Massive Transfusion

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Definition(s)

- Classic
  - Complete replacement of a patient's blood volume within 24 hours (about 10 units/ 70kg adult)
- Greater than 50 units within the first 24 hours
- Greater than 50 units within the first 48 hours
- Comparisons made difficult

"Reality"

- Typical patient initially bleeds without any replacement at scene
- Receives crystalloid en route
- Only then receives blood in ED or OR
- How does one determine when transfusion becomes massive?

Reality

- Hemorrhage models show that 70% of estimated blood volume is lost even before the 1st unit is given

New Definition Required

- Discrepancy between bleeding and replacement
- Behind the eight ball
- Proactive anticipatory "working"definition:
  - Administration of 4 units of blood within first hour, with anticipation of ongoing usage?
  - Administration of 4 units of blood within first 4 hours?

Massive Transfusion Protocol Development:

All players at the table

- Surgeons
- Emergency Medicine
- Anesthesia
- Lab
- Blood Bank
- Nursing
- Trauma Program Manager
- IS
- Medical Records
- Admitting

MTP: Logistics

- **Hospital Specific (Resource Dependent)**
  - Proximity of Blood Bank to ED/OR
  - Point of care testing
  - Sophisticated Tube system
  - Blood fridge in ED/OR
  - Runner service
  - Lab personnel on trauma activations
  - Transfusion specialists 24/7
    - Pathology Residents
  - None of the above

MTP: Process Issues

- **Primary Goal:**
  - Timely, coordinated, access to adequate blood supply
- **Secondary Goals:**
  - Standardization
  - Avoid surgeon distraction from operative field
    - Accountability built into the process
  - Minimize product wastage

Massive Transfusion Activation

MTP: Process

- **Formal Activation vs "The Slide…"**
  - Overhead announcement of Massive Transfusion
  - Beeper
  - 2 way radio
  - QI Tip: Incorporate activation time into ED flowsheet & anesthesia record
- **Who Can Activate?**
  - Surgeon
  - Anesthesia
  - Emergency Medicine?
  - PA / NP / Nurse?
  - Also responsible for timely deactivation

MTP: Process

- **Indications for Activation**
  - Class IV Shock
  - Class III Shock with anticipated blood loss requiring 10 unit replacement and likelihood of continued hemorrhage
  - Or 4 units within one hour & more anticipated

- The actual loss of blood does not have to occur before the judgment is made that such loss is imminent
- Never based on laboratory values!

MTP: Process

- **Patient Identification** CAUTION:
  - Mislabel risk high in multiple trauma
  - Sophisticated John Doe system
  - SPEED and SAFTEY
- **Blood Draws**
  - Ideal if Lab personnel respond to activations
  - Nurse drawn & labeled
    - (prelabeled tubes John Doe packet)
  - Adequate non hemolyzed specimen
  - Tip: May obtain from externally dripping wound as last resort

Emergency Uncrossmatched (immediate)

- **Ideally in ED before patient**
- **O Positive**
  - For males
  - 36% donor pool
- **O Negative**
  - For childbearing females & children
  - Only 8% donor pool

QI: Delay to Specimen

- ✓ If more than 4 U of Emergency O blood given before specimen obtained
- ✓ Leads to subsequent difficulty in compatibility testing
- ✓ Stay with type O blood
- ✓ Review cause of delay

Blood Progression

1. **Emergency Uncrossmatched (immediate)**

2. **Type Specific (10 mins)**
   - ABO and Rh compatible

3. **Crossmatched (40 mins)**
   - ABO and Rh type
   - Other known antibodies

MTP: Process

- **Specimen transportation**
  - Lab Personnel
  - Tube system (caution)
  - Runner (baton pass off)
    - Eye to eye
    - Differentiate this specimen from others

MTP: Process

- **Blood Containers**
  - ED/OR Blood Refrigerator (stationary)
  - Ice Chest (advantage of being portable)
- **Typical Massive Transfusion Pack:**
  - 6-10 units PRBC's
  - 4-6 units FFP
  - 1 pheresis Platelets unit (6-8 random)

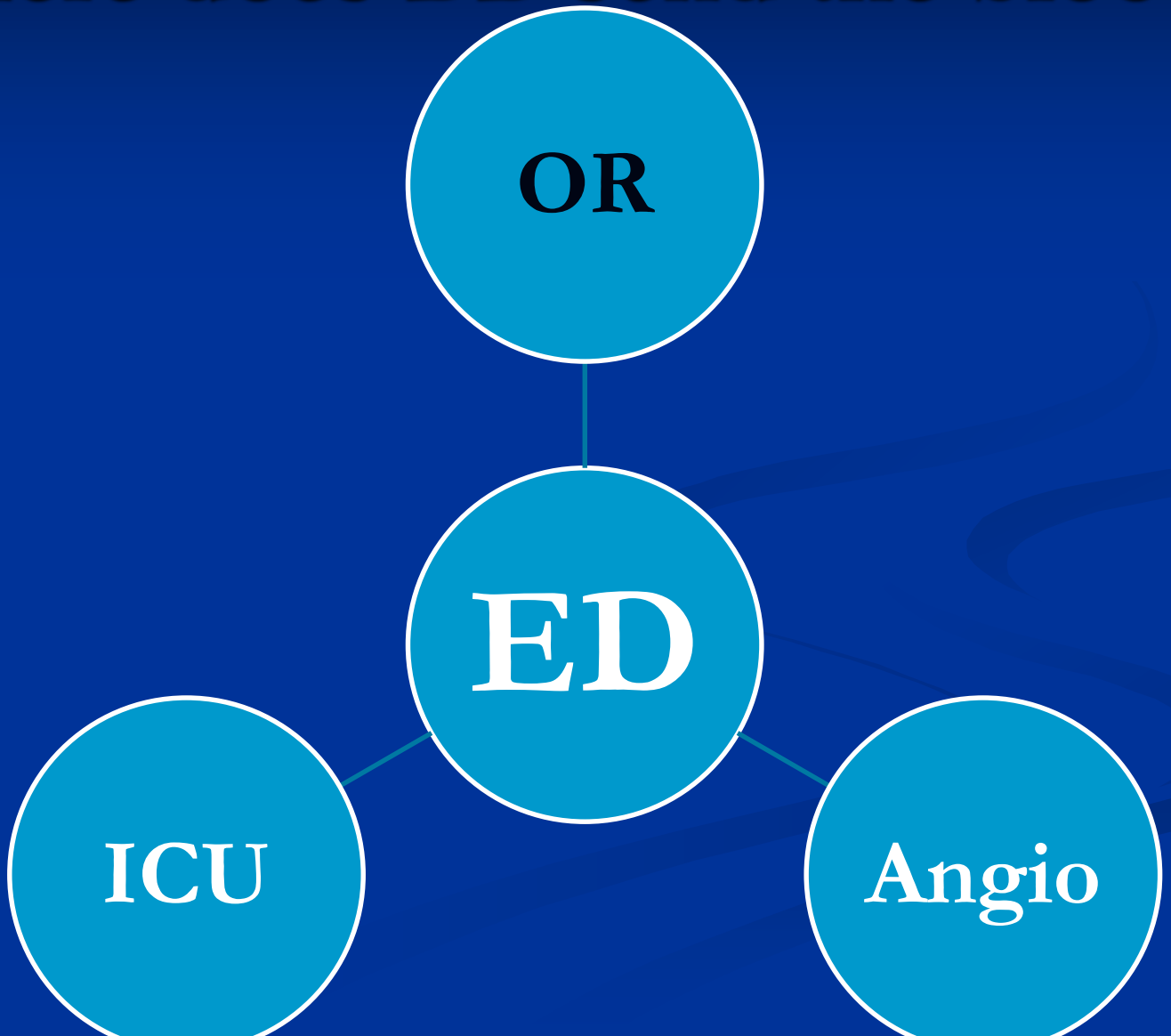
Massive Transfusion Pack

Product	# Units	Container Temp	Time out Of BB	Re-Issue Ability
PRBC	6-10	Ice Chest	3-8 hours	Yes
FFP	4-6	Ice Chest	3-8 hours	Yes
Platelets	1 pheresis	Room Temp	3 hours	Yes

FFP or Thawed Plasma

- **Policy:**
  - Thaw time variable (equipment dependent)
  - Typical: 2 units in 20 minutes
  - TIP: Most Blood Banks keep 4-6 pre-thawed plasma at all times
    - Re-cycle daily
    - Monitor for wastage
    - Consider sending it with initial chest of blood

GPS device on patient?
Where does BB send the blood?



MTP: Process

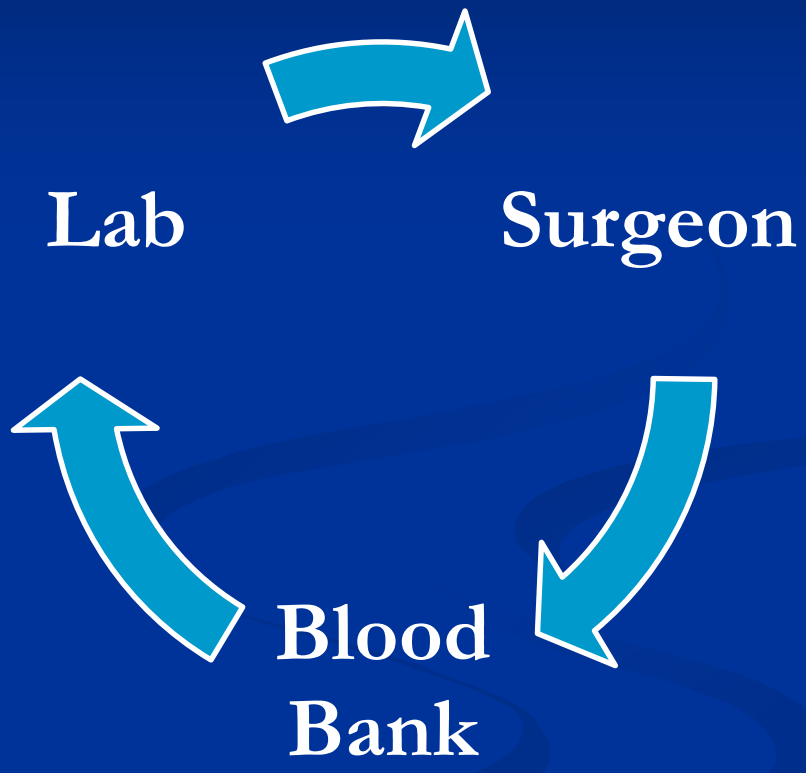
- **Blood Bank Accountability**
  - Mobilize immediate staffing (cross train)
  - Stay 6-10 U ahead at all times
  - Continuous communication with anesthesia/surgeon
  - Monitor and maintain inventory

BB Inventory Maintenance

- Automatic switch of patients to ABO compatible blood as blood supply dwindles:
- Male Patient A Neg O+, A+, then A-, then O-
- Blood Bankers always think about the current patient as well as the next one coming in

Communication Logistics

- BB/Lab direct phone contact to Surgeon/Anesth
- Intercom
- 2 Way Radio
- Red "Hot Line" Phone



MTP Process

- **Suggested Coagulation Tests**
  - PT-INR
  - PTT
  - Platelets
  - Fibrinogen
  - Ionized Calcium
- Suggested Frequency: q 30 – 60 min

Just how old are you?

- Do you remember when whole blood was given?
- Phased out in 1970's to component therapy
- Initial additives: blood out date was 21 days
- Then extended to 35 days (late 1970's)
- Then extended to 42 days (1980's)

Blood Additives Affect on Coagulopathy

- **CPDA1**
  - 35 day out date
  - **Hct 75%**
    - No Adenine
    - Preferred in Neonates
- Most hospitals have a mix of blood additives due to distribution issues

- **Adsol AS1**
- **Nutricel-AS3**
- **Optisol AS5**
  - 42 day outdate
  - **Hct 60%**
  - 50cc plasma
  - 100cc additive saline

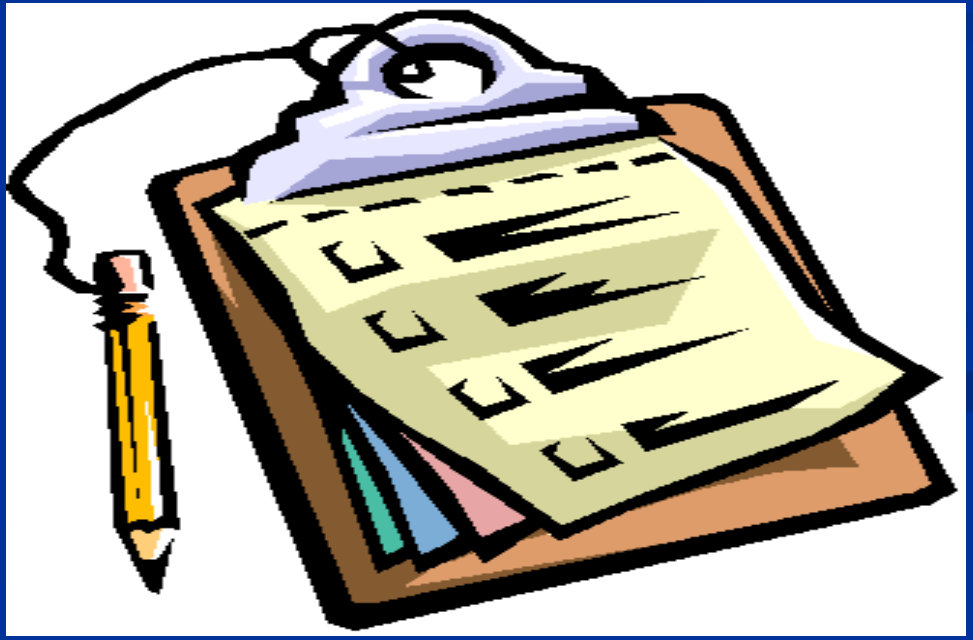
Farringer J of Trauma 1993

Historically 3 MTP Management Strategies

1st Strategy

Transfuse coagulation components according to a formula based upon # units RBC transfused

- ✓ Prophylactic administration = not supported by research



2nd Strategy

- Defer component transfusion until microvascular bleeding is identified in the wound

3rd Strategy

- Directed replacement protocol based on coagulation monitoring

Reality…

- Challenge is how to operationalize
- How to administer products in a timely manner?
- With pending labs results?
  - Order labs and components simultaneously
  - When lab results known product available

Directed Component Replacement

- **FFP**
  - PT or aPTT > 1.5 times control
  - INR alone not recommended to base MTP decisions
    - INR elevations are not indicative of the risk of bleeding unless they are > 1.8 and are associated with an elevated PTT
  - Reality:
    - If PT-INR/PTT pending with ongoing blood loss
    - Give 2 units FFP for every 5-6 units of blood given

Directed Component Replacement

- **Platelets**
  - Platelet count less than 50,000 with ongoing bleeding
    - 1 pheresis platelet unit = 6-8 random donor units
- **Cryoprecipitate**
  - Fibrinogen less then 80-100 mg/dl
  - Give 10 u Cryo

Conclusion

- Transfusion triggers for RBC and Platelets have been abandoned
- RBC administration =
  - physiologic instability and on going blood loss
- Platelets administration =
  - thrombocytopenia with on going blood loss
- FFP
  - Relationship to # units given
  - Replacement ratios vary among trauma centers

Ideal RBC to Plasma Ratio?

- Majority of studies show survival advantage
- 1:1 or 1:2
- No Prospective randomized controlled trials

EAST Guidelines RBC Transfusion in Adult Trauma and Critical Care 2009

- Level I
  - RBC transfusion is indicated for patients with:
    - Evidence of shock
    - Acute hemorrhage and hemodynamic stability
    - Restrictive strategy is as effective as liberal

SPEED is Important

1. PT prolongation

- Occurs early!
- If FFP delayed >3u RBC PT crosses hemostatic threshold regardless of amt of FFP subsequently given

2. Fibrinogen

- Fibrinogen depletion easier to correct

Suggested Formula

- FFP/PRBC ratio 1:1 or 1:2
- Give 2 u FFP with first units of PRBC to start

- Fibrinogen depletion is prevented when the FFP/PRBC ratio of 4:5 was used

Model Recommendations

3. Platelets

- Even if replacement of platelets is delayed until 10 units of PRBC given
- Critical platelet dilution is prevented
- Reinforces: prophylactic administration of PLT is unnecessary

Suggested Formula

- PLT: Blood Ratio

  8 : 10

NOT A PERMANENT PART OF THE CHART

Massive Transfusion Tracking Sheet

Automatic Numerical Order of Transfusions

Suggested Sheet Use: Follow the numbers and cross off units as you give them

	Chest Shipment	RBC's	Thawed Plasma	PLT's 1 Jumbo Apheresis unit = 6 (old style)	CRYO 10 units 1 pooled unit = 5 single unit's	rFVIIa Dose 6 mg dose for > 100 kg 5mg dose for 65-100 kg (Pediatric dosing per physician)
Class I Trauma	Chest 1	1 3 5	2 4 6			
	Chest 2	7 9 11	8 10 12			
Massive Transfusion	Chest 3	14 16 18	15 17 19	13		
	Chest 4	23 25 27	24 26 28		20, 21	22 From Pharmacy
	Chest 5	30 32 34	31 33 35	29		
	Chest 6	39 41 43	40 42 44		36, 37	38 From Pharmacy
	Chest 7	46 48 50	47 49 51	45		
	Chest 8	55 57 59	56 58 60		52, 53	Ask for order 54
	Chest 9	62 64 66	63 65 67	61		
	Chest 10	71 73 75	72 74 76		68, 69	Ask for order 70
Continue as necessary						

- Remember to deactivate the massive transfusion guideline over the trauma radio when finished

NOT A PERMANENT PART OF THE CHART

Is There A Limit to Massive Transfusion After Trauma?

- **No**
  - There is no threshold for stopping blood in a massive transfusion
  - Duration and severity of shock are predictors of mortality not volume of blood given

Blood Costs (MI $)

Product	Packaged	Cost
PRBC	1 unit	$850
FFP	1 unit	$250
Platelets	1 random unit 1 pheresis unit	$250 $1000
Cryo	1 unit 10 units pooled	$100 $900
Example MTP	22 u PRBC 16 u FFP 3 ph PLTs 1 Cryo	One Patient $25,800 Total Wow!

Complications of Massive Transfusion Theoretical vs Genuine?

- **Depletion 2,3 DPG (*Theoretical*)**
  - Decreased O2 off load
- **Hypocalcemia (*Genuine*)**
  - Significant citrate load
  - Monitor ionized calcium
- **Hyperkalemia *(Theoretical)***
  - Storage lesion
- **Coagulopathy (*Genuine)***

  Multifactorial:
  - Coagulation abnormalities
  - Excessive fibrinolysis
  - Hypothermia, Acidosis,
  - Dilutional coagulopathy
- **Hypothermia (*Genuine)***
  - Rapid infusers 42 C
  - Hypothermia protocol

Emerging Effects

- Trauma -Independent risk factor:
  - Death
  - Perioperative infection
  - SIRS
  - ICU admission
- Age of blood – (MOF)
  - # u > 14 days
  - # u > 21 days

Emerging Effects of Blood

- Detrimental Immunomodulation
- Increased risk for cancer recurrence
- Stimulation of cytokine release (> 14 days)
- Enhanced acute inflammatory response

Do you know the age of blood transfused in your trauma center?

- Blood bankers always release "short date" (older blood) first on a first come first served basis
- Average age of RBC's transfused is 21 days
- 40% > 28 days
- Huge ramifications on blood supply

Supportive Guidelines

- ✓ Pleural Autotransfusion
- ✓ Intra Operative Cell Saver
- ✓ Hypothermia control
- ✓ Damage control surgery
- ✓ Recombinant Factor VIIa
- ✓ Blood substitutes (future…)

MTP Case: ED Analysis

Class I Pedestrian vs car 3 min notice, EMS: no IV or ETT
Open Book Pelvis, Liver Lac

Time	2048	2058	2108	2120	2130	2140	2150	2205	To OR
BP	51/33	68/33	57/38	89/38	105/53	105/55	78/56	78/50	
P	133	122	126	124	131	131	116	118	
Tx's	ETT	Hgb 13.9 Unable to start IV Plain Films Subclavian Cordis Placed			pH 7.15 BD –16 To CT (BP 105/55) Angio Notified Did not activate MTP!				Total: 16 L 12 U
IV			3L	3L	3L	2L	2L	1L	
Blood			**4u** **O+** **20min!**	2u O+		2u O+	2u O+	2u O+	

GSW Chest

- Found down in snow bank
- Single GSW to Lt Chest
- EMS: load & go
- Total EMS time: 8 min
- 2 min prior notice to Tr Center
- Surgeon present on arrival
- Signs of life
- ETT @ 2 min
- Chest opened @ 3 min
- Femoral Cordis 9F@ 7 min
- Blood specimen to lab @ 7 min
- 1st unit up on rapid infuser @ 8 MINs

Cost Savings

- **T&S vs T&C in trauma program**
  - T&S for majority of trauma
  - T&C reserved for those only at high risk:
    - Class I activations
      - Can we do even better?
    - Are there predictors of blood use in trauma or is it just common sense?
      - Physiologic and Mech of Injury


shifthappens

In Summary

- MTP serves as a barometer of Trauma Program Maturity
- Reflects the highest level of multidisciplinary collaboration working together in a timed event
- Challenge: to continuously update your protocols to reflect current literature
- Critique every massive transfusion as another opportunity for improvement!