Whole blood MTP in OBGYN

UTHealth Houston

Scope of the problem

- **Trauma**
  - Fourth leading cause of mortality in the USA.
  - More than 30% of trauma-related deaths are due to massive hemorrhage
  - Focus on pre-hospital and immediate intervention for massive coagulopathy
- **Obstetric hemorrhage**
  - #3 cause of maternal death
  - 1-3% in 2009, increased to 4.3 - 10% in 2019.
  - 27% of maternal death worldwide, 11.2% in the US
  - Increasing frequency likely related to increased rates of cesarean, placenta accreta spectrum, and maternal surgical comorbidity (obesity, AMA, etc..)

Whole blood facts

- WB is stored between 1 °C and 6 °C.
- WB can last up to 21 days
- Most centers in the USA limit the use of WB to 14–21 days
- Our trauma center uses LTO+WB (<1:256)
- Some centers have a higher threshold for titers; as low as 1:50.

Logistics of Whole Blood

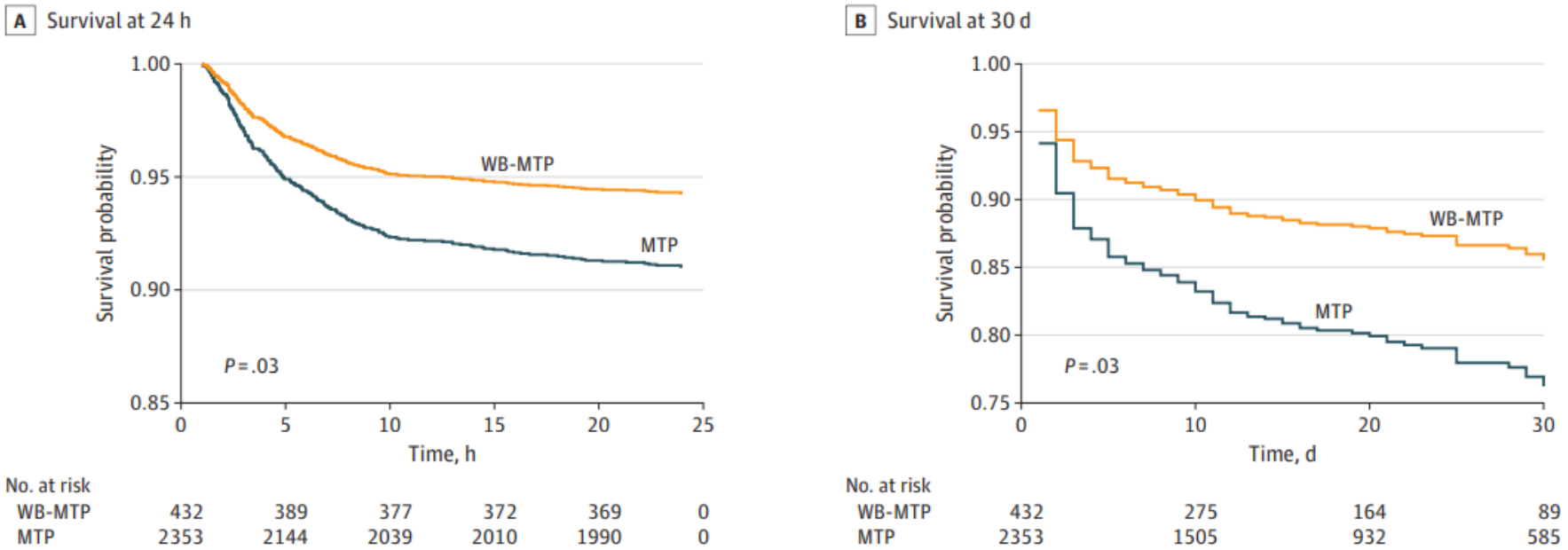
- WB can be given through a warmed rapid infuser during MTP
  - This is not recommended for all elements of CT.
- WB is all components in a single IV line (rapid/simple administration)
- WB does not need to be thawed, like FFP and cryoprecipitate do.
- Decreased likelihood of an administrative error with WB transfusion when compared to CT
- Rh negative Type O whole blood is rare in the donor pool and difficult to procure

JAMA Surgery | Original Investigation

Association of Whole Blood With Survival Among Patients Presenting With Severe Hemorrhage in US and Canadian Adult Civilian Trauma Centers

Crisanto M. Torres, MD, MPH; Alistair Kent, MD, MPH; Dane Scantling, DO, MPH; Bellal Joseph, MD; Elliott R. Haut, MD, PhD; Joseph V. Sakran, MD, MPH, MPA

Figure 2. Adjusted Kaplan-Meier Survival Estimates by Transfusion Group



MTP indicates massive transfusion protocol and WB-MTP, whole blood as an adjunct to component therapy–based MTP.

Whole blood, even as little as 1 unit early on, is associated with increased survival

Proposed mechanism: More rapid and effective correction of coagulopathy

Torres et al. Association of Whole Blood with Survival Amond Patients Presenting With Severe Hemorrhage in US and Canadian Adult Civilian Trauma Centers. JAMA Surg. 2023

Obstetric Specific Considerations

- Is obstetric bleeding different than trauma?
  - We do not believe so. Uterus or GSW.
- Obstetric patients are admitted to the hospital and all have T+S
  - Lets us pre-screen for antibodies and prepare CT-MTP in advance
- Obstetric bleeding is possible more dangerous – early identification
  - More occult bleeding, abruption, AFI, VTE etiologies – limiting identification
  - "Healthy Patient" paradox introduces bias – high index of suspicion needed
- Management is the same = Massive resuscitation + exploratory surgery.
- "Can't release non-type-specific WB in the setting of known T+S because of the risk of hemolysis."
- Concerns about RhD in female patients of childbearing age.

Anaesthesia 2015, 70 (Suppl. 1), 78–86 doi:10.1111/anae.12913

Review Article

Haemostatic management of obstetric haemorrhage

R. E. Collis[1] and P. W. Collins[2,3]

Table 2 Clauss fibrinogen as a biomarker for predicting progression of postpartum haemorrhage (PPH). Values are median (IQR) or mean (SD).

Reference	Number studied	Entry criteria	Definition of progression	Fibrinogen level; g.l^{-1} Non-progression	Fibrinogen level; g.l^{-1} Progression
Charbit et al. [25]	128	Second line uterotonic after manual evacuation	Fall in Hb > 40 g.l^{-1}, ≥ 4 units RBC, need for invasive procedure*	4.4 (3.7–5.1)	3.3 (2.5–4.2)
Cortet et al. [35]	738	Vaginal delivery > 500 ml PPH Excluding genital tract trauma, uterine rupture, accreta and praevia	Fall in Hb > 40 g.l^{-1}, any red cell transfusion, need for invasive procedure, admission to ICU	4.2 (1.2)	3.4 (0.9)
Gayat et al. [37]	257	Admission to referral centre for PPH†	Need for an invasive procedure	2.65 (2.08–3.46)†	1.8 (1.09–2.52)†
De Lloyd et al. [36]	240	Any cause of PPH and time of first coagulation test	Need for ≥ 4 units red cells or PPH > 2500 ml	4.4 (1.1)	3.1 (1.0)
Collins et al. [27]	346	Any cause of PPH 1000–1500 ml	Need for ≥ 4 units red cells or PPH > 2500 ml	3.9 (3.2–4.5)	2.8 (2.1–3.8)

*Most defined as progressing based on fall of Hb > 40 g.l^{-1}.
†Fibrinogen was taken on average 4 h after the onset of bleeding on admission to a referral centre and this contributes to the lower fibrinogen levels in this cohort.

Coagulopathy evidence by decreased fibrinogen is a marker for progression to more severe PPH

- Additional RBC units transfused
- Additional invasive procedures

Early correction of coagulopathy has biological plausibility in obstetric bleeding for reduction of morbidity and mortality.

Collis et al. Haemostatic management of obstetric haemorrhage. Anaethesia. 2015

Obstetric patients get whole blood on ambulances

Case Report

Whole Blood Administration for Obstetric-Related Hemorrhage During Prehospital Transport

Abigail Polzin, MD, FACEP, Kaihlen Smith, BS and Thomas Rumpza, RN

Maternal deaths due to hemorrhage, most of which are preventable, have increased since 1980.[1,2] Although the first publication of a successful whole blood transfusion after postpartum hemorrhage was released 150 years ago,[3] very few studies examining outcomes of whole blood transfusion in obstetric emergencies have been published since.[4–8] The International Federation of Gynecology and Obstetrics recommends that whole blood can be used in cases of massive hemorrhage, and whole blood transfusion is considered a safe and deliberate choice for management of obstetric hemorrhage in other parts of the world.[9,10]

After the whole blood program initiation for our transport team, the tertiary care centers in our health system have also begun using whole blood in other resuscitations, including massive transfusion for obstetric hemorrhage. Currently, our main facility can keep 4 units of O-negative whole blood available for known Rh-negative female patients; however, the transport team continues to carry O-positive whole blood. Considering the findings from our experience, we encourage other health care professionals and health systems to investigate the use of whole blood in obstetric and other nontrauma hemorrhage.

Polzin et al. Whole blood administration for obstetric-related Hemorrhage During Prehospital Transport. Obstet Gynecol. 2023.

Whole blood for postpartum hemorrhage: early experience at two institutions

David S. Morris,[1] Maxwell A. Braverman,[2] Jessica Corean,[3] John C. Myers,[2] Elly Xenakis,[4] Kayla Ireland,[4] Leslie Greebon,[4] Sarah Ilstrup,[5] and Donald H. Jenkins[2]

- **Intermountain medical center**
- 16 units of LTOWB
  - 8 of Rh neg, 8 of Rh pos
  - Leukoreduced, <1:256
- Any ABO can receive LTOWB
- RBC salvage at 14 days to turnover stock

- **UT San Antonio**
- 8 units of LTO+WB
- All patients eligible
- 20 units maintained, 4 reserved for OB hemorrhage
- Limit 12 units LTO+WB
- Crossmatched WB prior to accreta surgery
- CT if no crossmatch compatible WB available.

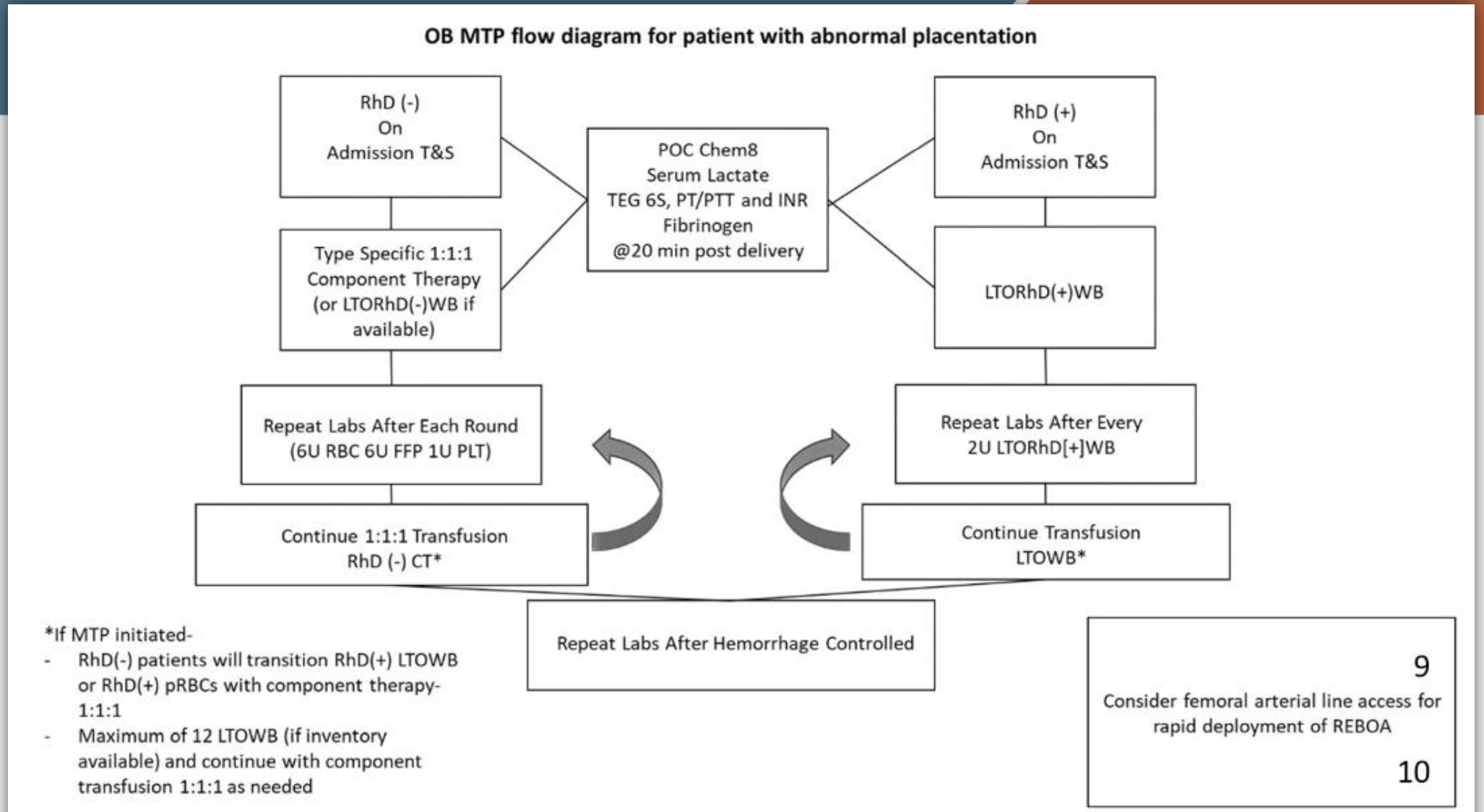


FIGURE 1 Obstetric (OB) hemorrhage protocol. CT, component therapy; LTORhD(+)WB, low titer type O RhD (+) whole blood; POC, point of care; T&S, type and screen; TEG, thrombelastography.

Myers et al. Risk factors for massive transfusion in obstetrical hemorrhage and consideration of a whole blood program. Transfusion 2023

Whole blood transfusion reduces overall component transfusion in cases of placenta accreta spectrum: a pilot program

Jessian L. Munoz[a,b], Alison M. Kimura[a,b], Elly Xenakis[a,b], Donald H. Jenkins[c], Maxwell A. Braverman[c], Patrick S. Ramsey[a,b] and Kayla E. Ireland[a,b]

[a]Division of Maternal Fetal Medicine, University of Texas Health Sciences Center at San Antonio, San Antonio, TX, USA; [b]Department of Obstetrics & Gynecology, University Health System, San Antonio, TX, USA; [c]Division of Trauma and Emergency Surgery, The University of Texas Health Science Center at San Antonio, San Antonio, TX, USA

Table 2. Operative characteristics.

Factor	Whole blood ($n = 16$)	Component ($n = 18$)	p Value
Admission hemoglobin (g/dl)	10.5 ± 1.5	10.7 ± 1.3	.626[a]
Operative time (min)	319.6 ± 161.1	230.7 ± 128.5	.08[a]
Urinary stent placement	13 (81)	11 (61)	.27[c]
Uterine artery embolization	8 (50)	3 (17)	.076[c]
EBL (ml)	2600 (2000, 4750)	3000 (1875, 5250)	.90[b]
Component transfusion			
Whole blood	3.5 (1.3, 4)	–	–
Red blood cells	0 (0, 2)	4.5 (2, 6.8)	**.003**[b]
Platelets	0 (0, 0.8)	0 (0, 1)	.89[b]
Fresh frozen plasma	0 (0, 3.3)	3 (0, 5)	**.001**[b]
Cryoprecipitate*	0 (0, 0)	0 (0, 0)	.18[b]
Volume transfused (ml)**	2607	4683	**.03**[a]
GU injury	3 (19)	3 (17)	1.0[c]
Intentional cystotomy	3 (19)	3 (17)	1.0[c]
Incidental cystotomy	0	2 (11)	.49[c]
Ureteral injury	1 (6)	0	.47[c]
PAS by Pathology			
Accreta	1 (6)	4 (22)	.34[c]
Increta	3 (19)	3 (17)	1.00[c]
Percreta	12 (75)	11 (61)	.47[c]
Post-operative Hemoglobin (g/dl)	10.3 ± 2.0	10.3 ± 2.4	.98[a]
Post-operative LOS	4 (3, 5.8)	4 (2.8, 5)	.44[b]

Conclusions

In the setting of suspected PAS pathology, at a quaternary referral center, whole blood may be considered for initial resuscitation with similar post-operative outcomes, fewer component transfusions and fewer donor exposures. As PAS cases continue to increase, the development of novel approaches to patient management will be required to continue to optimize outcomes for complex surgical cases.

Munoz et al. Whole blood transfusion reduces overall component transfusion in cases of placenta accreta spectrum: a pilot program. Journal of Maternal-Fetal & Neonatal Medicine. 2021

Transfusion. 2023 May:63 Suppl 3:S112-S119. doi: 10.1111/trf.17331. Epub 2023 Apr 17.

Risk factors for massive transfusion in obstetrical hemorrhage and consideration of a whole blood program

John C Myers [1], Maxwell A Braverman [1], Angelo Ciaraglia [1], Rahaf Alkhateb [2], Lauran Barry [1], Zachary Brooke [1], Jeffrey Chang [3], Hanzhang Wang [4], Rafael Elenes [5], Byron Hepburn [6], Kayla Ireland [3], Rachelle Jonas [1], Jeremy Nelson [6], Santiago Pedraza [1], Jun Song [3], Susannah Nicholson [1], Brian Eastridge [1], Ronald Stewart [1], Leslie Greebon [2], Elly Xenakis [3], Donald Jenkins [1]

Retrospective study of 610 patients who required massive transfusion due to obstetric hemorrhage.

93% were RhD positive
3.7% possessed an antibody on T+S
CT was not given at the 1:1:1 Ratio

TABLE 3 Distribution of blood types between MT and Non-MT groups.

Blood type	MT[a] ($n = 73$)	Non-MT[a] ($n = 537$)
A+	25 (34.3)	140 (26.1)
A−	0 (0.0)	6 (1.1)
AB+	2 (2.74)	15 (2.8)
B+	8 (11.0)	51 (9.5%)
B−	0 (0.0)	7 (1.3%)
O+	36 (49.3)	296 (55.1)
O−	2 (2.7)	22 (4.1)

[a]Variables represented as *n* (%).

Component and timing	MT[a] ($n = 73$)
RBC pre-partum[c]	2.27 (1.39, 3.16)
FFP pre-partum	1.64 (0.6, 2.69)
PLT pre-partum	0.25 (0.07, 0.42)
Cryo pre-partum	0.03 (0, 0.08)
RBC post-partum[d]	8.56 (4.98, 12.15)
FFP post-partum	6.63 (3.06, 10.2)
PLT post-partum	1.1 (0.49, 1.7)
Cryo post-partum	0.81 (0.34, 1.28)
Product ratio[e]	1: 0.48: 0.51

Open access Brief report

Trauma Surgery & Acute Care Open

Another piece of the hemolytic disease of the fetus and newborn puzzle after RhD-positive transfusion in trauma resuscitation: the proportion of pregnant women who produce high titer anti-D

Mark H Yazer ,[1] Stephen P Emery,[2] Darrell J Triulzi,[1] Philip Spinella,[3] Christine Leeper [4]

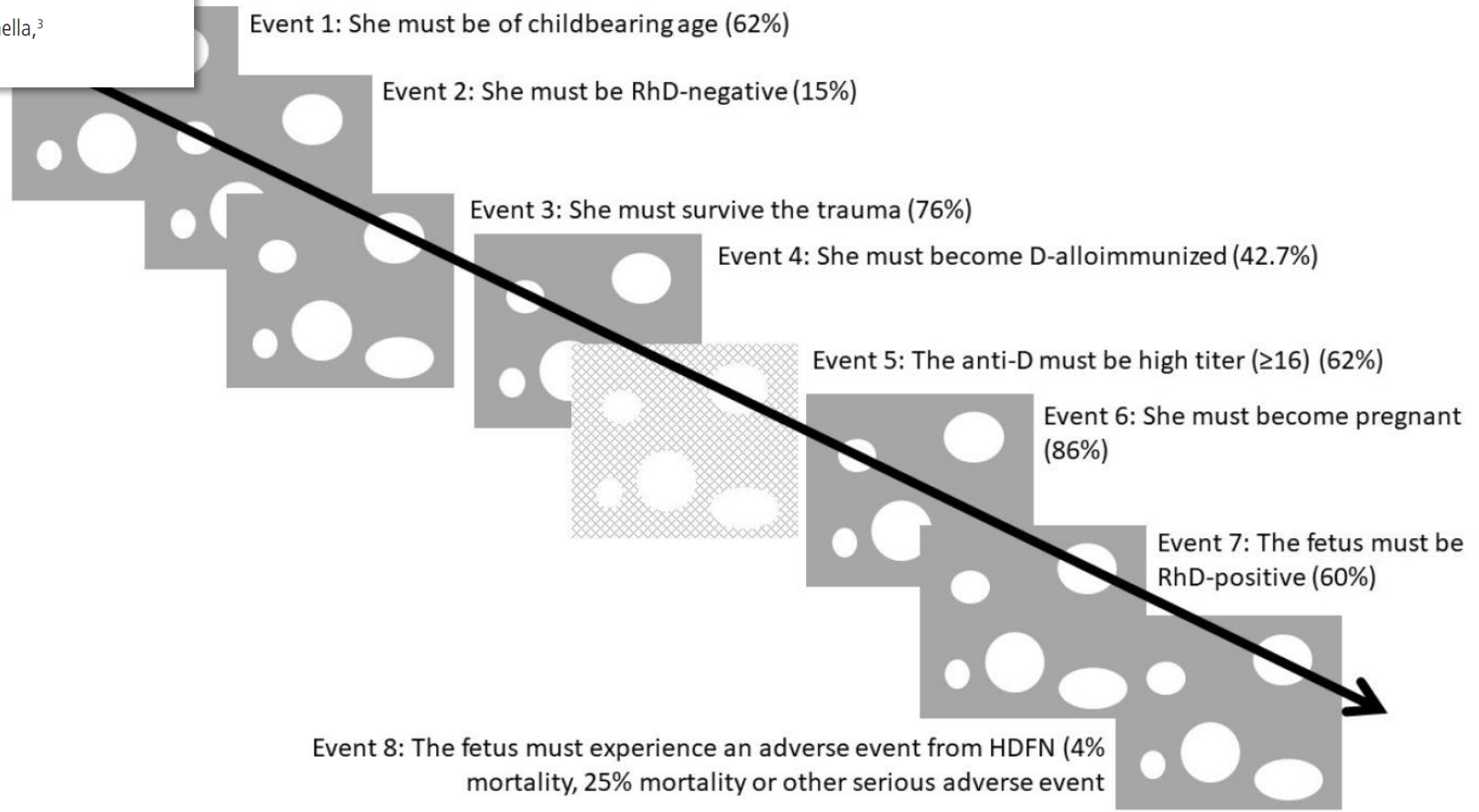


Figure 1 Swiss cheese model demonstrating the events that must occur for hemolytic disease of the fetus and newborn (HDFN) to occur after the transfusion of RhD-positive red blood cell-containing blood products to an RhD-negative woman during trauma resuscitation and the probability of occurrence of each event. The light colored and textured Swiss cheese slice (Event 5) represents the novel contribution to the HDFN risk equation presented in this study. See text for explanation of the probabilities listed next to each event. Modified and reprinted from reference[6] with the kind permission of John Wiley and Sons.

Our (OB/MFM) Plan and Strategy

Labor and Delivery is a helicopter.

The accreta OR is a trauma OR.

1. Incorporate whole blood into all obstetric hemorrhage management through modification of MTP protocols
   - LTO+WB + CT for All MTP regardless of blood type
   - First 4 Units of MTP resuscitation in all cases will be whole blood.
   - Stored on labor and delivery, same protocol as the helicopter.
2. Whole blood for resuscitation for planned accreta surgery
   - Anticipated massive blood loss in every case
   - Weeks/months to prepare type specific whole blood – possible?

Our (OB/MFM) Plan and Strategy

Current Practice

MTP Activation

First Cooler

4 Units PRBC
4 Units FFP
1 Unit Cryo

Second Cooler

4 Units PRBC
4 Units FFP
Jumbo Platelets

Repeat/Continue MTP with CT

Whole Blood MTP

MTP Activation

First Cooler

4 Units Whole Blood

Second Cooler

4 Units PRBC
4 Units FFP
1 Unit Cryo

Third Cooler

4 Units PRBC
4 Units FFP
Jumbo Platelets

Repeat/Continue MTP with CT

Whole blood benefits

- Whole blood has 2x the "active products" in 2/3 of the volume
- Less TRALI/TACO
- Easier to administer
- Universal release O+LTWB
- Can store in refrigerator, no thawing required
- Single IV access needed
- Belmont compatible

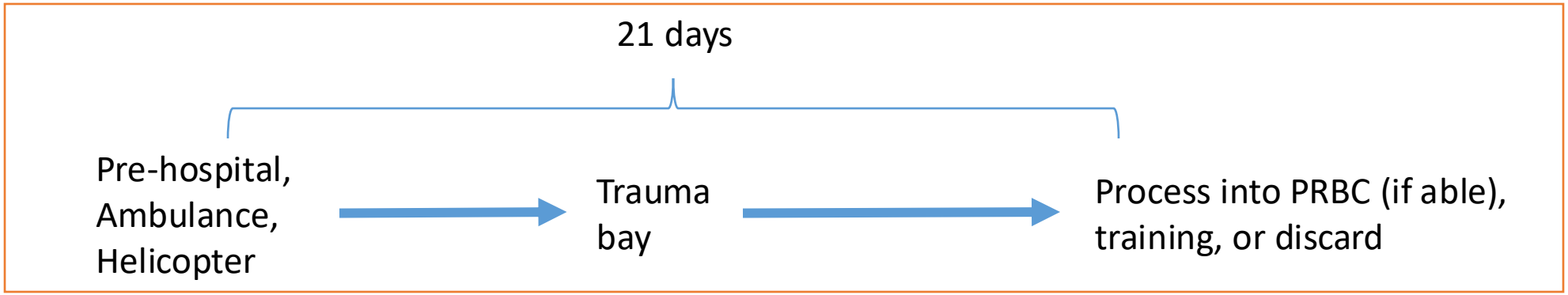
What we (OB/MFM) will do when implementing WB MTP for all obstetric hemorrhage.

- Monitor for hemolysis in all patients after transfusion
- Post transfusion clinical services
- Monitor the implementation with QUAPI, blood bank and relevant safety committees.
- Acknowledge that this approach is cutting edge and publish our results for others to also benefit.

Process pathway for WB units

LTO+WB

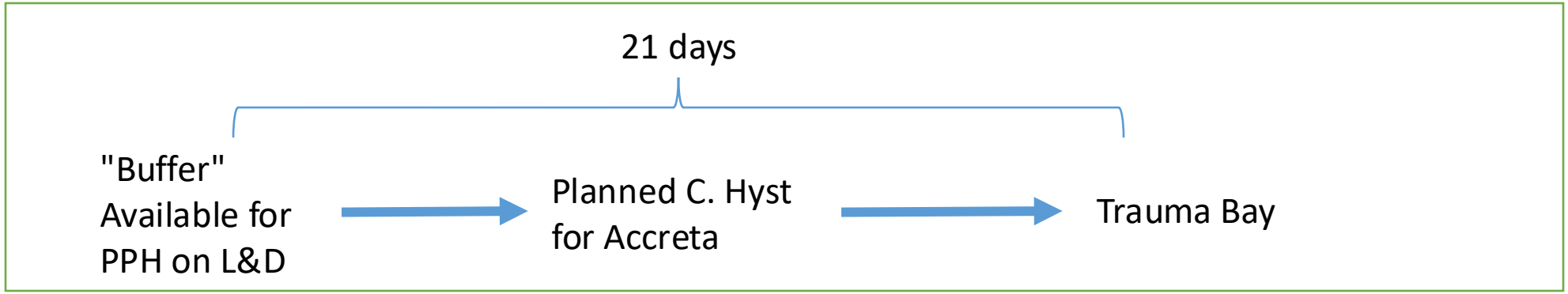
Trauma Lifecycle LTO+WB



SWTRAC reports <1% waste

LTO+WB,
O+, A+, B+

OB PPH Type Matched WB – Obstetric Whole Blood Bank Program



Given constant C.Hyst demand from accreta program potential for waste is low when keeping stock of ABO type matched whole blood available for L&D.

- 7 years ago 1 woman/month intubated in the ICU with MTP
- Now 1 woman/year ICU with MTP
- No maternal death in 5 years

- Roughly 20-25 women/year with abnormal placenta (PASD) x5 years (not all will get and not all are candidates) = 120 women who have received whole blood