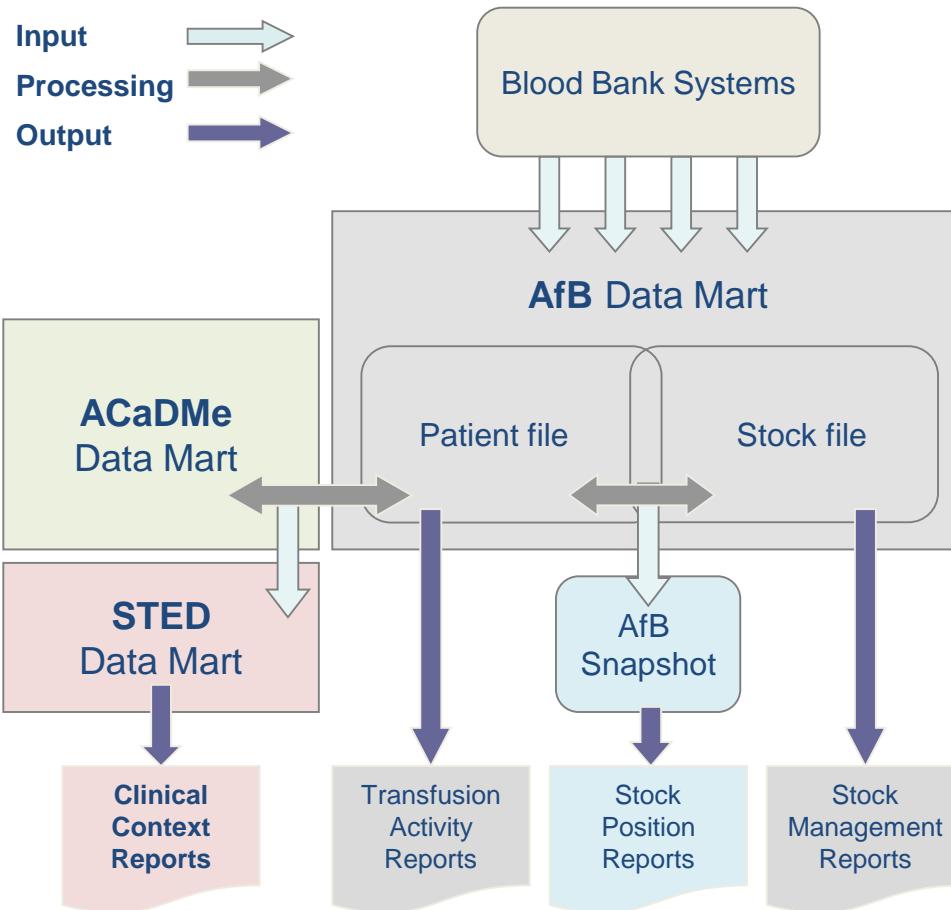


**Account for Blood**



**Data ...**  
**Dialogue ....**  
**Discovery .....**

# AfB Data Flows



**AfB**  
Routine, up-to-date national data on the supply & use of blood components (2009 to date)

## ACaDMe

NHSS hospital episode data provide the clinical context in which blood components are used.

## Linkage

By rules for date & clinical priority; updated monthly (after ACaDMe load)

## Similar Data:

Netherlands (2010)  
Scandinavia (2012)

# AfB Outputs

## Metrics

- Patients & procedures
- Transfused patients & procedures
- Units transfused
- Units fated



## Routine reports

- Stock transactions
- Surgical blood use
- Age & gender specific blood use
- Blood use by other clinical group



## Comparisons

- By Consultant responsible for care
- By hospital (type) / Health Board
- Temporal

## Ad hoc data

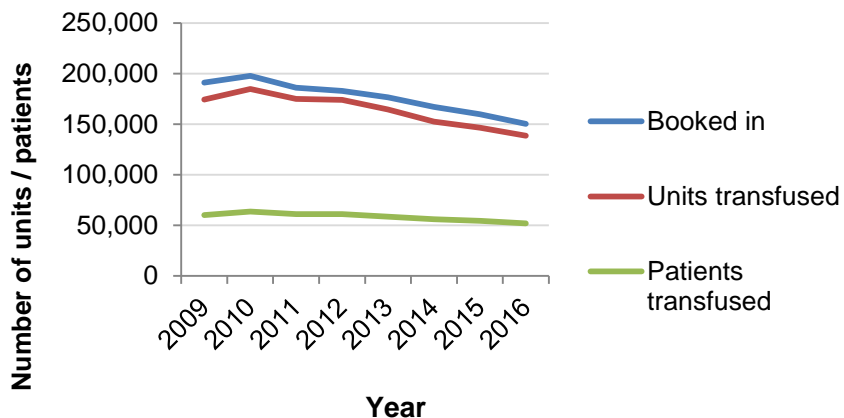
- NHSS Clinical teams
- SNBTS management info e.g. HEV/HCV
- BBT research & audit programme

Transfusion  
Epidemiology

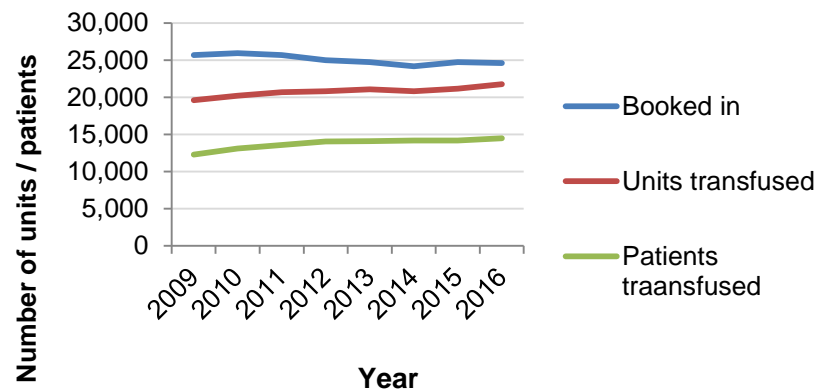
# Using AfB data to understand patterns of blood use

# Temporal Trends in Blood Use

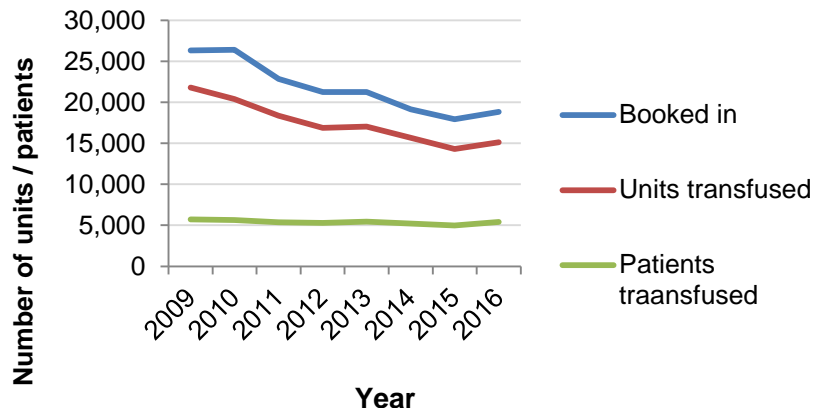
## Red cells



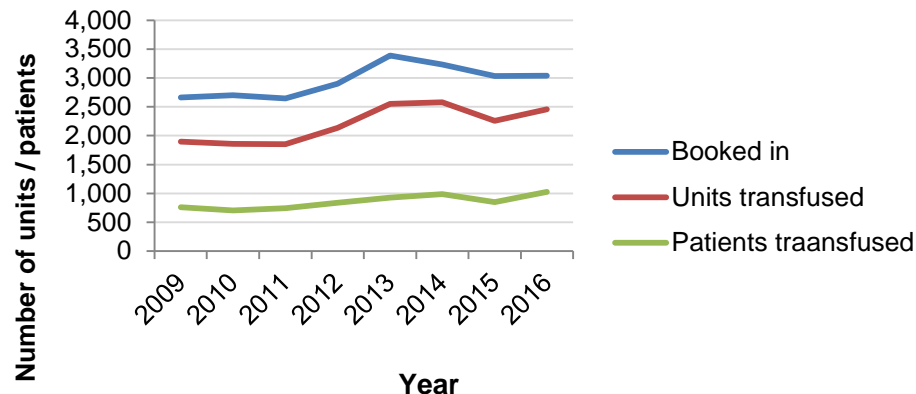
## Platelets



## FFP

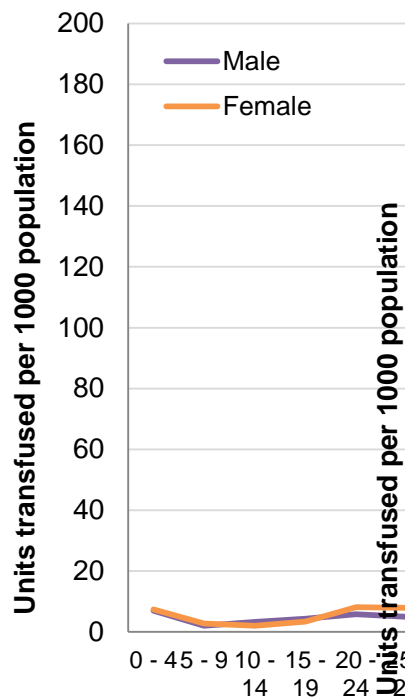


## Cryoprecipitate

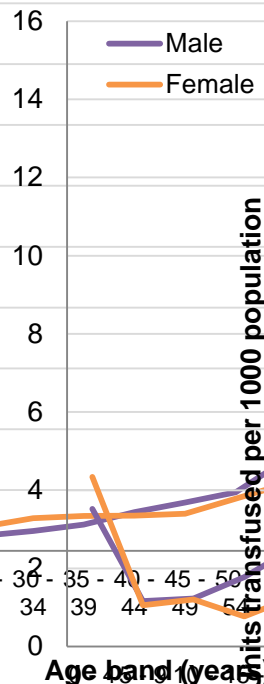


# Transfusion Rates by Age & Gender (2016 data)

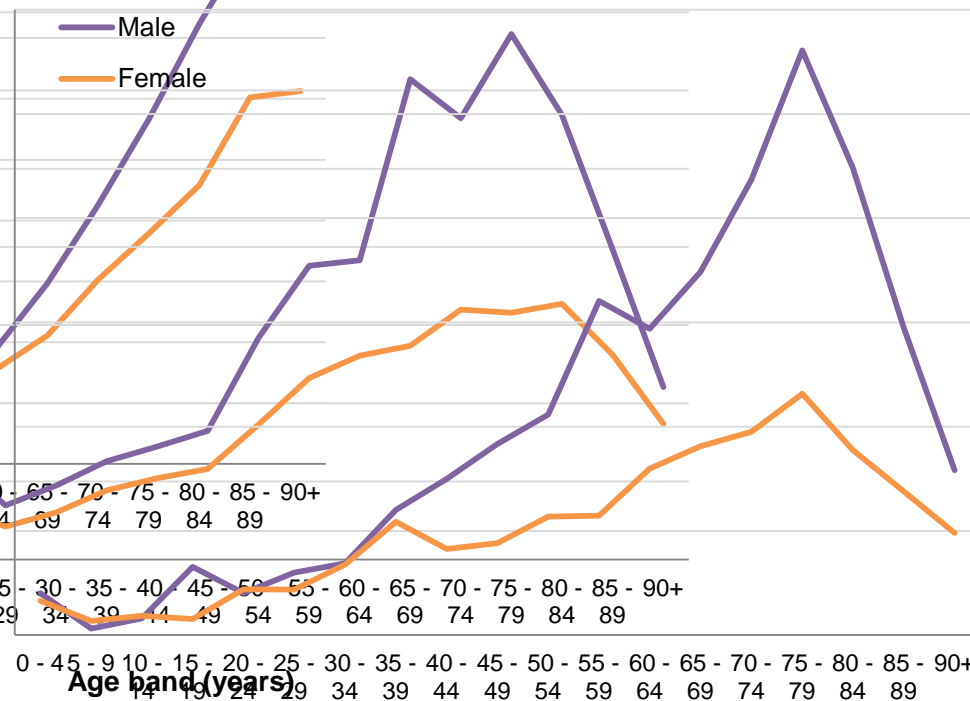
## RBCs



## Platelets

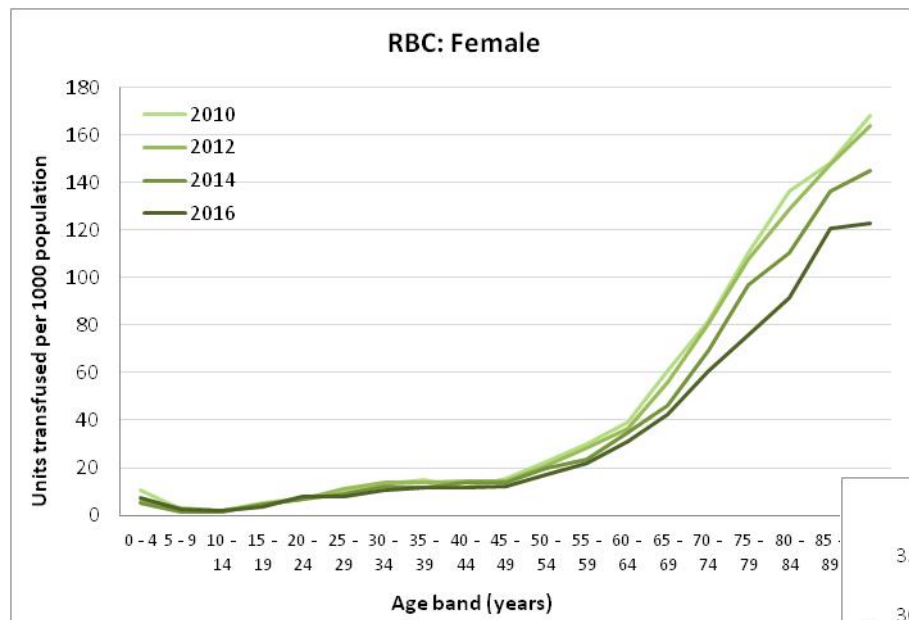


## FFP



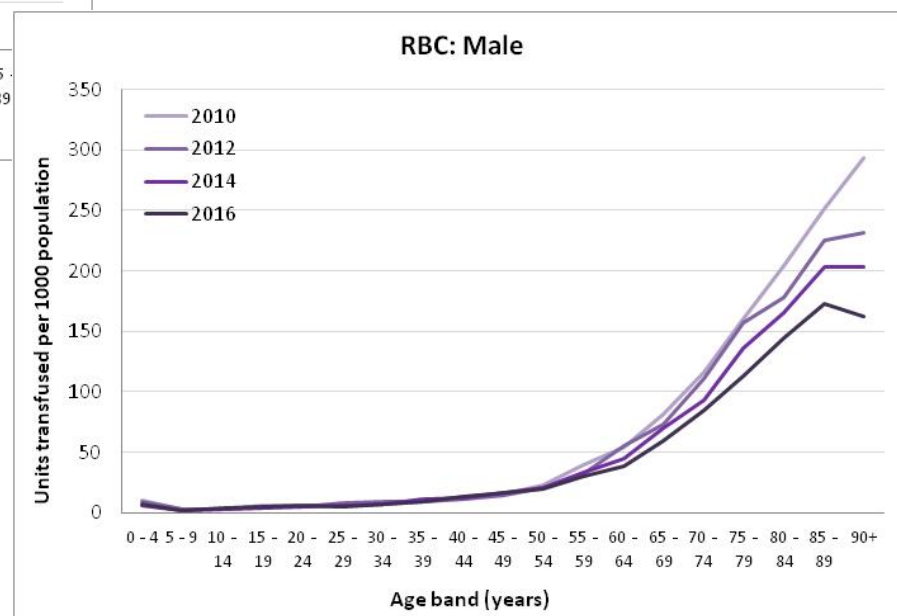
Component	All Units Transfused	Units transfused with missing data	% units with missing data
RBCs	136131	2459	1.8%
Platelets	21034	707	3.3%
FFP	14460	643	4.3%
Cryo	2197	258	10.5%

# Transfusion Rates by Age & Gender

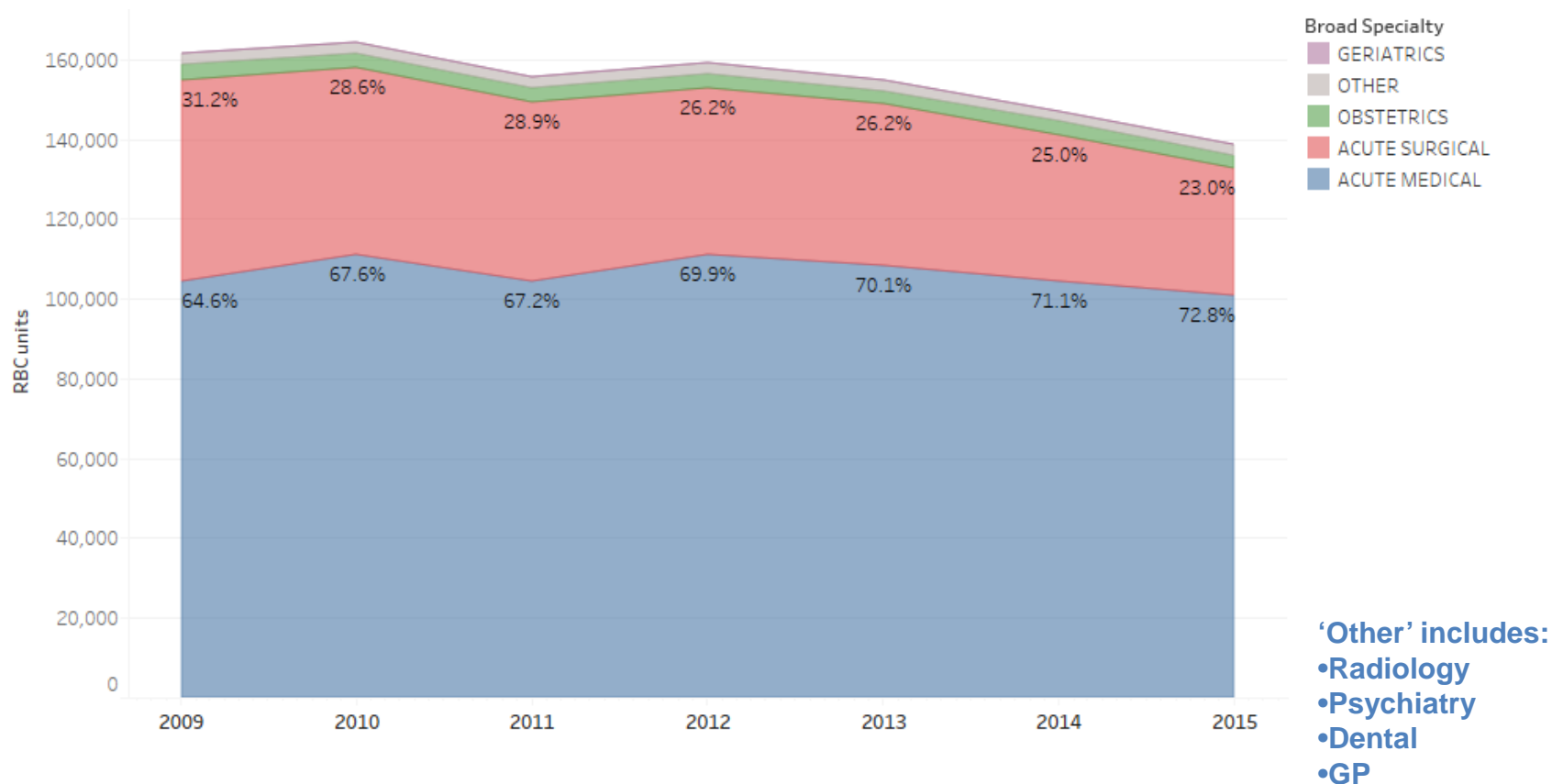


Red Cell Transfusion Rates  
Males > Females

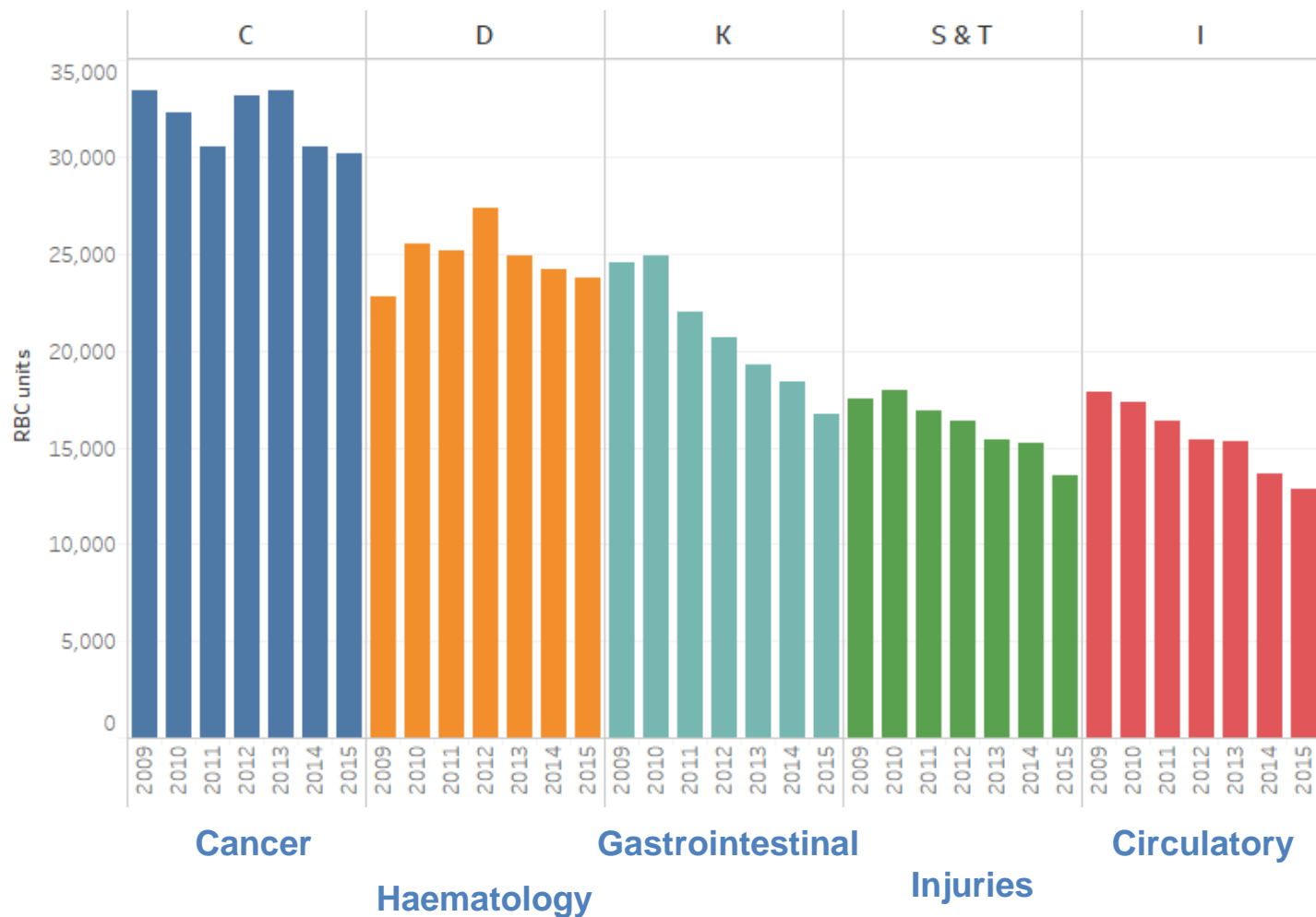
Red Cell Transfusion Rates  
▼ over time greater in older age groups



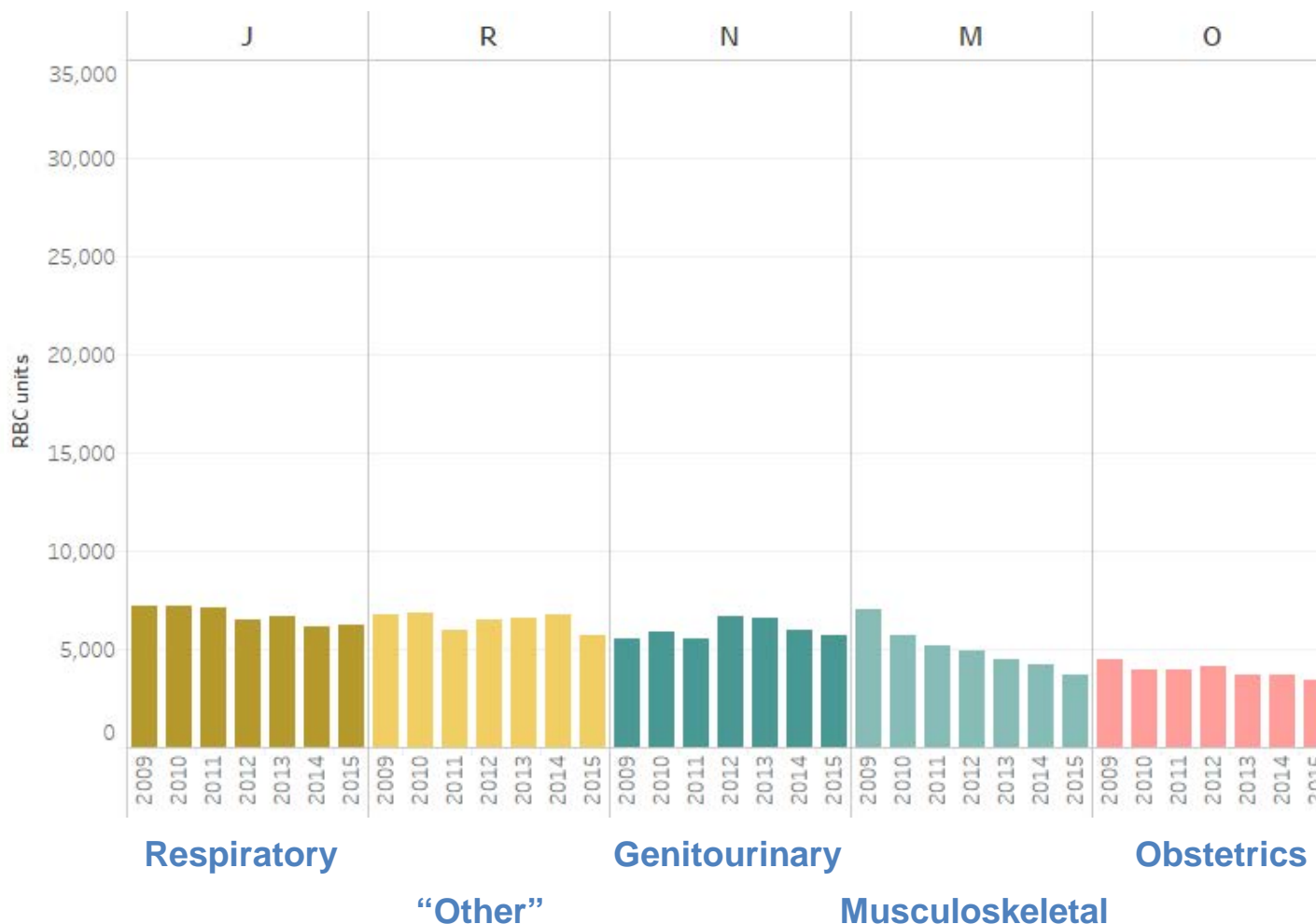
# Red Cell Use by Clinical Setting



# Red Cell Use by Primary Diagnosis (ICD10 Chapter)

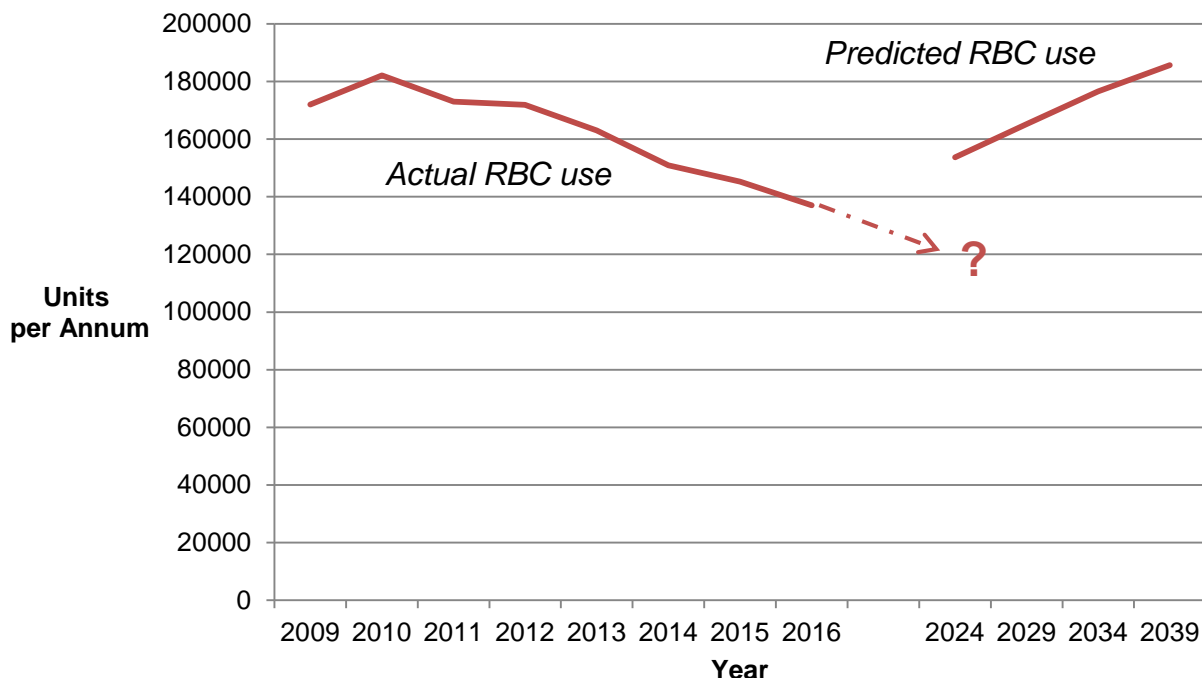


# Red Cell Use by Primary Diagnosis (ICD10 Chapter)



# Red Cell Use: The future?

**Red Cell Units Transfused: Actual (2009-16) & Predicted based on demographic change**



Assumes **no change** to current drivers of clinical use (rates):

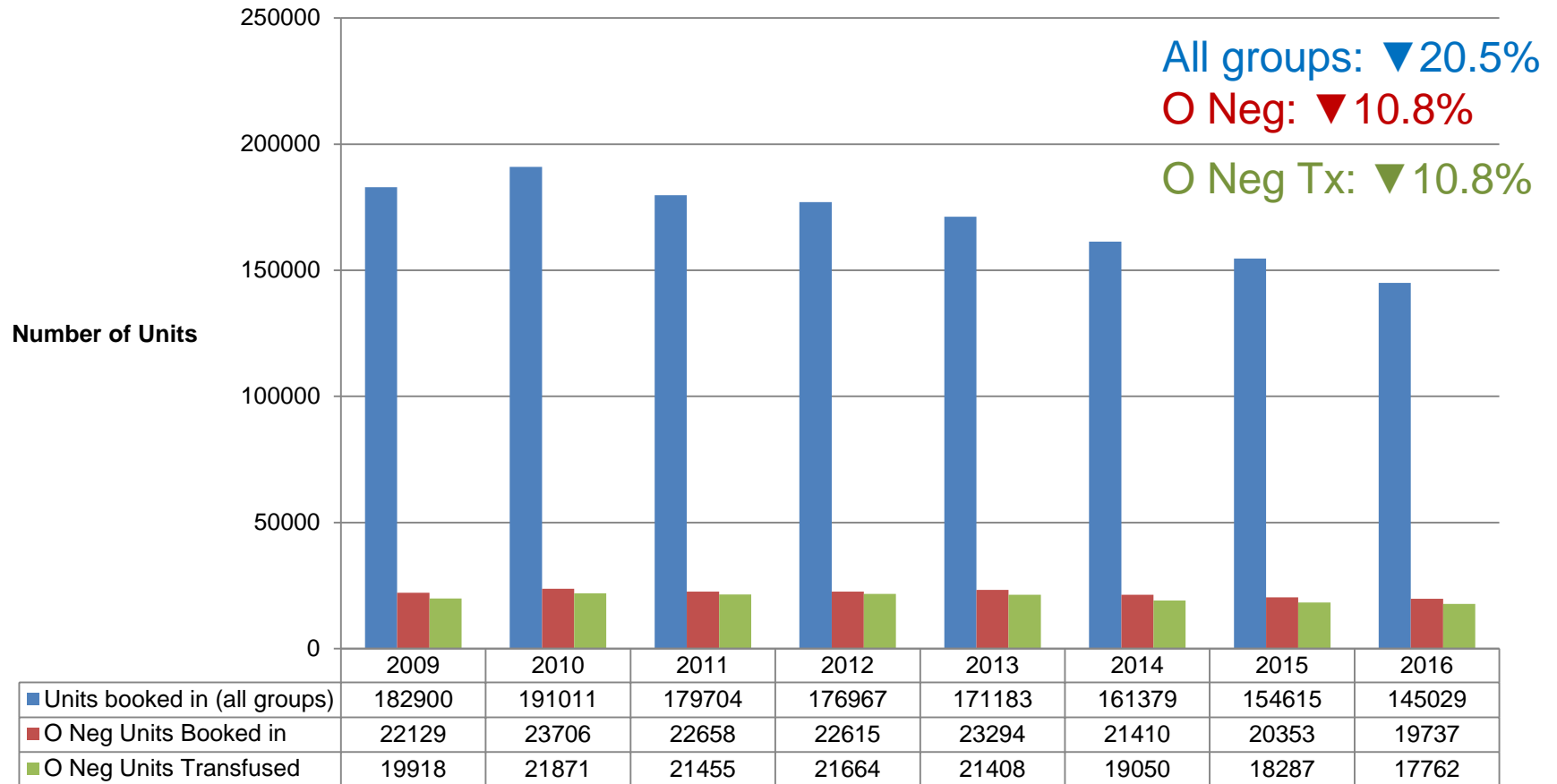
- Disease incidence & prevalence
- Transfusion triggers
- Blood conservation
- Anaemia management
- New treatments
- New surgical techniques
- Eligible patients

Hospital  
Transfusion  
Committees

# Using AfB data to inform clinical transfusion practice

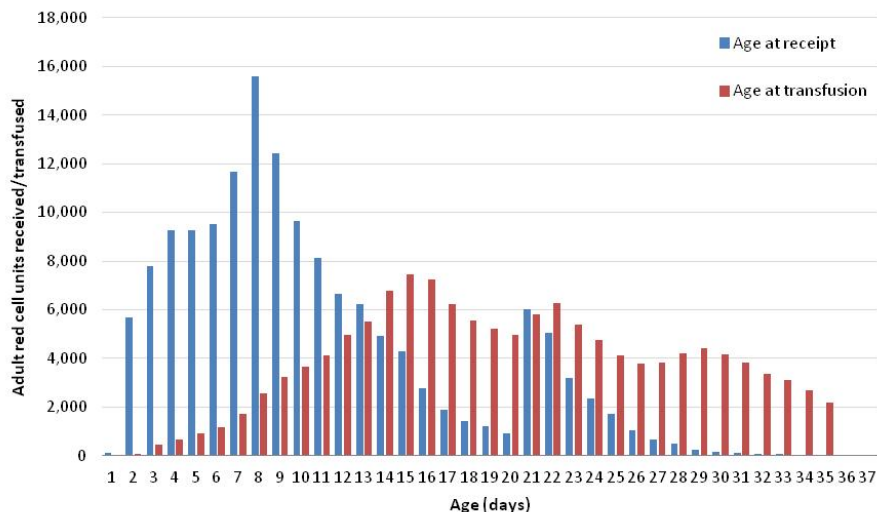
# Adult Group O D neg RBC

## Red Cell Demand from Hospital Blood Banks

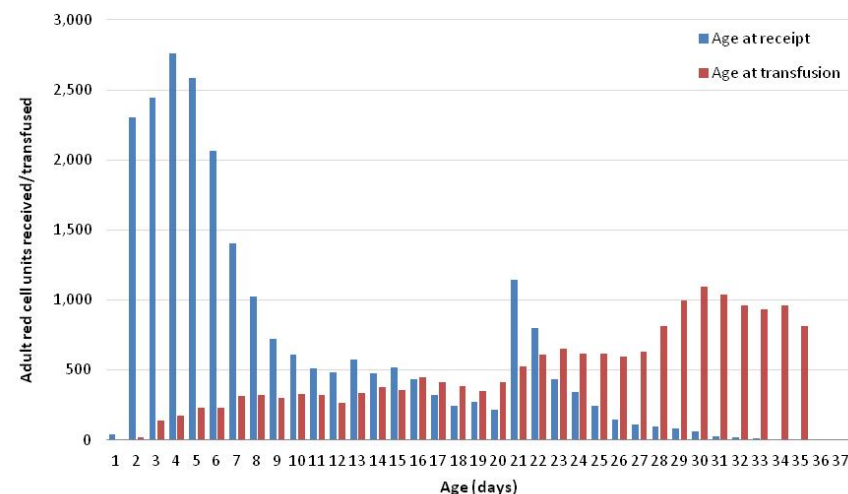


# Group O Rh(D) Red Cell Use

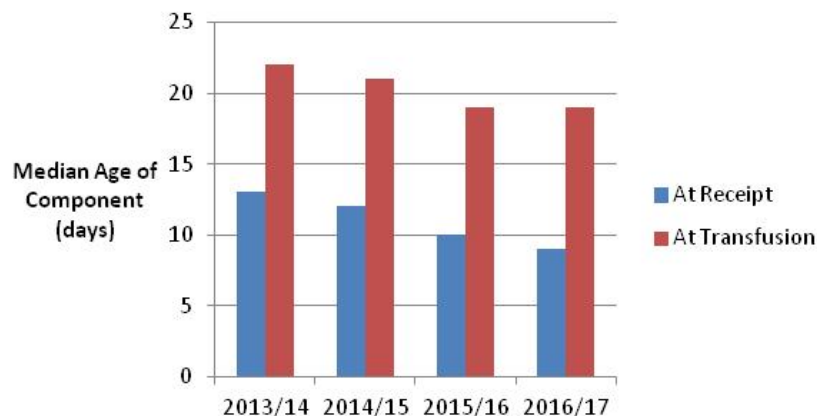
Age of adult red cells: 2016/17



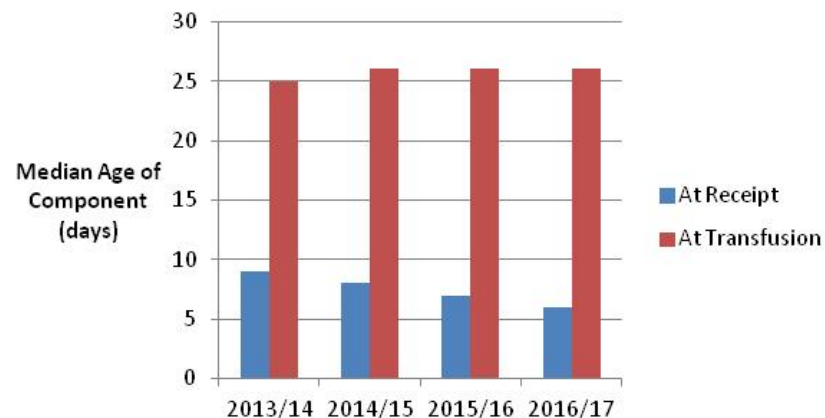
Age of adult Oneg red cells: 2016/17



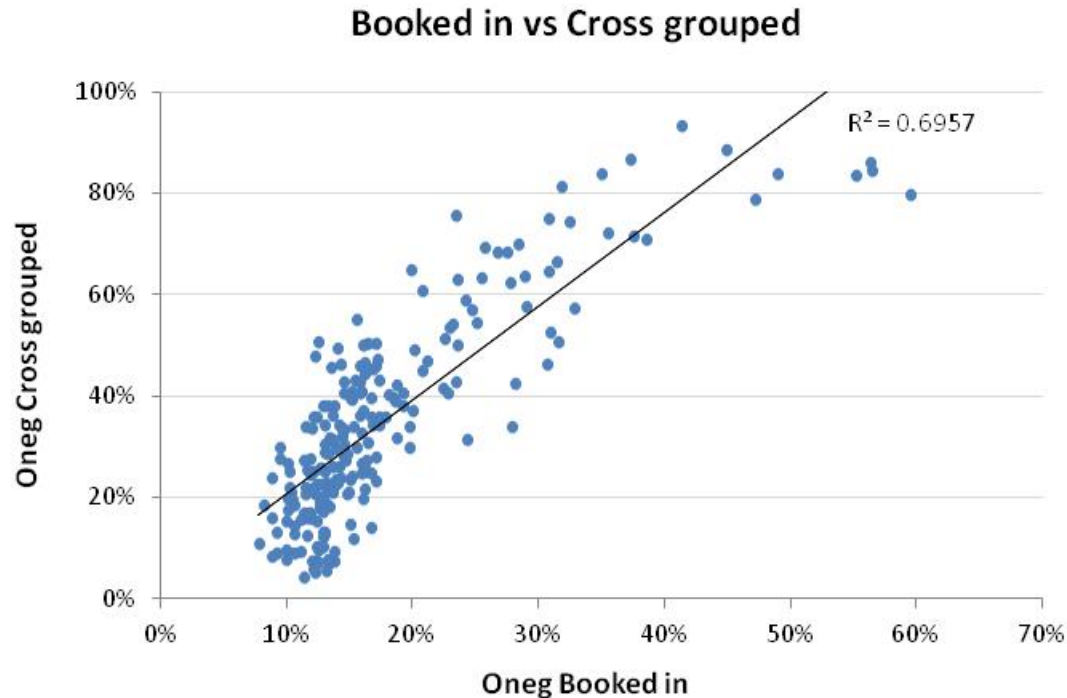
Adult Red Cell Units



Adult O Negative Red Cell Units



# Group O Rh(D) Red Cell Use



Each point represents the data for an individual blood bank over a quarter year

	Correlation coefficient	$R^2$
% O neg units outdated	0.498	0.247
% O neg units not transfused	0.599	0.358
% O neg units cross-grouped	0.838	0.696

# Group O Rh(D) 'Cross grouping'

Reason for Cross Group	Number of units	Proportion of units	Proportion with O Rh(D) positive recipient
Emergency transfusion	181	21%	50%
Serological	129	15%	44%
ABO Availability	48	6%	0
Short date ( $\leq 5$ days to exp)	368	43%	86%
Unknown	131	15%	84%
<b>Total</b>	<b>857</b>	<b>100%</b>	<b>67%</b>

- National Scottish audit (2012)
- Adult red cell units cross grouped in 2 months (October & November)
- KPI for cross-grouping reduction set in 2014
- Local re-audit

# Surgical Blood Use Dashboard

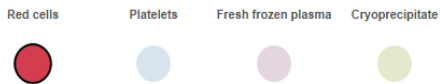
## NHS GREATER GLASGOW & CLYDE

### Overview 2015/2016

Select hospital:

GLASGOW ROYAL INFIRMARY	A1 Teaching
INVERCLYDE ROYAL HOSPITAL	A2 Large General
QUEEN ELIZABETH UNIVERSITY HOSPITAL	A1 Teaching
ROYAL ALEXANDRA HOSPITAL	A2 Large General
ROYAL HOSPITAL FOR CHILDREN	A4 Children's
STOBHILL HOSPITAL	A2 Large General
WEST GLASGOW	A1 Teaching

Select component:



Clinical Group Description	Acute procedures	Procedures transfused	Units transfused	% Procedures Transfused	Units per procedure transfused
Fracture fixation	3,493	535	1,261	15%	2.4
Hemiarthroplasty	761	183	388	24%	2.1
Primary total hip replacement	920	114	242	12%	2.1
Operations on ileum	482	74	219	15%	3.0
Other operations on liver	533	36	210	7%	5.8
Excision of colon	541	81	203	15%	2.5
Hysterectomy	1,109	82	197	7%	2.4
Primary total knee replacement	1,460	82	158	6%	1.9
Congenital heart defect repair	125	77	157	62%	2.0
Amputation of leg above knee	76	41	119	54%	2.9
Kidney transplantation	154	36	118	23%	3.3
Revision total hip replacement	137	44	117	32%	2.7

Latest financial year data table

Top-10 display  
Scroll down to view more  
Select procedure

Standard STED measures

Pre-filtered for Health Board  
Select Hospital

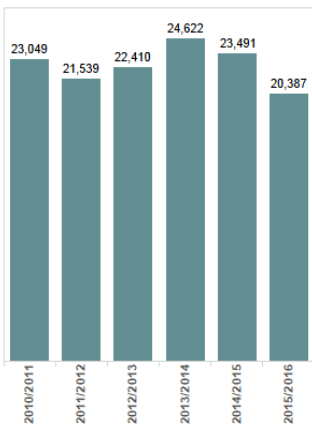
Select blood component

Filter-responsive graphs

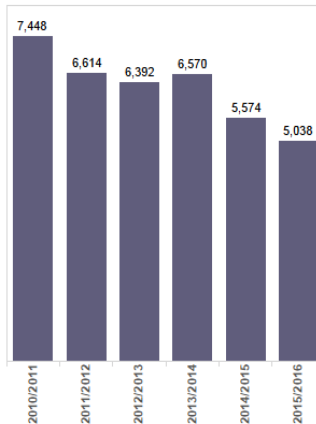
Hover-over pop-up details box

6 year trends

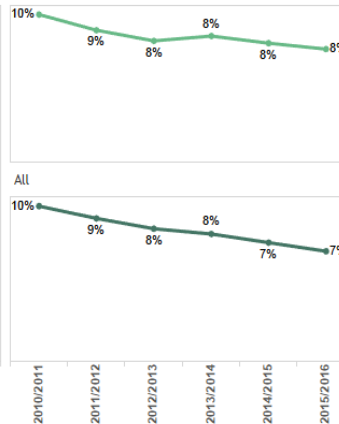
Acute procedures



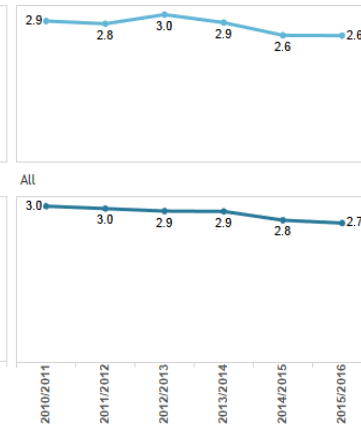
Units transfused



% Procedures transfused



Units per procedure transfused



National hospital type comparisons

# Reviewing the MSBOS

- Actual blood use per patient by surgical procedure
  - % patients transfused; no. of units transfused
- Individual Hospital / Health Board data
- Compare with current MSBOS
- Inform & agree change – mostly reduction
  - Cross match to Group & Save
  - Group & save to no sample

Policy Impact

**Using AfB data to  
assess demand  
and monitor new  
policy impact**

# Confirmatory Group Policy

## Potential impact on demand for O, D negative blood?

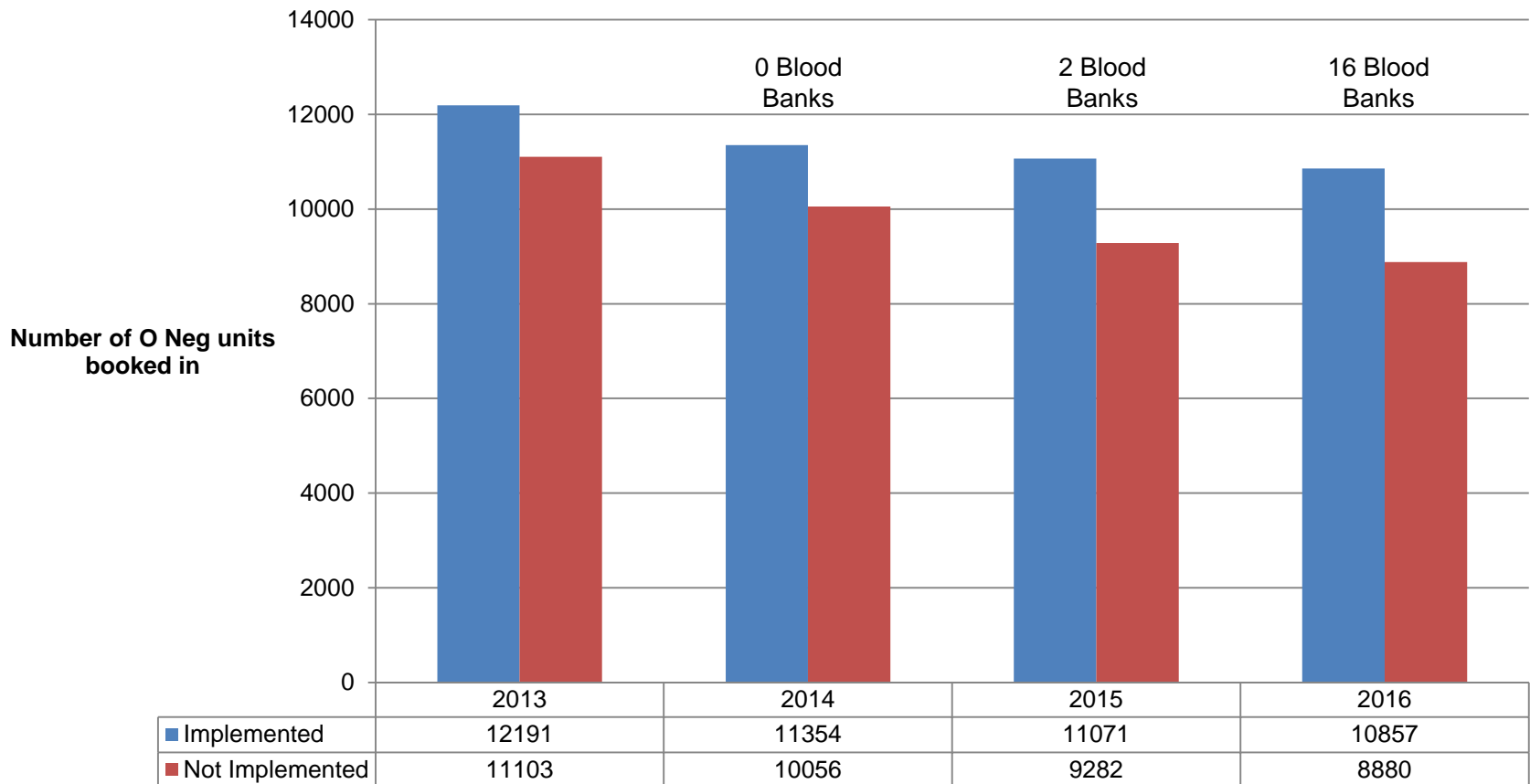
Base data: 2015 activity; Historical data: 2009-2015

- Red cell units *issued* on first sample (i.e. No historical sample in dataset)
  - All recipient groups: 18.3%
  - Non-O D negative recipients: 16.6%
- Red cell units *transfused* on first sample:
  - All recipient groups: 14.5%
  - Non-O D negative recipients: 13.1%
- 'Urgency' of transfusion:
  - Within 1 hour of sample receipt: 0.9% transfusions (all recipient groups)
  - **Within 2 hours** of sample receipt: 2.3% transfusions (all recipient groups)
  - Within 6 hours of issue: 18% transfusions (all recipient groups)
- **In practice - none - yet!**
  - Efficiency vs urgency influences turnaround time
  - Returns to stock
  - Use of units that would otherwise have time expired
  - Use of units that would otherwise have been cross-grouped

**Additional  
15,000 units  
per annum**

# Confirmatory Group Policy

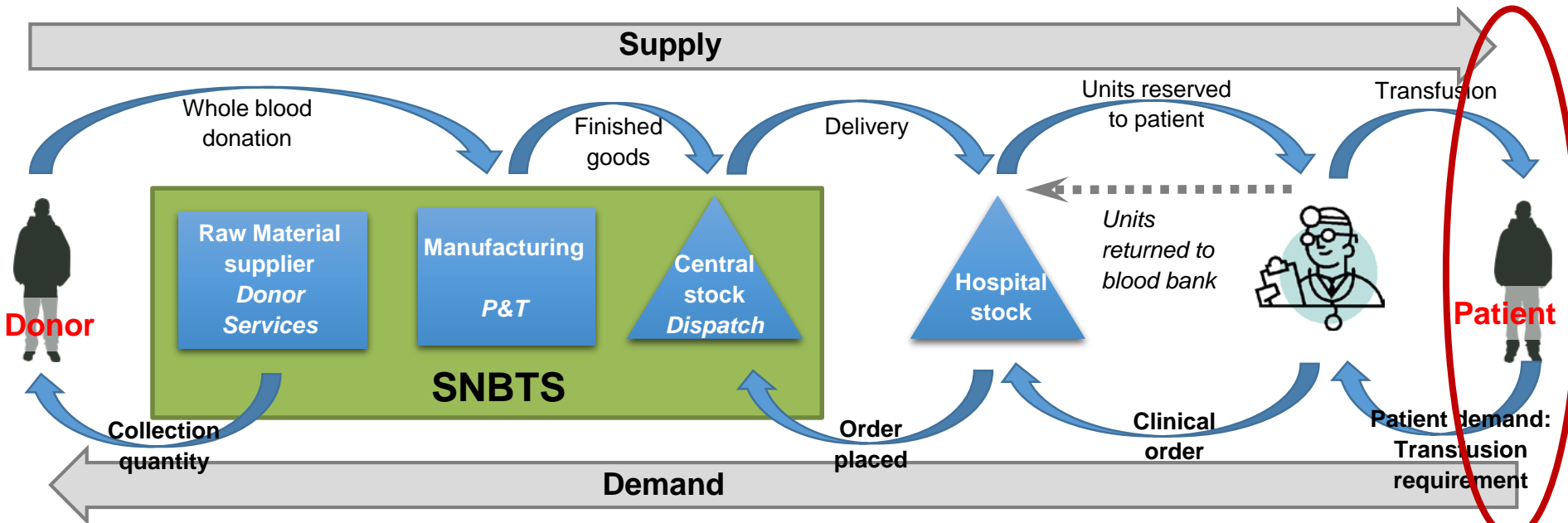
**O Neg demand: 2nd sample policy vs no policy**



**Innovate UK  
Knowledge  
Transfer  
Partnership**

# **Using AfB data to measure and improve supply chain performance**

# The blood supply chain



Demand signal moves backwards with each level responding to a signal generated from the preceding downstream level

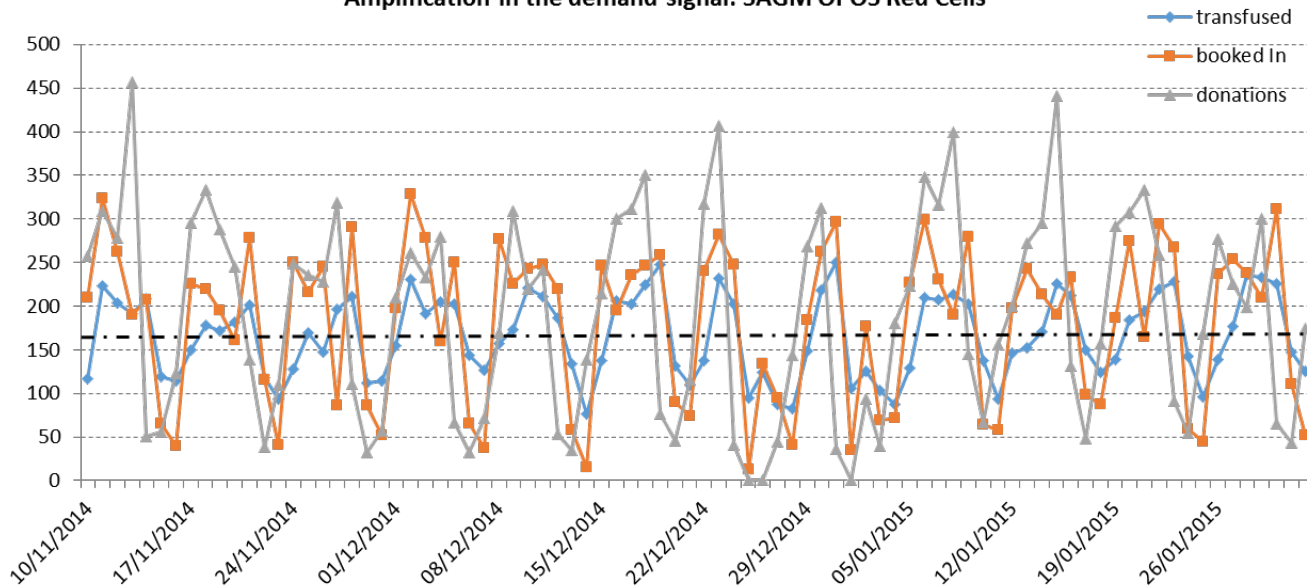
A good supply chain aligns all their activities to fulfil the requirements of the end customer .... Patients (& clinicians)

- Over supply is wasteful
- Under supply impairs quality of care with potential for adverse patient outcomes

# Bullwhip in the blood supply chain

The bullwhip effect occurs when the demand signals in the supply chain are **amplified** as they move backwards through the supply chain

Amplification in the demand signal: SAGM OPOS Red Cells



## Impact

- Inventory swings
- Surplus expedited deliveries
- Surplus inventory  
→ TIMEX
- Older age of blood at transfusion
- Pressure on upstream supply chain activities

We measure bullwhip using the classic amplification ratio (AR):

$$AR_{B/A} = \frac{CoV_B}{CoV_A}$$

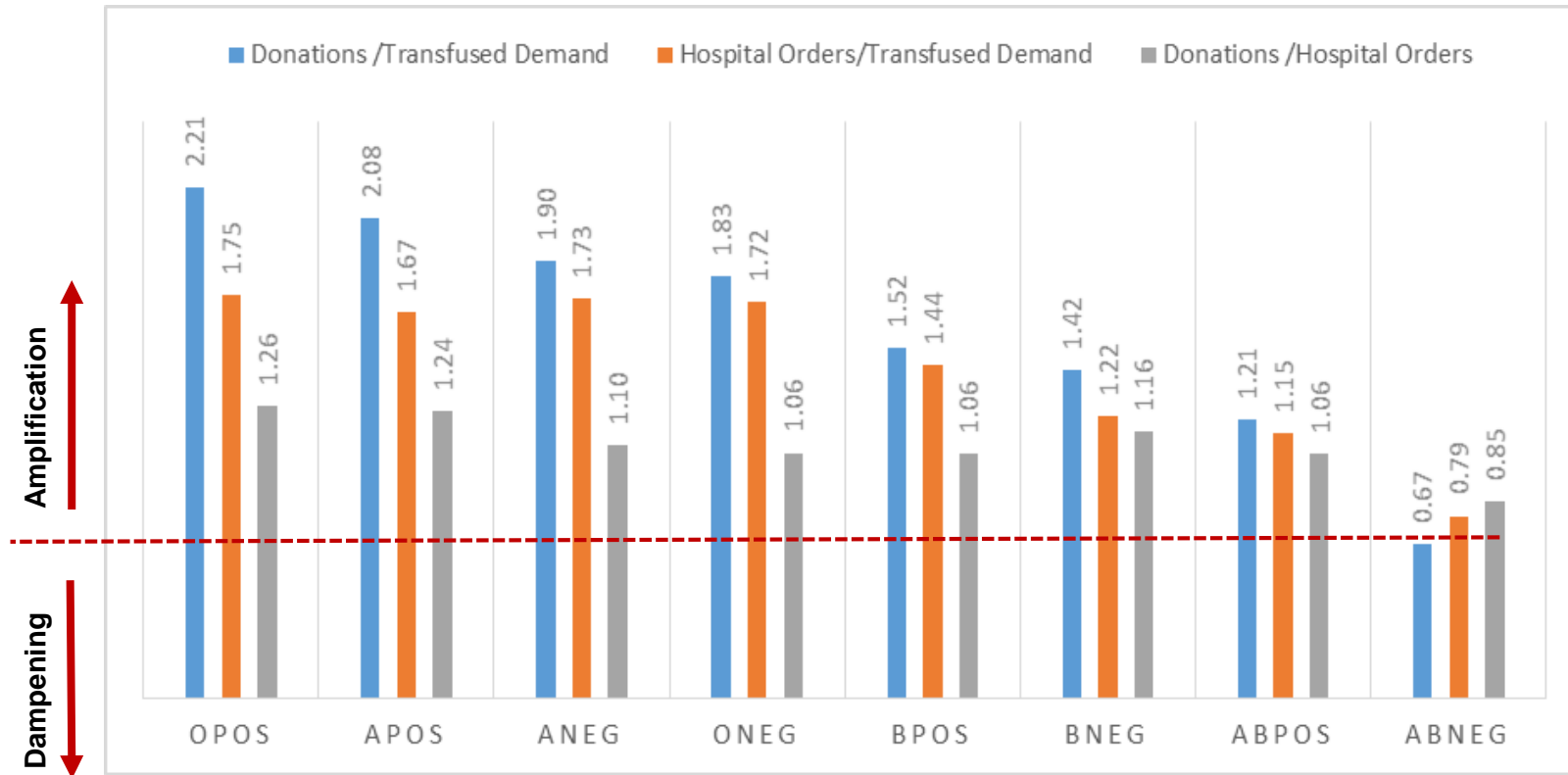
CoV = Coefficient of variation

A,B = supply chain echelons where A is closest to the end consumer

	transfused	booked in	donated
<b>AR Ratios</b>	<b>1.75</b>	<b>1.26</b>	
<b>CoV</b>	28.3%	49.5%	62.6%
<b>StDev</b>	46.8	89.4	117.9
<b>Avg units pd</b>	165	181	188

**AR > 1 indicates presence of Bullwhip**

# Bullwhip in the blood supply chain



*Bullwhip ratios between supply chain echelons for different RBC components*

- Present in all blood groups except for ABNEG
- Most amplification is introduced by hospital blood banks

# Causes of Bullwhip in the Blood Supply Chain



Not sure how many units will be returned



Over-reaction to clinical orders demand signal

Price  
fluctuations/  
promotions

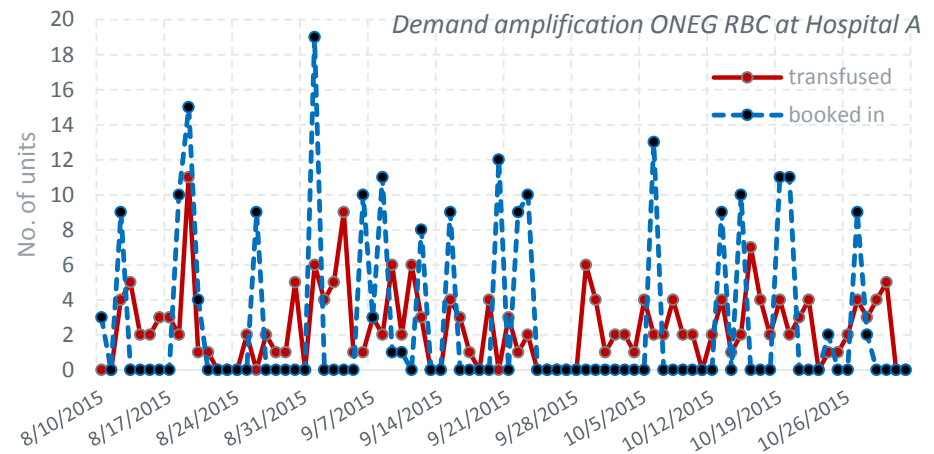


## Causes of Bullwhip



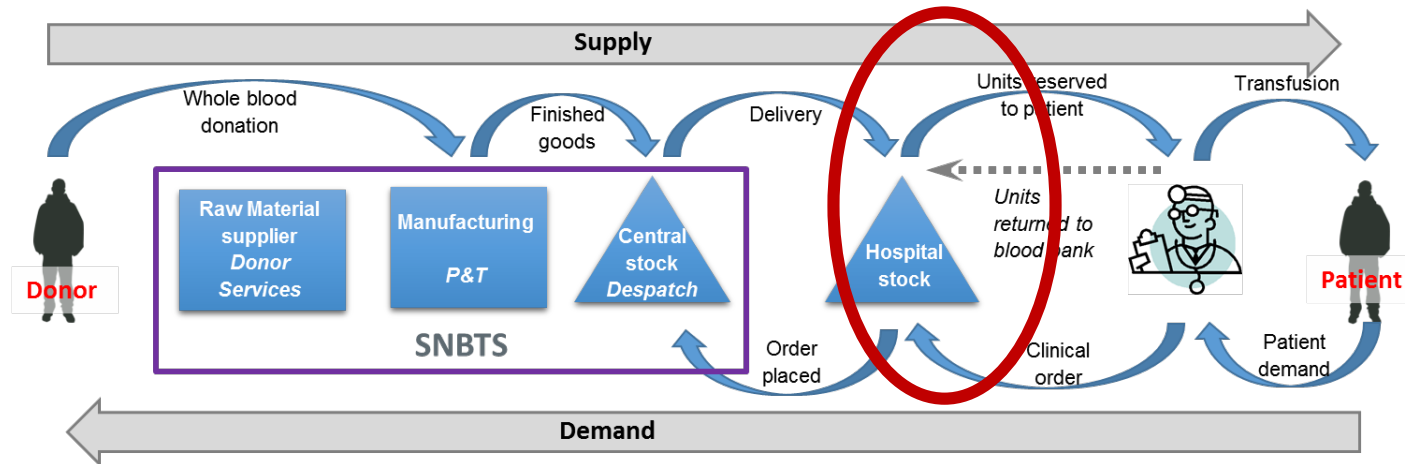
Different experiences/  
comfortable stock  
level

Order 'Just  
in case'



# An Inventory Replenishment Pilot

Aim: To determine the impact of a **data driven inventory replenishment model** on blood bank ordering volatility and the bullwhip effect



## Case Study

Blood bank at a large acute hospital

**Inventory control policy:** Target Stock Level/Order up to with Cycle Safety Stock

Policy was tested on **5 high volume, fast moving RBC components:**

- ANEG RBC
- APOS RBC
- BPOS RBC
- ONEG RBC
- OPOS RBC

# Impact on Ordering & Bullwhip

PRE PILOT	ANEG	APOS	BPOS	ONEG	OPOS
Average order size	1.25	6.93	1.73	2.88	9.93
No. of positive order days	15	32	18	21	38
Av. interval between orders	3.7	1.8	3.1	2.7	1.5
CoV order size	1.74	1.14	1.85	1.65	1.03

PILOT	ANEG	APOS	BPOS	ONEG	OPOS
Average order size	1.93	5.86	1.88	2.73	8.34
No. of positive order days	18	52	22	22	52
Av. interval between orders	3.1	1.1	2.5	2.5	1.1
CoV order size	2.17	1.11	1.83	1.58	0.88
% Change CoV order size	+25%	-3%	-11%	-4%	-14%

Smaller, more frequent ordering

Less volatile ordering

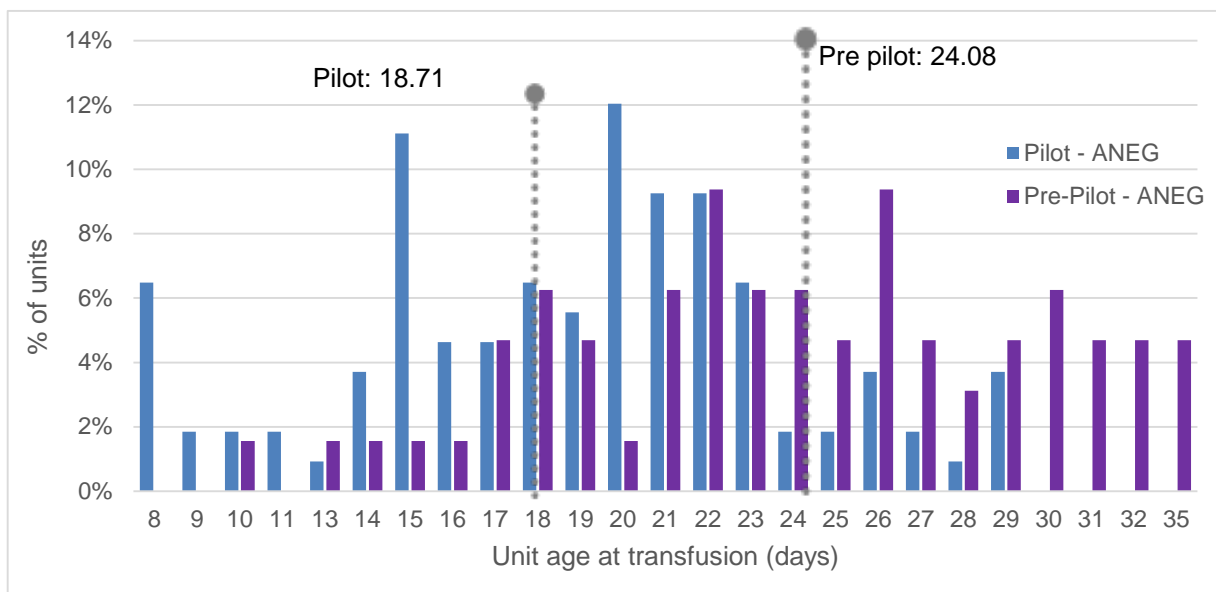
	ANEG	APOS	BPOS	ONEG	OPOS
Pre Pilot Bullwhip Ratio	1.48	1.83	1.89	1.84	1.96
Pilot Bullwhip Ratio	1.64	1.70	1.51	1.20	1.59
AR Change	+0.16	-0.13	-0.38	-0.64	-0.37
% AR Change	+10.6%	-7.09%	-19.8%	-35.0%	-19.2%

Reduction in Bullwhip

If all blood banks adopted measures to reduce order volatility, then the cumulative effect would smooth the aggregate demand signal thus reducing pressure on blood processing and collection activities, and improve the match between supply and demand.....

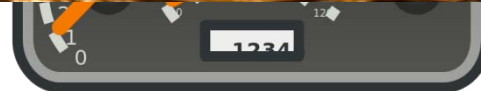
# Impact on component age at transfusion & deliveries

- More regular use of scheduled deliveries, and 50% reduction in use of costly ad hoc deliveries of RBC components
- Average component age at transfusion revealed a reduction in age of between 0.7 days (APOS) to 7.2 days (BPOS)



**5.37 day reduction**

# Data, Dialogue, Discovery...





# Acknowledgements



- Dr Katherine Forrester  
*Transfusion Researcher, SNBTS*
- BBT teams throughout Scotland
- Siu Cheng & Dr Christine Rutherford  
*KTP Project Team, Heriot Watt University*
- Innovate UK (*KTP 9479*)