Big Data in Transfusion Medicine

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Oxford University Hospitals NHS
NHS Foundation Trust

NHS
Blood and Transplant

Overview of talk

- What does ‘big data’ mean?
- How can it be used in transfusion medicine?
- What are the challenges and the limitations?

What does *'Big Data'* mean?

- Industry and academia are drowning in data
- There is no formal definition of ***"Big Data"***
- Maybe: '***The technological ability to store, aggregate, and process data***'
- The key is to be able to process and analyse data so that it can be used for a useful purpose

Use of *'Big Data'* in healthcare

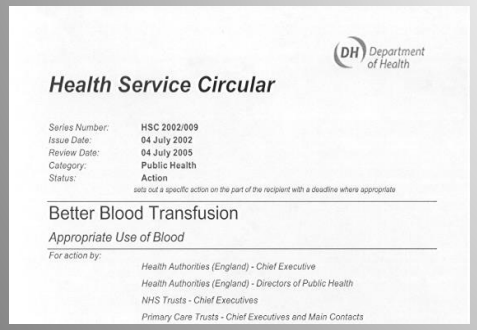
- Can provide rich data which can be used to improve patient outcomes
- Facilitated by:-
  - ✓ Increasing uptake of Electronic Health Records (EHRs) by hospitals
  - ✓ Data linkage between different IT systems

How can *'Big Data'* be used to drive progress in transfusion medicine?

- Benchmarking: comparison of blood use by different clinical teams and by different hospitals
- Use of machine learning to develop algorithms for good practice within EHRs e.g. MSBOS
- Electronic clinical decision support
- Detection of transfusion-related complications e.g. TACO

High level efforts in the UK to improve transfusion practice in hospitals

- Better Blood Transfusion (1997, 2002 & 2007) and Patient Blood Management Seminars (2012)
- 2001/02: National Blood Transfusion Committee and National Comparative Audit of Blood transfusion programme established
- NICE guidelines (2015), NICE Quality Standards (2016)
- Choosing Wisely recommendations for transfusion (2017)
- Transfusion 2024


Department of Health

Health Service Circular

Series Number:	**HSC 2002/009**
Issue Date:	**04 July 2002**
Review Date:	**04 July 2005**
Category:	**Public Health**
Status:	**Action**

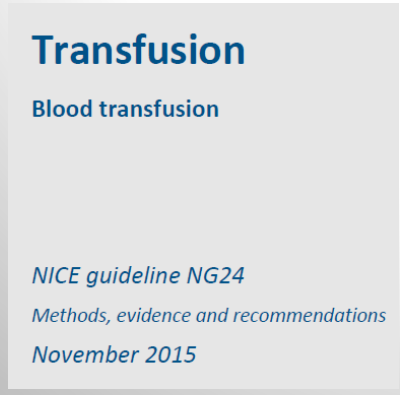
sets out a specific action on the part of the recipient with a deadline where appropriate

Better Blood Transfusion

Appropriate Use of Blood

For action by:

Health Authorities (England) - Chief Executive
Health Authorities (England) - Directors of Public Health
NHS Trusts - Chief Executives
Primary Care Trusts - Chief Executives and Main Contacts

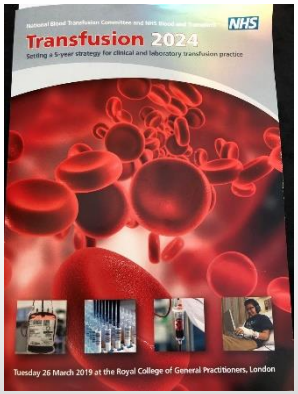

Transfusion

Blood transfusion

NICE guideline NG24

Methods, evidence and recommendations

November 2015



Reducing unnecessary red blood cell transfusion in hospitalised patients

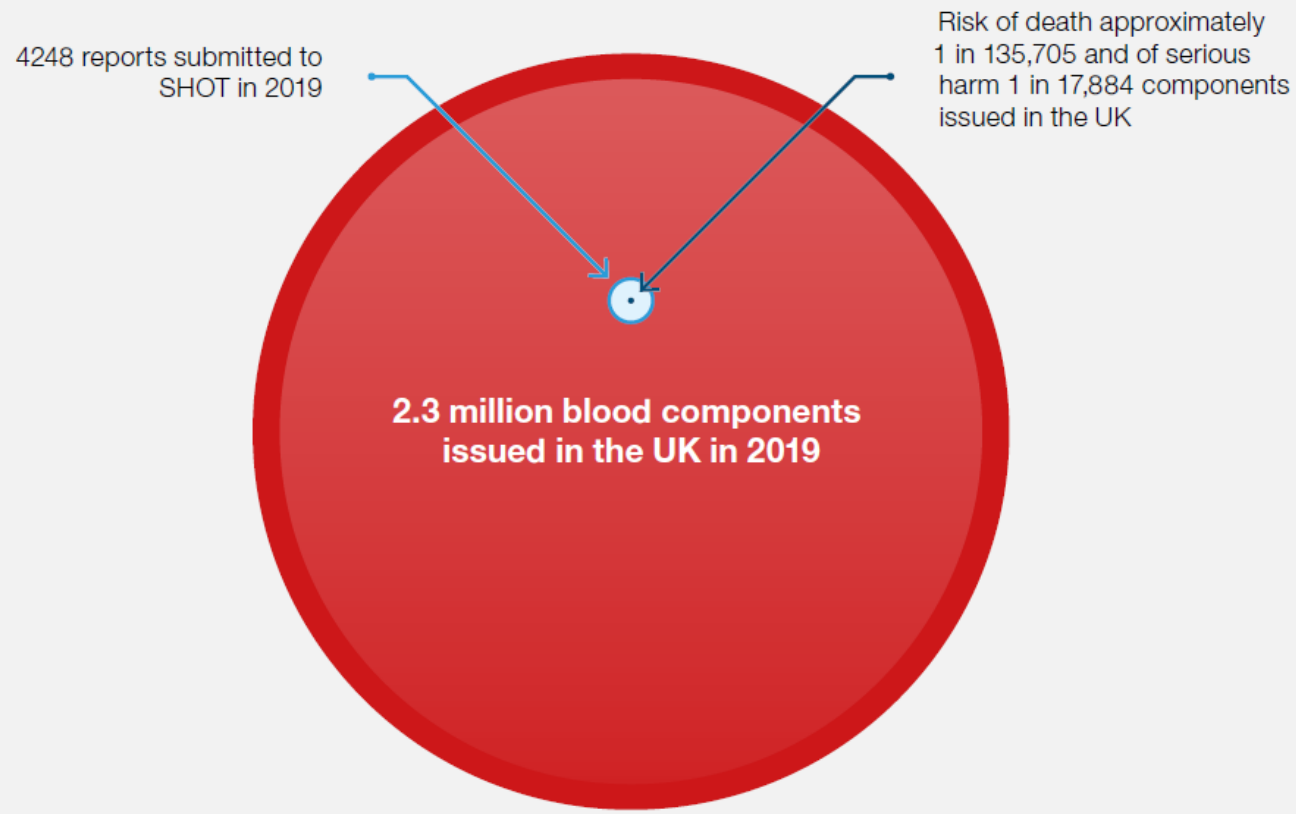
Nishila Mehta,[1,2] Michael F Murphy,[3,4,5] Lawrie Kaplan,[6] Wendy Levinson[1,6]

the bmj | *BMJ* 2021;373:n830 | doi: 10.1136/bmj.n830

There has been considerable progress.....

- Reduction in red cell transfusions
- Reduction in wrong transfusions

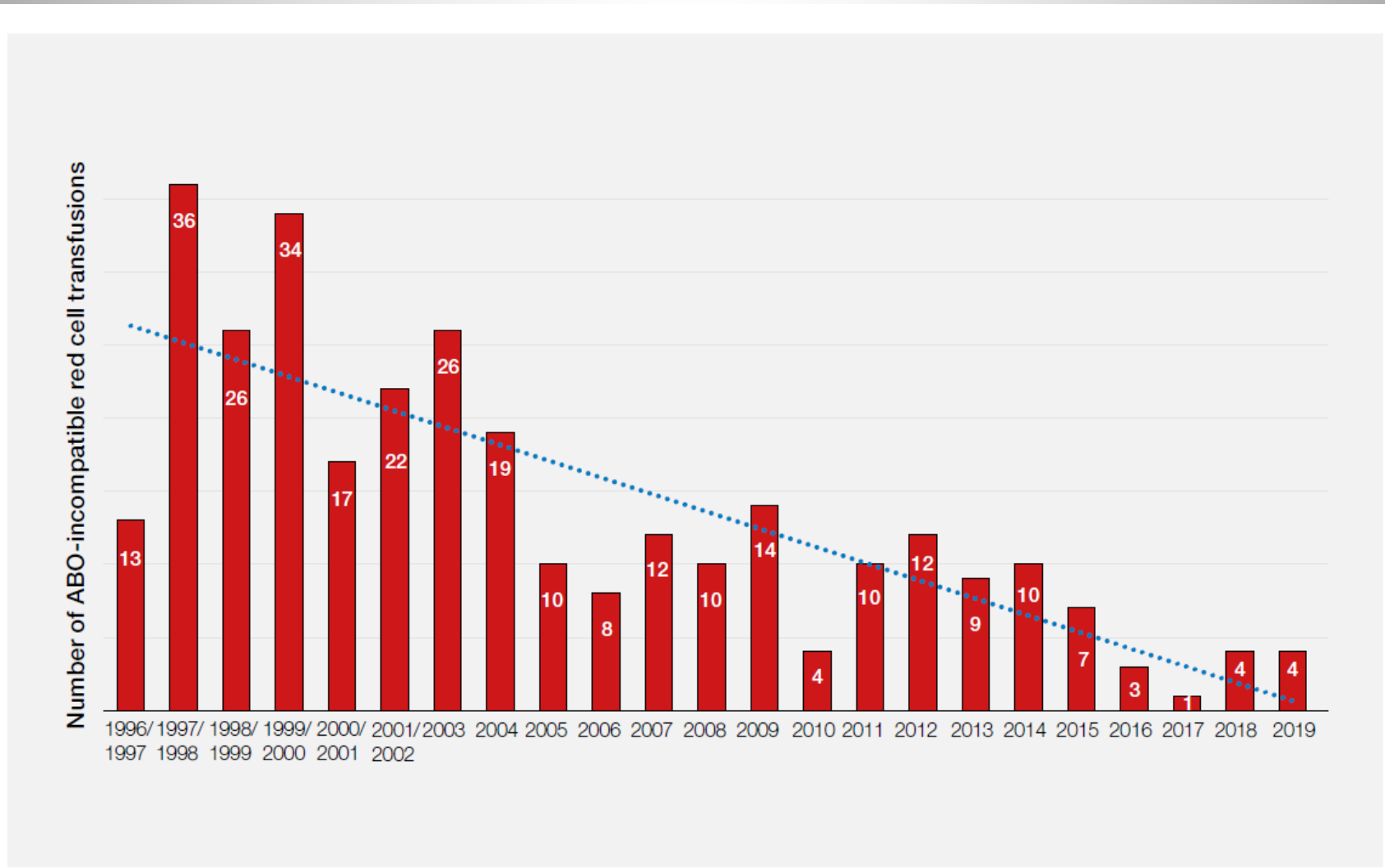
Risk of harm or death from transfusion is very low



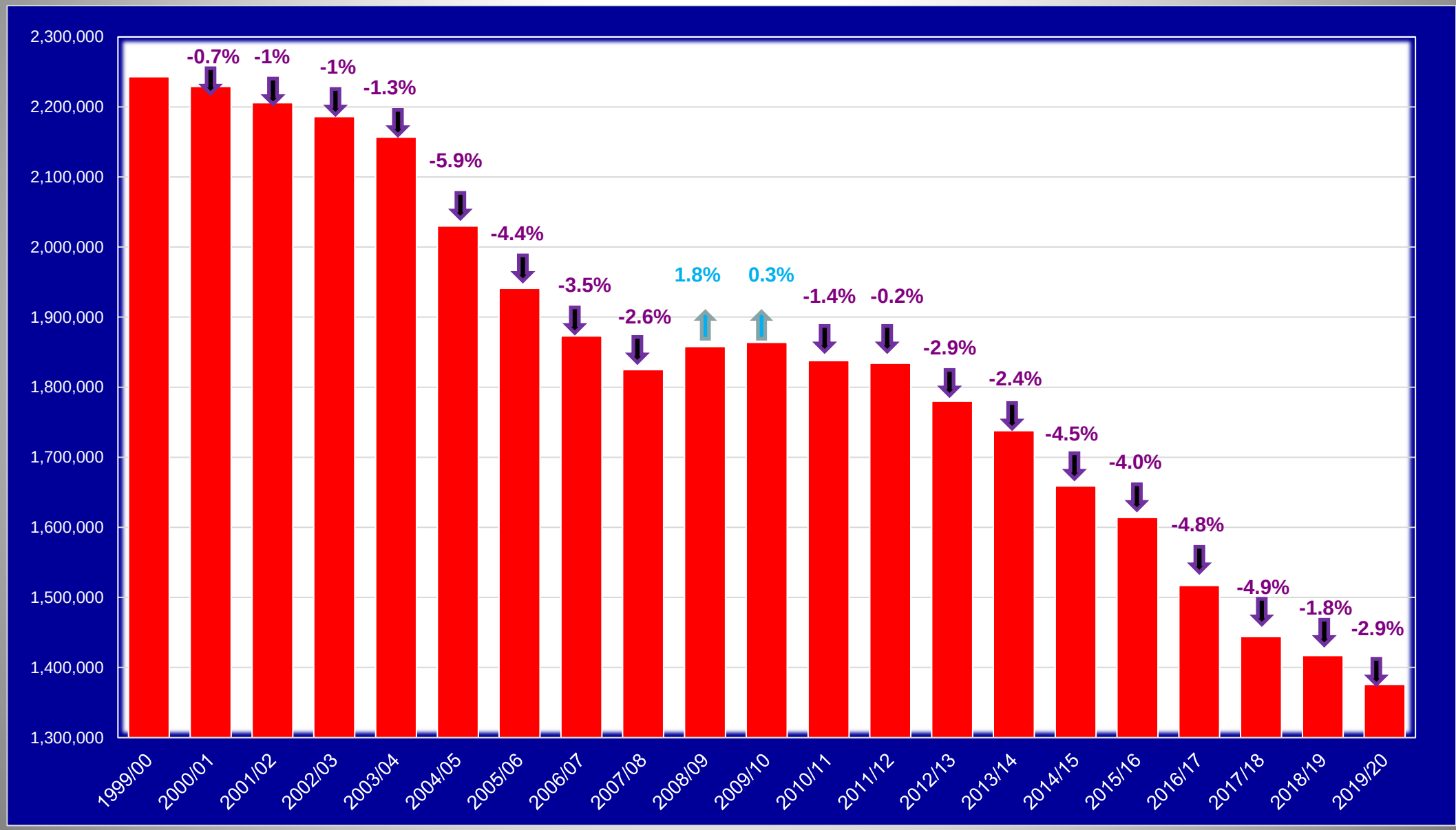
The risks of transfusion-transmitted infection are much lower than all other transfusion-related complications

Note: This is a representative image and not accurate to scale

Reduction in ABO incompatible red cell transfusions



Reduction in Red Cell use in England 1999-2020



Still much to do.....

- National, regional and local audits consistently show inappropriate use of 15-20% red cells and 20-30% platelets/plasma
- Poor implementation of methods to avoid use of blood
- Safety of hospital transfusion still an issue
- Need to improve education and training
- Transfusion laboratories poorly staffed and resourced
- Poor IT for blood safety and for providing data on blood usage

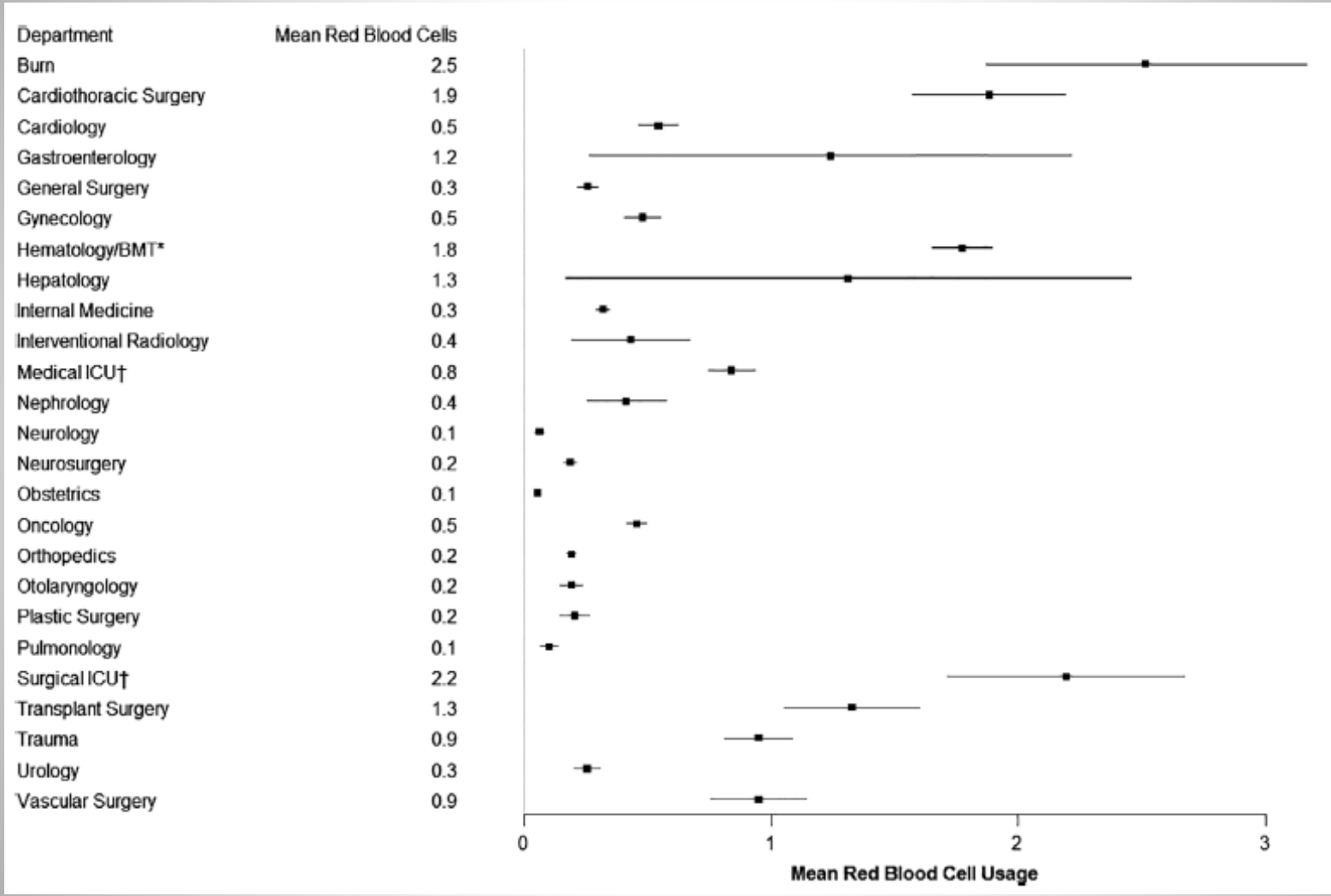
Variation in red cell use by hospital

Blood Component Transfusions per 1,000 Bed Days by Hospital

Hospital	A	B	C
Red Cells	42.42	40.40	49.50
Platelets	11.69	7.76	11.66

D’Souza et al (unpublished)

Variation in red cell use by specialty



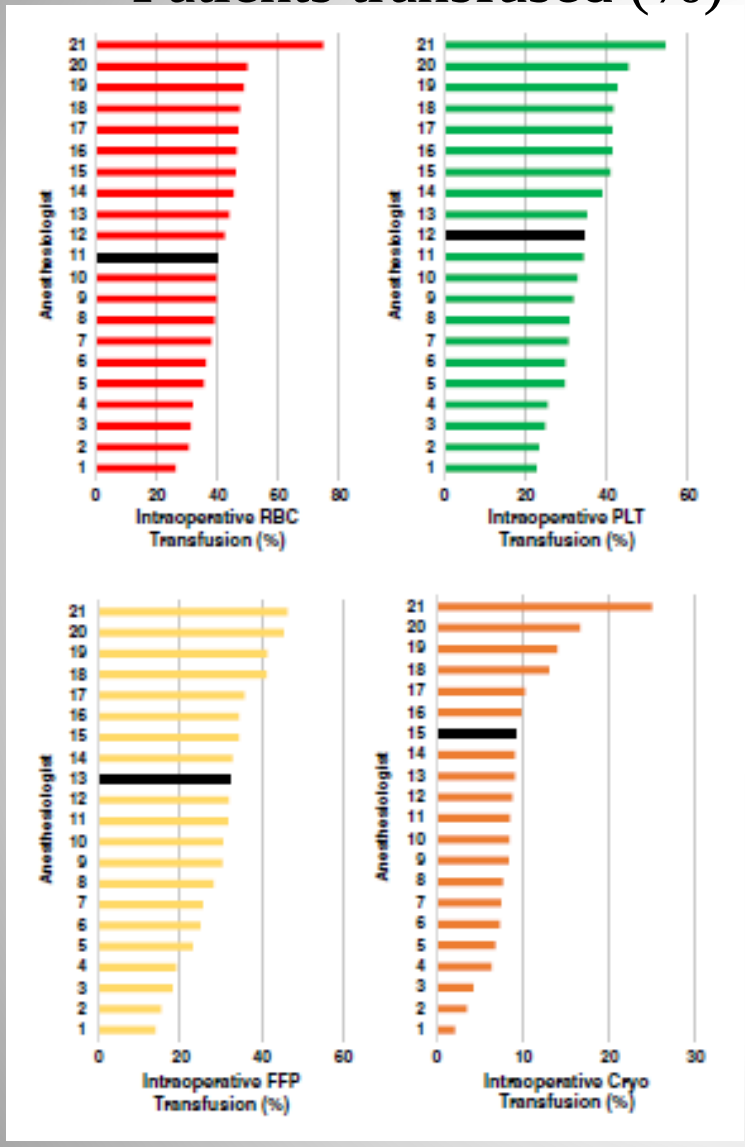
Metcalf RA et al. Transfusion 2019:59:2316-23

Variation in compliance with Hb trigger by specialty

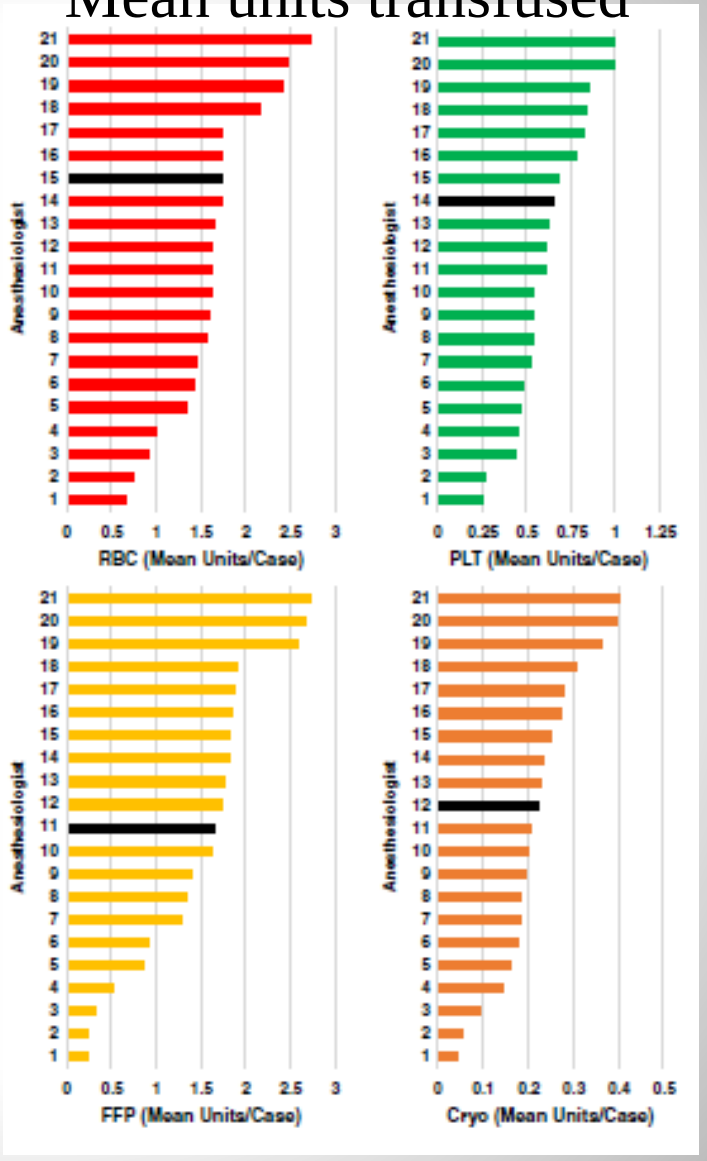
Staples S et al. Transfusion 2020:60:1658-65

Variation in red cell use by clinician

Patients transfused (%)

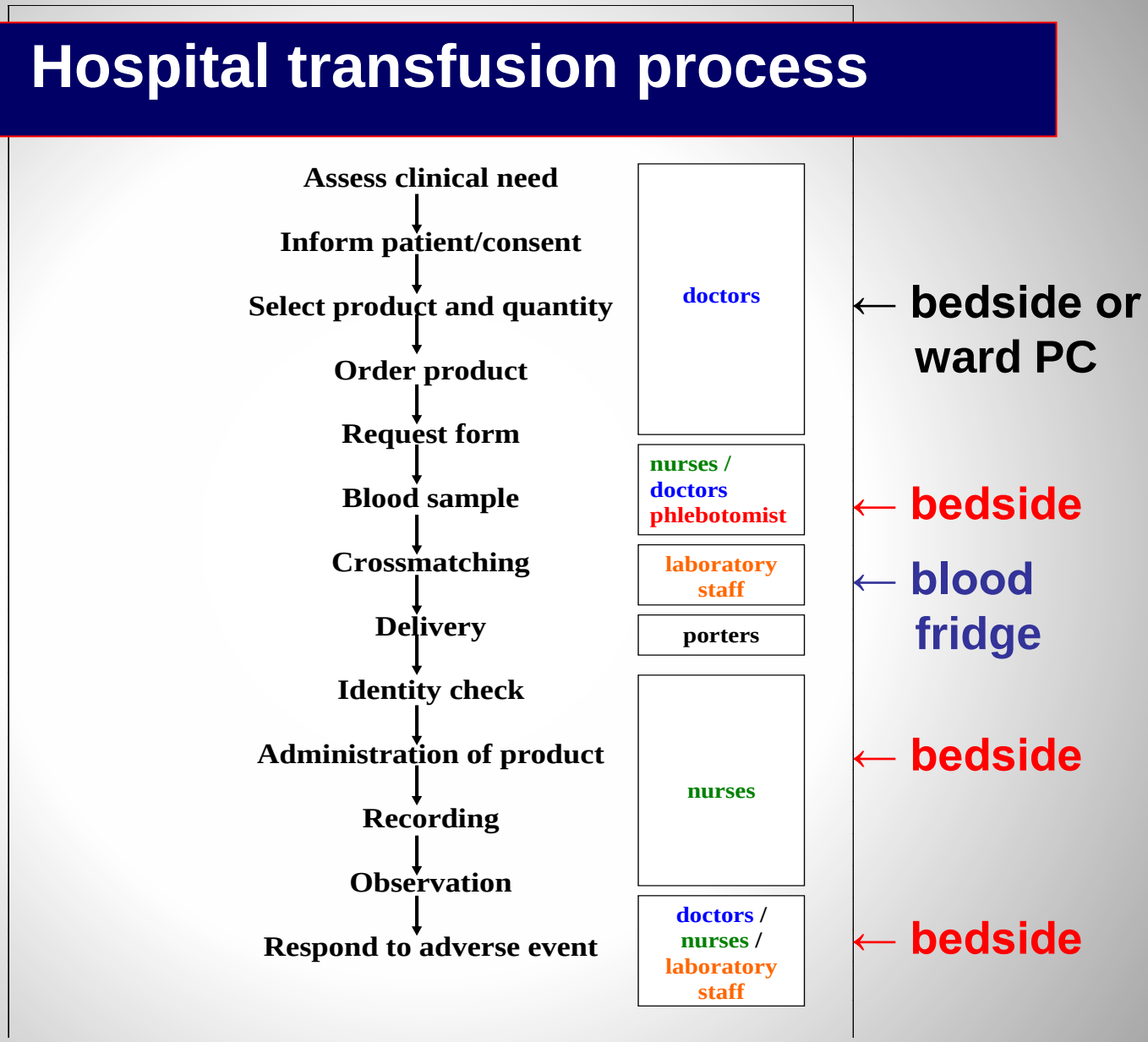


Mean units transfused



Hensley NB et al. Transfusion 2019:59:3058-64

Hospital transfusion process



End-to-end electronic process for transfusion safety

Transfusion safety at the bedside

Assess clinical need	doctors	← bedside or ward PC
Inform patient/consent		
Select product and quantity		
Order product		
Request form		
Blood sample	nurses / doctors phlebotomist	← bedside
Crossmatching	laboratory staff	← blood fridge
Delivery	porters	
Identity check	nurses	← bedside
Administration of product		
Recording		
Observation		
Respond to adverse event	doctors / nurses / laboratory staff	← bedside

Electronic transfusion process

Less paperwork

1 nurse

16 individual steps to carry out before safe to commence the transfusion

Turner CL, Casbard A & Murphy MF (2003) Barcode technology: its role in increasing the safety of transfusion. *Transfusion*. **43**, p1200-1209.

Davies A, Staves J, Kay J, Casbard A & Murphy MF (2006) End-to-end electronic control of the hospital transfusion process to increase the safety of blood transfusion: strengths and weaknesses. *Transfusion*. **46**, p352-364.

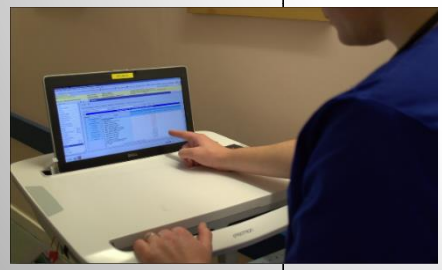
End-to-end electronic process for transfusion safety

Transfusion safety at blood fridges

Assess clinical need	doctors	← bedside or ward PC
Inform patient/consent		
Select product and quantity		
Order product		
Request form		
Blood sample	nurses / doctors phlebotomist	← bedside
Crossmatching	laboratory staff	
Delivery	porters	← blood fridge
Identity check	nurses	← bedside
Administration of product		
Recording		
Observation		
Respond to adverse event	doctors / nurses / laboratory staff	← bedside

Electronic blood ordering

'Decision support'
for better practice



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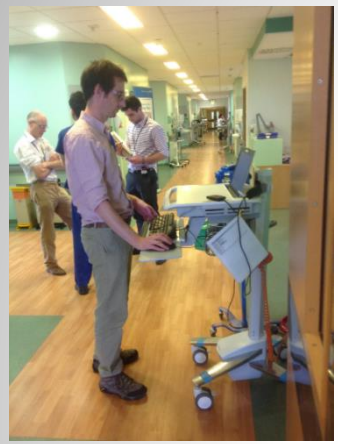
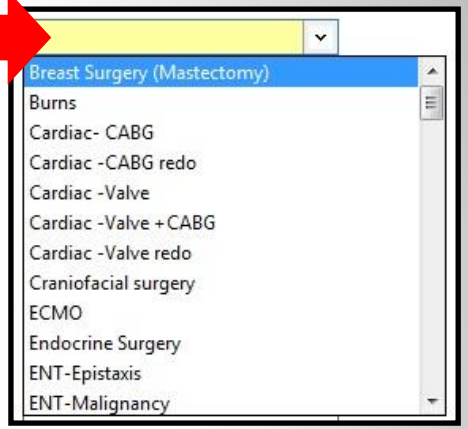
Electronic blood ordering, decision support and data feedback to clinicians at the OUH has saved £500k from reduced blood use in the last 2 years



1 Capture the diagnostic group



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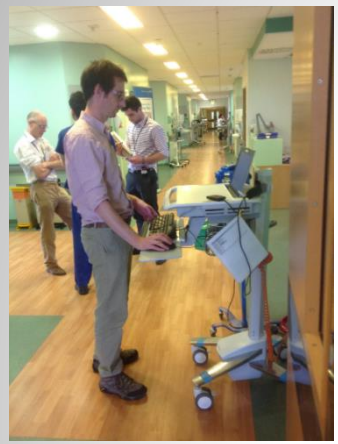

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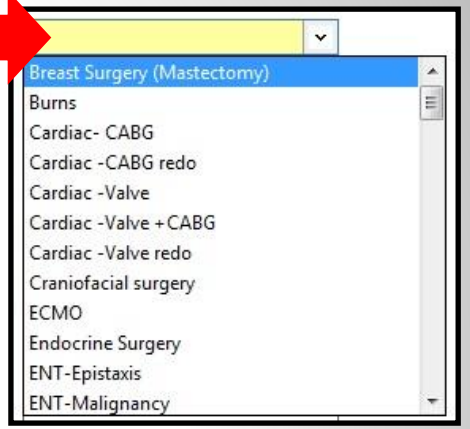
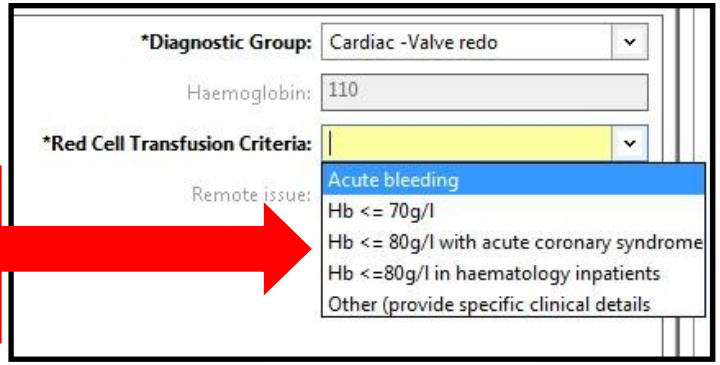


2 Select a reason for transfusion



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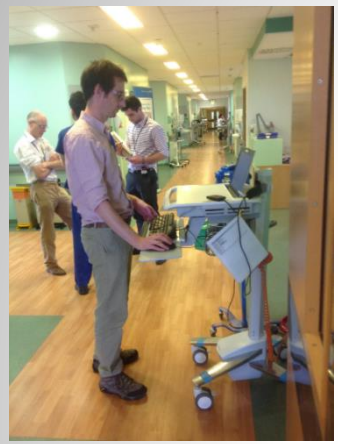

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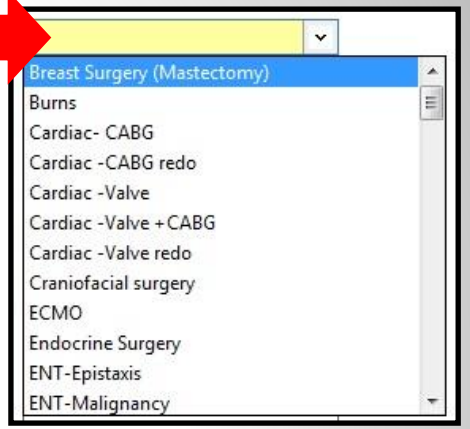
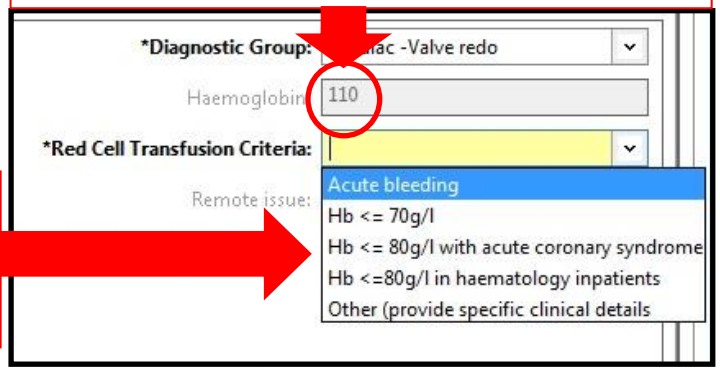


3 Automatic capture of the most recent relevant result



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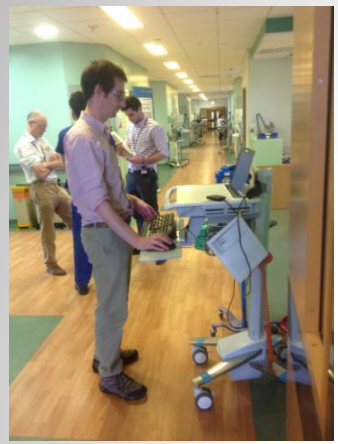

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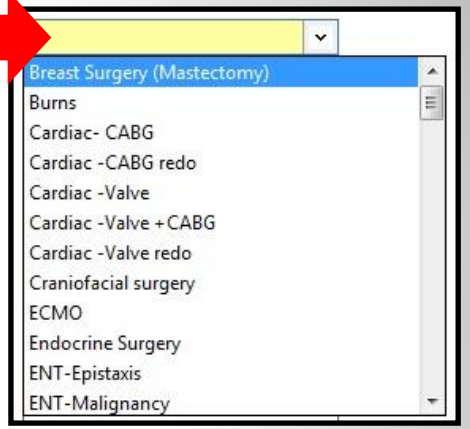

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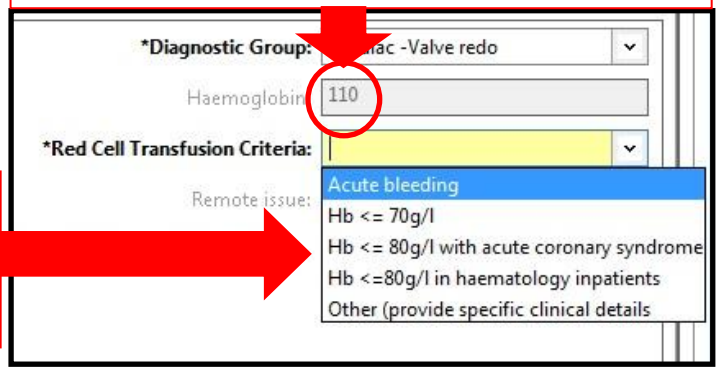
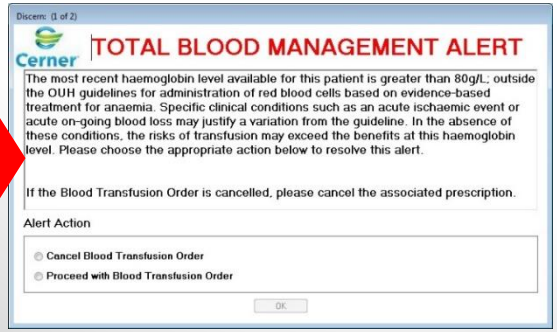


2 Select a reason for transfusion

4 Alert if transfusion not justified



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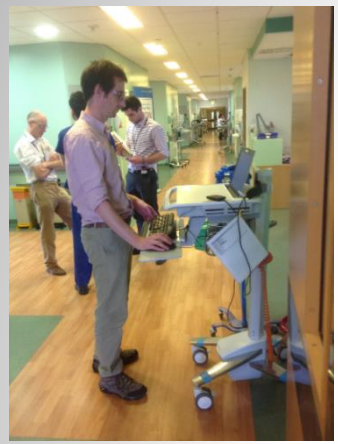

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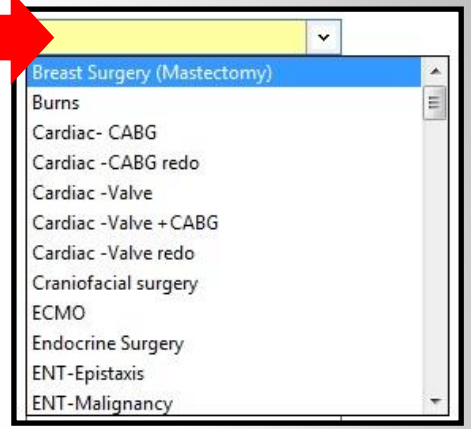

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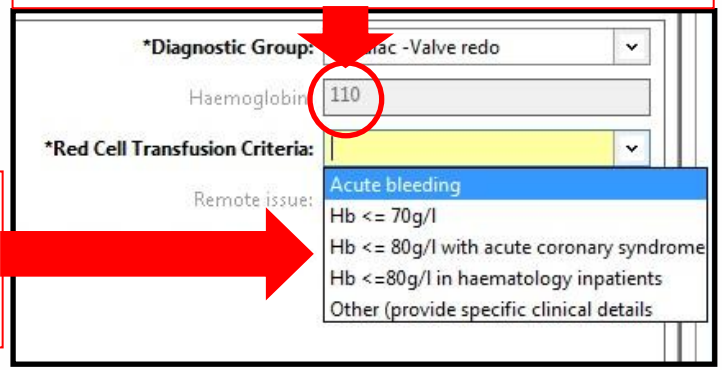

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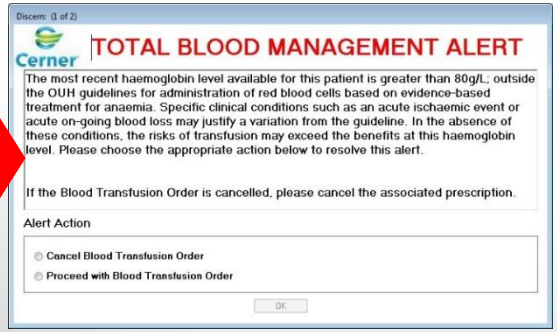

5

Reason for over-riding alert

- **Instruction from senior clinician**
- **Recent point-of-care result (provide the result, date and time)**
- **Disagree with recommendation (provide reasons)**
- **Additional patient co-morbidity (provide details)**
- **Other (provide details)**

6 Daily review of blood order alerts

ID	ALERT_DTTM	Diagnostic_Group	Clinical_details	#_of_RBCorFFP_units_only	CRITERIA	Result	MRN	PATIENT_NAME	PRSNL_RAISING_ALERT	Position	WARD_AT_TRANSFUSION	ORDER_STATUS	OVERRIDE_REASON	OVERRIDE_REASON_COMMENT
1,430	09/04/2018 10:42	GI-Lower GI bleed	PR bleed. haemorrhoids. Multipole myeloma	2	Hb <= 70g/l	hb=80				Specialist Registrar	J-ED	Completed	Instruction from senior clinician	VBG shows Hb 47
1,431	09/04/2018 16:28	Haem-AML	aml, low plt	0	PLT count <= 20 with plt consumption	plt=31				House Officer Pre Reg	J-WD 6C SSW	Completed	Instruction from senior clinician	
1,432	09/04/2018 12:16	Haem-AML	AML, post AraC, PV bleed, platelets 10 on POCH	0	Other (provide specific clinical details	plt=16				Specialist Registrar	C-WD OncHTriage	Completed	Recent point of care test	Platelet 10 POCH, PV bleed
1,433	09/04/2018 14:23	Renal-CRF	upper GI bleed	2	Hb <= 70g/l	hb=92				Senior House Officer	C-RDA Main RDU	Completed	Disagree - provide reason in textbox	
1,434	09/04/2018 15:43	Haem-Lymphoma	line thrombosis on fragmin, target plt >30	0	Other (provide specific clinical details	plt=29				Specialist Registrar	C-RDA DTU Chemo	Completed	Other (provide details)	prioir thrombosis, target plt >30
1,435	09/04/2018 15:49	Neuro-Intracranial bleeding	TBI - hb 67	1	Hb <= 70g/l	hb=71				Specialist Registrar	J-WD Neuro ICU	Completed	Recent point of care test	67
1,436	09/04/2018 13:52	Haem-MDS	MDS	1	Other (provide specific clinical details	hb=103				Staff Nurse	C-OP DTU	Completed	Instruction from senior clinician	
1,437	09/04/2018 14:57	Ortho-Redo Hip	requested for possible intraoperative blood loss	1	Other (provide specific clinical details	hb=88				Senior House Officer	NOC-Ward B	Ordered	Instruction from senior clinician	
1,438	09/04/2018 18:56	Paed- top up transfusion	Blood loss during spinal surgery	1	Hb <= 70g/l	hb=71				Senior House Officer	J-WD Melanies	Completed	Instruction from senior clinician	
1,439	09/04/2018 11:06	Haem-MDS	Hb-79	1	Hb <=80g/l in haematology inpatients	hb=79				Senior House Officer	C-WD Haem	Completed	Instruction from senior clinician	Hb-79

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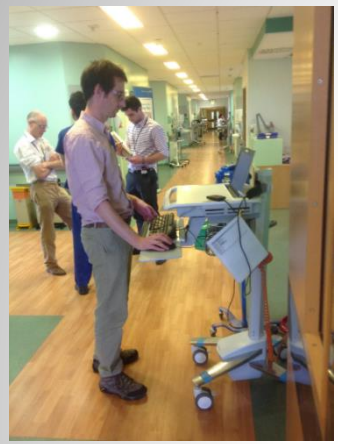

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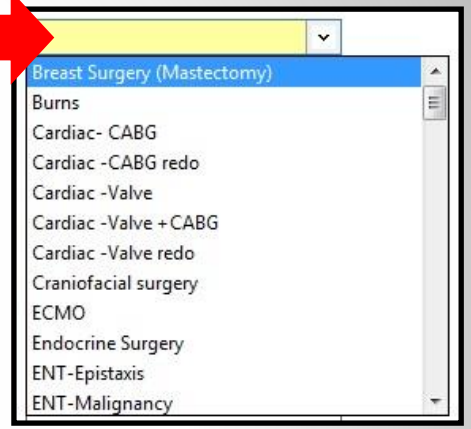

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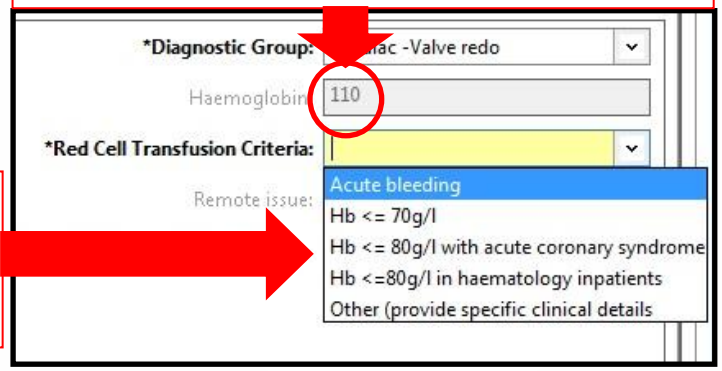
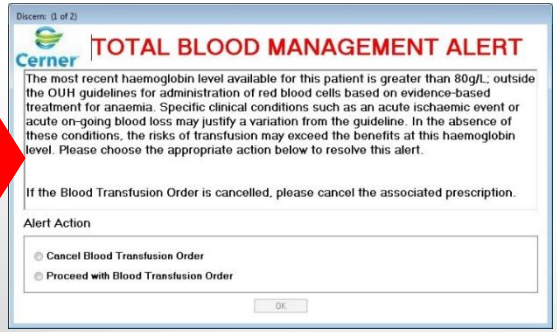


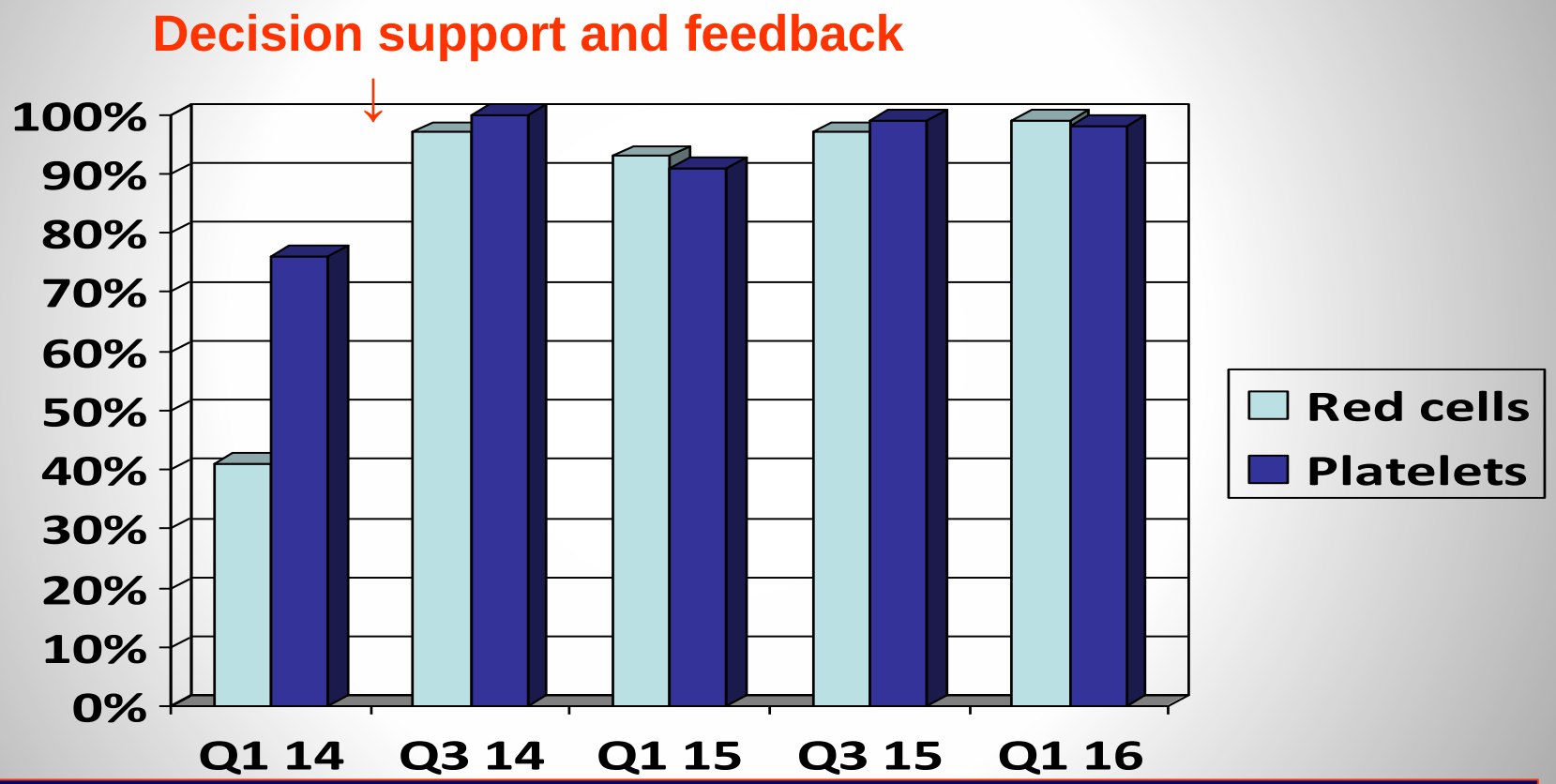
2 Select a reason for transfusion

7 Data feedback to drive blood reduction

4 Alert if transfusion not justified

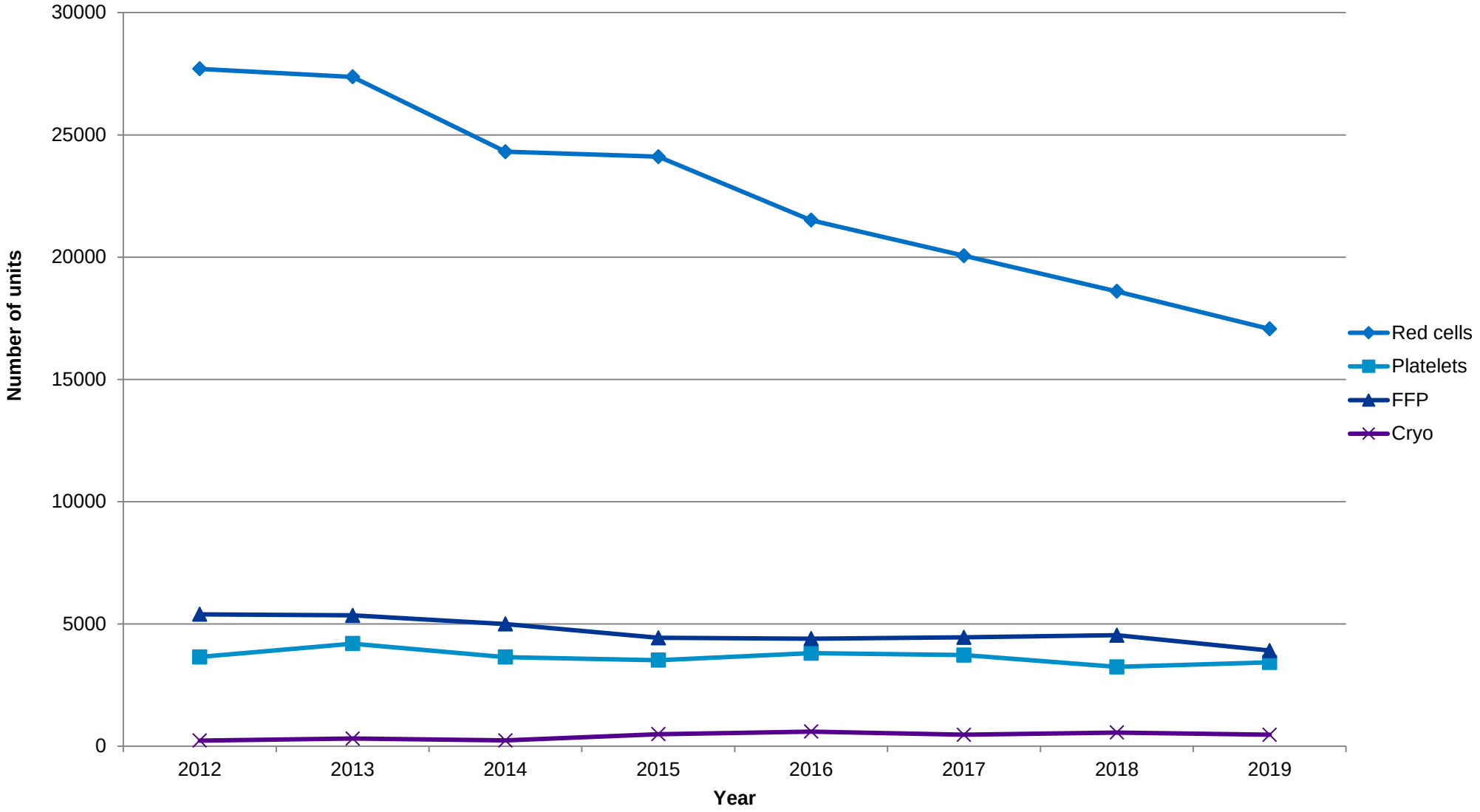


Compliance with agreed transfusion triggers in haematology improved from <50% to >90%

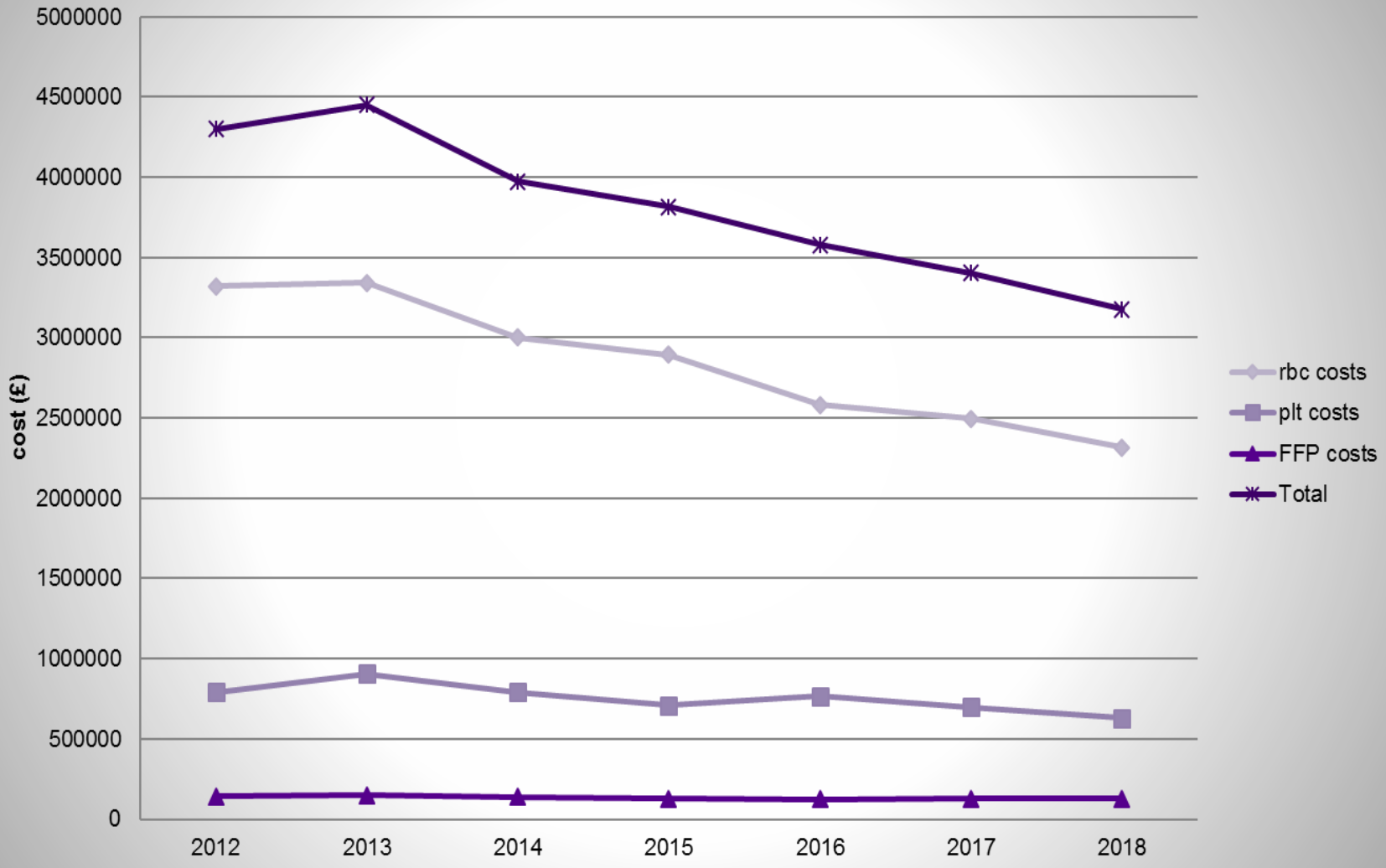


Butler CE, Noel S, Hibbs SP, Miles D, Staves J, Mohaghegh P, Altmann P, Curnow E, Murphy MF (2015) Implementation of a clinical decision support system improves compliance with restrictive transfusion policies in hematology patients. *Transfusion.* **55**, p. 1964-1971.

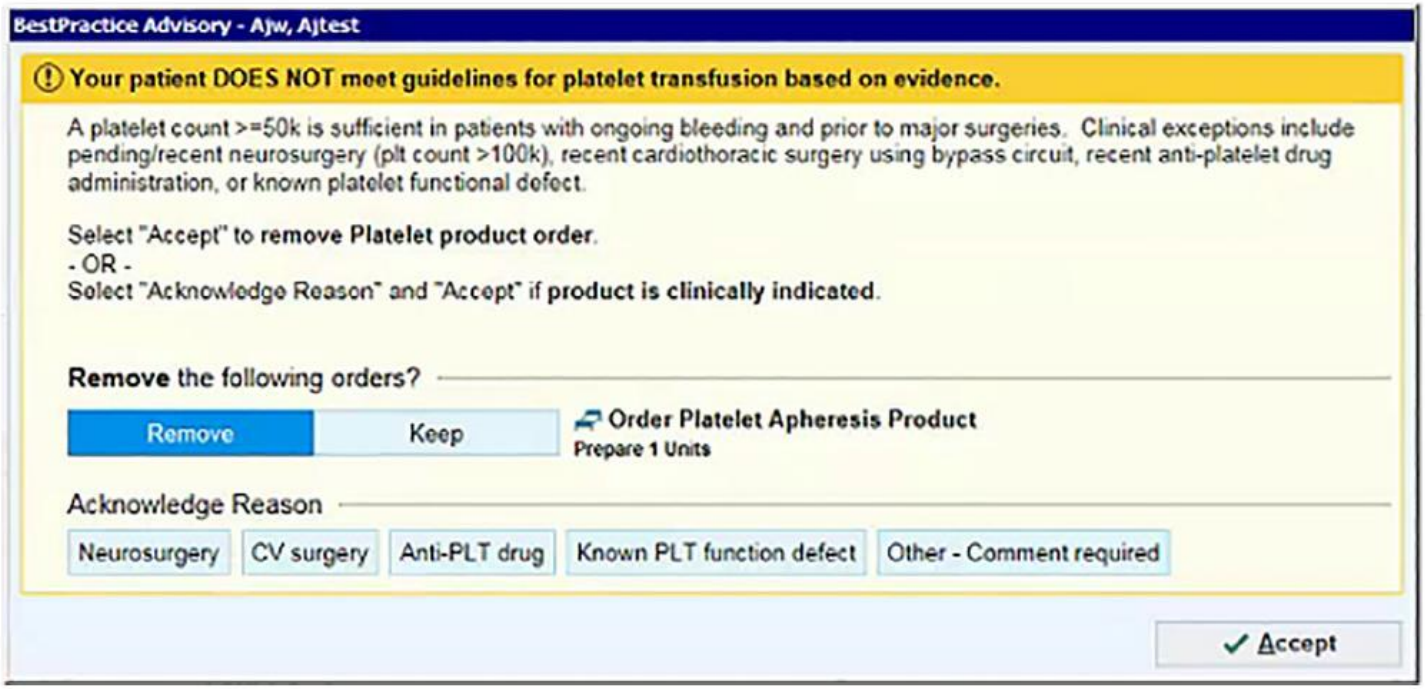
Number of Blood Products



Reduction of > £1million in annual blood budget in Oxford in 6 years



Randomising best practice alerts

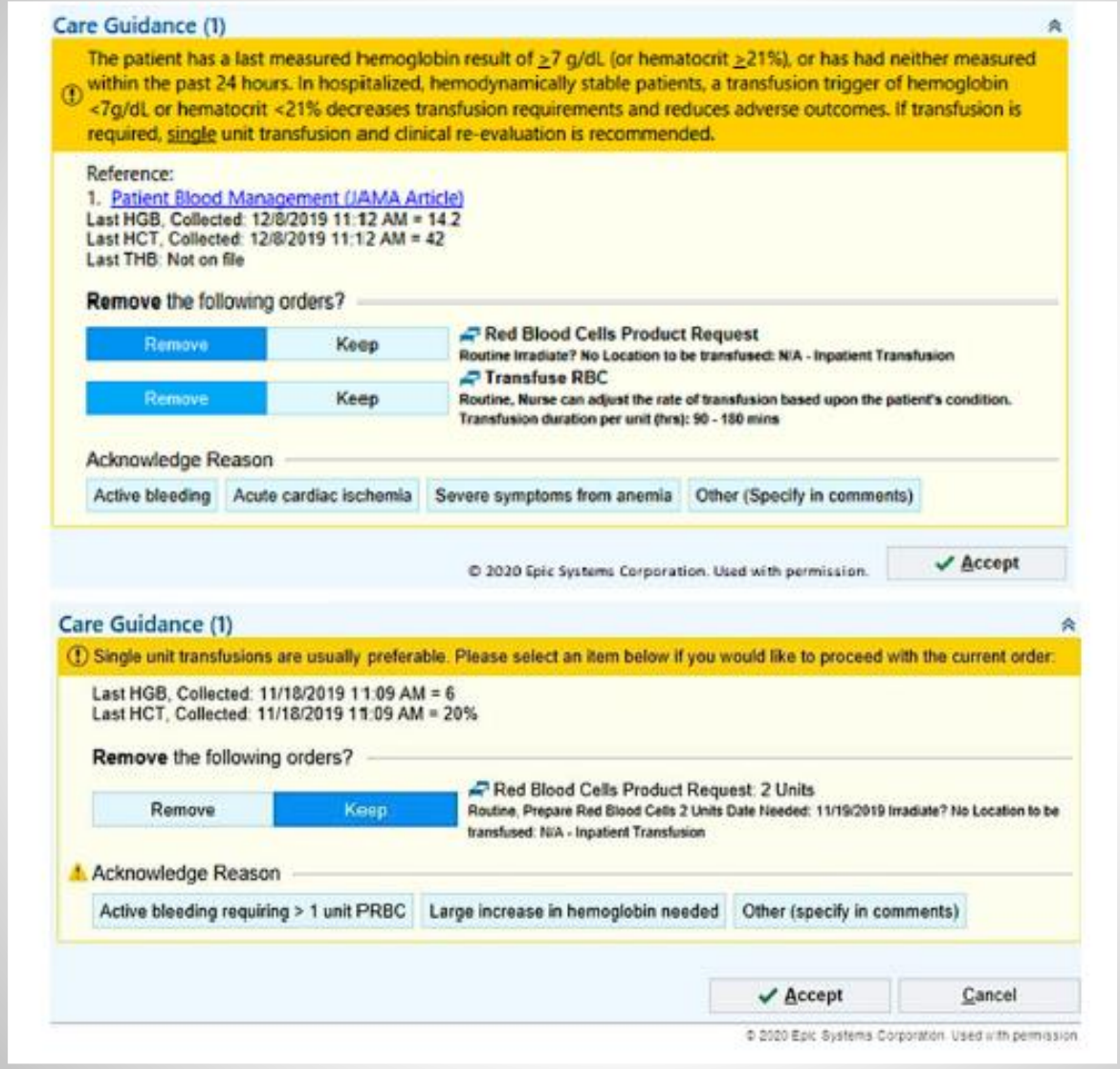


	Platelets	PPID
Control alert	65.7 (20.8)	2.3 (0.8)
Visible alert	49.1 (13.5)	2.1 (0.8)
p Value	0.07	0.53

PPID: platelets used per inpatient day

Murphy C et al Vox Sanguinis 2021 Jun 3. doi: 10.1111/vox.13132

Customising best practice alerts



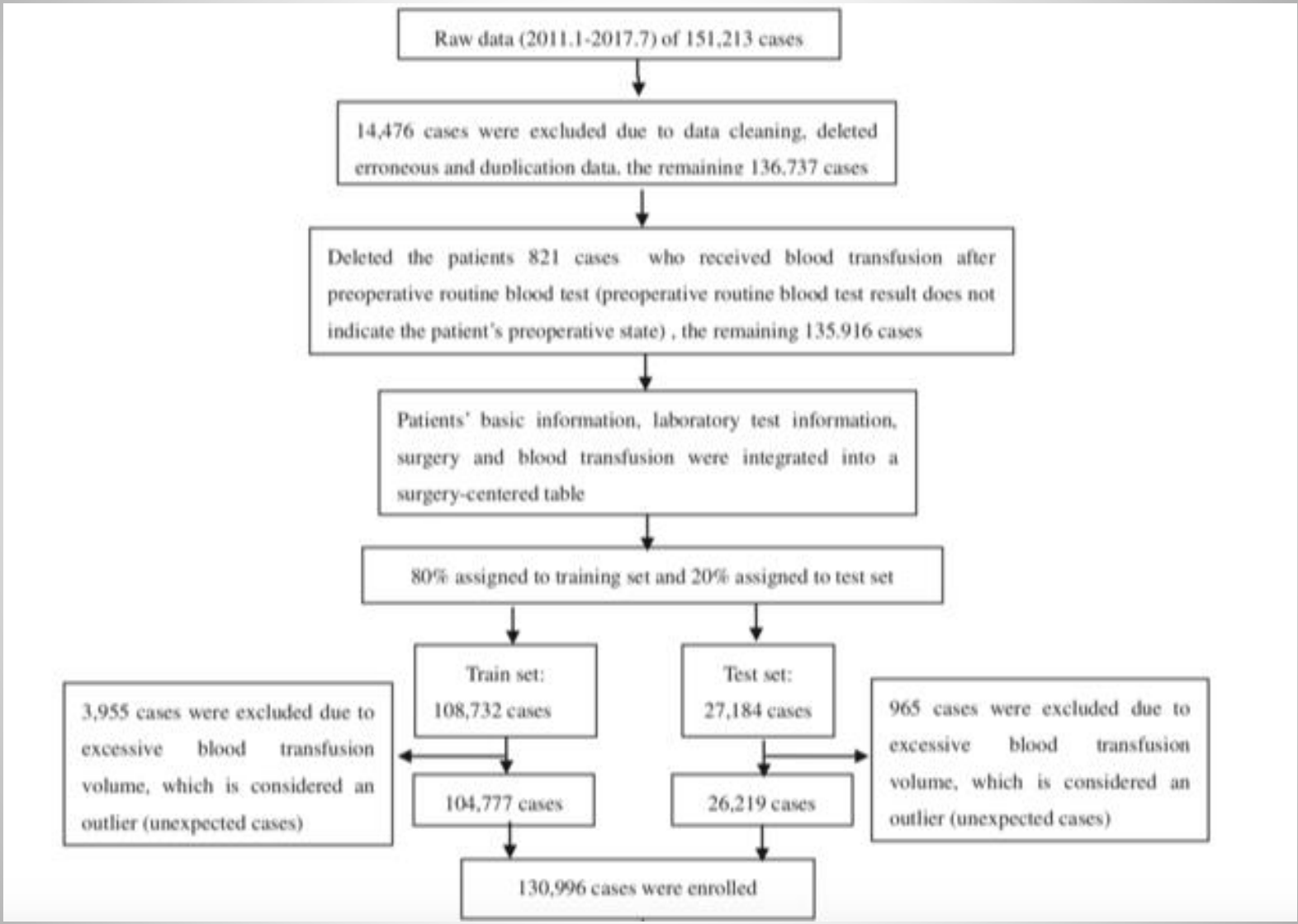
Metcalf RA et al. Transfusion 2021:61:669-670

Machine learning

- Machine learning is a component of artificial intelligence
- It involves the automated discovery of patterns within data
- The model ‘learns’ from examples rather than being programmed with rules or following a strict hypothesis

Shouval R et al BJHaem 2021; 31:262-70

Machine learning for predicting blood use



Feng Y et al Transfusion Medicine 2021; 31:262-70

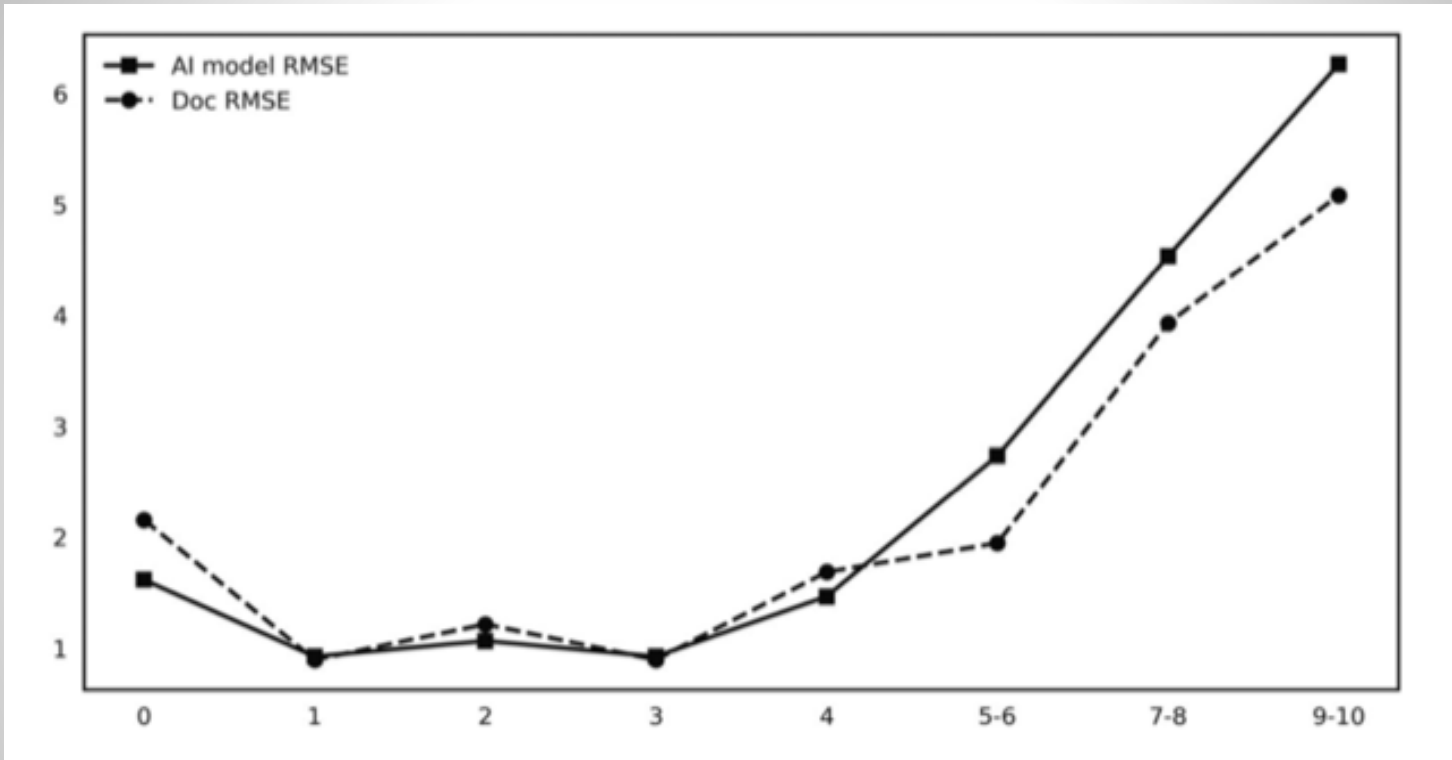
Machine learning for predicting blood use

Factors	N	Min	Max	Mean	Std
Age (years)	130 996	0	109	51	17
Weight (kg)	129 895	3	180	66.6	14.5
Height(cm)	130 131	50	215	164.1	12.7
Sex	130 996				
Male	64 396 (49%)				
Female	66 600 (51%)				
Surgical grade	130 923				
First-grade surgery	1426 (1.1%)				
Secondary surgery	11 299 (8.6%)				
Tertiary surgery	87 464 (66.8%)				
Four-stage surgery	30 734 (23.5%)				
Autologous blood storage (units)	4452	0	4	0.07	0.36
RBC application total (units)	130 996	0	25	0.83	2.14
Blood transfusion volume (units)	130 996	0	10	0.82	1.54
BTV = 0 (unit)	90 387 (69%)				
BTV = 1 (unit)	1238 (1%)				
BTV = 2 (unit)	11 862 (9%)				
BTV = 3 (unit)	12 006 (9%)				
BTV = 4 (unit)	8953 (7%)				
5 ≦ BTV ≦ 6 (units)	3930 (3%)				
7 ≦ BTV ≦ 8 (units)	1310 (1%)				
9 ≦ BTV ≦ 10 (units)	1310 (1%)				

Abbreviations: BTV, blood transfusion volume; Max, maximum value; Min, minimum value; N, number; RBC, red blood cell; Std, standard deviation.

Feng Y et al Transfusion Medicine 2021; 31:262-70

Machine learning for predicting blood use



Feng Y et al Transfusion Medicine 2021; 31:262-70

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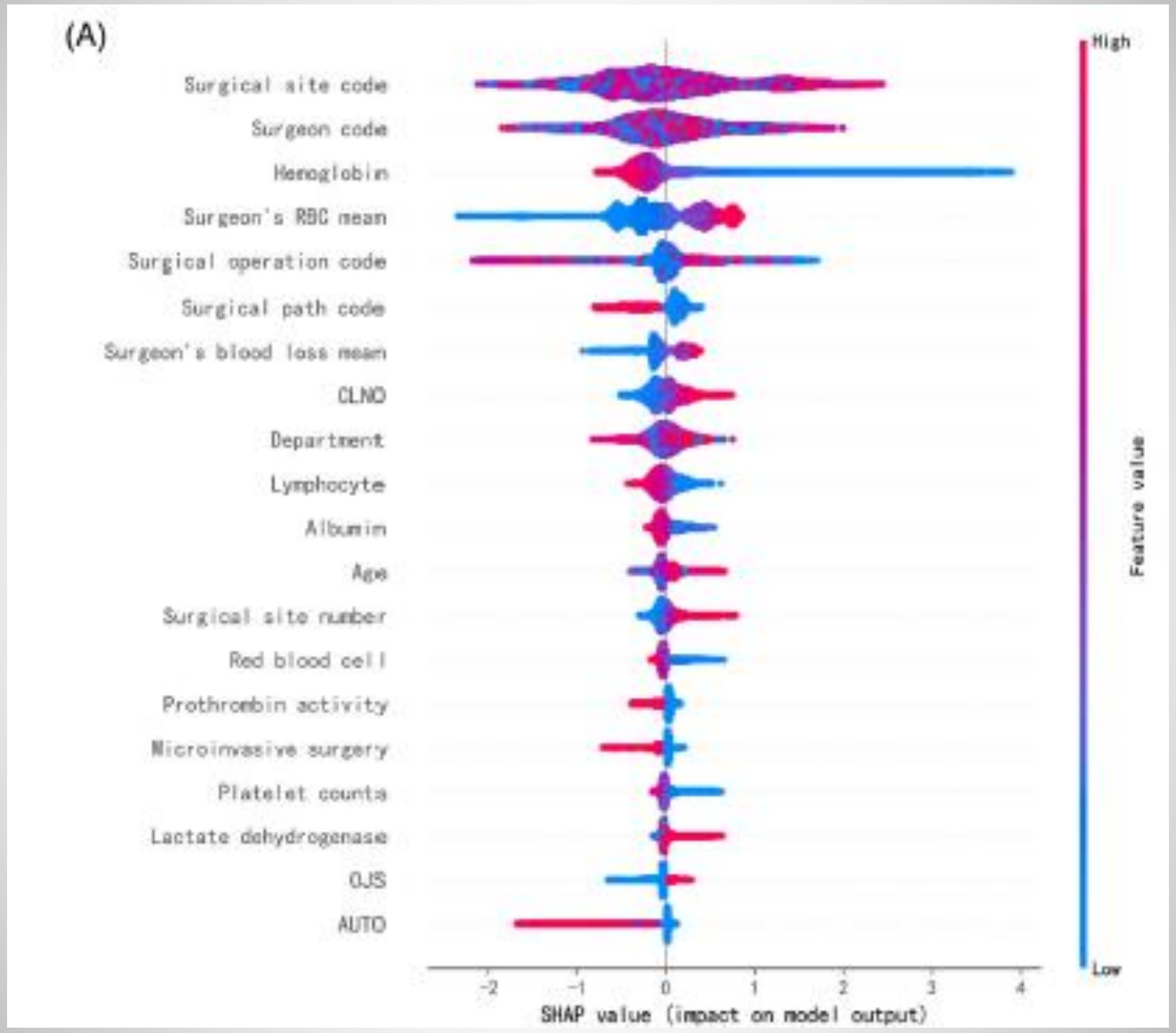

Feng Y et al Transfusion Medicine 2021; 31:262-70

Big data: challenges & limitations

- Investment for hardware, set up software, train staff, and develop informatics services on both a local and national scale
- Information governance: concerns about patient confidentiality
- Common data standards and interconnectivity of IT systems
- Reliable and precise input e.g. accurate coding of clinical episodes

Key actions for hospitals to reduce unnecessary transfusions

Intervention category	Examples
Education	Educational material, guidelines, departmental presentation, workshops, individual meetings, audit and feedback
Policy change	Protocol or algorithm, department policy, financial incentive
Decision support	Order form (computerised or paper), order sets, computerised physician order entry, reminders, checklists
Audit and feedback	Retrospective, prospective, audit approval

Reducing unnecessary red blood cell transfusion in hospitalised patients

Nishila Mehta,[1,2] Michael F Murphy,[3,4,5] Lawrie Kaplan,[6] Wendy Levinson[1,6]

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NIHR/NHSBT Blood & Transplant Research Units (BTRUs)

Aim: support the needs of NHSBT for research to improve the supply of blood, blood products, stem cells and tissues and organs for transplantation

- £20 million over 5 years
- 5 Priority Areas:
  - Blood Donation;
  - Organ Donation and Transplantation;
  - Therapeutics;
  - Transfusion and Transplantation Transmitted Infections;
  - Data Driven Transfusion Practice

https://www.nihr.ac.uk/documents/nihr-blood-and-transplant-research-units-competition-brief/27100

NIHR/NHSBT Blood & Transplant Research Units (BTRUs)

Objectives of the Data Driven Transfusion Practice unit will be to conduct:

- Research that improves patient outcomes for those who receive blood products through learning from better connectivity of data between NHSBT and NHS Trusts
- Research to reduce inappropriate variation in clinical practice and to optimise supply and use of components
- Novel data linkage and to develop analytical methods to facilitate effective research and audit on an ongoing basis

https://www.nihr.ac.uk/documents/nihr-blood-and-transplant-research-units-competition-brief/27100

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