1

Learning Objectives

After participating in this program you should be able to….

- Define and discuss the issues with proper use of blood components.
- Review the rise of patient blood management strategies.
- Discuss the sustainability of the blood supply.

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History of Transfusion Medicine

1628

British physician William Harvey discovers the circulation of blood. The first known blood transfusion is attempted soon afterward.

Blundell's Blood Gravitator

http://bloodjournal.hematologylibrary.org/content/112/7/2617/F5.large.jpg

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Blood transfusion was the most common procedure performed during hospitalizations in 2010 (11 percent of hospital stays with a procedure), and it was common among all age groups except infants.

Table 2. Number of stays, stays per 10,000 population, and percentage change in rate for procedures with the most rapid growth, 1997 and 2010

All-listed CCS procedures	Number of stays with the procedure in thousands		Stays with the procedure per 10,000 population (rate)		Percentage change in rate
	1997	2010	1997	2010	1997–2010
All stays (with and without procedures)	34,681	39,008	1,272	1,261	–1%
All stays with any procedure	21,257	24,740	780	800	3%
Procedures with most rapid growth in stays per population*					
Indwelling catheter	60	214	2	7	213%
Prophylactic vaccinations and inoculations	567	1,837	21	59	185%
Blood transfusion	1,098	2,815	40	91	126%
Spinal fusion	202	492	7	16	115%
Abdominal paracentesis	117	264	4	9	99%
Incision and drainage; skin and subcutaneous tissue	118	265	4	9	97%
Arthroplasty knee	329	730	12	24	96%
Enteral and parenteral nutrition	277	613	10	20	95%
Arterio- or venogram (not heart and head)	143	286	5	9	76%
Hemodialysis	473	850	17	27	58%
Respiratory intubation and mechanical ventilation	919	1,638	34	53	57%

Source-http://www.AHRQ.gov/

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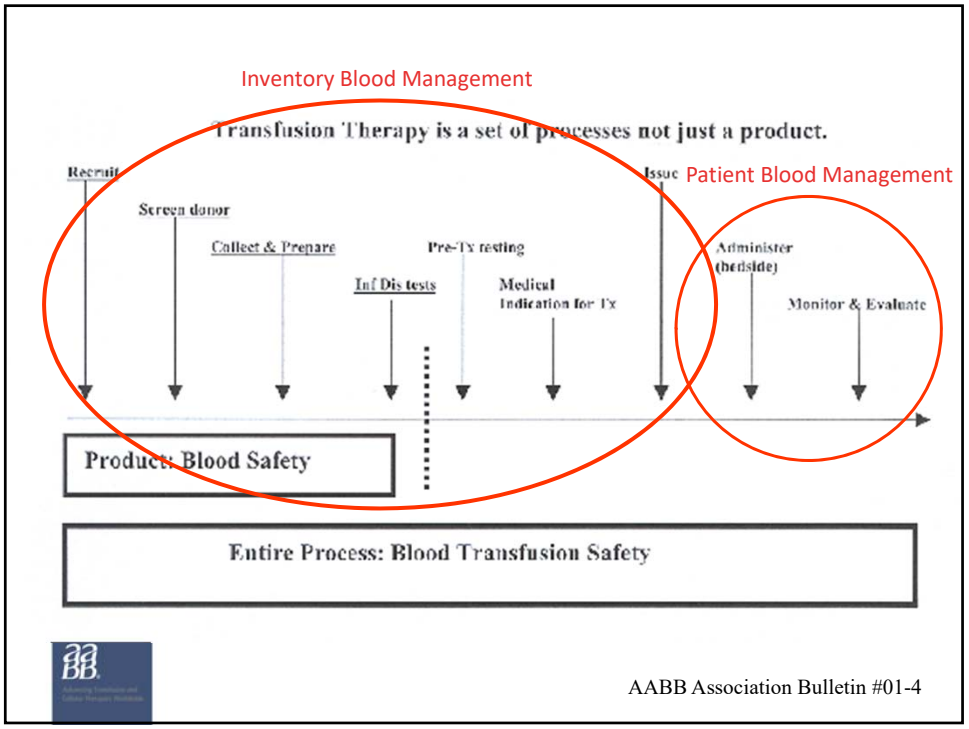
Inventory Blood Management
Transfusion Therapy is a set of processes not just a product.
Recruit
Screen donor
Collect & Prepare
Inf Dis tests
Pre-Tx testing
Medical Indication for Tx
Issue
Patient Blood Management
Administer (bedside)
Monitor & Evaluate
Product: Blood Safety
Entire Process: Blood Transfusion Safety
AABB Association Bulletin #01-4

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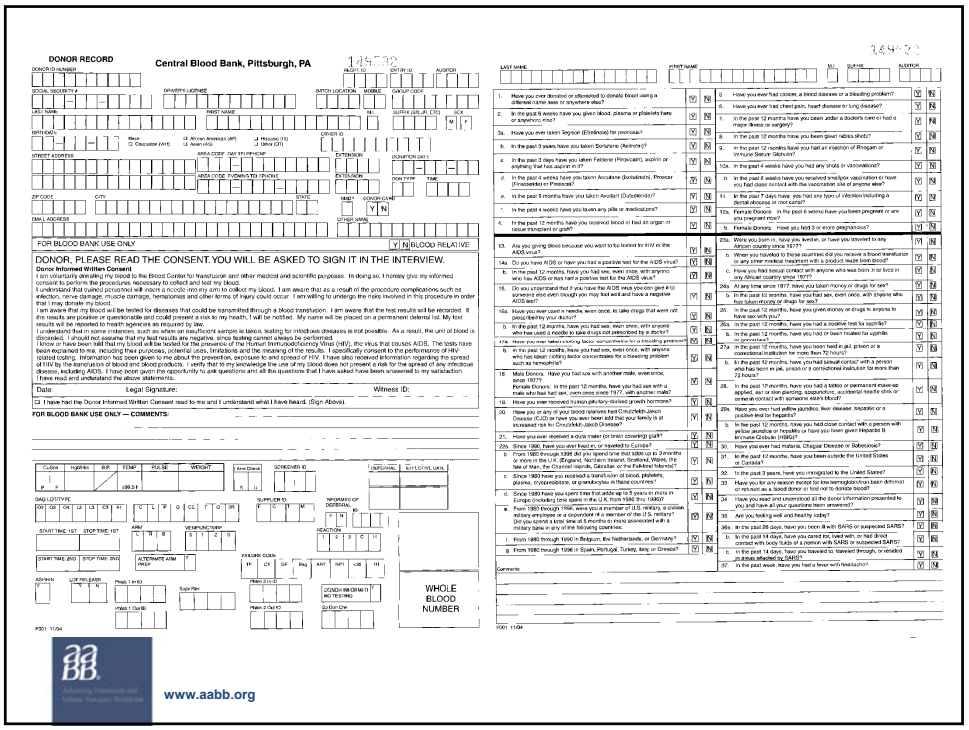
DONOR RECORD
Central Blood Bank, Pittsburgh, PA
DONOR, PLEASE READ THE CONSENT. YOU WILL BE ASKED TO SIGN IT IN THE INTERVIEW.
Donor Informed Written Consent
FOR BLOOD BANK USE ONLY — COMMENTS:
WHOLE BLOOD NUMBER
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Donor Methods

- Whole Blood Collection
- Apheresis Collection

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Blood Components

- Packed Red Blood Cells (PRBC)
- Plasma (FFP)
- Platelets
- Cryoprecipitate

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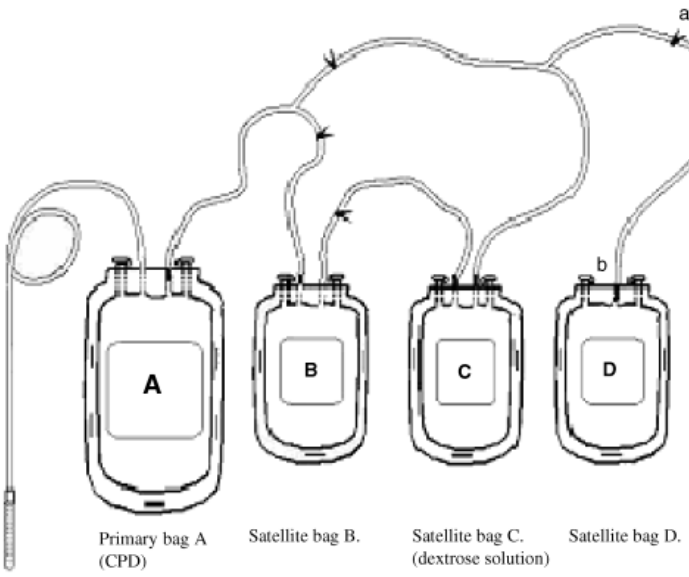

a. Clip
b. Break off valve

Kurup, P. A et al Vox Sanguinis 2003;85:253-261

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Table 8-4. Biochemical Changes in Stored Non-Leukocyte-Reduced Red Blood Cells

Variable	CPD		CPDA-1				AS-1	AS-3	AS-5
	Whole Blood		Whole Blood	Red Blood Cells	Whole Blood	Red Blood Cells	Red Blood Cells	Red Blood Cells	Red Blood Cells
Days of Storage	0	21	0	0	35	35	42	42	42
% Viable cells (24 hours posttransfusion)	100	80	100	100	79	71	76 (64-85)	84	80
pH (measure at 37 C)	7.20	6.84	7.60	7.55	6.98	6.71	6.6	6.5	6.5
ATP (% of initial value)	100	86	100	100	56 (± 16)	45 (± 12)	60	59	68.5
2,3-DPG (% of initial value)	100	44	100	100	<10	<10	<5	<10	<5
Plasma K+ (mmol/L)	3.9	21	4.20	5.10	27.30	78.50*	50	46	45.6
Plasma hemoglobin	17	191	82	78	461	658.0*	N/A	386	N/A
% Hemolysis	N/A	N/A	N/A	N/A	N/A	N/A	0.5	0.9	0.6

*Values for plasma hemoglobin and potassium concentrations may appear somewhat high in 35-day stored RBC units; the total plasma in these units is only about 70 mL.

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Technical Manual, 15th Ed. AABB Press, P. 176

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Leukocyte depleted blood

- Leukocyte depletion moderates the immune modulation
- Because white blood cells harbor viruses, leukocyte depleted blood is thought to decrease the viral load to a patient and thus further reduce the infectious risk.

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Blood Testing

- Hepatitis B surface antigen (HBsAg)
- Hepatitis B core antibody (anti-HBc)
- Hepatitis C virus antibody (anti-HCV)
- HIV-1 and HIV-2 antibody (anti-HIV-1 and anti-HIV-2)
- HTLV-I and HTLV-II antibody (anti-HTLV-I and anti-HTLV-II)
- Serologic test for syphilis
- Nucleic acid amplification testing (NAT) for HIV-1 and HCV
- NAT for WNV
- Chagas Dz

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INFECTIOUS COMPLICATIONS

- HIV 1: 2,135,000
- HTLV 1: 2,993,000
- HCV 1: 1,935,000
- HBV 1: 205,000

Others: HDV, CMV, EBV, parvovirus, bacterial (Y. enterocolitica, Pseudomonas spp., Staphylococcus spp.), treponemal (syphilis, Borrelia), parasitic (malaria, babesiosis), Prions

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Dodd R.Y., et al. Transfusion 2002;42:975-9

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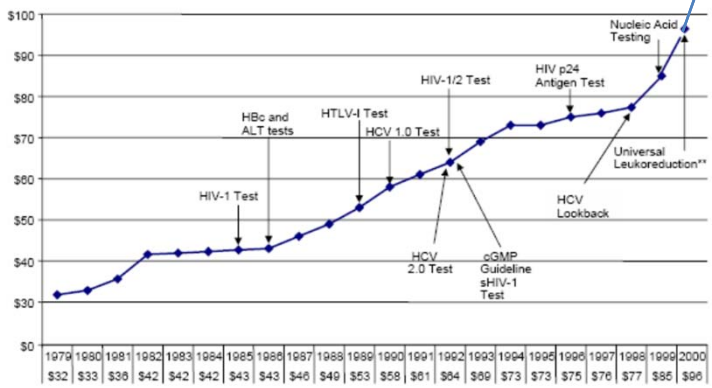
Figure 8: Blood Charges per Unit to Hospitals by ABC Member Centers and Implementation of Selected Blood Safety Technologies, 1979 – 2000



** As of December 2000, 12 of ABC's 75 member centers distributed only leukoreduced red blood cells. The average price was calculated using these center's fees for leukoreduced red cells.

Source: America's Blood Centers, 2001.

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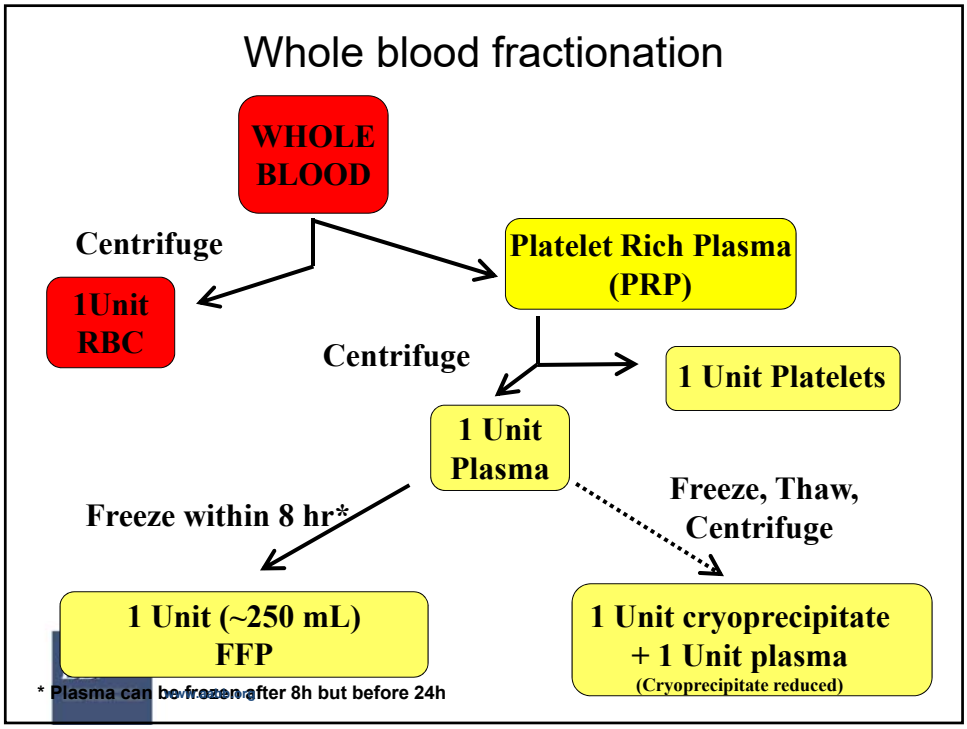

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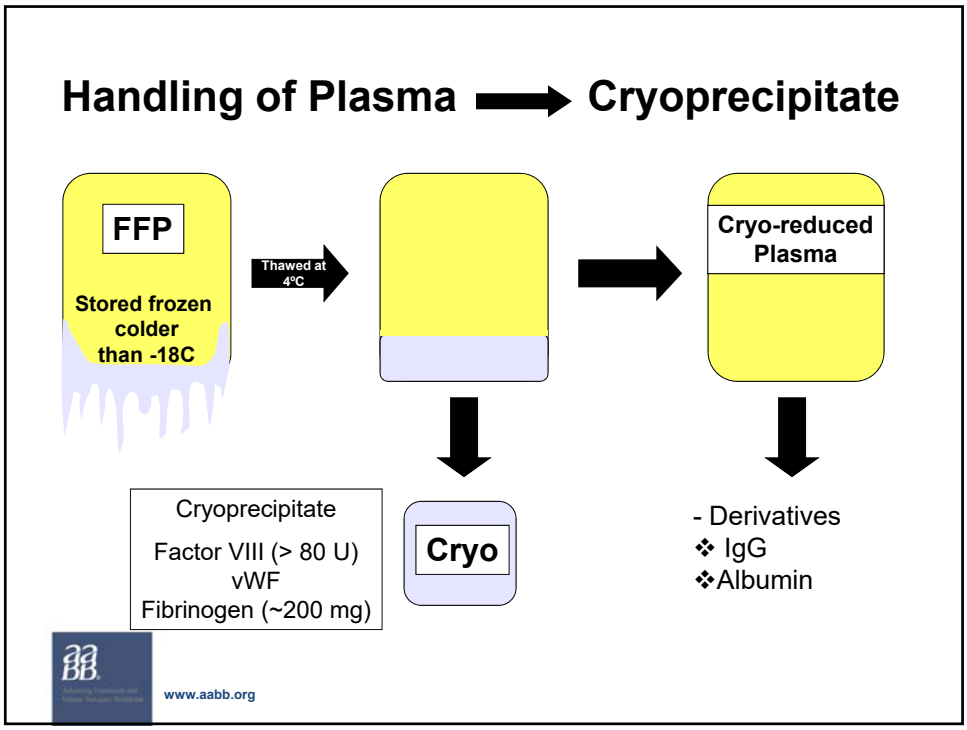

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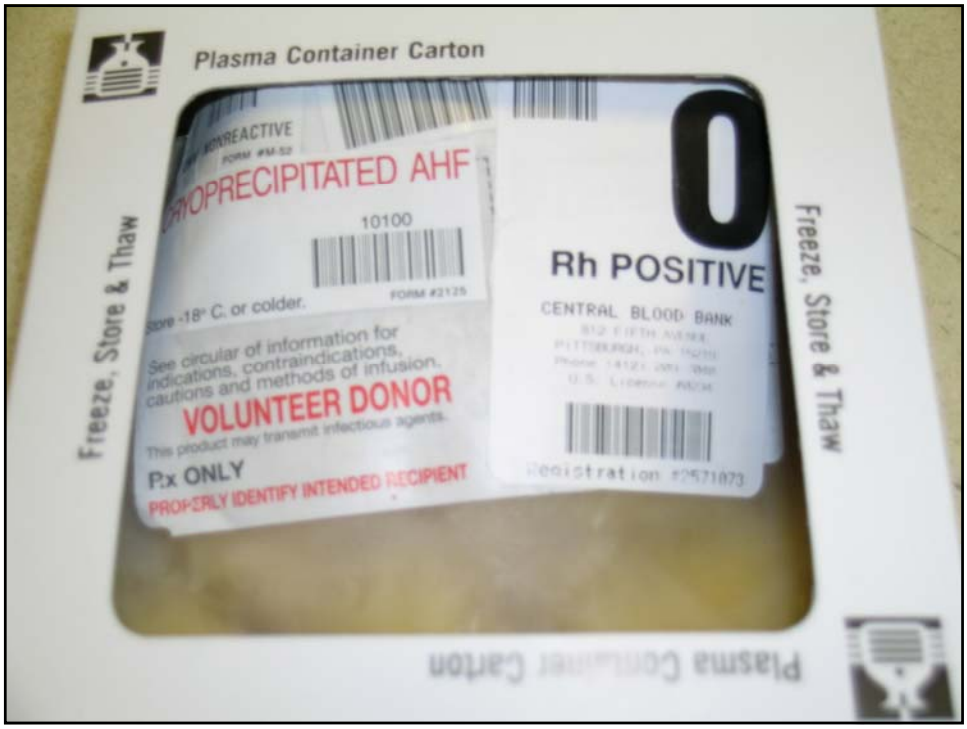

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Donor Methods

- Single unit
- Apheresis

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Bloodless Medicine
Patient Blood Management
Blood Conservation
Blood Management

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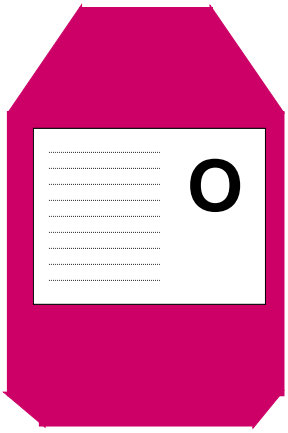
Red Blood Cells (RBC)



- RBC concentrate units contain the RBC from one whole blood donation minus the losses in processing.
- This typically amounts to 150 to 250 mL of RBC that contain 40 to 70 g of hemoglobin.

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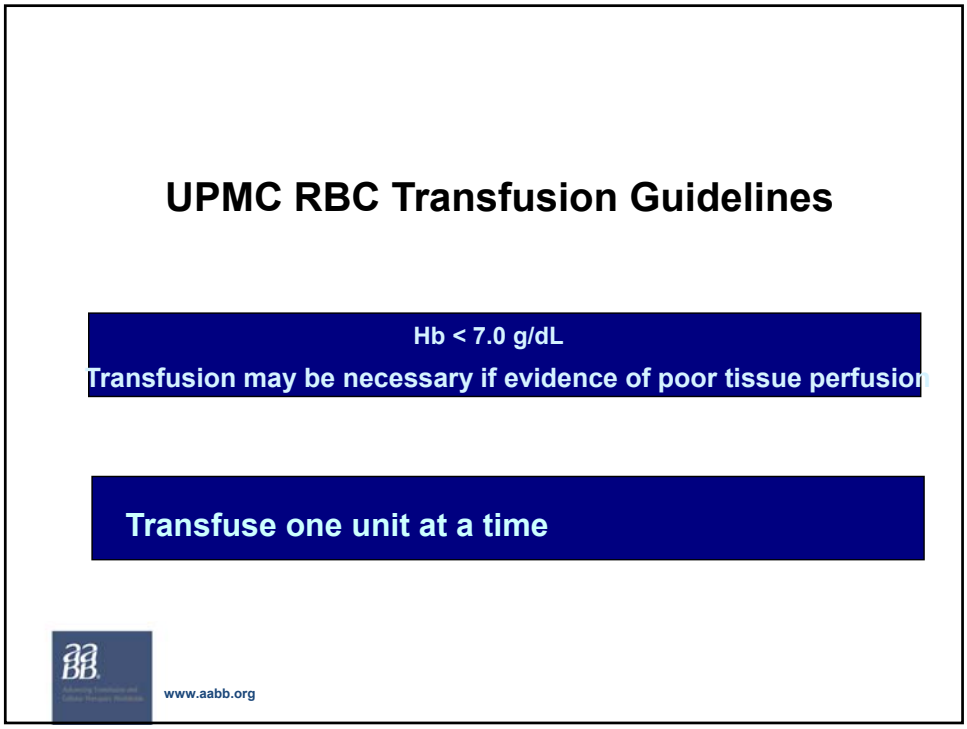

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UPMC Plasma Transfusion Guidelines

INR > 1.6

And evidence of clinical bleeding

Transfuse 15-20 mL/kg volume

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PLASMA DOSAGE DEPENDS ON PATIENT'S SIZE, SITE OF BLEED OR POTENTIAL BLEEDING, CLOTTING FACTOR ACTIVITY NEEDED FOR HEMOSTASIS AND THE EXPECTED FACTOR RECOVERY AFTER TXN, AND FACTOR HALF LIFE IN VIVO

Factors	Name	In-vivo Half life	In-vitro 4C Half life	% of normal needed for hemostasis	% In-vivo Recovery
I	Fibrinogen	3-6 days	years	12-50	50-70
II	Prothrombin	2-5 days	>21 days	10-25	50
V	Labile factor, proaccelerin	4.5-36 hours	10-14 days	10-30	80
VII	Stable factor, Proconvertin	1-7 hours	>21 days	>10	100
VIII	Anti-hemophilic factor	8-12 hours	7 days	>30	60-70
IX	Plasma thromboplastin component	12-24 hours	>21 days	>30	20
X	Stuart Prower factor	20-50 hours	>21 days	10-40	50-95
XI	Plasma Thromboplastin antecedent	40-80 hours	>21 days	20-30	90
XIII	Fibrin-stabilizing factor	3-12 days	>21 days	>5	50-100
AT III	Antithrombin III	60-90 hours	>42 days	>80	50-100

FOR A 70 kg patient with 3000 mL plasma volume
Each 100 mL FFP increases most clotting factors (except F9) ~1.5 -3%

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Consensus Indications

Prophylactic transfusion

- **10,000/ µL without additional risk factors such as sepsis or invasive procedure**
- **Higher thresholds for neonates**
- **Avoid low hematocrit in patients with thrombocytopenia or platelet dysfunction**

Therapeutic transfusion

- **50,000/ µL (surgery, massive transfusion)**
- **ITP only if significant hemorrhage**

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Br J Haematol 1998,101:609-617.

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Platelet Transfusions in Massive Transfusion

- **Platelet count falls to about 50,000/ µL after transfusion of red cells equivalent to about 2 blood volumes**
- **There is consensus that the platelet count should be maintained above 50,000/µL in patients with acute bleeding**
- **A higher target level has been recommended in patients with multiple trauma or central nervous system injury**

College of American Pathologists. (1994) Practice parameter for the use of fresh frozen plasma, cryoprecipitate and platelets. *Journal of the American Medical Association*, 271, 777-781.
Hiippala S. (1998) Replacement of massive blood loss. *Vox Sanguinis*, 74 (suppl 2), 399-407.

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"Sweat saves blood, blood saves lives, but brains saves both"

- Erwin Rommel

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Threats to the sustainability of the blood supply

1. Declining donor population
2. New and emerging pathogens
3. Increasing regulatory burden
4. Decreasing demand
5. Hospital demands for new products
6. Decreasing revenue to support innovation
7. Increasing concerns about the health and safety of donors

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Summary of the inappropriate use of blood from large regional and national audits of blood use

Title	Year	Number of Hospitals	N cases audited	Inappropriate use	Guideline Standard
Red cell transfusion	2002	All 13 hospitals in N. Ireland	360	19% of patients inappropriately transfused and 29% over-transfused	British Committee for Standards in Haematology (BCSH) (2001)
Red cells in hip replacement	2007	139/167 (83%)	7465	48% of patients	British Orthopedic Assoc. (2005)
Upper GI bleeding	2007	217/257	6750	15% of RBCs, 42% of platelets, 27% of FFP	British Soc. of Gastroenterology (2002)
Red cell transfusion	2008	26/56 (46%) hospitals in two regions	1113	19.5% of transfusions	BCSH (2001)
FFP	2009	186/248 (75%)	5032	43% of transfusions to adults, 48% to children, 62% to infants	BCSH (2004)
Platelets in haematology	2011	139/153 (91%)	3296	27% of transfusions	BCSH (2003)
Cryoprecipitate	2012	43/82 (52%) from 3 regions	449	25% of transfusions	BCSH (2004)

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Courtesy of Mike Murphy, Oxford, England

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National Summit on Overuse September 21,2012

- American Medical Association (PCPI) and Joint Commission co-sponsored the summit
- Aimed to build consensus around ways to minimize overuse of five treatments
  - Heart vessel stents
  - Blood transfusion
  - Ear tubes
  - Antibiotics for common cold
  - Early scheduled births
- Appropriate use will improve Quality and Safety of Patient Care

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Appropriate Use of Medical Resources

American Hospital Association's PHYSICIAN LEADERSHIP FORUM

American Hospital Association®

1. Appropriate blood management in inpatient services
2. Appropriate antimicrobial stewardship
3. Reducing inpatient admissions for ambulatory sensitive conditions (i.e. low back pain, asthma, uncomplicated pneumonia)
4. Appropriate use of elective percutaneous coronary intervention
5. Appropriate use of the intensive care unit for imminently terminal illness

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Six Point Patient Blood Management Strategy at UPMC

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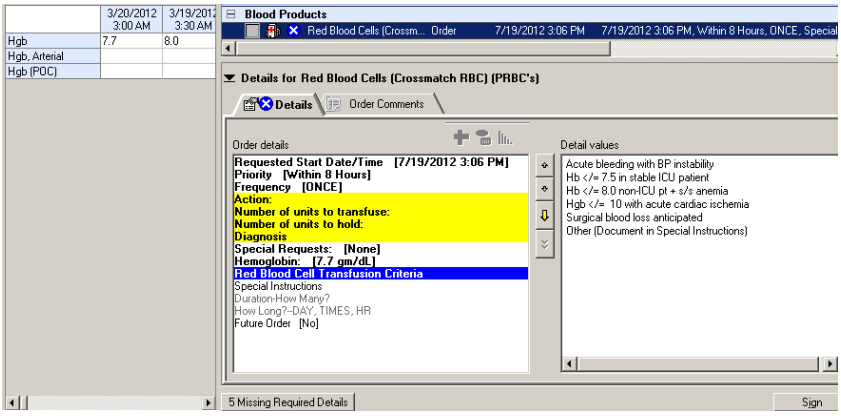
Enhanced RBC Physician Order Entry Field



- Red Blood Cell Transfusion Criteria is a required field
- An alert will appear if the most recent Hgb does not correspond with the criteria sele
- No alert will appear if the Hgb is less than or equal to 7.5 gm/dl.
- No alerts will appear when *Acute bleeding with BP instability*

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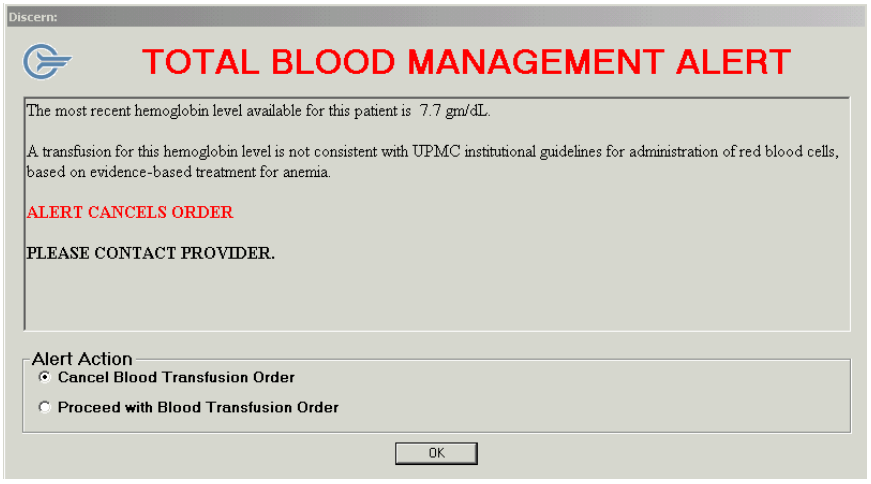
Alert Based on Order Logic



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	A	B	C	D	E	F	G	H
1	MRN Encounter	Facility	Alert ID	Order Id	Order Mnemonic	Ordering Physician	Ordering Physician Position	Red Blood Cell Transfusion Criteria
2	785123456	HZN	1125813739	3074640366	Crossmatch Red Blood Cells		Nursing, Practitioner (Meds)	Hb <= 8.0 non-ICU pt + s/s anemia
3	785416469	HZN	1125774733	3074293889	Crossmatch Red Blood Cells		Physician, Medical Staff (Meds)	Other (Document in Special Instructions)
4	784179443	MCK	1125724796	3073830175	Red Blood Cells (Crossmatch RBC)		Physician, Medical Staff (Meds)	Hgb <= 10 with acute cardiac ischemia

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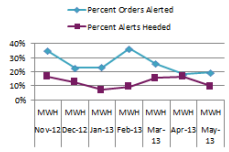
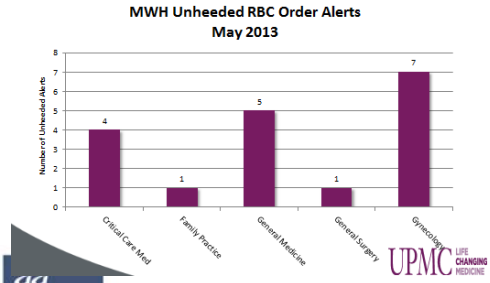
Transfusion Indication Variance

The information found on this page is property of UPMC and intended for internal purposes only

Facility	Total Orders	Total Alerts	Alerted Orders Not Placed	Percent Orders Alerted	Percent Alerts Heeded
PUH	248	182	23	73.4%	12.6%
SHY	208	138	21	66.3%	15.2%
HAM	198	77	21	38.9%	27.3%
PAS	144	74	10	51.4%	13.5%
SMH	146	59	7	40.4%	11.9%
EAS	73	37	10	50.7%	27.0%
HZN	58	28	4	48.3%	14.3%
MER	275	27	4	9.8%	14.8%
NOR	39	23	0	59.0%	0.0%
MWH	103	20	2	19.4%	10.0%
MCK	82	12	3	19.4%	25.0%
BED	15	10	3	66.7%	30.0%





- System comparison of total blood orders, total alerts, and % orders heeded.
- Trending for % orders alerted and % orders heeded
- Service lines with highest unheeded alerts
- Service line drill down to physician level unheeded alerts

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Six Point Patient Blood Management Strategy at UPMC

1. Leverage computerized physician order entry (CPOE) systems to guide evidence-based transfusions
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4. Promote anemia management strategies
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6. Provide blood management education, awareness and auditing for clinicians; in addition to patient-centered shared decision making tools

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Sources of Blood Waste

1. Preoperative autologous donation (PAD)
2. Inappropriate transfusions
3. Excessive phlebotomy
4. Elevated Crossmatch to Transfusion Ratio (C:T
5. Wasted Blood products
6. Dispensing of blood to the OR

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2013 UPMC Central Laboratory (CLB)

- 15,000 tubes of blood handled daily
- Discard approximately 2 mL per tube
- 30 Liters of blood discarded daily

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- **30% of the blood transfused was phlebotomized**
- **Average Phlebotomy was 65 mL/day**

Table 2—*Phlebotomy

Transfusions	Blood Drawn, mL	
	Total†	Daily‡
None	601±77	40±5
1-5 U	858±59	61±4
>5 U	1,708±137	68±6
>10 U	2,156±208	70±6

*Significant differences ($p<0.05$).
†None vs 1-5; None vs >5; None vs >10; 1-5 vs >5; and 1-5 vs >10.
‡None vs 1-5; None vs >5; and None vs >10.

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Corwin HL et al. Chest 1995;108:767

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Sources of Blood Waste

1. Preoperative autologous donation (PAD)
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4. Elevated Crossmatch to Transfusion Ratio (C:T)
5. Wasted Blood products
6. Dispensing of blood to the OR

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Blood Stocks Management Scheme Annual Report – 2011/12

6.2 Red Cell Wastage (by Blood Service)

- *NHSBT:* 19,687 units were wasted, increased from 15,931 units in 2010/11[2]. This was 1.1% of issues compared to 0.9% in 2010/11.
- *NIBTS:* Wastage data was not available this year [3]
- *WBS:* 374 units were wasted, an increase from 266 in 2010/11. This was 0.4% of issues compared to 0.3% in 2010/11.
- *SNBTS:* Wastage data is not available this year.
- *IBTS:* 1,423 units were wasted, a decrease from 1600 in 2010/11. This was 1.0% of issues compared to 1.2% in 2010/11.

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Reduce all forms of waste related to blood transfusion practices

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True Cost of Waste

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Sources of Blood Waste

1. Preoperative autologous donation (PAD)
2. Inappropriate transfusions
3. Excessive phlebotomy
4. Elevated Crossmatch to Transfusion Ratio (C:T)
5. Wasted Blood products
6. Dispensing of blood coolers to the OR

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Fear of What Could Happen

Fact:
72% of blood product coolers packed up for the OR are returned untouched!

Plan:
Use CM procedures to qualify for cooler products being available at start of case

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Patient Blood Management
Life's Liquid Organ

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Autotransfusion

AKA Intraoperative Blood Salvage, Cell Salvage, Cell Saving

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Six Point Patient Blood Management Strategy at UPMC

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Patient Blood Management
Life's Liquid Organ

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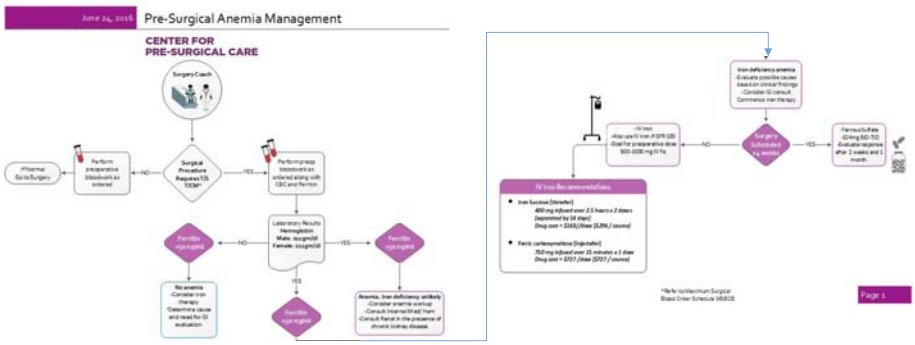
Strategy 4
Preoperative Anemia Management



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Patient Blood Management
Life's Liquid Organ

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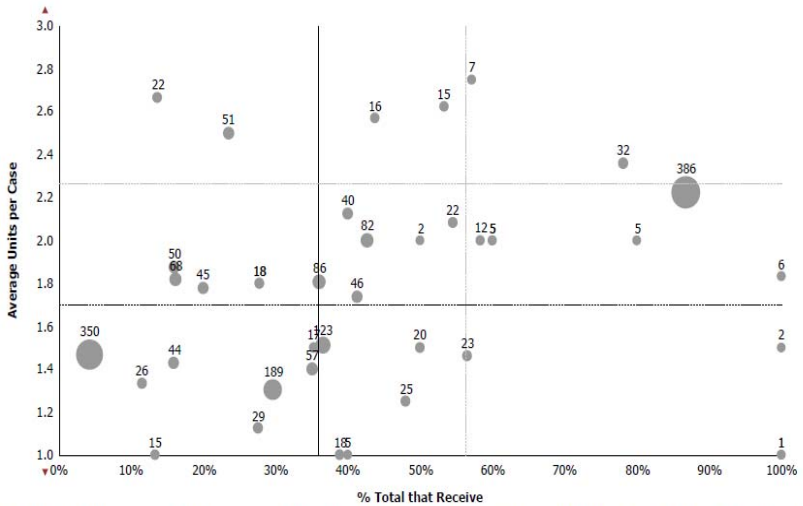
Blood use by surgeon by DRG reporting
Primary Total Hip Replacement



* Boundaries of the graph have been set to allow for effective analysis therefore exceptional values may not be displayed.

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Blood use by surgeon by DRG reporting
Primary Total Hip Replacement

	2009 Q 3	2009 Q 4	2010 Q 1	2010 Q 2	2010 Q 3
Discharges	376	442	432	411	409
Total Receiving Blood	153	179	138	175	151
% Total that Receive	40.7%	40.5%	31.9%	42.6%	36.9%
Average Units per Case	1.97	1.93	1.87	2.22	1.87
ALOS w Blood	3.8	3.4	3.3	3.4	3.6
ALOS w/o Blood	3.5	3.3	3.1	3.1	3.1
Ave Charges w Blood	$90,965	$81,021	$82,873	$78,380	$79,704
Ave Charges wo Blood	$65,493	$63,276	$62,018	$65,165	$68,276
% Autologous	12.4%	10.1%	8.0%	9.1%	12.6%
Home Discharge %	71.5%	70.4%	83.1%	73.5%	69.9%
Facilty Discharge %	28.5%	29.6%	16.9%	26.5%	30.1%
Deceased Discharge %					
Other Discharge %					

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Blood use by surgeon by DRG reporting
Primary Total Hip Replacement

1 2 % Units	Physician	Discharges	Total Receiving Blood (1)	Average Units per Case (2)	ALOS w/	ALOS w/o	Ave Charges w Blood w/	Ave Charges w Blood w/o	% Autologous
		386	**86.8%**	**2.2**	1.9	1.9	$82,961	$78,596	3.3%
		350	4.3%	1.5	3.3	2.4	$54,309	$49,840	
		189	29.6%	1.3	4.7	4.0	$111,934	$103,235	3.6%
		123	**36.6%**	1.5	3.4	2.8	$71,220	$76,212	42.2%
		86	**36.0%**	**1.8**	4.3	3.3	$56,221	$49,339	
		82	**42.7%**	**2.0**	4.6	2.4	$106,666	$74,389	5.7%
		68	16.2%	**1.8**	5.1	4.3	$55,418	$41,696	
		57	35.1%	1.4	6.2	4.4	$135,311	$121,190	
		51	23.5%	**2.5**	4.6	4.2	$56,386	$54,757	66.7%
		50	16.0%	**1.9**	4.2	3.7	$81,000	$70,393	
		46	**41.3%**	**1.7**	4.3	4.0	$54,480	$49,625	47.4%
		45	20.0%	**1.8**	3.8	3.9	$48,475	$45,170	66.7%
		44	15.9%	1.4	2.9	2.1	$71,095	$64,127	14.3%
		40	**40.0%**	**2.1**	5.3	3.5	$39,866	$35,703	
		32	**78.1%**	**2.4**	3.2	3.4	$105,314	$89,677	
		29	27.6%	1.1	3.9	3.4	$70,340	$64,517	37.5%
		27	11.1%	**5.0**	9.3	3.9	$88,742	$52,354	
		26	11.5%	1.3	3.3	3.7	$36,732	$37,561	33.3%
		25	**48.0%**	1.2	4.9	5.1	$78,875	$71,438	66.7%

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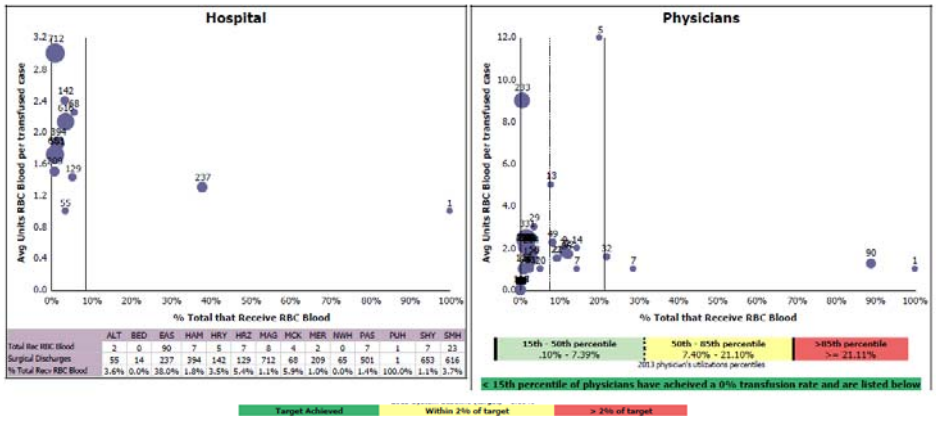
Primary Total Hip Replacement
2018



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WOLFF CENTER at UPMC

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UPMC Hospitals
Blood Utilization for Hip Replacement
Data as of Jun-2017

	2016/Jul	2016/Aug	2016/Sep	2016/Oct	2016/Nov	2016/Dec	2017/Jan	2017/Feb	2017/Mar	2017/Apr	2017/May	2017/Jun
Surgical Discharges	199	214	210	223	214	263	219	236	229	231	197	181
Total Receiving RBC Blood	18	21	23	17	14	23	25	21	21	24	18	18
% Total that Receive RBC Blood	9.0%	9.8%	11.0%	7.6%	6.5%	8.7%	11.4%	8.9%	9.2%	10.4%	9.1%	9.9%
Avg Units RBC Blood per transfused case	1.83	2.38	1.48	1.53	1.43	1.83	1.28	1.57	1.52	1.83	2.39	1.50
Allogeneic RBC Blood (Units)	26	28	21	23	10	23	21	18	14	24	23	13
Auto Transfusion RBC Blood (Units)	7	22	13	3	10	19	11	15	18	20	20	14
Total Receiving TXA	168	165	172	189	170	208	176	194	184	176	158	147
% Total that Receive TXA	84.4%	77.1%	81.9%	84.8%	79.4%	79.1%	80.4%	82.2%	80.3%	76.2%	80.2%	81.2%
Avg Units TXA per transfused case	1.60	1.64	1.71	1.69	1.54	1.46	1.49	1.48	1.58	1.82	2.01	2.00
ALOS w Blood	3.5	3.4	2.8	3.4	3.0	2.7	3.0	2.8	2.6	3.0	3.3	2.2
ALOS w/o Blood	2.4	2.4	2.4	2.3	2.2	2.2	2.2	2.3	2.2	2.3	2.4	2.2
Home Discharge %	75.4%	72.9%	78.6%	79.8%	79.9%	85.6%	87.2%	85.2%	81.7%	86.1%	81.2%	81.8%
Facilty Discharge %	24.6%	27.1%	21.4%	20.2%	20.1%	14.4%	12.8%	14.4%	18.3%	13.9%	17.3%	18.2%
Deceased Discharge %								0.4%			0.5%	
Other Discharge %											1.0%	

2015 System Baseline (target)= 14.78%
Target Achieved | Within 2% of target | > 2% of target

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UPMC Blood Product Use

July 2012- June 2013

Blood Product	Total Products Used				Total Products Used by Total Surgical Cases				Total Products Used by Total IP Acute Admissions			
	July 2011 - June 2012	July 2012 - June 2013	Variance	Percentage Variance	July 2011 - June 2012 (231,523 Cases)	July 2012 - June 2013 (241,998 Cases)	Variance	Percentage Variance	July 2011 - June 2012 (193,526 Cases)	July 2012 - June 2013 (211,497 Cases)	Variance	Percentage Variance
Whole Blood	4	0	4	-100.0%	0.00	0.00	0.00	-100.0%	0.00	0.00	0.00	-100.0%
Packed Cells	85,116	74,711	10,405	-12.2%	0.37	0.31	0.06	-16.0%	0.44	0.35	0.09	-19.7%
*Leukoreduced Red Cell Product**	35,660	31,935	3,725	-10.4%	0.15	0.13	0.02	-14.3%	0.18	0.15	0.03	-18.1%
Red Blood Cells, Divided	3,501	2,844	657	-18.8%	0.02	0.01	0.00	-22.3%	0.02	0.01	0.00	-25.7%
Washed/Frozen Cells	151	304	(153)	101.3%	0.00	0.00	(0.00)	92.6%	0.00	0.00	(0.00)	84.2%
FFP/Thawed Plasma	44,279	41,522	2,757	-6.2%	0.19	0.17	0.02	-10.3%	0.23	0.20	0.03	-14.2%
Cryo Poor Plasma	1,821	2,255	(434)	23.8%	0.01	0.01	(0.00)	18.5%	0.01	0.01	(0.00)	13.3%
Platelets	78,383	65,797	12,586	-16.1%	0.34	0.27	0.07	-19.7%	0.41	0.31	0.09	-23.2%
Cryoprecipitate	12,728	10,231	2,497	-19.6%	0.05	0.04	0.01	-23.1%	0.07	0.05	0.02	-26.4%
Platelet Pheresis	2,268	2,068	200	-8.8%	0.01	0.01	0.00	-12.8%	0.01	0.01	0.00	-16.6%
Granulocytes	28	36	(8)	28.6%	0.00	0.00	(0.00)	23.0%	0.00	0.00	(0.00)	17.6%
Total**	**228,279**	**199,768**	**28,511**	**-12.5%**	**0.99**	**0.83**	**0.16**	**-16.3%**	**1.18**	**0.94**	**0.24**	**-19.9%**

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Savings = $3,992,979.20

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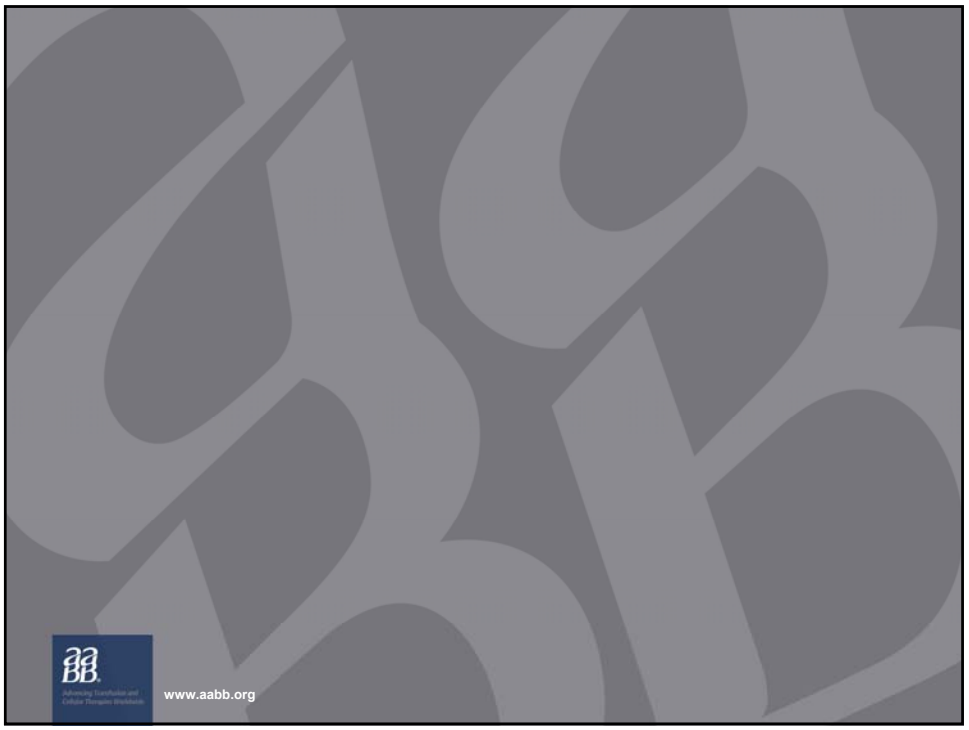

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Questions?

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