
- Record packs on Mass Transfusion Chart - mark off box as unit is started (on clipboard).
- Notify Blood Bank when patient is transferred to a different area or the MTP is stopped.

CONSIDER TXA



NOT Permanent Record
TXA bolus

MASS TRANSFUSION TRACKER

Patient Weight: _____
Whole Blood C

CaCl ₂ given at "C"	Time First Pack Started:														
PLASMA	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Rapid Infuser	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
PRBC	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Rapid Infuser	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
PLATELETS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Hand Push	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
CRYO	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Hand Push	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45

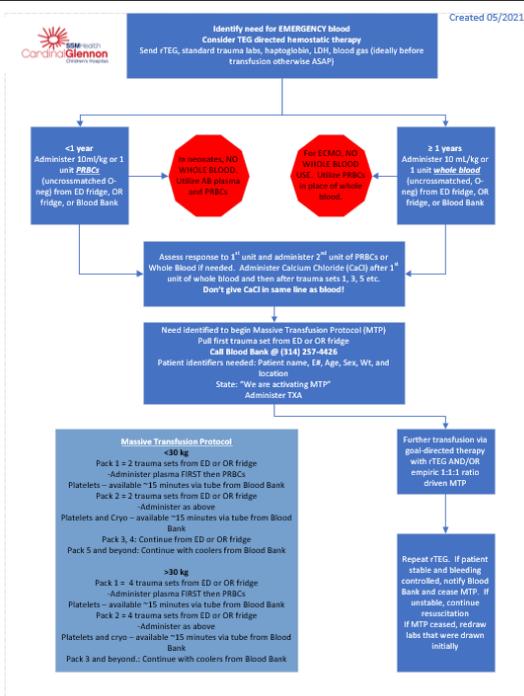
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Re-evaluate!

Staff were still uncomfortable, and we were still not as balanced as we wanted to be



Second intervention (Early 2021)



Algorithms!

We realized these were “okay”, but we could do better

Is one protocol for <30 kg and >30kg adequate for our patients?

RESEARCH SNAPSHOT THEATER: TRAUMA, PEDIATRIC I

1579: FLUID OVERLOAD IS ASSOCIATED WITH PROLONGED ADMISSION IN CRITICALLY ILL PEDIATRIC TRAUMA PATIENTS

Piryani, Ravi¹; Alvarez, Cynthia²; Nordin, Andrew³; Bass, Kathryn³; Wrotniak, Brian³; Ducato, Cathleen³; Kramer, Bree³; Swayampakula, Anil⁴

[Author Information](#)

[Critical Care Medicine](#) 50(1):p 793, January 2022. | DOI: 10.1097/01.ccm.0000812640.62223.21

Open access

Original research

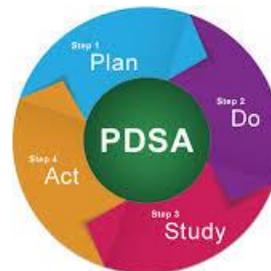
Trauma Surgery & Acute Care Open

Overtransfusion of packed red blood cells during massive transfusion activation: a potential quality metric for trauma resuscitation

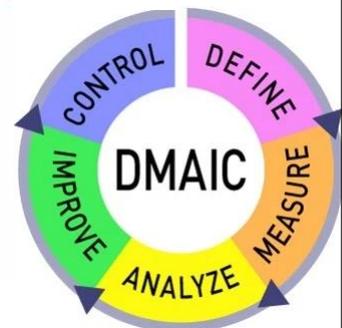
Galinus Bamparas,¹ Raymond Huang,¹ William G Lee,¹ Yassar M Hashim,¹ Samuel H Pepkowitz,² Ellen B Klapper,³ Daniel R Margulies³



Performance Improvement



Rapid Improvement Event



5 KG

Electric Shock		Dosing	Dose
Defibrillation V-Fib or Pulseless V-Tach	1st dose	2 joules/kg	10 joules
	Subsequent doses	4 joules/kg	20 joules
Synchronized for Cardioversion	1st dose	1 joules/kg	5 joules
	Subsequent doses	2 joules/kg	10 joules
Code Medications			
Drug	Route	Dosing	Dose
EPINEPHrine	(0.1 mg/mL) IV/IO	0.01 mg/kg	0.05 mg
	(1 mg/mL) ET**/Trach	0.1 mg/kg	0.5 mg
		Maximum dose: 2.5 mg	
Adenosine	Must immediately follow with a 5 mL flush		
	(3 mg/mL) Rapid IV Initial	0.1 mg/kg	0.5 mg
	Rapid IV Repeat	0.2 mg/kg	1 mg
Amlodarone	(50 mg/mL) IV/IO	5 mg/kg	25 mg
		Perfusing rhythm: Further dilute dose to 2 mg/mL w/ D5W and give over 20-60 minutes. Non-perfusing rhythm/codes: May give IV bolus without dilution	
Calcium Chloride 10%	(100 mg/mL) IV/IO	20 mg/kg	100 mg
Dextrose 10%	(100 mg/mL) IV/IO	0.5 gm/kg	2.5 gram
EPINEPHrine		See above	
Hypertonic Saline 3%	(513 mEq/L) IV	5 mL/kg	25 mL
Lidocaine 2%	(20 mg/mL) IV/IO	1 mg/kg	5 mg
	(20 mg/mL) ET**	2 mg/kg	10 mg
Magnesium Sulfate	(40 mg/mL) IV/IO	50 mg/kg	250 mg
Mannitol	(12.5 g/50 mL) IV	1 g/kg	5 gram
Sodium Bicarbonate 8.4%	(1 mEq/mL) IV/IO	1 mEq/kg	5 mL*
		*Dilute dose with equal part NS/D5W for infant concentration 4.2%	
Seizure Medications			
Fosphenytoin	(50 mg PE/mL) IV/IO/IM	20 mg PE/kg	100 mg PE
		*Dilute dose with equal part NS for final concentration 25 mg/mL	
Levetiracetam	(10 mg/mL) IV	60 mg/kg	300 mg
Lorazepam	(2 mg/mL) IV/IO/IM	0.1 mg/kg	0.5 mg
Midazolam	(5 mg/mL) IM/Intranasal*	0.2 mg/kg	1 mg
PHENobarbital	(65 mg/mL) IV/IO	20 mg/kg	100 mg

**Flush ET doses with 5 mL NS and follow with 5 ventilations
*For intranasal draw up additional 0.1 mL for atomizer

Emergency Drug Dose Book

20 KG

Electric Shock		Dosing	Dose
Defibrillation V-Fib or Pulseless V-Tach	1st dose	2 joules/kg	50 joules
	Subsequent doses	4 joules/kg	75 joules
Synchronized for Cardioversion	1st dose	1 joules/kg	20 joules
	Subsequent doses	2 joules/kg	50 joules
Code Medications			
Drug	Route	Dosing	Dose
EPINEPHrine	(0.1 mg/mL) IV/IO	0.01 mg/kg	0.2 mg
	(1 mg/mL) ET**/Trach	0.1 mg/kg	2 mg
		Maximum dose: 2.5 mg	
Adenosine	Must immediately follow with a 5 mL flush		
	(3 mg/mL) Rapid IV Initial	0.1 mg/kg	2 mg
	Rapid IV Repeat	0.2 mg/kg	4 mg
Amlodarone	(50 mg/mL) IV/IO	5 mg/kg	100 mg
		Perfusing rhythm: Further dilute dose to 2 mg/mL w/ D5W and give over 20-60 minutes. Non-perfusing rhythm/codes: May give IV bolus without dilution	
Calcium Chloride 10%	(100 mg/mL) IV/IO	20 mg/kg	400 mg
Dextrose 50%	(0.5 g/mL) IV/IO	0.5 gm/kg	10 gram
EPINEPHrine		See above	
Hypertonic Saline 3%	(513 mEq/L) IV	5 mL/kg	100 mL
Lidocaine 2%	(20 mg/mL) IV/IO	1 mg/kg	20 mg
	(20 mg/mL) ET**	2 mg/kg	40 mg
Magnesium Sulfate	(40 mg/mL) IV/IO	50 mg/kg	1000 mg
Mannitol	(12.5 g/50 mL) IV	1 g/kg	20 gram
Sodium Bicarbonate 8.4%	(1 mEq/mL) IV	1 mEq/kg	20 mEq
		*Dilute dose with equal part NS for final concentration 25 mg/mL	
Seizure Medications			
Fosphenytoin	(50 mg PE/mL) IV/IO/IM	20 mg PE/kg	400 mg PE
		*Dilute dose with equal part NS for final concentration 25 mg/mL	
Levetiracetam	(10 mg/mL) IV	60 mg/kg	1200 mg
Lorazepam	(2 mg/mL) IV/IO/IM	0.1 mg/kg	2 mg
Midazolam	(5 mg/mL) IM/Intranasal*	0.2 mg/kg	4 mg
PHENobarbital	(65 mg/mL) IV/IO	20 mg/kg	400 mg

**Flush ET doses with 5 mL NS and follow with 5 ventilations
*For intranasal draw up additional 0.1 mL for atomizer

MASSIVE TRANSFUSION DOSE BOOK



Created by:
Dr. Steven Laffey,
Dr. K. Brian Thompson,
Josh Dugal,
and Tiffany Taylor

10 kg			
Step	Product to Administer	Dose/Standard Volume All blood products (except cryo): standard dose is 10 mL/kg	Volume to administer
Emergency Release Product			
1	Whole Blood *Substitute PRBC if Whole blood is not available*	1-unit Whole Blood Standard volume: 500 mL 1-unit PRBC Standard Volume: 300 mL	100 mL
2	Calcium Chloride 10% (CaCl) Dose: 20mg/kg	Standard Concentration: 100mg/mL	2 mL 200 mg
3	Whole Blood *Substitute PRBC if Whole blood is not available*	1-unit Whole Blood Standard volume: 500 mL 1-unit PRBC Standard Volume: 300 mL	100 mL
4	Tranexamic Acid (TXA) Dose: 15mg/kg	Standard Concentration: 100mg/mL	1.5 mL 150 mg
*Continue to give whole blood until supply depleted. Administer CaCl after every other dose of whole blood. If PRBCs are only product available, administer 2 doses, then move to MTP Packs.			
5	Move to MTP Pack 1 – Notify SLU-H BB MTP being activated at Cardinal Glennon Provide SLU-H with following information Patient Name: Male or Female: E#: Patient Current Location: Authorizing Attending:		
6	Ensure order for MTP placed in EPIC Can be found in order sets when searched "PDS MASSIVE" *Can be a verbal order placed by nursing*		

4th Edition: Updated 11/2022

10 kg			
MTP PACK 1			
7	Plasma	1-unit Standard Volume: 300 mL	100 mL
8	PRBCs	1-unit PRBC Standard Volume: 300 mL	100 mL
9	Plasma	1-unit Standard Volume: 300 mL	100 mL
10	PRBCs	1-unit Standard Volume: 300 mL	100 mL
11	Calcium Chloride 10% (CaCl) Dose: 20 mg/kg	Standard Concentration: 100mg/mL	2 mL 200 mg
12	Platelets	1-unit Standard Volume: 250 mL	100 mL
MTP PACK 2			
13	Plasma	1-unit Standard Volume: 300 mL	100 mL
14	PRBCs	1-unit PRBC Standard Volume: 300 mL	100 mL
15	Plasma	1-unit Standard Volume: 300 mL	100 mL
16	PRBCs	1-unit Standard Volume: 300 mL	100 mL
17	Calcium Chloride 10% (CaCl) Dose: 20 mg/kg	Standard Concentration: 100mg/mL	2 mL 200 mg
18	Platelets	1-unit Standard Volume: 250 mL	100 mL (Pack 3, 5, 7, 9, etc.)
19	Cryo	1-unit Standard Volume: 10mL	10mL (1 unit)
MTP PACK 3 AND ON REPEAT STEPS 13-19			

*If patient SIPA is **above the cutoff**, there should be a high suspicion patient is still in shock

Shock Index Pediatric Adjusted (SIPA)				
SIPA = HR/Systolic BP				
Age (years)	Normal HR	Normal Systolic BP	SIPA Cutoff	
1 to 3	70-110	90-110	1.2	
4 to 6	65-110	90-110	1.2	
7 to 12	60-100	100-120	1	
Greater than 12	55-90	100-135	0.9	

4th Edition: Updated 11/2022

25 kg			
Step	Product to Administer	Dose/Standard Volume All blood products (except cryo): standard dose is 10 mL/kg	Volume to administer
Emergency Release Product			
1	Whole Blood *Substitute PRBC if Whole blood is not available*	1-unit Whole Blood Standard volume: 500 mL 1-unit PRBC Standard Volume: 300 mL	250 mL
2	Calcium Chloride 10% (CaCl) Dose: 20 mg/kg	Standard Concentration: 100mg/mL	5 mL 500 mg
3	Whole Blood *Substitute PRBC if Whole blood is not available*	1-unit Whole Blood Standard volume: 500 mL 1-unit PRBC Standard Volume: 300 mL	250 mL
4	Tranexamic Acid (TXA) Dose: 15mg/kg	Standard Concentration: 100mg/mL	3.75 mL 375 mg
*Continue to give whole blood until supply depleted. Administer CaCl after every other dose of whole blood. If PRBCs are only product available, administer 2 doses, then move to MTP Packs.			
5	Move to MTP Pack 1 – Notify SLU-H BB MTP being activated at Cardinal Glennon Provide SLU-H with following information Patient Name: Male or Female: E#: Patient Current Location: Authorizing Attending:		
6	Ensure order for MTP placed in EPIC Can be found in order sets when searched "PDS MASSIVE" *Can be a verbal order placed by nursing*		

4th Edition: Updated 11/2022

25 kg			
MTP PACK 1			
7	Plasma	1-unit Standard Volume: 300 mL	250 mL
8	PRBCs	1-unit PRBC Standard Volume: 300 mL	250 mL
9	Plasma	1-unit Standard Volume: 300 mL	250 mL
10	PRBCs	1-unit Standard Volume: 300 mL	250 mL
11	Calcium Chloride 10% Dose: 20 mg/kg	Standard Concentration: 100mg/mL	5 mL 500 mg
12	Platelets	1-unit Standard Volume: 250 mL	1 unit
MTP PACK 2			
13	Plasma	1-unit Standard Volume: 300 mL	250 mL
14	PRBCs	1-unit PRBC Standard Volume: 300 mL	250 mL
15	Plasma	1-unit Standard Volume: 300 mL	250 mL
16	PRBCs	1-unit Standard Volume: 300 mL	250 mL
17	Calcium Chloride 10% Dose: 20 mg/kg	Standard Concentration: 100mg/mL	5 mL 500 mg
18	Platelets	1-unit Standard Volume: 250 mL	1 unit (Pack 3, 5, 7, 9, etc.) 25 mL (2.5 units)
19	Cryo	1-unit Standard Volume: 10mL	25 mL (2.5 units)
MTP PACK 3 and ALL FURTHER PACKS – REPEAT STEPS 13-19			

*If patient SIPA is **above the cutoff**, there should be a high suspicion patient is still in shock

Shock Index Pediatric Adjusted (SIPA)				
SIPA = HR/Systolic BP				
Age (years)	Normal HR	Normal Systolic BP	SIPA Cutoff	
1 to 3	70-110	90-110	1.2	
4 to 6	65-110	90-110	1.2	
7 to 12	60-100	100-120	1	
Greater than 12	55-90	100-135	0.9	

4th Edition: Updated 11/2022

Does volume matter? 2 packs of MTP

Traditional protocol <30 kg

MTP Dose Book

	10 kg	25 kg
PRBCs	1200 mL	1200 mL
Plasma	1200 mL	1200 mL
Platelet	250 mL	250 mL
Cryo	20 mL	20 mL
Total	2,670 mL	2,670 mL

	10 kg	25 kg
PRBCs	400 mL	1,000 mL
Plasma	400 mL	1,000 mL
Platelet	100 mL	250 mL
Cryo	10 mL	25 mL
Total	910 mL	2,275 mL

We utilize a manual rapid transfusion device in order to deliver controlled volumes along with a compatible warmer

SSM Health Cardinal Glennon Children's Hospital Massive Transfusion Dose Book
IF ADMINISTERING WHOLE BLOOD: DRAW LDH, HAPTOGLOBIN AND BLOOD GAS

≥70 kg			
Step	Product to Administer	Dose/Standard Volume All blood products (except cryo): standard dose is 10 mL/kg	Volume to administer
Emergency Release Product			
1	Whole Blood *Substitute PRBC if Whole blood is not available*	1-unit Whole Blood Standard volume: 500 mL 1-unit PRBC Standard Volume: 300 mL	1 unit
2	CaCl 10% Dose: 20 mg/kg	Standard Concentration: 100mg/mL	10 mL 1000 mg
3	Whole Blood *Substitute PRBC if Whole blood is not available*	1-unit Whole Blood Standard volume: 500 mL 1-unit PRBC Standard Volume: 300 mL	1 unit
4	TXA Dose: 15mg/kg	Standard Concentration: 100mg/mL	10 mL 1000 mg
5	Move to Massive Transfusion Protocol (next page)		
CONSIDER TRANSFER TO A PEDIATRIC TRAUMA CENTER (PTC) *Early notification to PTC and begin to arrange transport services* *quickest and most appropriate is preferred*			



Access Line
888-229-2424

*Through our exceptional health care services,
 we reveal the healing presence of God.*

3rd Edition: Updated 08/2022

SSM Health Cardinal Glennon Children's Hospital Massive Transfusion Dose Book
IF ADMINISTERING WHOLE BLOOD: DRAW LDH, HAPTOGLOBIN AND BLOOD GAS

≥70 kg			
MTP PACK 1			
7	Plasma	1-unit Standard Volume: 300 mL	1 unit
8	PRBCs	1-unit PRBC Standard Volume: 300 mL	1 unit
9	Plasma	1-unit Standard Volume: 300 mL	1 unit
10	PRBCs	1-unit Standard Volume: 300 mL	1 unit
Repeat steps 7-10 then move to step 11			
11	CaCl 10% Dose: 20 mg/kg	Standard Concentration: 100mg/mL	10 mL 1000 mg
12	Platelets	1-unit Standard Volume: 250 mL	1 unit
MTP PACK 2			
13	Plasma	1-unit Standard Volume: 300 mL	1 unit
14	PRBCs	1-unit PRBC Standard Volume: 300 mL	1 unit
15	Plasma	1-unit Standard Volume: 300 mL	1 unit
16	PRBCs	1-unit Standard Volume: 300 mL	1 unit
Repeat steps 13-17 then move to step 18			
17	CaCl 10% Dose: 20 mg/kg	Standard Concentration: 100mg/mL	10 mL 1000 mg
18	Platelets	1-unit Standard Volume: 250 mL	1 unit
19	Cryo	1-unit Standard Volume: 10mL	1 unit
MTP PACK 3 and ALL FURTHER PACKS – REPEAT STEPS 13-19			

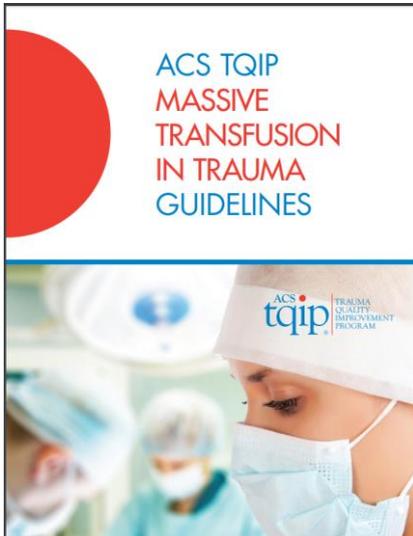
*If patient SIPA is above the cutoff, there should be a high suspicion patient is still in shock

**Shock Index Pediatric
 Adjusted (SIPA)**
 SIPA = HR/Systolic BP

Age (years)	Normal HR	Normal Systolic BP	SIPA Cutoff
1 to 3	70-110	90-110	1.2
4 to 6	65-110	90-110	1.2
7 to 12	60-100	100-120	1
Greater than 12	55-90	100-135	0.9

3rd Edition: Updated 08/2022

How do we review our activations?



Performance indicators for the process of massive transfusion should include:

- Time from calling MTP to infusion of first unit RBC
- Time from calling MTP to infusion of first unit plasma
- Adherence to a predetermined ratio or goal between one to two hours after initiation of the MTP
- Informing the transfusion service that MTP has been terminated within one hour of termination
- Wastage rates for blood products

Patient Name:

MRN:

Date of Service:

MTP Summary Report

Mechanism of injury:

Time MTP activated:

Time MTP

Did the patient receive TXA? Yes or no

Units involved:

Total units administered

Blood Product	Total units/volume
Whole Blood	
PRBCs	
Plasma	
Platelets	
Cryo	
Calcium Gluconate	

How much was wasted?

Goals per MTP Guideline for 70 kg – 1 MTP Pack

Blood Product	Total units and/or volume
Whole Blood	2 units
PRBCs	2 units PRBCs
FFP	2 units Plasma
Platelets	1 units platelet
Cryo	0 units cryo
CaCl	4 doses (4 g)
TXA	1 loading dose

Outcome: in PICU

Patient Name: Iowa, CGCG06192022

MRN: 1648974

Date of Service: 06/19/2022

MTP Summary Report

Mechanism of injury: MVC

Time MTP activated: Not documented

Time MTP ended: Not documented

Did the patient receive TXA? Yes or **no**

Units involved: ED and OR

Total other fluid given: in ED 1 L NS, 1 L LR; 200 mL 3% saline; in OR 9 L isolyte; 150 mL 3% saline

Total units administered:

Blood Product	Total units/volume
Whole Blood	2 units/1,066 mL
PRBCs	9 units/ 2,513 mL
Plasma	8 units/ 2,310 mL
Platelets	2 units / 548 mL
Cryo	5 units / 70 mL
Calcium Gluconate	6 doses/4.5 g

How much was wasted?

Goals per MTP Guideline for 45 kg – 4 MTP Packs

Blood Product	Total units and/or volume
Whole Blood – 1 dose, 450 mL	2.5 doses
PRBCs	8 units PRBCs
FFP	8 units Plasma
Platelets	3 units platelets
Cryo	15 units cryo
CaCl	6 doses (3.6 g)
TXA	1 loading dose



Knowledge is power!

- Send report to Trauma Liaisons:
 - Anesthesia
 - ED
 - Trauma Surgeons
 - Critical Care
 - Nursing Leaders of ED, PICU, and OR
- Review at Secondary Review with Trauma Medical Directors
- Review at Trauma Performance Improvement and Patient Safety Meeting (PIPS)



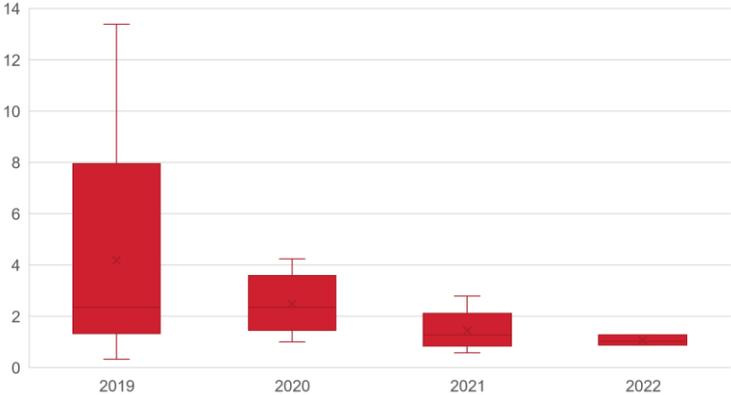
Did our book work?



Review

Our goal was to improve ratios and be as close to 1:1 as possible for PRBC:FFP

Year	Average Ratio
2019	3.37
2020	2.49
2021	1.44
2022	1.25



Surprise result! Low Frequency – Always needed when activated?

	2019	2020	2021	2022
MTP Activated	12	15	6	8
True MTP (>40ml/kg)	9	4	5	7



Limitations, considerations, and future directions

- Around the time we started using this book, we also implemented whole blood at our center
 - Chicken vs. egg situation – but most likely a combination of the two contributed to our success
- We need to look more in depth into the patient outcomes and if/any transfusion reactions to truly say this book has been a success. Plan to do so at end of this year to have 2 years of data.
- Shared with our colleagues at Texas Children's Hospital to see if our results are reproducible at other Pediatric Trauma Centers



Special Thanks



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Thank you

Questions?

