



DAY 2 > TRANSFUSION REACTIONS & SICKLE CELL DISEASE



# Transfusion Reactions

Friday November 18<sup>th</sup> 2022, 09:30 – 10:15



**Christine Cserti-Gazdewich, MD FRCPC**  
*Assistant Professor, University of Toronto*  
*Departments of Medicine & Laboratory Medicine / Pathobiology*



Transfusion Medicine Specialist / Clinical Hematologist,  
Laboratory Medicine Program & Division of Hematology

Clinician Teacher

Adjunct Researcher



# Disclosure

- **Relevant relationships with commercial entities:**
  - None
- **Potential for conflicts within this presentation:**
  - Funding from Canadian Blood Services in transfusion reaction research
  - Hemovigilance committee memberships (TTISS, AABB, ISBT)
- **Steps taken to review and mitigate potential bias:**
  - Peer-reviewed content
  - Non-proprietary titles
  - Declaration of use-context (EBM vs off-label)





- **Blood transfusion is the most commonly performed hospital procedure, occurring in >10% of hospital stays.**



**AHRQ**  
Agency for Healthcare  
Research and Quality  
**HEALTHCARE COST AND  
UTILIZATION PROJECT**

Roubinian et al. [BMC Health Serv Res.](#) **2014**; 14:213

<https://healthtalk.unchealthcare.org/transfusion/>



**Reaction rates:  
1-10% per  
encounter**



**~Half of  
transfusions  
may be  
unnecessary**

Kaufman et al. [Transfusion.](#) **2015**; 55: 144-53.

Hendrickson et al. [Transfusion](#) **2016**; 56:2587-2596.

Jenkins et al. [Jt Comm J Qual Patient Saf](#) **2017**; 43: 389-95

“... safety will never be an absolute;



it is only as good  
as the human beings on the frontline

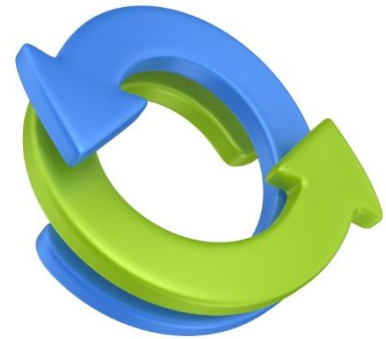


and the guidance  
under which the system is regulated”



# Objectives – Hemovigilance **Philosophies**

- **Recognition matters:** I will consider transfusion reactions on my differential diagnosis if relevant disturbances occur after product exposure
- **Reporting matters:** I will report these suspicions to my blood bank, as I appreciate the impact that feedback has on informing risks, and identifying (& neutralizing) dangers
- **Collaboration matters:** As a witness, I will share my observations & impressions



# ACUTE



Within 24h

# DELAYED



>24h  
Days  
Weeks  
Months later

# Objectives – *Entities to Know*

- Describe presentation, frequency, and management of the **3 most commonly encountered but minor** adverse transfusion events
- State the **3 most important causes of transfusion-related mortality and severe morbidity**, ie- **potentially life-threatening acute transfusion reactions** and how we mitigate the risks for these events



# DELAYED: (Deferred)



Delayed Hemolytic Transfusion Reactions  
(DHTR) →  
HyperHemolysis Syndrome (HHS)

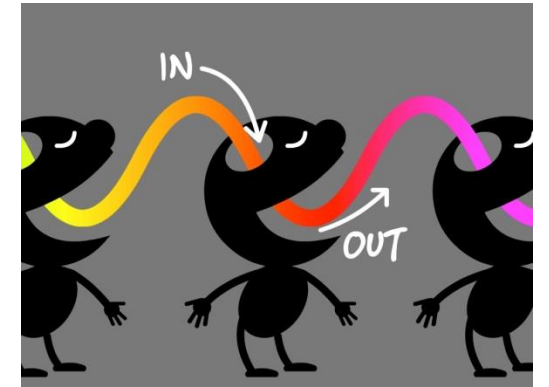
Transfusion-  
Associated Graft Vs  
Host Disease  
(TA-GVHD)

*Platelet Transfusion*  
*Refractoriness* →  
Post Transfusion Purpura  
(PTP)

+ other hazards,  
from common (iron overload) to  
uncommon (non-acute/non-bacterial infections)



# How Can We Inform Patients of the Risks of Transfusion?



- By the extent to which we participate in **HEMOVIGILANCE**
- WHAT should be reported? :
  - **all** transfusion **reactions** [adverse events] and transfusion-related **errors** [incidents]
- TO WHOM are these reports meant to be directed?:
  - the Hospital Transfusion Service (“blood bank”)
    - for internal committees
    - for external stakeholders

# Reporting Rules: External Stakeholders



**TRACKERS** – Public Health Agency of Canada (PHAC) via Transfusion Transmitted Injuries Surveillance System (TTISS)

**MAKERS** – Canadian Blood Services (CBS) or Derivative Manufacturers

**REGULATORS** – Canada Vigilance Program

**ISTARE** - International  
Surveillance of Transfusion-  
Associated Reactions and  
Events

**25 countries**

**2006 – 2012**

**133 million components**

AFFSSaPS - France

Biovigilance Network - US

SHOT - UK

TTISS - Canada

TRIP- Netherlands

Politis et al. *Vox Sang.* **2016**; 111(4):409-417.

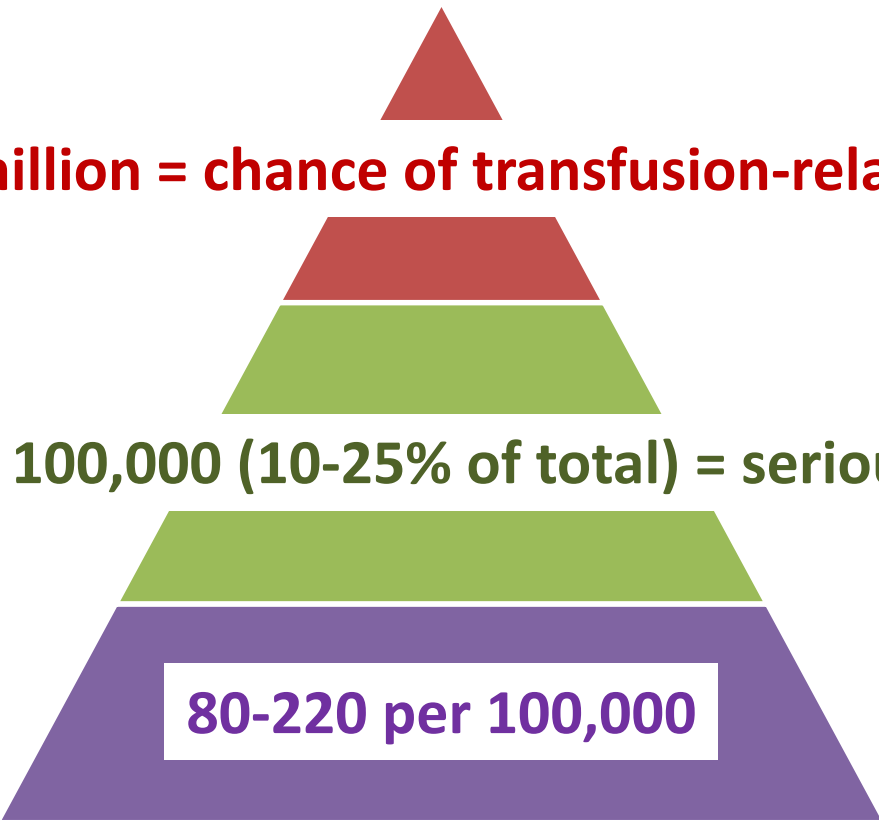
**NHSN** - National  
Healthcare Safety Network  
Hemovigilance Module of  
the CDC **USA**

**2013 – 2015**

**8 million components**

Kracalik et al. *Transfusion* **2021**; 61: 1424-34.

## “Frequencies”



**3 per million = chance of transfusion-related death**

**15-20 per 100,000 (10-25% of total) = serious reaction rate**

**80-220 per 100,000**

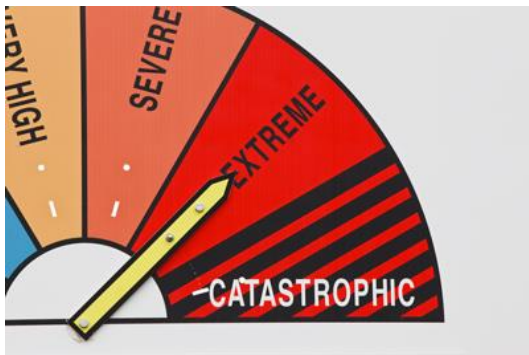
# Qualifying the Event: Provisional Adjectives

- SEVERITY

- Grade 1 (non-severe)
  - Mild
  - Moderate

---

- Grade 2 (severe)
- Grade 3 (life-threatening)
- Grade 4 (death)

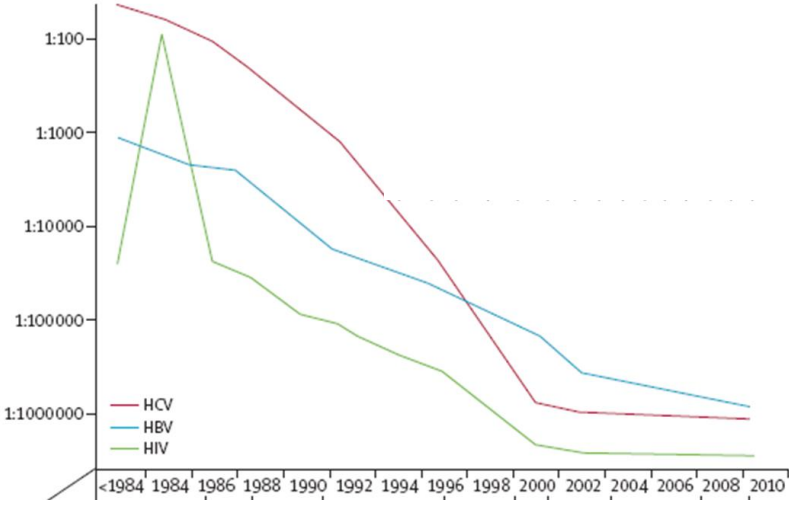


- IMPUTABILITY, CERTAINTY

- Definite (certain)
- Probable (likely)
- Possible
- Unlikely (doubtful)
- Excluded

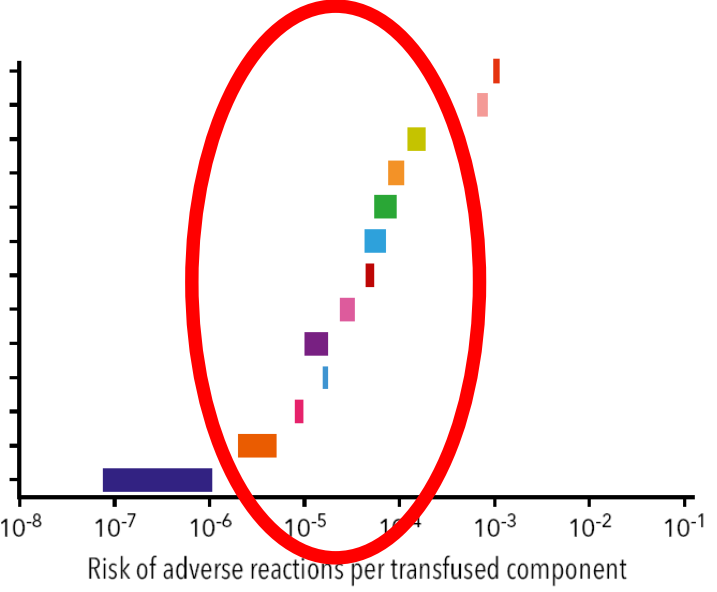


Aggregate Transfusion Transmitted Viral Infection (TTVI) hazards:  $< 1/10^5$



Justice Horace Krever

Aggregate non-TTVI hazards:  $> 1/10^5$

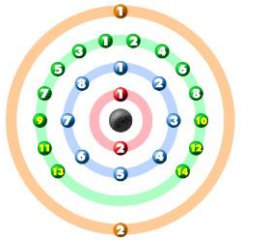


Andrzejewski Jr et al. *Int J Clin Transfus Med.* **2014**; 2: 45-57.

Goel et al. *Blood* **2019**; 133: 1831-9

# Minimum Disclosure Framework

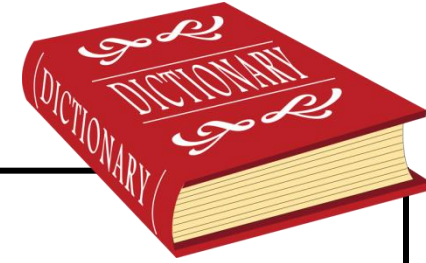
*in Layman's Terms & Logscale Frequencies*



logscale  
1  
2  
3  
4  
5  
6

<b>Common, minor events</b> (1 / 10 <sup>1</sup> -10 <sup>2</sup> )	non-serious <b>fever</b> non-serious <b>hives</b> make <b>antibodies</b> to donor antigens (RBC, HLA)
<b>Serious, potentially fatal events</b> (1 / 10 <sup>3</sup> -10 <sup>5</sup> )	<b><u>breathing</u> trouble:</b> –volume-driven fluid excess –immune injury-driven fluid leaks –anaphylaxis / severe bronchospasm <b><u>bacterial</u> contamination</b> of unit <b><u>botched</u> process</b> (wrong sample or bag)
<b>Extremely rare events</b> (1 / 10 <sup>6</sup> or less)	viral contamination of unit ( <b>hepatitis, HIV</b> ) <b>new</b> or <b>rare</b> (not tested-for) <b>bugs</b> fatal immune “take-over” by product

# Your Acronymic Glossary (What to Learn)



FNHTR	-non-serious fever
ATR	-non-serious hives
STR	-trigger new antibodies to red cells
TAD	-breathing trouble:
TACO	–volume-driven fluid excess
TRALI	–immune injury-driven fluid leaks
Anaphylaxis	–anaphylaxis / severe bronchospasm
TAS (“BaCon”)	-bacterial contamination of unit
AHTR / IBCT / WBIT	-botched process (wrong sample or bag)
TTVI	-viral contamination of unit
Emerging infections	-new, unexpected bugs
TA-GVHD, PTP	-fatal immune “take-over” by product



# *Secret Decoder Slide*

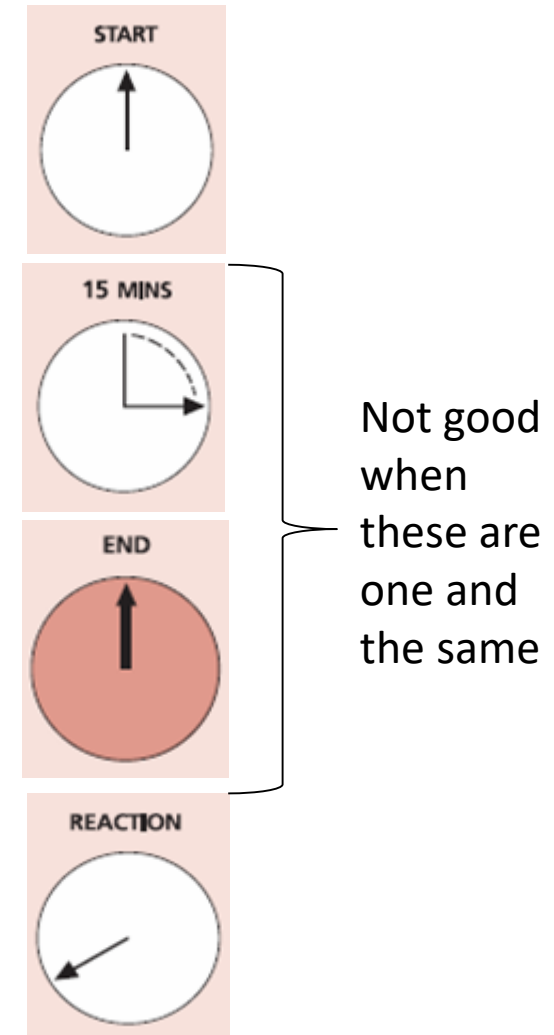
FNHTR	febrile non-hemolytic transfusion reaction
ATR	allergic transfusion reaction
STR	sensitization (serologic transfusion reaction)
TAD	transfusion-associated dyspnea
TACO	transfusion-associated circulatory overload
TRALI	transfusion related acute lung injury
Anaphylaxis	anaphylaxis (allergic bronchospasm)
TAS (“BaCon”)	transfusion-associated sepsis/bacterial contamination
AHTR / IBCT / WBIT	acute hemolytic transfusion reaction/incorrect blood component transfused/wrong blood in tube
TTVI	transfusion transmitted viral infection
Emerging infection	new, unexpected bugs
TA-GVHD, PTP	transfusion-associated graft-vs-host disease, post-transfusion purpura



# Our First Defense: Vital Signs: HR, BP, T, RR, SpO2

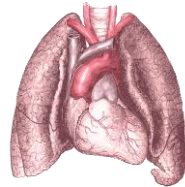
- time 0: vital signs
- 1<sup>st</sup> 15 minutes: SLOW infusion (50cc/h)
- **at 15 minutes:** vital signs re-check
- end: must be within 4 h;  
re-check vital signs
- reaction: vital signs

deadliest outcomes show up fast... &  
dose-dependent





*Febrile*

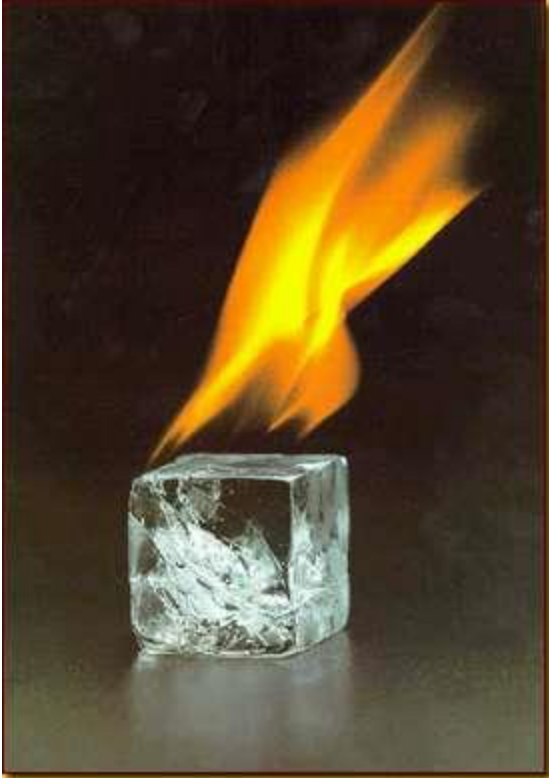


*Cardiorespiratory*

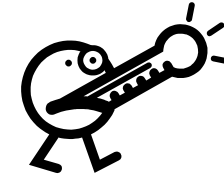


*Allergic*

# When Is It A Fever (Pyrexia) ?



- $T > 38^{\circ}\text{C}$  AND  $\uparrow$  by  $\Delta 1^{\circ}\text{C}$



OR

- the cytokine-provoked equivalent of chills or rigors



febriles



# Fever's Differential Diagnosis



HIGH RISK FEVER

danger gradient



acute hemolytic transfusion reaction (AHTR)

bacterial contamination (BaCon)/  
transfusion-associated sepsis (TAS)

fever due to underlying disease



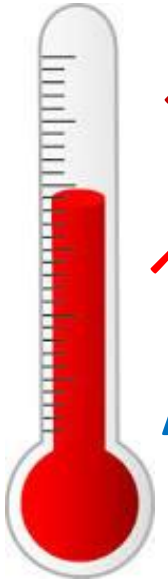
LOW RISK FEVER

febrile non-hemolytic transfusion reaction (FNHTR)



frequency gradient

# The “High Risk” Fever: *?BacOn ?Bad Match*

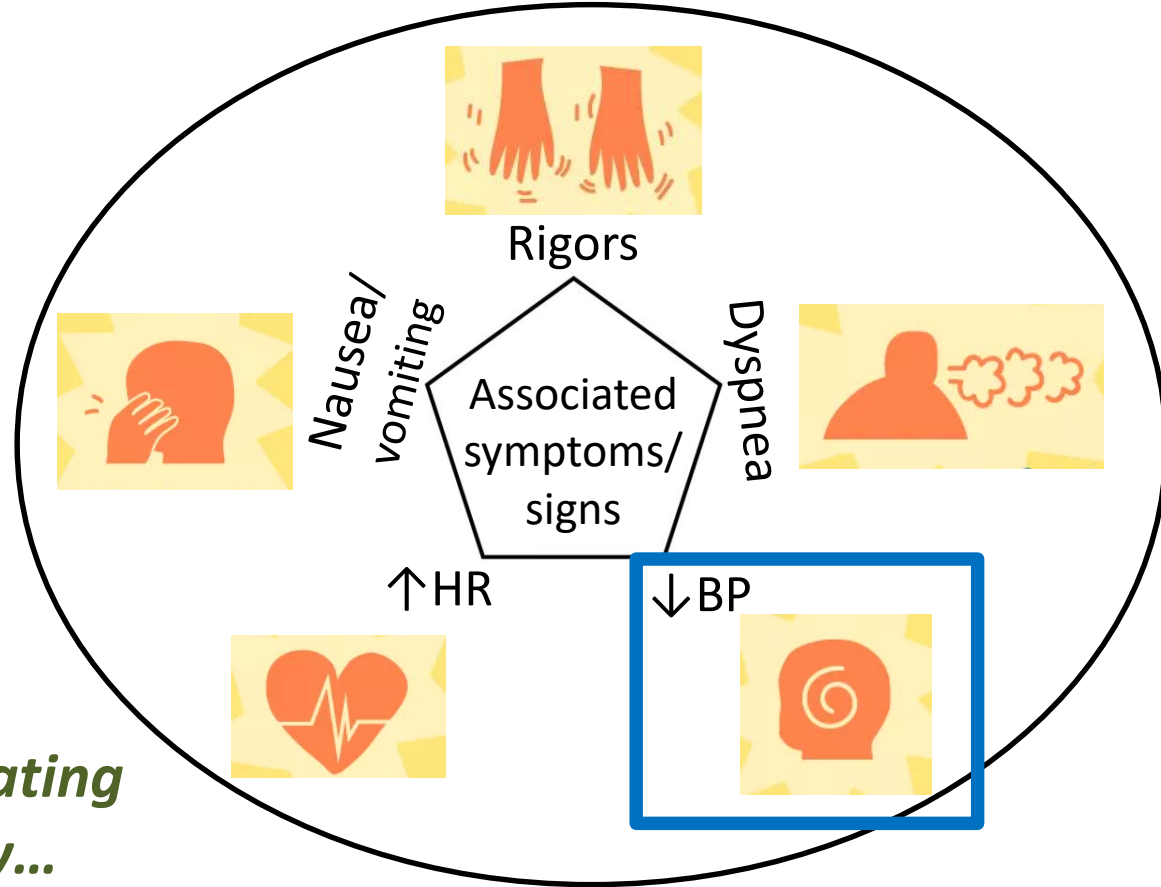


**↑Δ1°C to ≥39°C**

**↑Δ1°C to ≥38°C + any...**

**Antipyretic + any...**

*Early interim volume associating with ↑Δ1°C to ≥38°C, or any...*



As of 2022:

44

# blood group antigen systems

(ABO, Rh, ...) containing structures that are naturally “polymorphic”

47

RBC blood group related genes

> 200,000

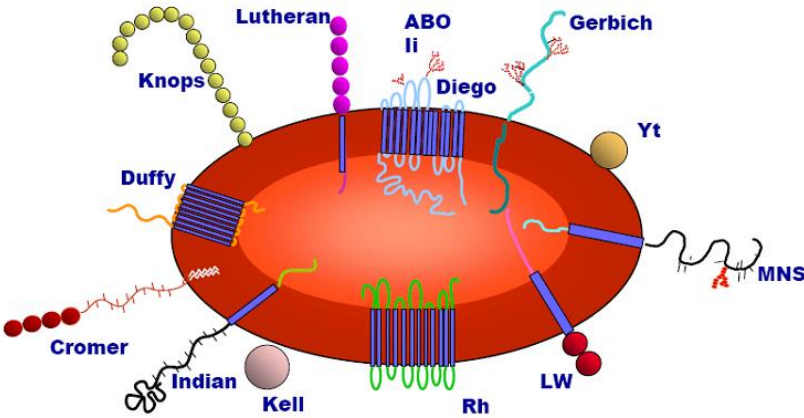
RBC blood group genetic alleles

> 1000

RBC blood group coding region variants

> 400

RBC antigens (known to provoke antibodies)



# Acute Hemolytic Transfusion Reaction (AHTR)

- **immune**
  - active/major (recipient antibodies)
  - passive/minor (donor antibodies)
- **non-immune**
  - devices damaging RBCs: heat or pressure infusers
  - biochemical:
    - potentiators of pre-existing hemolytic condition
      - C3/C4: PNH, CAS
    - donor RBC hemolysis
      - G6PD deficiency



# IBCT –

## Incorrect Blood Component Transfused



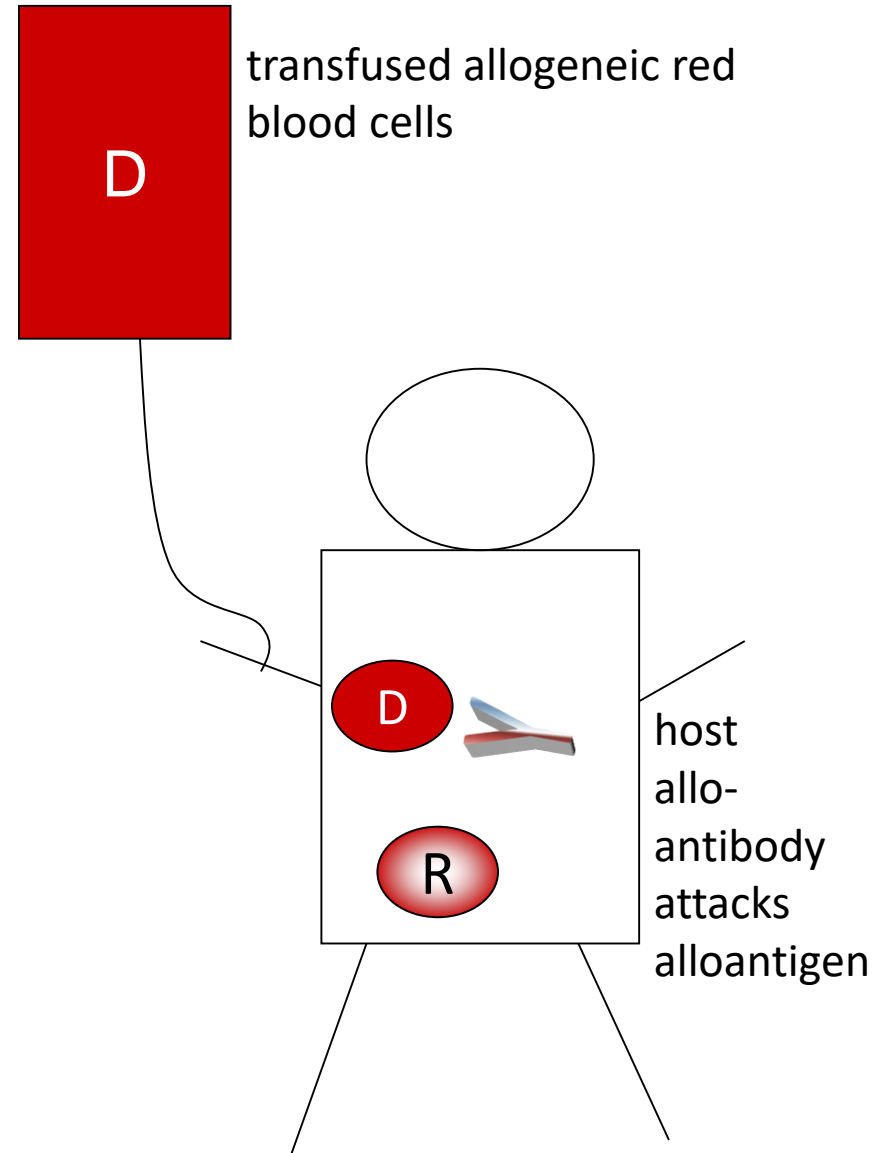


# Acute (or Delayed) Hemolytic Transfusion Reaction

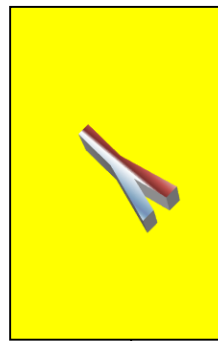
- **active** AHTR =  
MAJOR INCOMPATIBILITY

– recipient makes antibodies that  
destroy foreign RBC

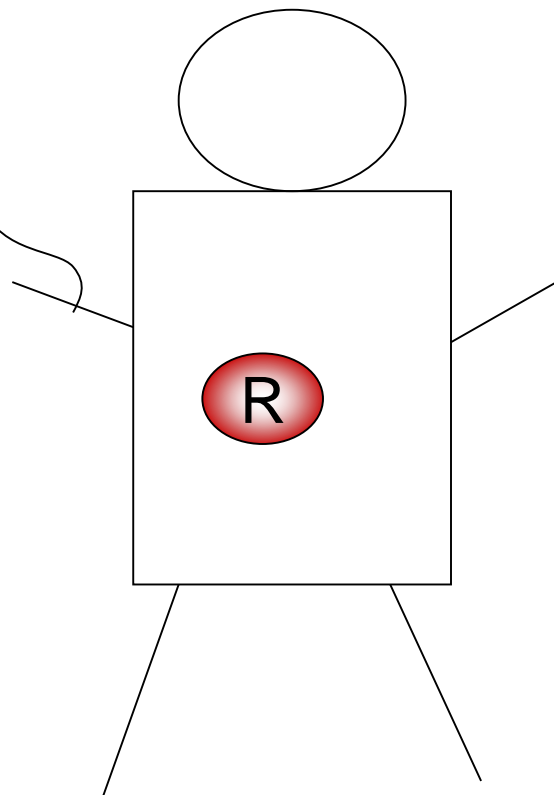
eg. RBC incompatible for (ABO or non-ABO-  
blood) antigens



# Acute (or Delayed) Hemolytic Transfusion Reaction



high plasma-volume (or  
plasma antibody-)  
containing products  
(platelets, **IVIG**)

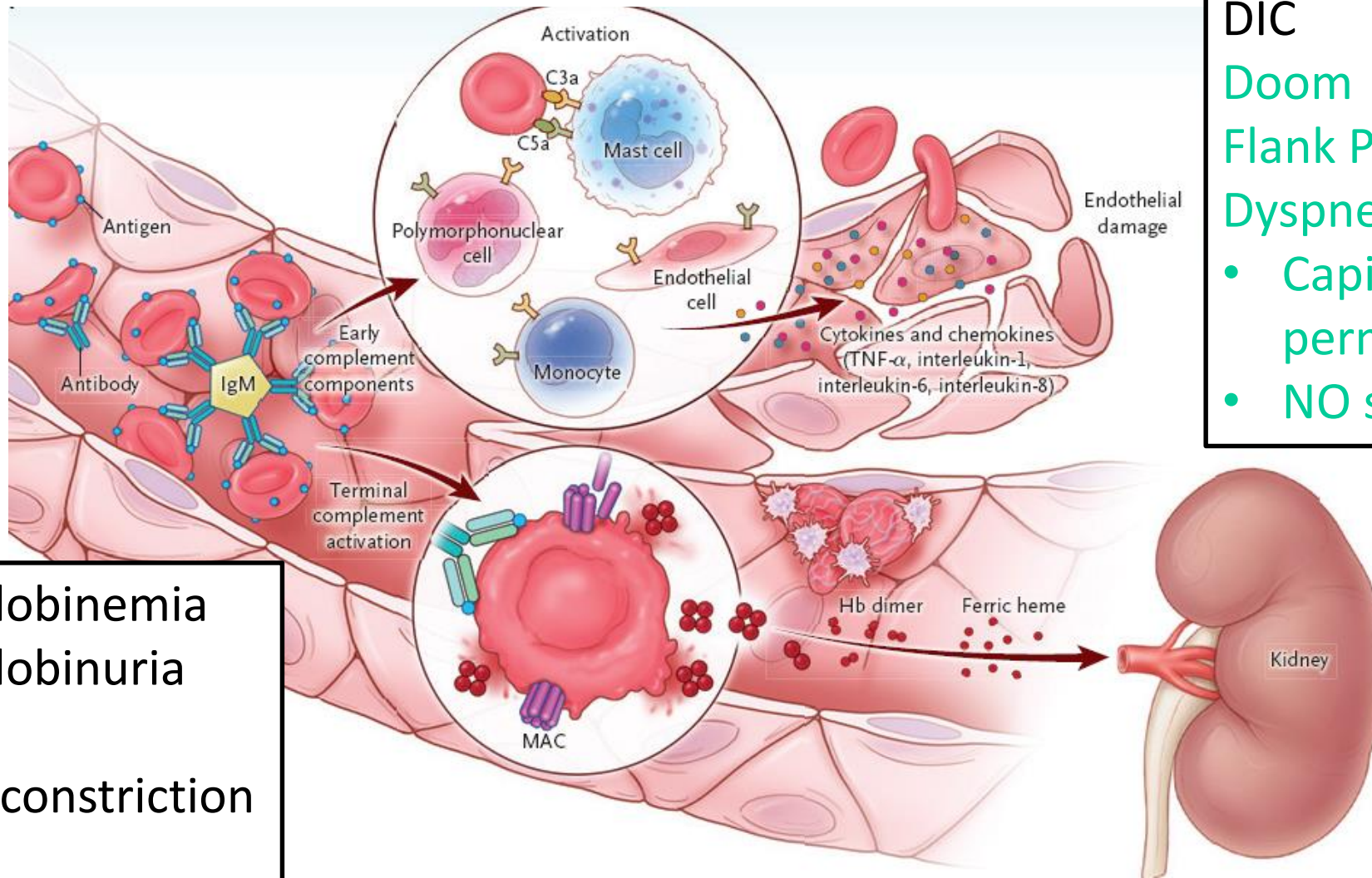


- **passive** AHTR =  
MINOR INCOMPATIBILITY

– product contains antibodies that  
destroy host RBC

eg. ABO antibodies  
("isohemagglutinins") targeting  
recipient

# (A)HTR

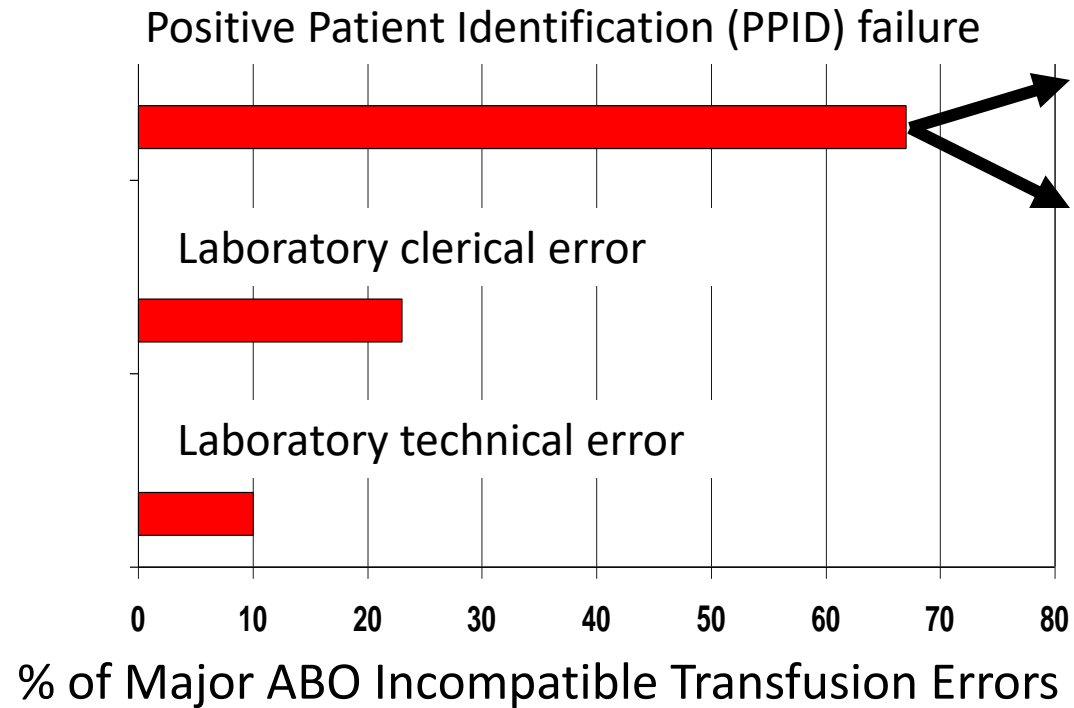


- Shock
- Fever
- DIC
- Doom
- Flank Pain
- Dyspnea
- Capillary permeability
- NO scavenging

- Hemoglobinemia
- Hemoglobinuria
- AKI:
  - Vasoconstriction
  - ATN

# Why/How Does The Mistake of Hanging ABO-Incompatible Blood Happen?

1 in 14,000 chance for incorrect blood component transfused (IBCT)



1 in 3000 samples labelled with another patient's name!  
(Wrong Blood In Tube [WBIT])

1. Errors in specimen collection (15%)

2. Errors in blood administration (majority)

hanging in haste without Positive Patient Identification (PPID)



# Human Errors Perspective – Sample Rules *and Calls for Higher Technology*

- risk of ABO-incompatible transfusion:  $1/40,000 >$   
*aggregate risk of all TTVI (1/50,000)*
- if sample labeled incorrectly: 1:28 chance of WBIT
- machine-readable systems  $\uparrow$  safety by  $>5$ -fold beyond manual/human processes



# Is There Hemolysis?

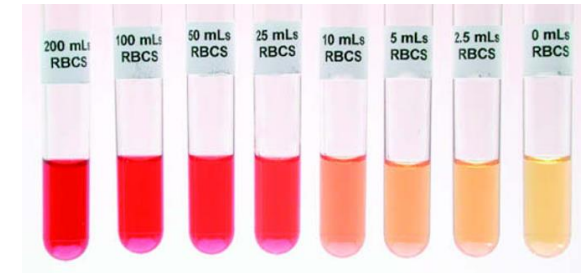
- without attributable bleeding,  
reticulocytosis / polychromasia /  $\uparrow$  MCV  
(or a *non-elevated* reticulocyte count)  
maps to negative (*exaggerated*) balance



- visible or measured elevation of pfHb

- breakdown markers

- $\uparrow$  bilirubin (unconjugated-predominant), AST



90% Sn  $\left\{ \begin{array}{l} \uparrow \text{LDH (\& AST > ALT)} \\ \downarrow \text{haptoglobin} \end{array} \right.$  *Conversely, N LDH (<220 U/L) & N hpto (>0.25g/L): 92% Sn to rule Out.*

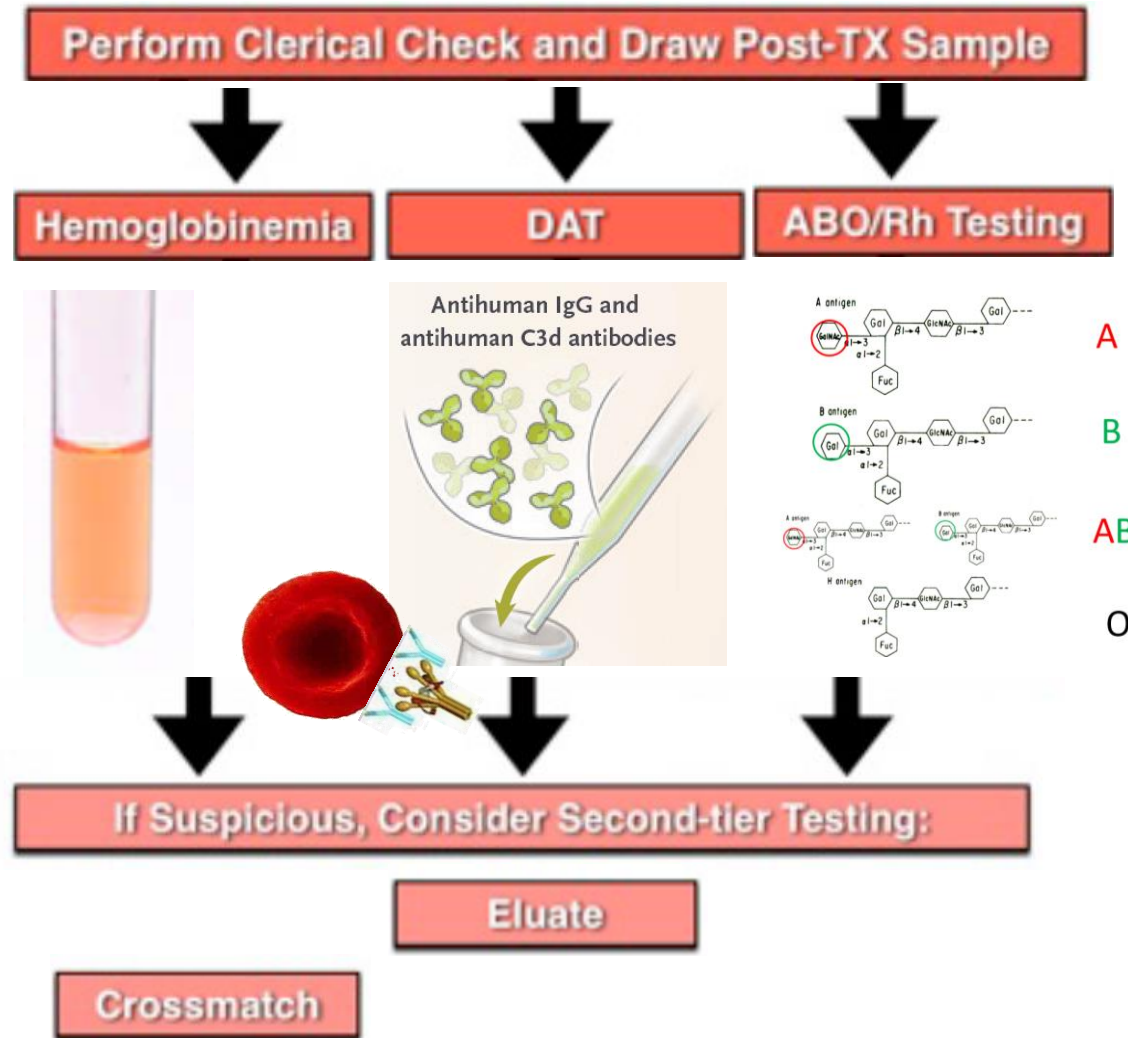


- hemoglobinuria/hemosiderinuria  $\pm$  pigment nephropathy

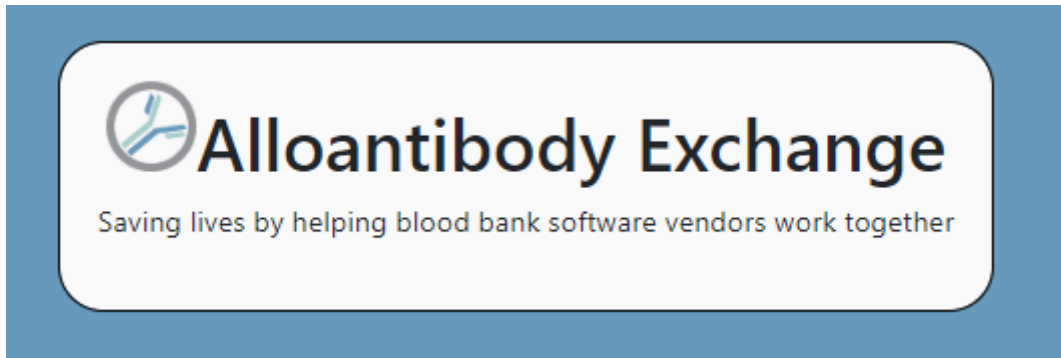


# If So, Is It Immune Incompatibility-Related?

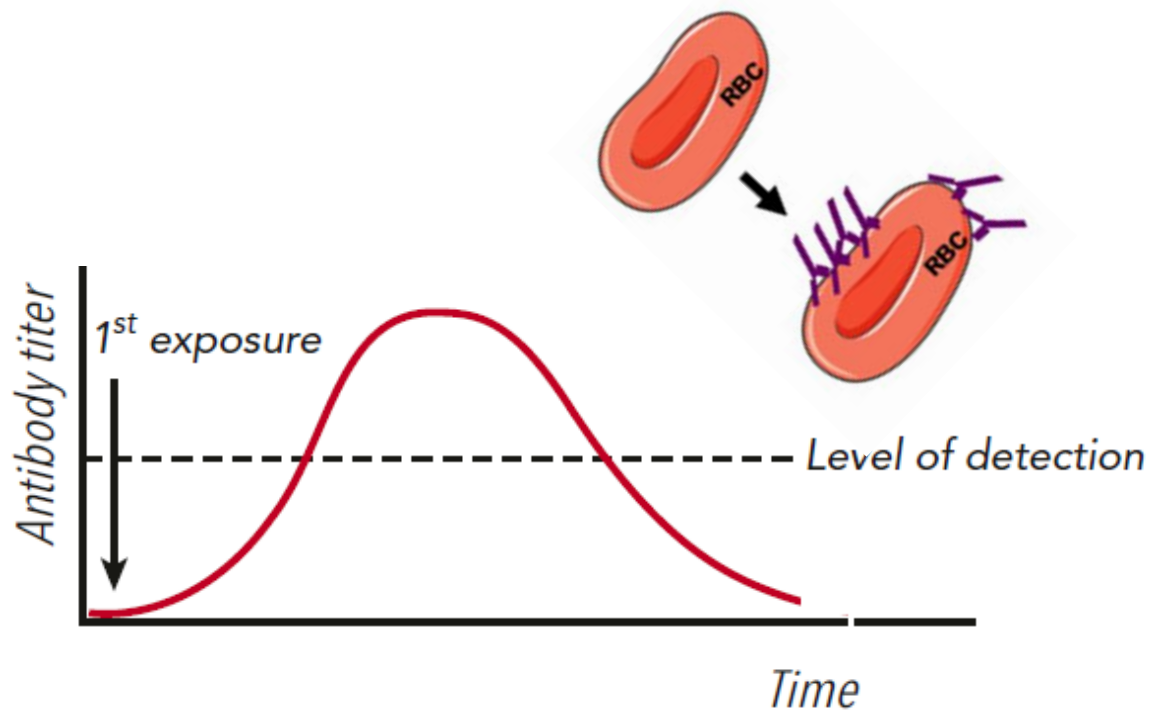
look at labels



- DIC?
- C3/C4 consumption?
- ferritin surge?



[www.alloantibody.org](http://www.alloantibody.org)



## TRANSFUSION SAFETY

Blood bank software vendor	Committed to share patient's alloantibody history
	<input checked="" type="checkbox"/>
	<input type="checkbox"/>
	<input type="checkbox"/>
	<input type="checkbox"/>
	<input checked="" type="checkbox"/>
	<input type="checkbox"/>

Encourage your vendor to join the Alloantibody Exchange.

<https://www.change.org/AlloantibodyInformationSharing2ImproveTransfusionSafetyForAllEverywhere>



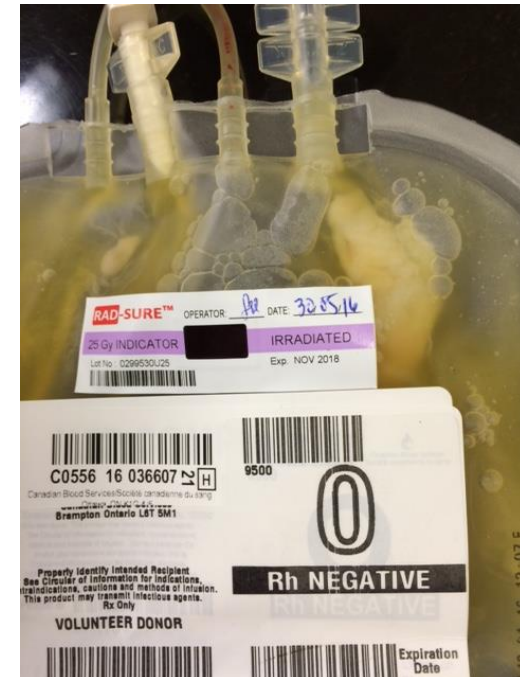
# Bacterial Contamination (BaCon) / Transfusion-Associated Sepsis (TAS)



The most BaCon-ific  
product of all... 1 / 1000

*irradiation is not a  
decontamination measure*

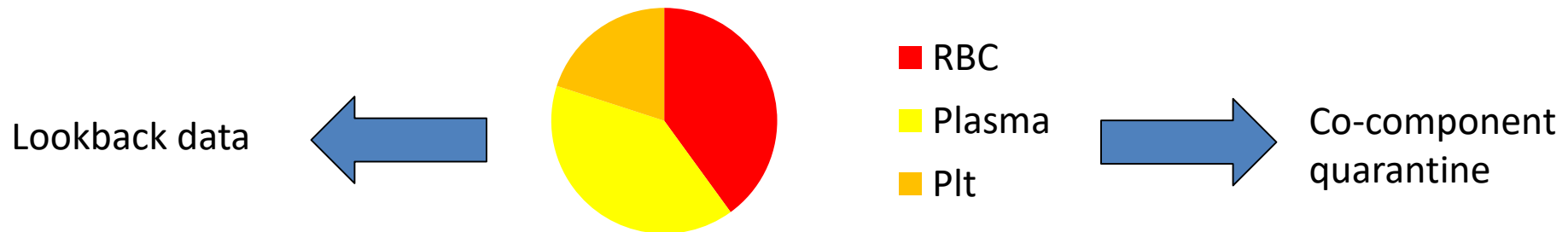
Room temperature ~20°C 7d	
Refrigerated 4°C 7 wk	
Frozen -20°C 1 yr	



# Culture / Investigation Pathway

PRE	POST		CONCLUSIONS
PATIENT		PRODUCT	
+	+	0/ND	Pre-existing sepsis
0/ND	+	+	Definite BaCon
0/ND	0/ND	+	Probable BaCon
0/ND	+	0/ND	Possible BaCon
+ / 0/ND	0/ND	0/ND	Doubtful BaCon

## Review of Donation/Donor Information

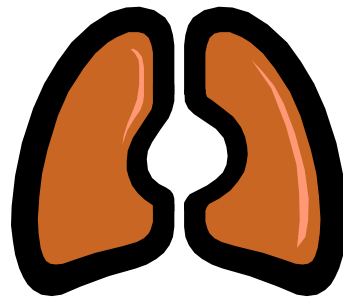


# Febrile Non-Hemolytic Transfusion Reaction (FNHTR): Diagnosis of Exclusion

- common: **1/20** platelet transfusions, **1/300** RBC transfusions

- **recipient has anti-leukocyte antibodies**  
(because of previous exposure to blood)
  - WBC in product complexed on transfusion
- **product has “pyrogens”**
  - cytokines / inflammatory mediators accumulate,  
inducing fever on transfusion





## Blood Product Given → Respiratory Distress

*Most “important” of all transfusion hazards*

High case morbidity  
& mortality rates, at  
high frequency

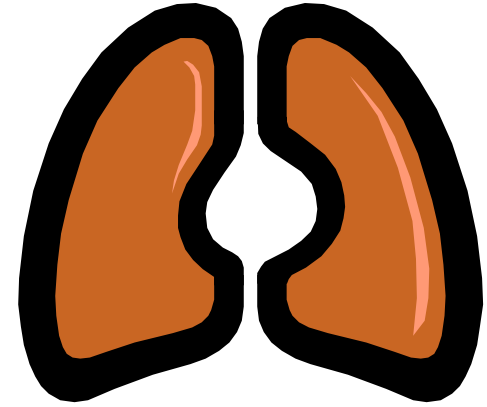


Accounting for 60% of  
transfusion-related  
deaths

deep-stuff:  
cardiorespiratory (dyspnea)



# Dyspnea



cardiogenic

**transfusion-associated circulatory overload (TACO)**

non-cardiogenic

transfusion-related acute lung injury (TRALI)

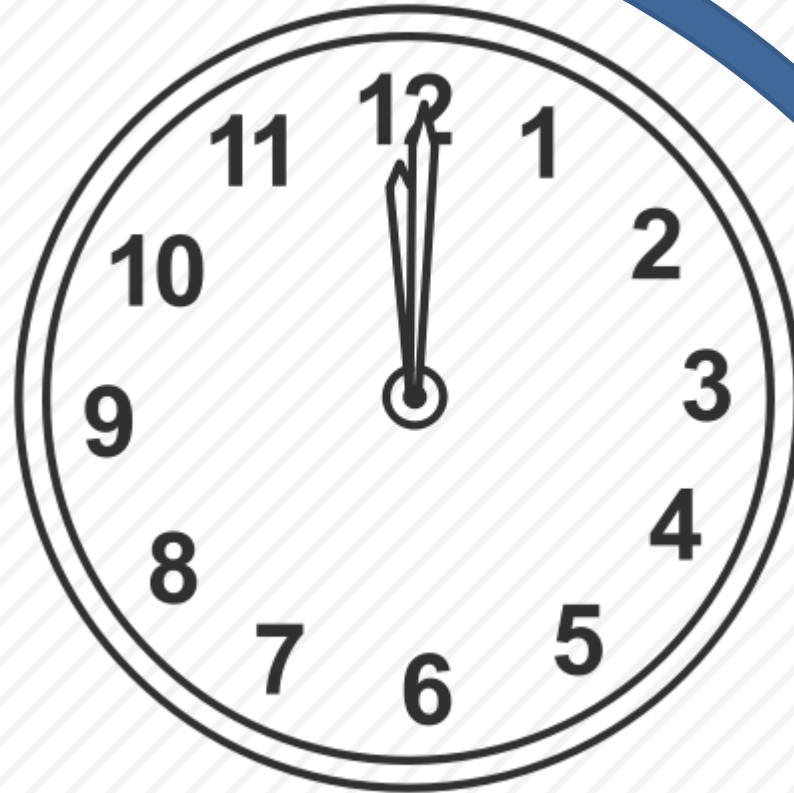
allergic reaction (bronchospasm)

*bacterial contamination or incompatibility reaction (off-target)*

underlying disease process

transfusion-associated dyspnea (TAD)

STOP ASAP



REPORT  
DISTRESS  
EVENTS WITHIN  
6-12H OF  
PRODUCT

# 1 Volume Status as the Discriminant (exam)

## 2 Structure: Infiltrates?



## 3 Function: Hypoxia?

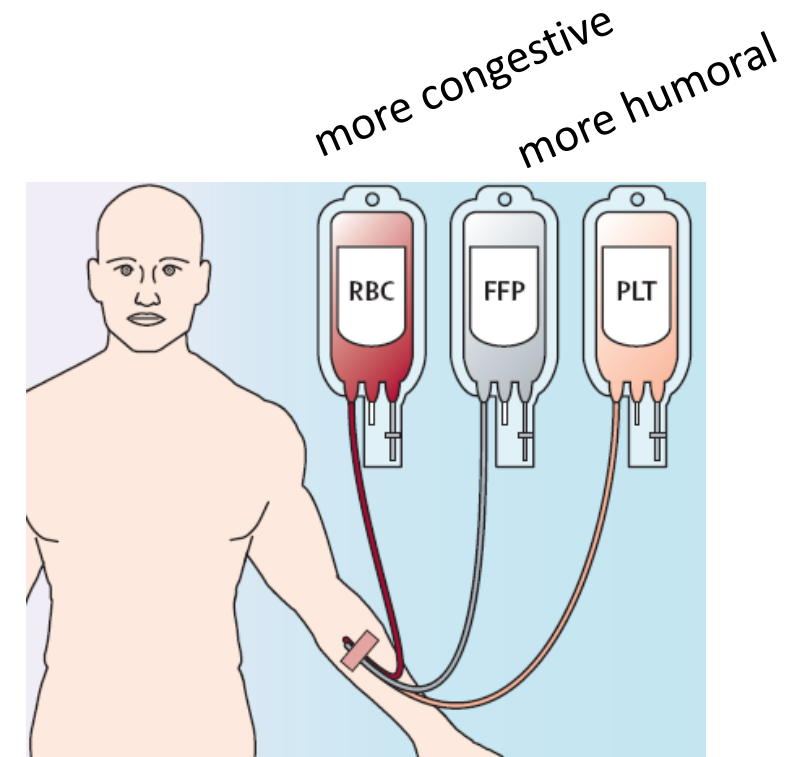
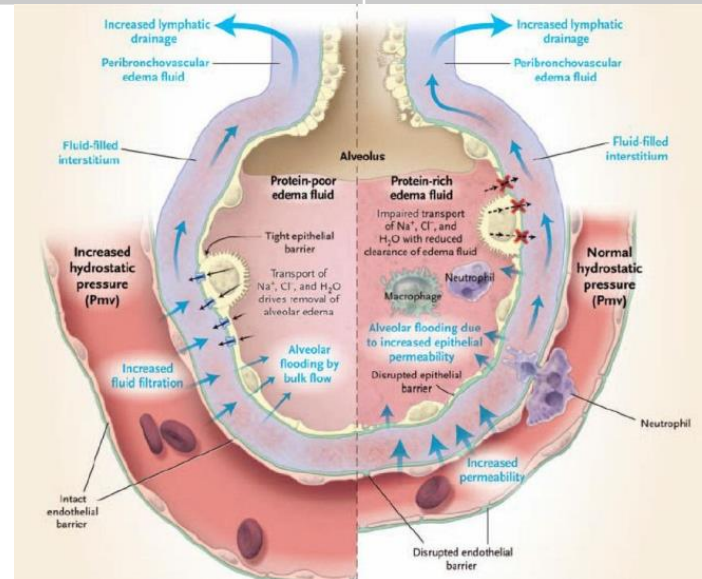


transfusion-associated circulatory overload (TACO)

transfusion-related acute lung injury (TRALI)

# Shared: 2-hit model

Fluid driver:	hydrostatic	permeability/leak
Immunology:	-	+
Agent:	dangerous doctor	dangerous donor
Biomarker:	cardiac stress	leukoagglutinins



Vlaar & Juffermans. *Lancet* **2013**; 382:984-94.



# Transfusion Associated Circulatory Overload (**TACO**):

≥ 1 REQUIRED:

OCCURRING  
WITHIN ≤ 12H  
AFTER  
TRANSFUSION

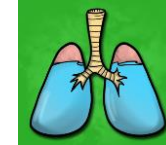


## Respiratory Distress

eg-

- tachypnea
- dyspnea
- cyanosis
- ↓spO<sub>2</sub> % without other causes
- bronchospasm/wheezing

AND/  
OR



## Pulmonary Edema

### Physical

*L heart findings without other causes, eg-*

- crackles
- orthopnea
- cough
- S3
- frothing/pink sputum

### Radiography:

*new/worsening changes, eg-*

- effusions
- widened vascular pedicle
- lobar vessel enlargement
- peribronchial cuffing
- Kerley lines
- alveolar edema
- cardiac silhouette enlargement

AND: 1 OR MORE OF:



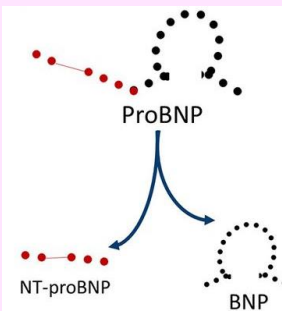
## Cardiovascular system changes not from underlying condition

- tachycardia
- ↑BP, PP (or ↓ if cardiogenic shock)
- JVP distension/↑ CVP/↑ cardiac silhouette
- peripheral edema

## Fluid overload



- + fluid balance or weight gain
- diuretic or dialytic response



## Natriuretic peptide (BNP)

↑ > ULN and 1.5x  
pre-transfusion value

for a **MINIMUM OF 3 CRITERIA**

# TACO Landscape



- Common – **1-10%** of encounters

Hendrickson JE et al, [Transfusion](#) **2016**; 56: 2587

- Assumed to be **reversible with diuretics**

Roubinian N & Murphy EL, [IJCTM](#) **2015**; 17

- Rising in rank as **commonest** reaction entity among **transfusion-related deaths**

TTISS (Ontario) 2014-2018: 13/35 (37%)	}	<b>37%</b> (95% CI: <b>33-41%</b> )
SHOT (UK) 2010-2020: 104/212 (49%)		
FDA (USA) 2014-2019: 72/262 (27%)		

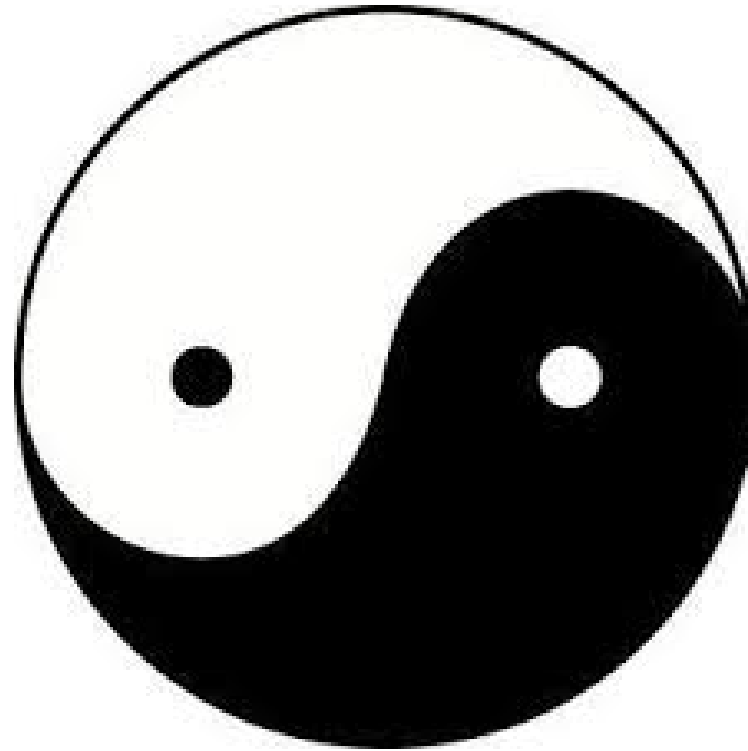
- Often serious (**1/5 to ICU**) ...

LOS effects...

**CFR: 1-10%**

# TACO: Accreditation Standards Expect Lab-to-Bedside Prevention Efforts

**IDENTIFYING  
WHO IS AT RISK**



**MODIFYING THE  
ORDER**

**New aaBB Standard 5.19.7 Transfusion-Associated Circulatory Overload (TACO) (30<sup>th</sup> edition, 2016):** *“The BB/TS shall have a policy for responding to requests for products for patients identified by the ordering physician or other authorized health professional as being at increased risk for TACO.”*

# TACO: Risk Factors (Finding Who Needs Mitigation)

- cardiorespiratory dysfunction

- MI, CHF, diuretics, abnormal cardiac studies
- tachypnea [RR>20], ambient air hypoxia [SpO<sub>2</sub> <92%], JVP >3cm ASA, bilateral chest rales, extra heart sounds [S3, S4]

- renal dysfunction

- age

- youngest
- oldest (>60-70 years)

- positive fluid balance

- weights, ins/outs, physical signs



- small receiver: low body weight
- anemic hyperdynamism
- heavy-handed giver:

- unwritten orders (verbal)
- unassessed patient
- big order
- too fast
- preceding crystalloids: “STACO”

- Li et al. [Transfusion](#) **2011**; 51:338-43.
- Lieberman et al. [Transfus Med Rev](#) **2013**; 27:206-12.
- Andrzejewski Jr et al. [Transfusion](#) **2013**; 53:3037-47.
- Alam et al. [Transfus Med Rev](#) **2013**; 27:105-12.
- Clifford et al. [Anesthesiology](#) **2015**; 122:21-8.
- Roubinian et al. [Crit Care Med](#) **2018**; 46:577-85.

# TACO: How to Change the Order to Mitigate Risk

- lower the trigger
- cancel
  - alternatives?
- reduce order size/volume
  - 1 instead of 2u RBC
  - concentrates instead of components
- slow the infusion rate
- (advance) volume decanting
  - diuretics, more UF on dialysis



Flash *Non-Cardiogenic*

Pulmonary Edema:



?Transfusion Related Acute Lung Injury (TRALI)

# Transfusion Related Acute Lung Injury (TRALI):

A + B + C:

A.



Acute Onset

- $paO_2/FiO_2 \leq 300$
- $spO_2 < 90\%$  on room air
- Other clinical evidence

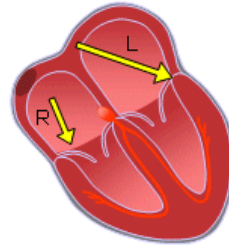


Hypoxemia



Bilateral Infiltrates

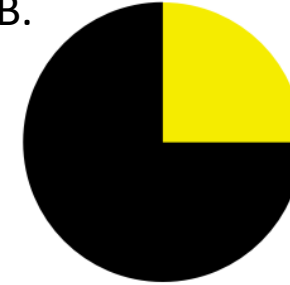
*CXR, CT, US*



Left Atrial Hypertension:  
absent, or (if present),  
not the main contributor  
to hypoxemia

*Echo, PCWP*

B.



Onset during or  
within **6h** of  
transfusion

*(Pulmonary edema/  
LAH studies captured  
within 24h)*

C.

No alternative ARDS risk factors

*Direct Lung Injury:*

- aspiration
- pneumonia
- toxic inhalation
- lung contusion
- vasculitis
- near drowning

*Indirect Lung Injury*

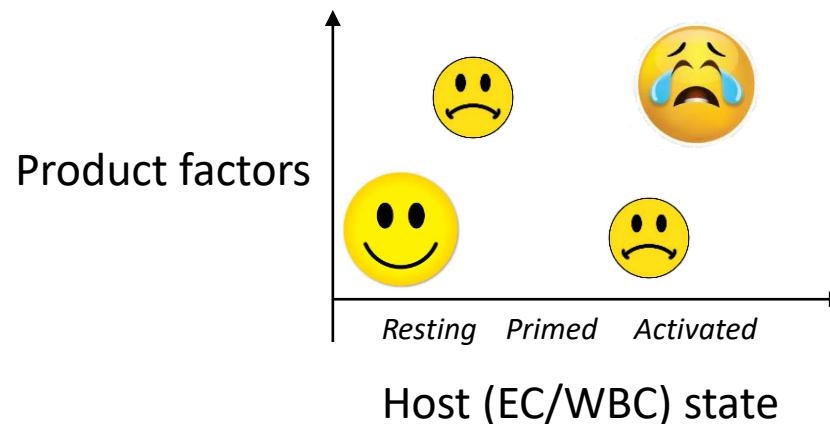
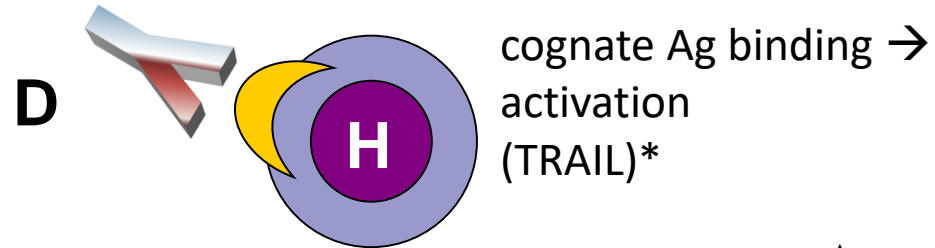
- non-pulmonary sepsis
- multiple trauma
- burn injury
- acute pancreatitis
- non-cardiogenic shock
- cardiopulmonary bypass
- drug overdose

*\* Neither leukoagglutinating (HLA or HNA) antibodies in donors  
(nor confirmation of cognate antigens in recipient) are required*

# TRALI: How It Happens: 2<sup>nd</sup> Hit[s] (*in a 1<sup>st</sup>-Hit Host*)

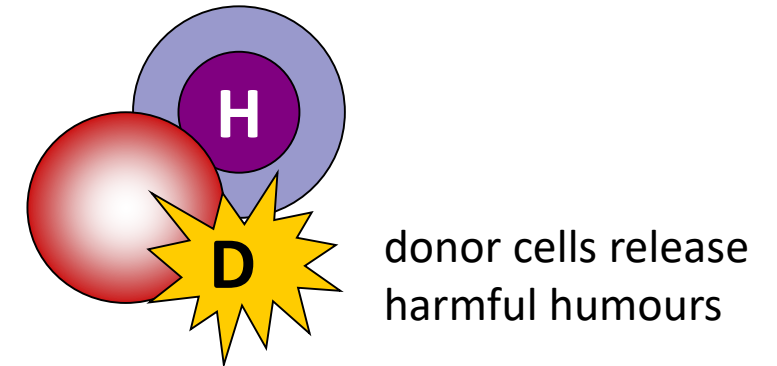
- **donor** had incidental anti-leukocyte antibodies (ALA) collected into product

- ALA (HLA [II>I], HNA) delivered IV
- ALA account(ed) for most cases



- **product toxins/biologic response modifiers (BRM)**

- products release biologically active lipids
  - biologically active lipids, lysoPC, microparticles
  - cytokines, chemokines (HMGB1, sCD40L)
  - NETs, mtDNA

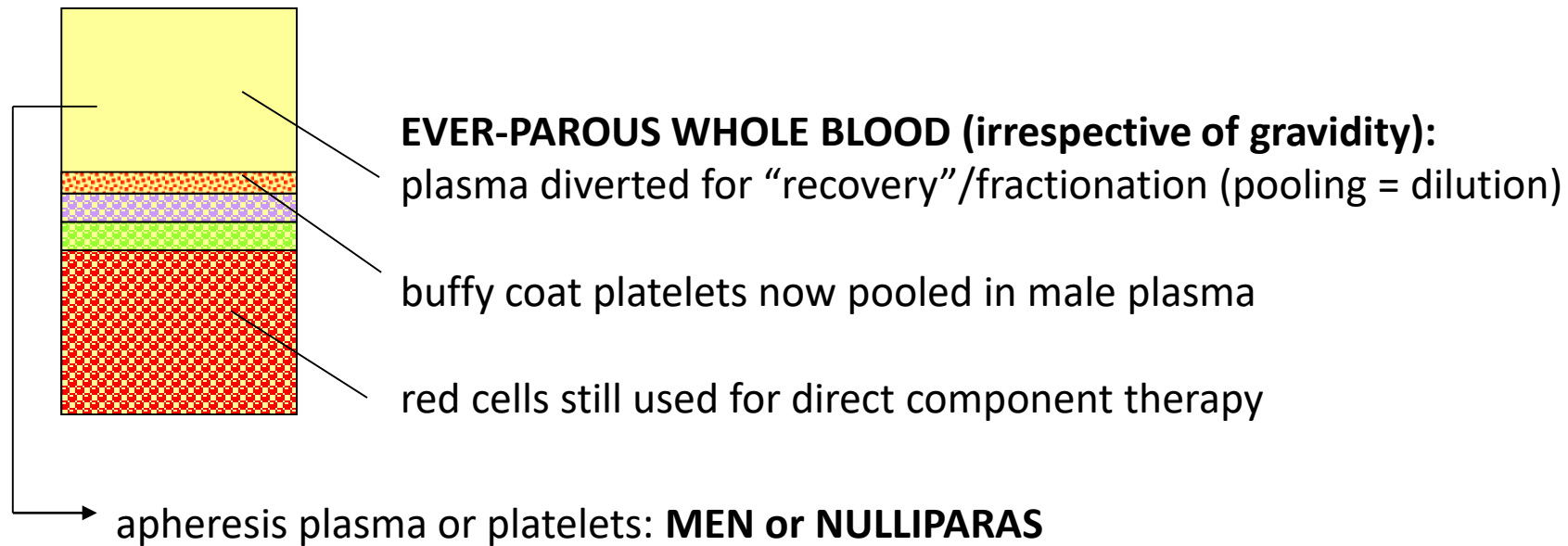




# Mitigating **Femme Fatale Effect**: Fewer TRALI Cases Expected (**Seen**) Now

- commonest way for (healthy) donors to (RBC/WBC)-sensitize is PREGNANCY
- production methods account for this potentially harmful “immune knowledge”

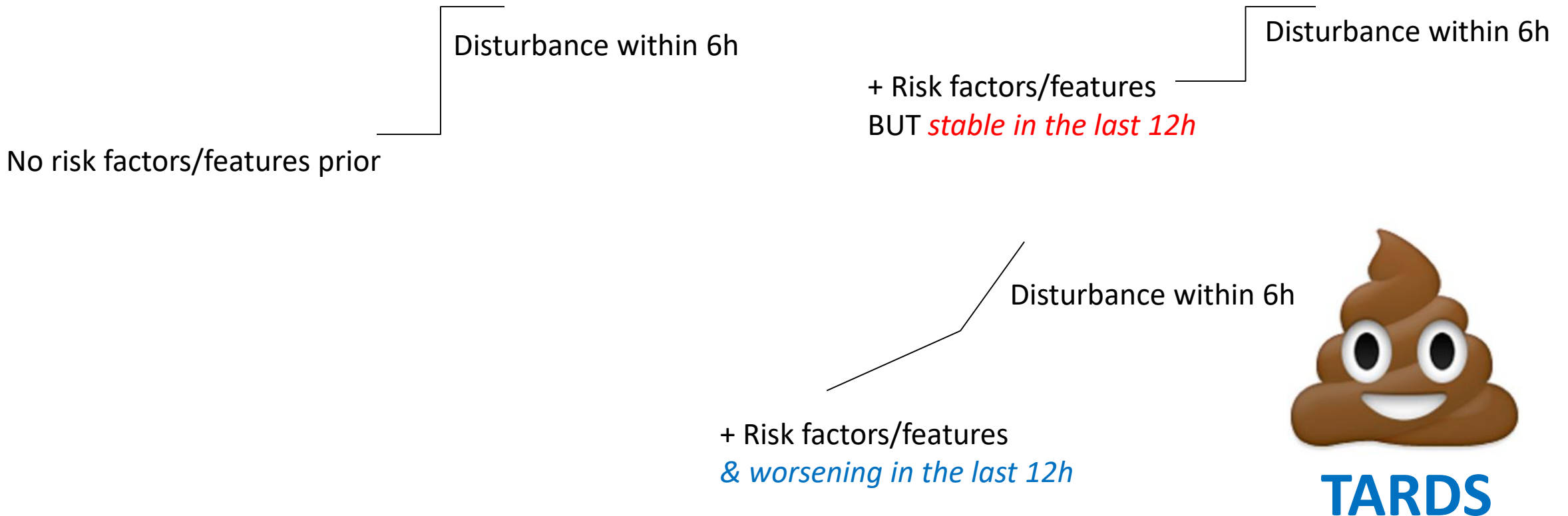
OR ~0.5



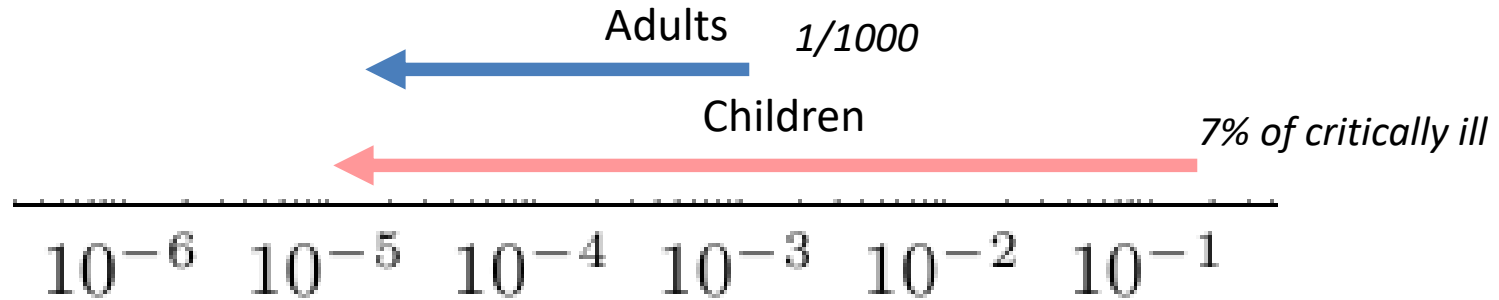
- Muller et al. [Transfusion](#). 2015; 55(1):164-75.
- Schmickl et al. [Crit Care Med](#). 2015; 43(1):205-25.

# Culpability/Certainty Spectrum:

TRALI Type I	TRALI Type II
TRALI	possible TRALI (pTRALI)



# TRALI Epidemiology



Vossoughi et al. [Transfusion](#) **2019**; 59: 2567-74

- Transfusion-attributable fatalities:

TTISS (Ontario) 2014-2018: 9/35 (26%)	}	<b>16%</b> (95% CI: <b>13-19%</b> )
SHOT (UK) 2010-2020: 7/212 (3%)		
FDA (USA) 2014-2019: 59/225 (26%)		

- **IHM**: up to 50%
- **CFR**: 5-25%

McVey et al. [Anesthesiology](#) **2019**; 131: 693-715.

# Why is dyspneic/hypoxic reaction reporting so important?

- A. Billings bring revenue
- B. Quality signal on dangerous doctors/facilities
- C. Reporting improves real-time care
- D. Co-component quarantine, donor investigation (deferral)
- E. Enables legal actions



# Allergic Reactions



*surface-stuff:  
skin (rash)*

# The Allergic Spectrum

- cutaneous eruption (= urticaria, pruritis, erythema, flushing)
- angioedema (=subcutaneous rather than cutaneous)
- respiratory:
  - bronchospasm
    - wheezing, stridor, hoarseness, dyspnea, hypoxia, feeling of asphyxia/doom
- gastrointestinal instability:
  - nausea/vomiting/abdominal cramping/diarrhea
- cardiovascular instability:
  - hypotension, chest pain, tachycardia
- anaphylactoid / anaphylactic reaction  $\pm$  death

frequency gradient

1% incidence

90% of  
ATR  
cases

danger gradient

**fatal anaphylaxis: 1 in 2-10 million**

# Why Allergic Reactions Happen

## CLASSIC ALLERGIC IgE

- **Recipient IgE to incoming donor allergens**
  - eg. drug & food allergens transfused to patient
- **Donor IgE to recipient allergens**
  - eg. donor's peanut allergy passed into recipient

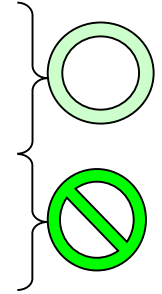


## RECIPIENT HAS MISSING OR VARIANT PROTEIN AND REACTS TO WILD-TYPE PROTEIN

*<5% of cases*

- eg **IgA**, haptoglobin, complement, albumin,  $\alpha$ 1anti-trypsin, transferrin

- anti-protein IgG develops



# Hypotension



acute hemolytic transfusion reaction (AHTR)

bacterial contamination (BaCon)

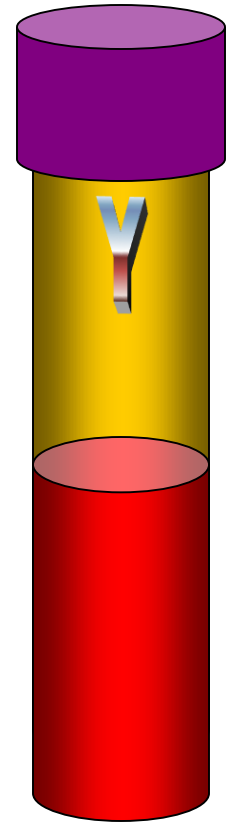
severe allergic transfusion reaction / anaphylaxis

bradykinin shock?



# Testing Approach

- We investigate with the following panels for:
  - **Febriles:** hemolysis, microbiology
  - **Dyspneics:** hemolysis, microbiology, CBS (donor ALA)
  - **Hypotensives:** hemolysis, microbiology
  - **Anaphylactics:** hemolysis, ?IgA/anti-IgA IgG  
(?other protein deficiencies)



Blood bank  
sample:  
BIAS = exploration  
for immune  
hemolytic  
incompatibility

# Major Take-Home Messages

- most common (acute) killers: TRALI & TACO, AHTR-IBCT, TAS

- what COULD go wrong (3 tiers: common, serious, rare)  

	<i>ATR / ETR / STR / TACO</i>		
	<i>Respiratory / BaCon / mix-up: AHTR</i>		
		<i>TTVI / rare bug / GVHD</i>	
	common,	serious,	rare)
	$10^1-10^2$	$10^3-10^4$	$10^5-10^6$
- you report to us, & we report within and to outside channels
- the only measure that has the power to mitigate EVERY single transfusion reaction type, is AVOIDANCE of the order itself...

# Happy Transfusion Endings...

