INTERNATIONAL CONSENSUS CONFERENCE
ICC·PBM
FRANKFURT
2018

ICC-PBM 2018: IMPLEMENTATION AND MAINTENANCE OF PBM PICOs 15-17

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ICC·PBM
FRANKFURT
2018

Patient Blood Management (PBM)

What is it?

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What is it?

"An evidence-based, multidisciplinary approach to optimising the care of patients who might need a blood transfusion"

Patient Blood Management (PBM)

What is it?

'The timely application of evidence-based medical and surgical concepts designed to. maintain hemoglobin concentration, optimize hemostasis and minimize blood loss in an effort to improve patient outcome'

SABM (Society for the Advancement of Blood Management)

Patient Blood Management (PBM)

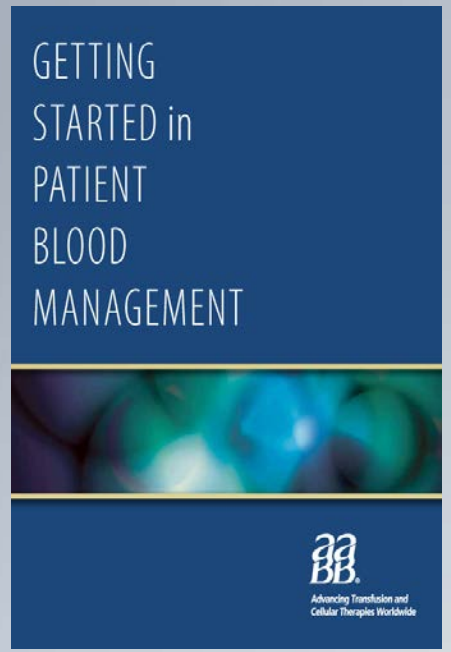
Many activities….

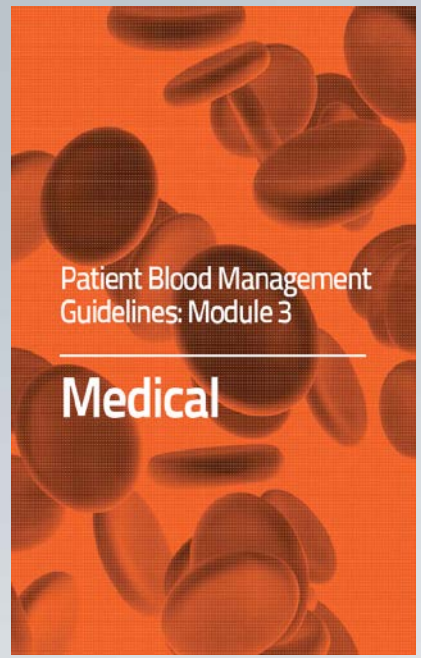
Patient Blood Management

	Optimize erythropoiesis	Minimize blood loss	Manage anemia
PREOPERATIVE	• Identify, evaluate, and treat underlying anemia • Preoperative autologous blood donation • Consider erythropoiesis stimulating agents (ESA) if nutritional anemias ruled out/treated • Refer for further evaluation if necessary	• Identify and manage bleeding risk (past/family history) • Review medications (antiplatelet, anticoagulation therapy) • Minimize iatrogenic blood loss • Procedure planning and rehearsal	• Compare estimated blood loss with patient-specific tolerable blood loss • Assess/optimize patient's physiologic reserve (*e.g.*, pulmonary and cardiac function) • Formulate patient-specific management plan using appropriate blood conservation modalities to manage anemia
INTRAOPERATIVE	• Time surgery with optimization of erythrocyte mass (note: unmanaged anemia is a contraindication for elective surgery)	• Meticulous hemostasis and surgical techniques • Blood-sparing surgical techniques • Anesthetic blood conserving strategies • Acute normovolemic hemodilution • Cell salvage/reinfusion • Pharmacologic/hemostatic agents	• Optimize cardiac output • Optimize ventilation and oxygenation • Evidence-based transfusion strategies
POSTOPERATIVE	• Manage nutritional/correctable anemia (*e.g.*, avoid folate deficiency, iron-restricted erythropoiesis) • ESA therapy if appropriate • Be aware of drug interactions that can cause anemia (*e.g.*, ACE inhibitor)	• Monitor and manage bleeding • Maintain normothermia (unless hypothermia indicated) • Autologous blood salvage • Minimize iatrogenic blood loss • Hemostasis/anticoagulation management • Be aware of adverse effects of medications (*e.g.*, acquired vitamin K deficiency)	• Maximize oxygen delivery • Minimize oxygen consumption • Avoid/treat infections promptly • Evidence-based transfusion strategies

Implementation and Maintenance of Patient Blood Management (PBM)

Many guidelines and initiatives (local, regional, national and international)



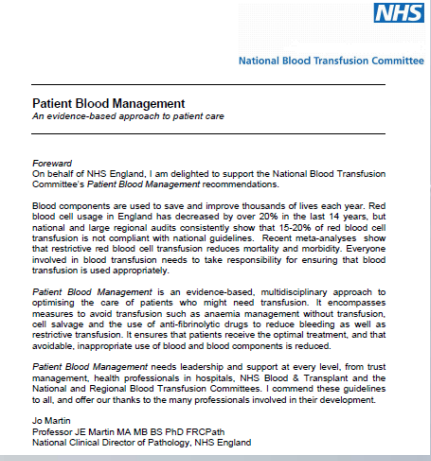


PaBloE: **Pa**tient **Blo**od Management in **E**urope

eba EUROPEAN BLOOD ALLIANCE

Guidelines for implementation of PBM

National Blood Transfusion Committee (England)



NHS

National Blood Transfusion Committee

Patient Blood Management

An evidence-based approach to patient care

Foreward

On behalf of NHS England, I am delighted to support the National Blood Transfusion Committee's *Patient Blood Management* recommendations.

Blood components are used to save and improve thousands of lives each year. Red blood cell usage in England has decreased by over 20% in the last 14 years, but national and large regional audits consistently show that 15-20% of red blood cell transfusion is not compliant with national guidelines. Recent meta-analyses show that restrictive red blood cell transfusion reduces mortality and morbidity. Everyone involved in blood transfusion needs to take responsibility for ensuring that blood transfusion is used appropriately.

Patient Blood Management is an evidence-based, multidisciplinary approach to optimising the care of patients who might need transfusion. It encompasses measures to avoid transfusion such as anaemia management without transfusion, cell salvage and the use of anti-fibrinolytic drugs to reduce bleeding as well as restrictive transfusion. It ensures that patients receive the optimal treatment, and that avoidable, inappropriate use of blood and blood components is reduced.

Patient Blood Management needs leadership and support at every level, from trust management, health professionals in hospitals, NHS Blood & Transplant and the National and Regional Blood Transfusion Committees. I commend these guidelines to all, and offer our thanks to the many professionals involved in their development.

Jo Martin
Professor JE Martin MA MB BS PhD FRCPath
National Clinical Director of Pathology, NHS England

D. Implementation of PBM

Implementation of good practice for blood avoidance and the use of blood
• Analyse casemix and clinical services to determine the main targets for PBM
• Identify PBM champions to help educate staff and patients
• Establish a PBM committee (either stand-alone or within the Hospital Transfusion Committee) to oversee the PBM programme
• Obtain a mandate for PBM from hospital management
• Educate clinicians about PBM and evidence-based transfusion practice
• Adopt a PBM scorecard to share with senior NHS Trust members to monitor adherence to guidelines for blood avoidance and the use of blood, including the use of benchmarking to identify clinicians/clinical teams who are consistently well outside of average blood use for a specific procedure

http://www.transfusionguidelines.org.uk/uk-transfusion-committees/national-blood-transfusion-committee/patient-blood-management

Guidelines for implementation of PBM

EU-PBM guide

D9 – PBM Implementation Guide

EU-PBM
EU guide for Member States on good practices for patient blood management

	(1) Establish urgency for PBM	(2) Form a powerful PBM group	(3) Create a vision for PBM	(4) Communicate the PBM-Vision within the hospital	(5) Empower the team and remove obstacles	(6) Generate short-term wins	(7) Build on the change	(8) Anchor PBM in culture
1	Baseline evaluation regarding main topics of PBM like prevalence of anaemia, blood loss, TR, TI Show the results focusing on their own baseline data compared with reference centres. Show the people: this is the "gold standard"	Main disciplines included (anaesthesia, surgery, transfusion medicine, laboratory, haematology, gastroenterology, pharmacology, quality management)	Vision of the PBM Group formulated and consented	Meetings, lectures and workshops are held	Identifying human and organisational obstacles (human or otherwise)	Revised blood ordering schedules	Consolidate and complete the implementation of the three-pillar strategy (e.g. Preoperative anaemia treatment if Hb < WHO threshold or if expected blood loss is likely)	Three pillar strategy anchored as part of the hospital's culture
2	Benchmarking transfusion and outcome data by implementing suitable data system to continuously benchmark transfusion and outcome with the possibility to identify practice and knowledge gaps.	Professionals included (physicians, nurses, perfusionists, hospital management, networkers, quality managers)	Vision in line with the current literature and the available resources of the hospital	PBM is communicated through the hospitals' homepage and intranet	Establish PBM training for staff	Micro sampling (smaller volumes, less frequent)	Continue with workarounds and solutions to overcome human, structural and organisational obstacles	Automated benchmarking and reporting process in place
3	Main arguments for the implementation of PBM Prepare a communication strategy with emotional and logical arguments Communicate current evidence	Leading professionals (key leaders), officially assigned by the hospital providers, included	Vision supported by the health authorities	Guidelines, literature and other information material are provided in print and electronically	Responsibilities of leaders clearly defined	Implementation of a single unit ordering and transfusion strategy	Implement a database for the continuous monitoring of key parameters Have a first version of the database including minimal dataset ready as early as possible	Routine reporting of key parameters to clinical directors and the hospital management

Guidelines for implementation of PBM

EU –PBM guide

D9 – PBM Implementation Guide

EU-PBM
EU guide for Member States on good practices for patient blood management

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4	Specially tailored educational information to • clinical directors and co-workers in surgery, nursing and finance • hospital managers (and health care providers) • primary care physicians patients and patient advocates	Support from hospital management (including budget for PBM)	Strategies for executing the PBM (vision) developed	Staff familiar with PBM concept	Recruiting personnel and technical support	Preoperative anaemia management • Patient information about options for preoperative anaemia treatment • Preoperative screening for anaemia and iron status	Internal auditing of transfusion practice on a regular basis	Multidisciplinary publications
5	Informed patient consent for anaemia treatment	Support from clinical directors	Each strategy should be executed within a given time frame (road map)	Lead by example (Number of available team leaders)	Incentives for team members (e.g. publications)	Preoperative check for coagulation and expected blood loss (e.g. Mercuriali algorithm to calculate expected blood loss and post-operative haematocrit)	Reporting results and achievements to hospital staff and management	PBM certification from national hospital accreditation programme
6	Adding relevant PBM questions to the preoperative checklists (SOP) of the surgeons and anaesthesiologists	Support from patient advocacy	Strategies should include a stakeholder mapping for the environment		Official empowerment from hospital managers	Standard use of antifibrinolytics	Motivate hospital staff to attend lectures and study publications	
7	Developing and introducing mandatory post- and undergraduate curricula	Support from IT-department for data management			Official empowerment from clinical directors	Irradiation of salvaged blood	Continuous improvement, rethinking strategies and goals	
8		Use of tools to facilitate the team				Using restrictive/symptomatic transfusion thresholds/triggers	Rewards and incentives for successful PBM team members	
9		Emphasis on networking and cross communication within the hospital teams				Other hospital specific easy wins (patient questionnaire)	Include project management / timeline / milestones / Benchmark cycles	
10							Set up a framework using stepwise indicator systems to follow changes • Structure indicators • Process indicators • Outcome indicators lower rate of patients with anaemia	

Implementation and Maintenance of Patient Blood Management (PBM)

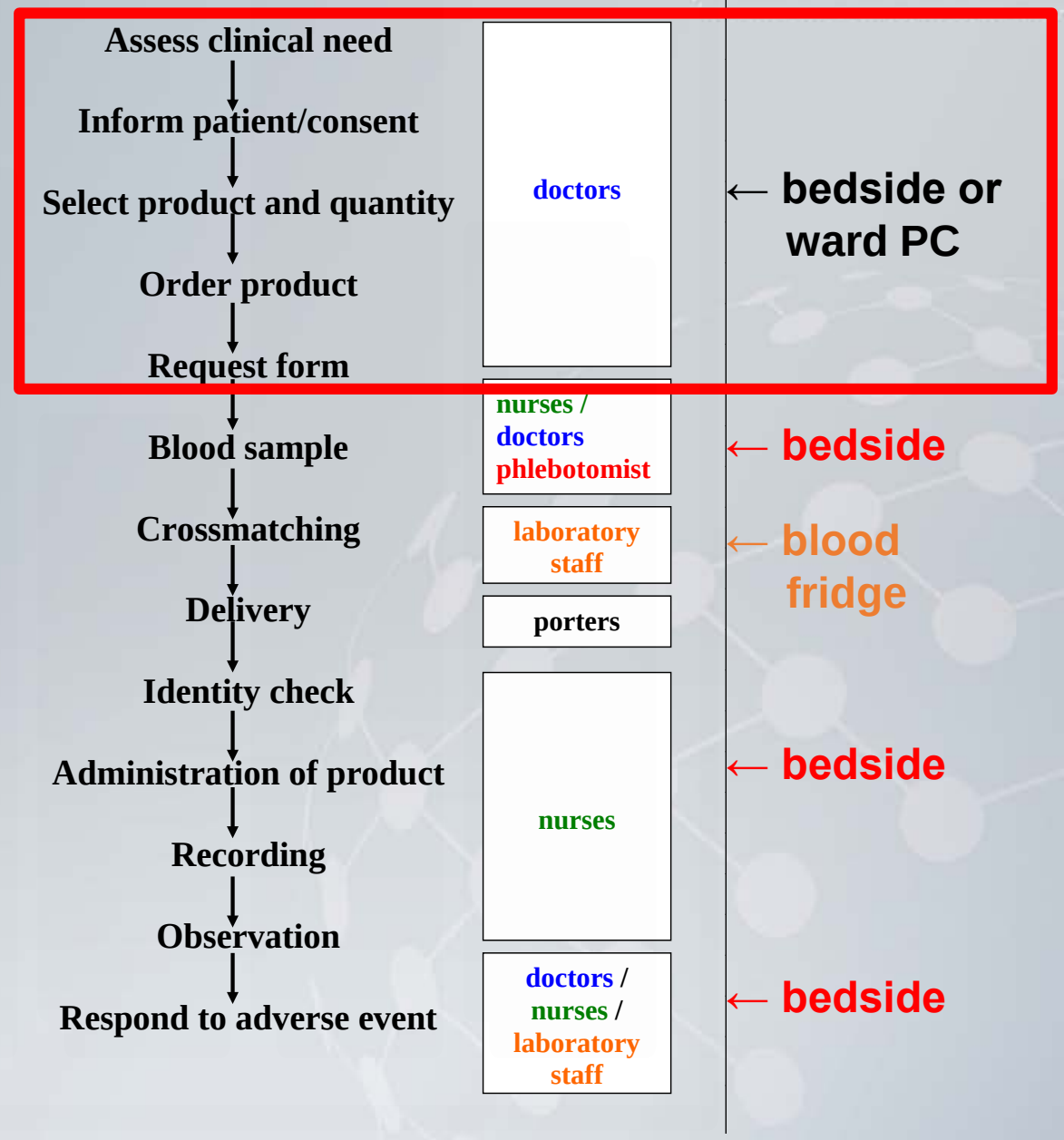
PICO question 15: Is a PBM program [intervention] effective to improve clinical and economic outcomes [outcomes] compared to no PBM program [comparison]?

PICO question 16: Is a specific behavioural intervention to promote the implementation of a PBM program [intervention] more effective to improve clinical and economic outcomes [outcomes] compared to no/another behavioural intervention [comparison]?

PICO question 17: Is a specific decision support system to promote the implementation of a PBM program [intervention] more effective to improve clinical and economic outcomes [outcomes] compared to no intervention or another decision support system/behavioural intervention [comparison]?

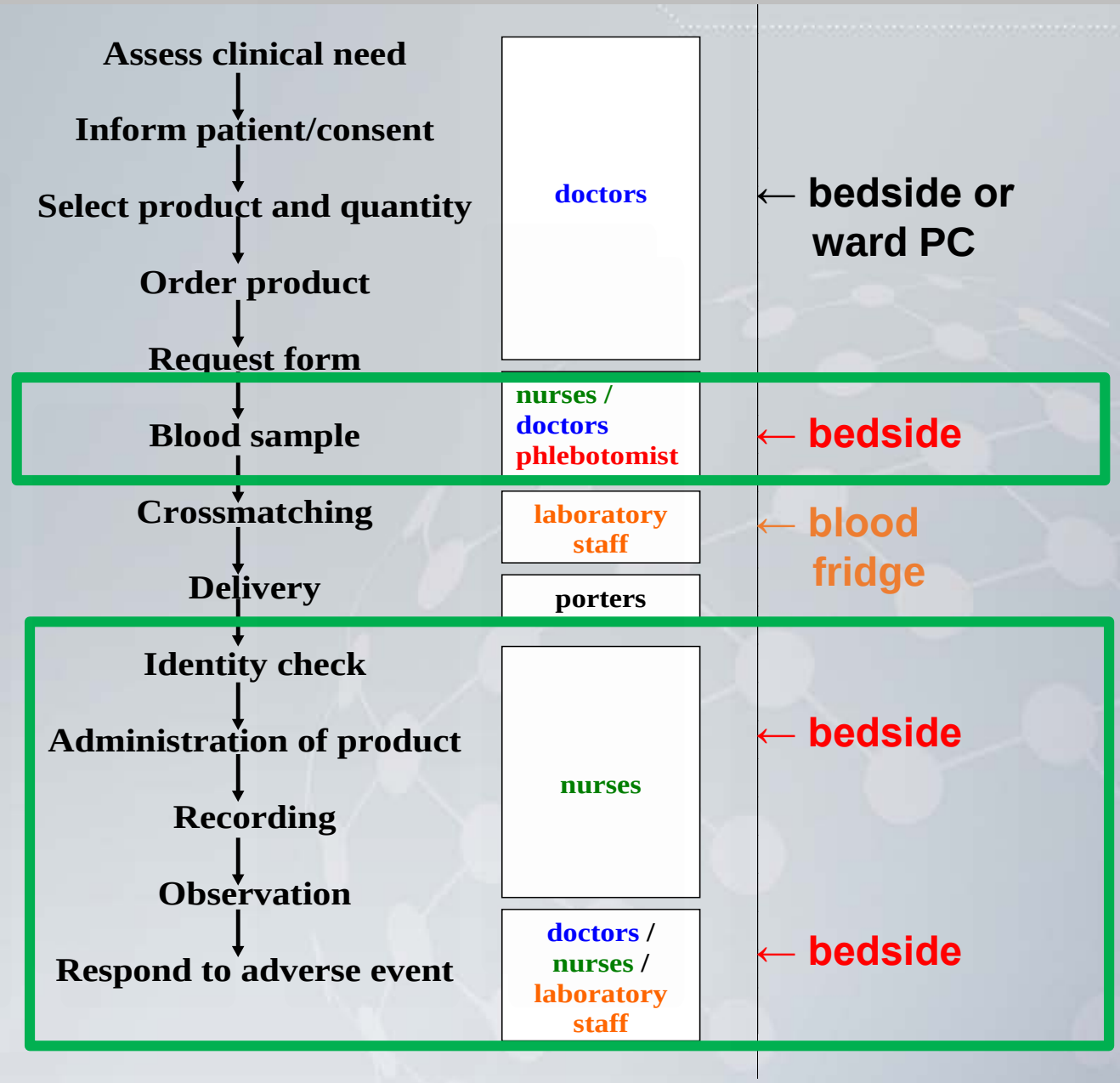
Example of simple behavioural intervention

Example of clinical decision support for blood ordering



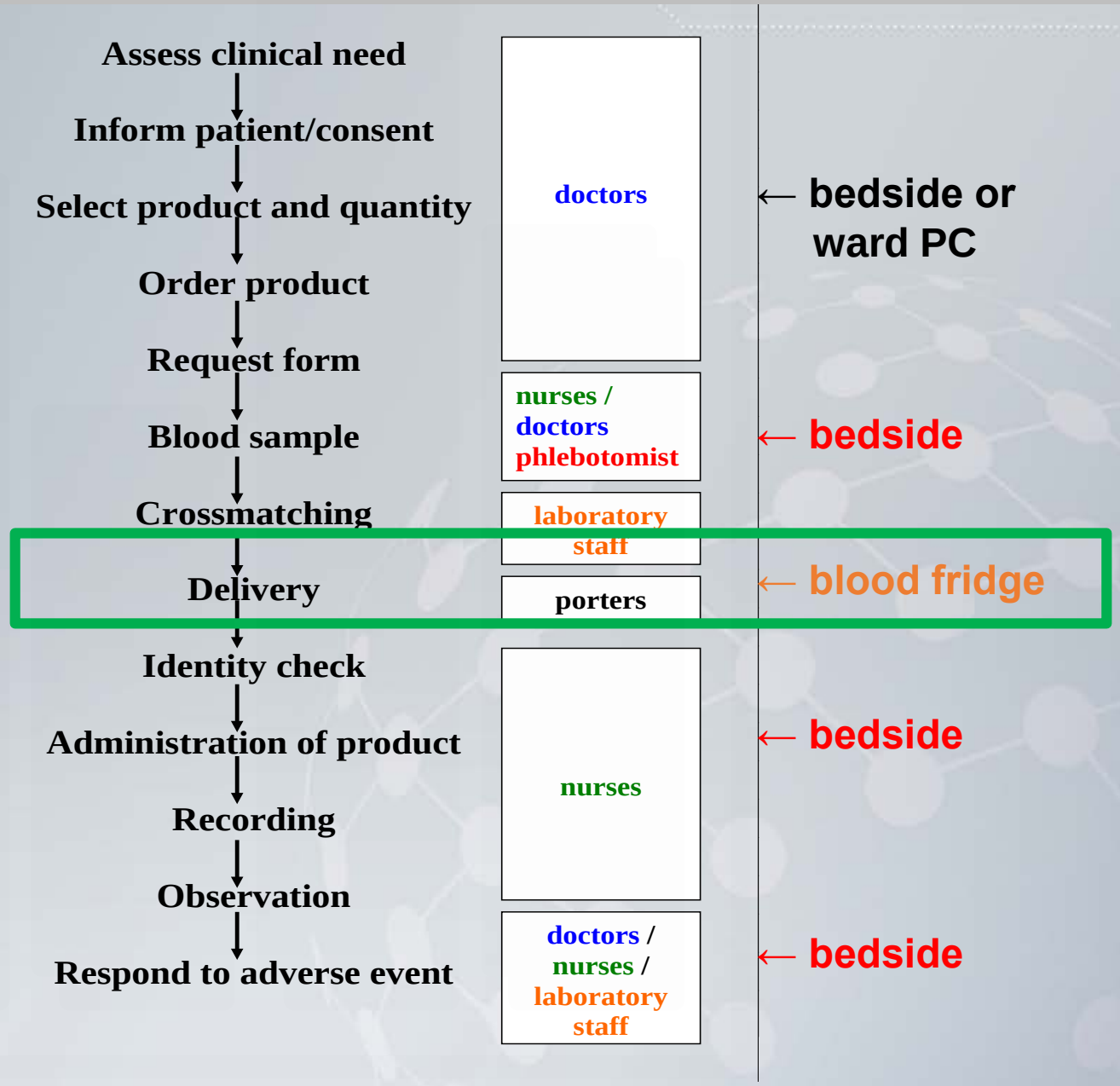
End-to-end electronic transfusion for transfusion safety

Transfusion safety at the bedside

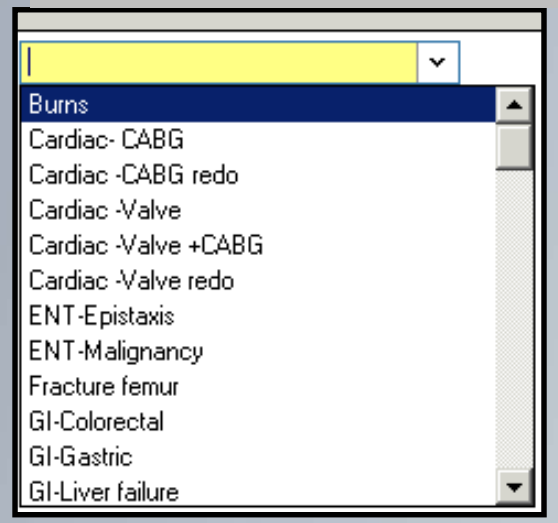


End-to-end electronic transfusion for transfusion safety

Transfusion safety at blood fridges



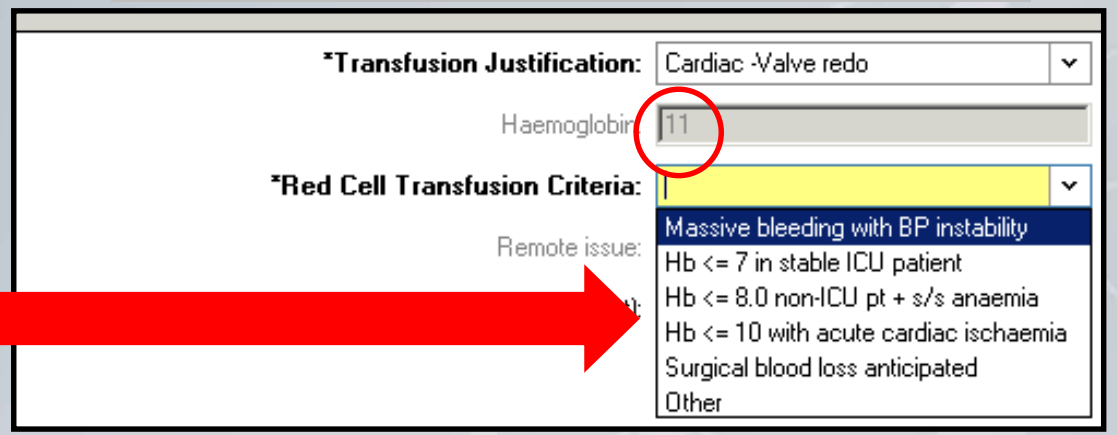
Example of clinical decision support for blood ordering



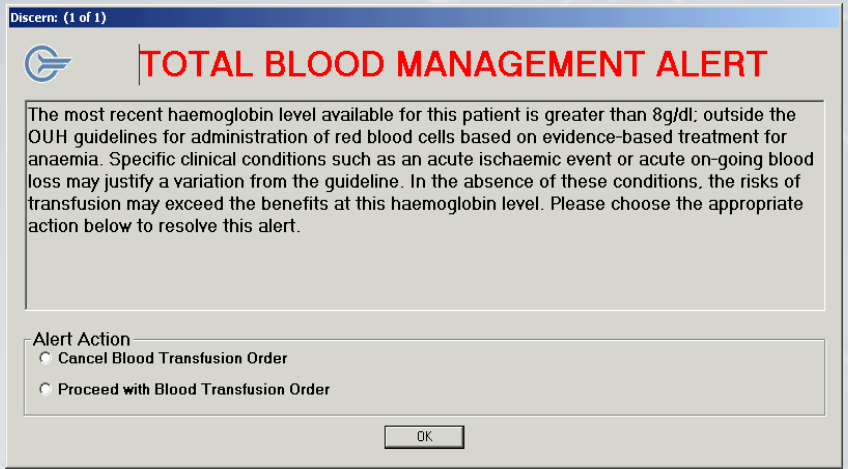
1 Capture the diagnostic group

2 Select a reason for transfusion

3 Automatic capture of the most recent relevant result



4 Alert if transfusion not justified



PICO questions

1. Is a specific **behavioural intervention** [intervention] more effective to improve blood product ordering [outcomes] compared to no/another behavioural intervention [comparison]? **(PICO 16)**

2. Is a specific **decision support system** [intervention] more effective to improve the appropriate use of blood products or clinical outcomes [outcome] compared to no intervention or another decision support system/behavioural intervention [comparison]? **(PICO 17)**

3. Is a **'comprehensive' PBM program** [intervention] effective to improve clinical and economic outcomes [outcomes] compared to no PBM program [comparison]? **(PICO 15)**

Selection criteria

POPULATION: patients who might need transfusion (surgical and non-surgical patients/ acute and chronic disease patients/adults and children) **(PICO 15-17)**

INTERVENTION:

Behavioural interventions (PICO 16):

- ➔ Guidelines
- ➔ Educational sessions (group or individual)
- ➔ Transfusion forms containing reminders of appropriate criteria for transfusion
- ➔ Audit with feedback (retrospective audits with feedback given to individuals or groups after the transfusion)
- ➔ Audit with approval (audit with approval needed before transfusion of products).

Decision support systems (PICO 17):

- ➔ Any electronic/computerised DSS that provides clinicians with recommendations on RBC, platelet, plasma, cryoprecipitate, or granulocyte ordering at the time the decision to order a transfusion is being made based on individual patient characteristics.

Comprehensive PBM programs (PICO 15):

- ➔ Component 1: interventions of at least 2 PBM pillars
- ➔ Component 2: behavioural interventions and/or decision support systems

COMPARISON (PICO 15-17): another or no intervention

OUTCOMES: blood product utilization **(PICO 15-17)**, clinical outcomes **(PICO 15)**, economic outcomes **(PICO 15)**

STUDY DESIGN: observational studies (cohort studies – before-after studies – time interrupted series) **(PICO 15-17)** and experimental studies (RCT) **(PICO 17)**

Flow chart PICO 16 (behavioural interventions)

Identification

Records identified through database searching (Pubmed, Embase, Transfusion Evidence Library) between 2010-2018 (n = 432)

Tinmouth review (2005) followed by a student's thesis (2010) (n = 28)

Screening

Records screened on title and abstract (n = 432)

Records excluded (n = 408)

Eligibility

Full-text articles assessed for eligibility (n = 24)

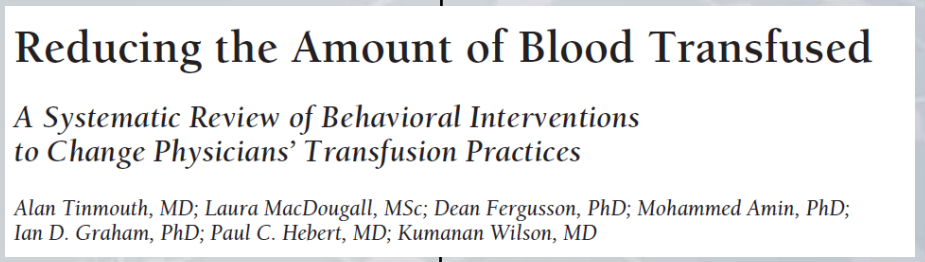
Records excluded (n = 18)
Reason for exclusion
•Outcome (n=10)
•Design (n=6)
•Intervention (n=2)

Included

n = 6

n = 13

n = 19 observational studies


Reducing the Amount of Blood Transfused

A Systematic Review of Behavioral Interventions to Change Physicians' Transfusion Practices

Alan Tinmouth, MD; Laura MacDougall, MSc; Dean Fergusson, PhD; Mohammed Amin, PhD; Ian D. Graham, PhD; Paul C. Hebert, MD; Kumanan Wilson, MD

Flow chart PICO 17 (decision support systems)

Computerised decision support systems to promote appropriate use of blood products

Sheila A Fisher[1], **Annemarie B Docherty**[2], **Carolyn Doree**[1], **Stephen P Hibbs**[3], **Michael F Murphy**[4], and **Lise J Estcourt**[5]

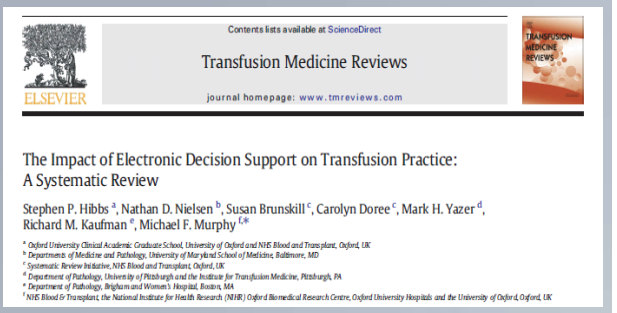
[1]Systematic Review Initiative, NHS Blood and Transplant, Oxford, UK

[2]Anaesthesia and Intensive Care, Royal Infirmary Edinburgh, Edinburgh, UK

[3]Department of Medicine, Queens Hospital, Barking, Havering and Redbridge NHS Trust, Romford, UK

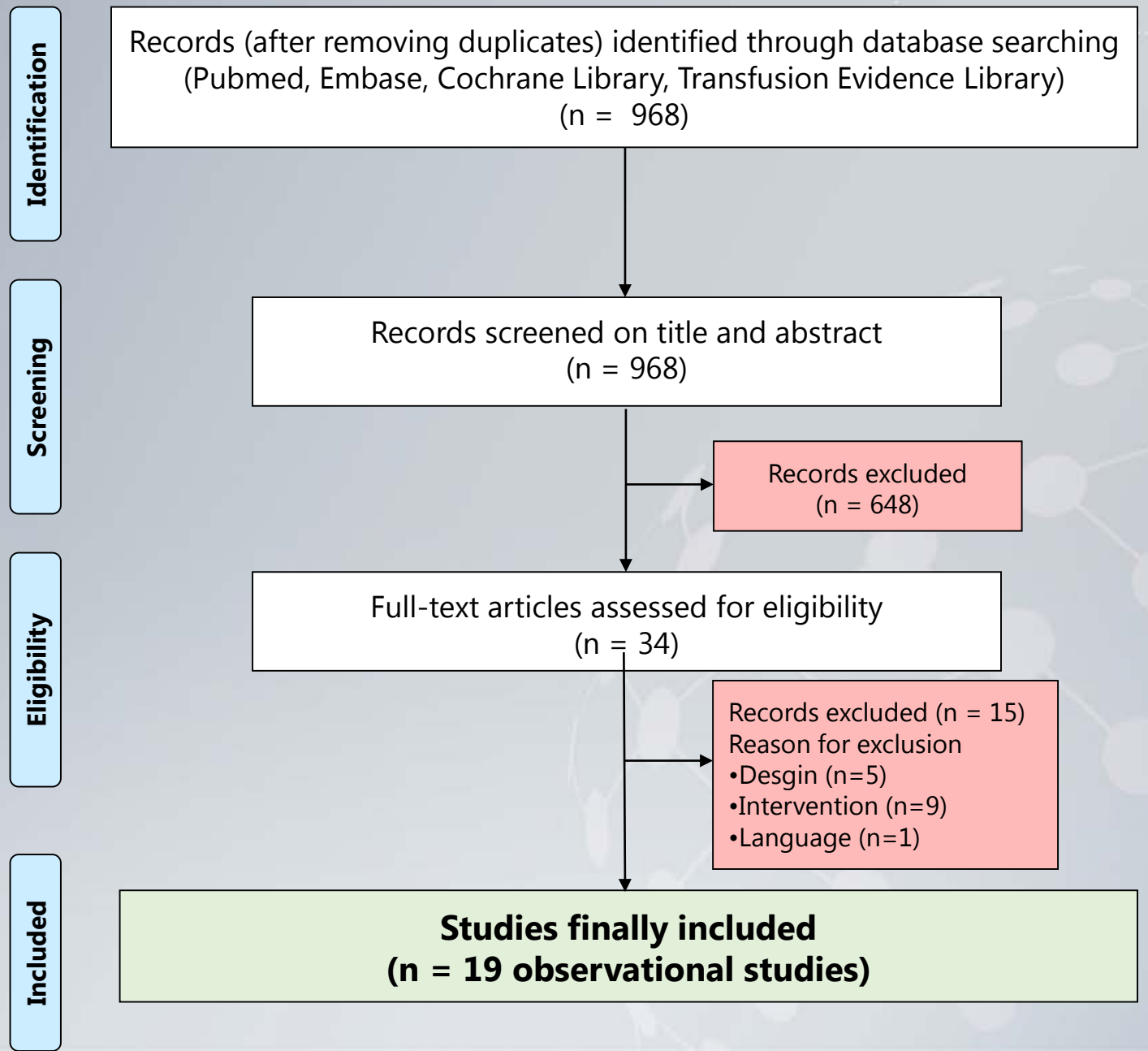
[4]NHS Blood and Transplant; National Institute for Health Research (NIHR) Oxford Biomedical Research Centre, Oxford University Hospitals NHS Foundation Trust and University of Oxford, Oxford, UK

[5]Haematology/Transfusion Medicine, NHS Blood and Transplant, Oxford, UK



3 observational studies (time interrupted series) and 1 experimental study (RCT)

Flow chart PICO 15 (comprehensive PBM programs)



Study characteristics PICO 16 (behavioural interventions)

Author, year, country	Study design	Targeted physicians
Abelow, 2017, Israel	Observational: Non-concurrent cohort study	Targeted physicians: all
Ballantyne, 2004, UK		Targeted physicians: surgeons
Brandis, 1994, South Africa		Targeted physicians: all
Cheng, 1996, Hong Kong		Targeted physicians: all
Eindhoven, 2005, The Netherlands		Targeted physicians: surgeons
Fontana, 2014, Switzerland		Targeted physicians: all
Garrioch, 2004, UK		Targeted physicians: all
Hui, 2005, Australia		Targeted physicians: all
Lee, 2015, Hong Kong		Targeted physicians: surgeons
Meyer, 2017, USA		Targeted physicians: anaesthesiologists
Mimica, 2008, Brazil		Targeted physicians: neonatal
Morrison, 1993, USA		Targeted physicians: obstetricians/gynaecologists
Muller, 2004, Switzerland		Targeted physicians: surgeons
Patel, 2016, USA		Targeted physicians: all
Sarode, 2010, USA		Targeted physicians: all
Spencer, 2005, UK		Targeted physicians: surgeons
Tavares, 2014, USA		Targeted physicians: all
Torella, 2002, UK		Targeted physicians: surgeons
Yeh, 2006, Taiwan		Targeted physicians: all

Study characteristics PICO 16 (behavioural interventions)

16 STUDIES COMPARING BEHAVIOURAL INTERVENTIONS VERSUS NO BEHAVIOURAL INTERVENTIONS

Author, year, country	Behavioural interventions				
	Guideline	Transfusion form	Audit-approval	Audit-feedback	Education
Abelow, 2017, Israel					
Ballantyne, 2004, UK					
Brandis, 1994, South Africa					
Cheng, 1996, Hong Kong					
Fontana, 2014, Switzerland					
Garrioch, 2004, UK					
Hui, 2005, Australia					
Lee, 2015, Hong Kong					
Meyer, 2017, USA					
Mimica, 2008, Brazil					
Morrison, 1993, USA					
Müller, 2004, Switzerland					
Sarode, 2010, USA					
Spencer, 2005, UK					
Torella, 2014, UK					
Yeh, 2006, Taiwan					

Study characteristics PICO 16 (behavioural interventions)

3 STUDIES COMPARING BEHAVIOURAL INTERVENTIONS VERSUS OTHER (BEHAVIOURAL) INTERVENTIONS

Author, year, country	Behavioural intervention		Other intervention			
	Guideline	Education	Guideline	Form	Audit-approval	Decision support system (CPOE)
Eindhoven, 2005, The Netherlands						
Patel, 2016, USA						
Tavares, 2014, USA						

Study characteristics PICO 17 (decision support systems)

3 different type of interventions[1] provided by the decision support system tested:

1. **"Simplest"**: advice on transfusion suitability based on single laboratory value compared with a given fixed threshold (e.g. Hb < 7g/dl)
2. **"More sophisticated"**: advice based on multiple criteria (e.g. lab values such as Hb, but also clinical symptoms such as cardiac ischemia or septic shock)
3. **"Most sophisticated"**: advice based on variable criteria (e.g. different Hb thresholds for different clinical symptoms or patient characteristics)

[1] Hibbs et al, Transfusion Medicine Reviews 2015, 29: 14-23

Study characteristics PICO 17 (decision support systems)

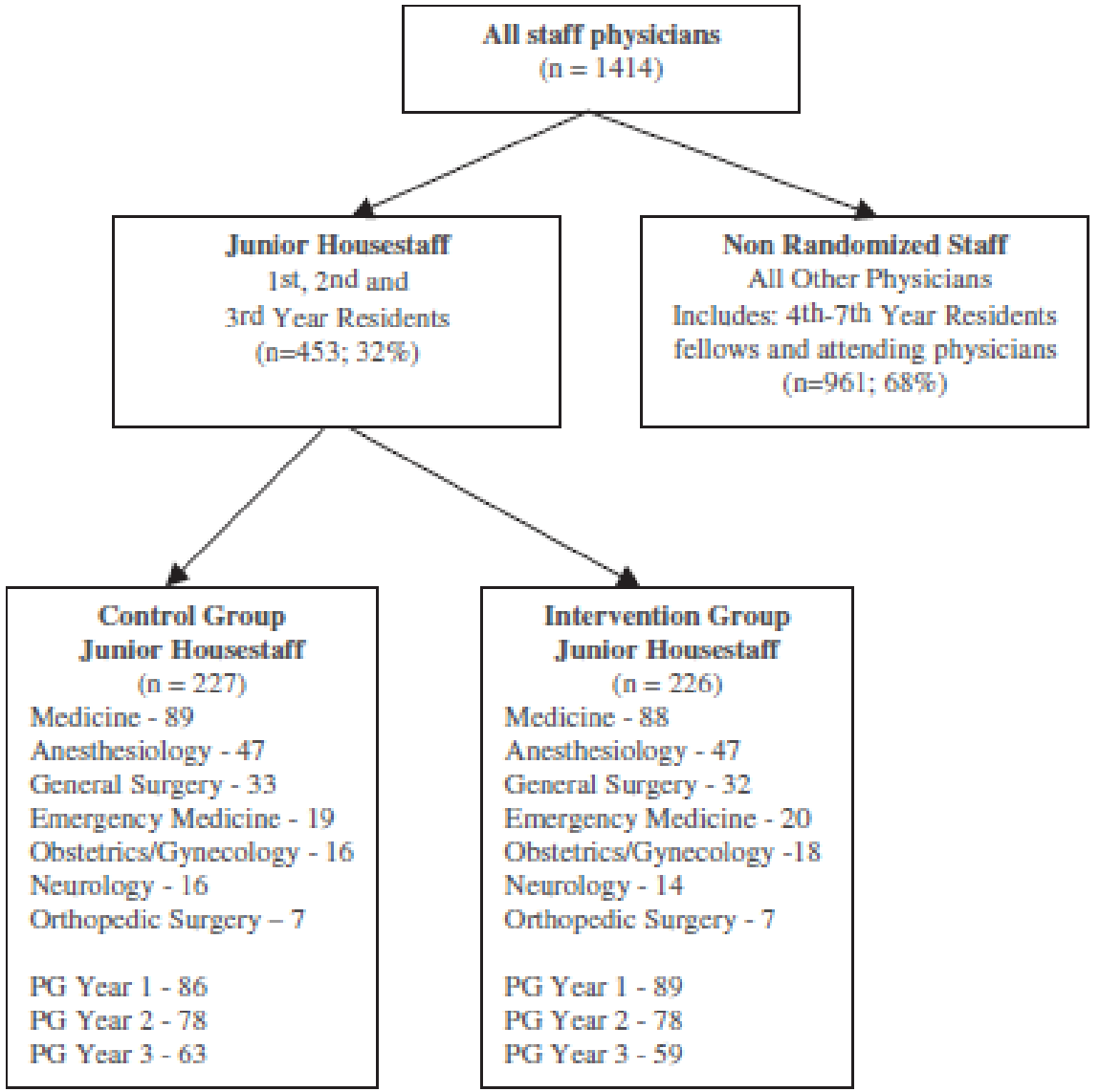
Author, year, country	Study design	Population	Intervention (decision support system (DSS))	Comparison
Adams, 2011, USA	Observational: interrupted time series (retrospective cohort study)	Children (medical, surgical, ICU) Study centre: single centre, tertiary hospital	**"More sophisticated"** CPOE (Cerner), alerts were created according to the current best-practice recommendations. The CPOE alert was designed to analyse the patient record and hemodynamic status Variables in the alert algorithm included the patient's age, diagnosis, most recent serum haemoglobin level and blood pressure.	Comparison: after DSS implementation versus before DSS implementation
Goodnough, 2014, USA	Observational: interrupted time series (retrospective cohort study)	177020 adult inpatient discharges (ED, medical, surgical, obstetrics, and ICU) Study centre: single centre, tertiary hospital	**"Simplest"** CPOE (Epic systems) Orders for RBC units triggered an interruptive alert in patients with the most recent (within 24 hr) Hb level of higher than 7 g/dL (8 g/dL in patients with acute coronary syndrome or post–cardiothoracic surgery). The alert contained the consensus guidelines, a link to relevant literature, and an "acknowledgment" reason for transfusion if the provider chose to continue with the RBC order.	Comparison: after DSS implementation versus before DSS implementation
Kassakian, 2016, USA	Observational: interrupted time series (retrospective)	All adult patients admitted to all services except obstetrics Study centre: single centre, tertiary hospital	**"More sophisticated"** Htc ≥21% and order for RBC transfusion is followed by an interruptive alert which also allows the user to turn off the alert with common reasons for RBC transfusion in patients with Htc ≥21% such as tachycardia, hypotension, active bleeding, acute coronary syndrome, instability, and imminent surgery.	Comparison: after DSS implementation versus before DSS implementation
Rothschild, 2007, USA	Experimental: randomized controlled trial	453 Junior Housestaff (1st, 2nd and 3rd year residents; medical, surgical, obstetrics, ICU) randomized into the intervention group (DSS) (n=227) and a control group (no DSS) (n=226) Study centre: single centre, tertiary hospital	**"Most sophisticated"** Details of DSS: Hct level for RBC, Plt count for Plt, PT/INR or APIT for plasma. DS-recommended doses were calibrated to patient characteristics and the preceding "trigger" laboratory results for component blood orders The DS logic recommended a dose (number of units) of product based on the most recent laboratory values, the patient's characteristics, and the expected therapeutic result of the product.	Comparison: DSS (CPOE system) versus no DSS

Study characteristics PICO 17 (decision support systems)
Only one randomized controlled trial (RCT)

Assessment of education and computerized decision support interventions for improving transfusion practice

Jeffrey M. Rothschild, Siobhan McGurk, Melissa Honour, Linh Lu, Aubre A. McClendon, Priya Srivastava, W. Hallowell Churchill, Richard M. Kaufman, Jerry Avorn, E. Francis Cook, and David W. Bates

TRANSFUSION 2007;47:228-239.



Study characteristics PICO 15 (comprehensive PBM programs)

Author, year, country	Targeted physicians		
	Surgeons	All	Unclear
Frank, 2017, USA			
Frew, 2016, UK			
Gross, 2015, USA			
Gross, 2016, USA			
Kansagra, 2017, USA			
Kopanidis, 2016, Australia			
Leahy, 2014, Australia			
Leahy, 2017, Australia (1)			
Leahy, 2017, Australia (2)			
Loftus, 2016, USA			
Mehra, 2015, Switzerland			
Meybohm, 2016, Germany			
Rineau, 2016, France			
Ternström, 2014, Sweden			
Thakkar, 2016, USA			
Theusinger, 2014, Switzerland			
Verdecchia, 2016, USA			
Xydas, 2012, USA			
Yaffee, 2014, USA			

Surgeons in 5 studies (26%)

All physicians in 11 studies (58%)

No information in 3 studies (16%)

Study characteristics PICO 15 (comprehensive PBM programs)

Author, year, country	Category					
	Cardiac surgery	Orthopaedic surgery	Gastrointestinal surgery	General surgery	General Medical	Malignant disease
Frank, 2017, USA						
Frew, 2016, UK						
Gross, 2015, USA						
Gross, 2016, USA						
Kansagra, 2017, USA						
Kopanidis, 2016, Australia						
Leahy, 2014, Australia						
Leahy, 2017, Australia (1)						
Leahy, 2017, Australia (2)						
Loftus, 2016, USA						
Mehra, 2015, Switzerland						
Meybohm, 2016, Germany						
Rineau, 2016, France						
Ternström, 2014, Sweden						
Thakkar, 2016, USA						
Theusinger, 2014, Switzerland						
Verdecchia, 2016, USA						
Xydas, 2012, USA						
Yaffee, 2014, USA						

Orthopaedic surgery: 6 studies (31%)

General surgery + medical : 6 studies (31%)

Cardiac surgery: 4 studies (21%)

Malignant disease: 2 studies (11%)

General surgery: 1 study (6%)

Study characteristics PICO 15 (comprehensive PBM programs)

Author, year, country	Intervention(s) to promote/monitor comprehensive/multi-faceted PBM programs						
	Guideline	Form	Audit	Education	Kotter principles	Decision support	Monitoring
Frank, 2017, USA	■	■	■	■	■	■	■
Frew, 2016, UK	■	■	■	■	■	■	■
Gross, 2015, USA	■	■	■	■	■	■	■
Gross, 2016, USA	■	■	■	■	■	■	■
Kansagra, 2017, USA	■	■	■	■	■	■	■
Kopanidis, 2016, Australia	■	■	■	■	■	■	■
Leahy, 2014, Australia	■	■	■	■	■	■	■
Leahy, 2017, Australia (1)	■	■	■	■	■	■	■
Leahy, 2017, Australia (2)	■	■	■	■	■	■	■
Loftus, 2016, USA	■	■	■	■	■	■	■
Mehra, 2015, Switzerland	■	■	■	■	■	■	■
Meybohm, 2016, Germany	■	■	■	■	■	■	■
Rineau, 2016, France	■	■	■	■	■	■	■
Ternström, 2014, Sweden	■	■	■	■	■	■	■
Thakkar, 2016, USA	■	■	■	■	■	■	■
Theusinger, 2014, Switzerland	■	■	■	■	■	■	■
Verdecchia, 2016, USA	■	■	■	■	■	■	■
Xydas, 2012, USA	■	■	■	■	■	■	■
Yaffee, 2014, USA	■	■	■	■	■	■	■

- ✓ Guideline only in 6 studies (31%)
- ✓ Guideline + decision support in 2 studies (10.5%)
- ✓ Guideline + monitoring in 1 study (6%)
- ✓ Guideline + 1-2 extra behavioural interventions in 4 studies (21%)
- ✓ Guideline + >2 extra behavioural interventions in 2 studies (10.5%)
- ✓ Guideline + ≥1 extra behavioural interventions + decision support/monitoring in 4 studies (21%)

Study characteristics PICO 15 (comprehensive PBM programs)

Author, year, country	PILLAR MANAGE ANAEMIA			PILLAR MINIMZE BLOOD LOSS						PILLAR OPTIMIZE ERYTHROPOEISIS		
	(Evidence-based) transfusion guidelines											
	RBC Transfusion guidelines (restrictive transfusion trigger (usually 7-8 g/dL in stable/fit patients or 8-9 g/dL in unstable/older patient with(out) cardiovascular disease, usually emphasis on single-unit transfusion)	PLT transfusion guidelines (a PLT count of fewer than 100 x 109/L and a prolonged prothrombin time)	FFP transfusion guidelines (prolonged coagulation time or Factor V activity <20%)	Pharmacologic - hemostatic agents	Anesthetic blood conserving strategies	Hemostasis - anticoagulation management	Autologous blood alvage	Blood-sparing surgical techniques	Meticulous hemostasis and surgical techniques	ESA/iron therapy if appropriate	Evaluate underlying anemia	Refer for further evaluation if necessary
Frank, 2017, USA												
Frew, 2016, UK												
Gross, 2015, USA												
Gross, 2016, USA												
Kansagra, 2017, USA												
Kopanidis, 2016, Australia												
Leahy, 2014, Australia												
Leahy, 2017, Australia (1)												
Leahy, 2017, Australia (2)												
Loftus, 2016, USA												
Mehra, 2015, Switzerland												
Meybohm, 2016, Germany												
Rineau, 2016, France												
Ternström, 2014, Sweden												
Thakkar, 2016, USA												
Theusinger, 2014, Switzerland												
Verdecchia, 2016, USA												
Xydas, 2012, USA												
Yaffee, 2014, USA												

Study characteristics PICO 15 (comprehensive PBM programs)

- ✓ Pillar manage anaemia
  - ✓ RBC transfusion strategies: 19 studies
  - ✓ PLT transfusion strategies: 2 studies
  - ✓ FFP transfusion strategies: 2 studies

- ✓ Pillar minimize blood loss
  - ✓ Pharmacologic – hemostatic agents: 12 studies
  - ✓ Anesthetic blood conserving strategies: 6 studies
  - ✓ Hemostasis – anticoagulation management: 1 study
  - ✓ Autologous blood salvage: 6 studies
  - ✓ Blood-sparing surgical techniques: 6 studies
  - ✓ Meticulous hemostasis and surgical techniques: 5 studies

- ✓ Pillar optimize erythropoiesis
  - ✓ ESA/iron therapy if appropriate: 14 studies
  - ✓ Evaluate underlying anaemia: 5 studies
  - ✓ Refer for further evaluation if necessary: 3 studies

Study characteristics PICO 15 (comprehensive PBM programs)

Author, year, country	Follow-up period (months)
Frank, 2017, USA	30
Frew, 2016, UK	60
Gross, 2015, USA	66
Gross, 2016, USA	60
Kansagra, 2017, USA	15
Kopanidis, 2016, Australia	24
Leahy, 2014, Australia	36
Leahy, 2017, Australia (1)	54
Leahy, 2017, Australia (2)	54
Loftus, 2016, USA	12
Mehra, 2015, Switzerland	12
Meybohm, 2016, Germany	12-30
Rineau, 2016, France	6
Ternström, 2014, Sweden	12
Thakkar, 2016, USA	12
Theusinger, 2014, Switzerland	36
Verdecchia, 2016, USA	96
Xydas, 2012, USA	6
Yaffee, 2014, USA	24

Median follow-up: 24 months [IQR: 42 months]

1. How substantial are the desirable anticipated effects? (= how large are the desirable effects of the intervention taking into account the importance of the outcomes (how much they are valued), and the size of the effect (the likelihood of experiencing a benefit or how much of an improvement individuals would be likely to experience)?)

- Trivial
- Small
- Moderate
- Large

- Varies
- Don’t know

2. How substantial are the undesirable anticipated effects? (= how large are the undesirable effects of the intervention taking into account the importance of the outcomes (how much they are valued), and the size of the effect (the likelihood of experiencing a benefit or how much of an improvement individuals would be likely to experience)?)

- Large
- Moderate
- Small
- Trivial

- Varies
- Don’t know

3. Does the balance between desirable and undesirable effects favor the intervention or the comparison? (= what is the balance between the desirable and undesirable effects, taking into account how much individuals value the main outcomes, how substantial the desirable and undesirable effect are and the certainty of those estimates?)

- Favors the comparison
- Probably favors the comparison
- Does not favor either the intervention or the comparison
- Probably favors the intervention
- Favors the intervention

- Varies
- Don’t know

Critical outcomes

Effect on blood product utililization

- Red cells
- FFP
- Platelets

Critical outcomes

Effect on blood product utililization

- Red cells
- FFP
- Platelets

Effect on clinical outcomes

- Hospital mortality
- 30 day mortality
- 30 day readmission
- Myocardial infarction
- Ischaemic stroke
- Kidney injury
- Length of hospital stay

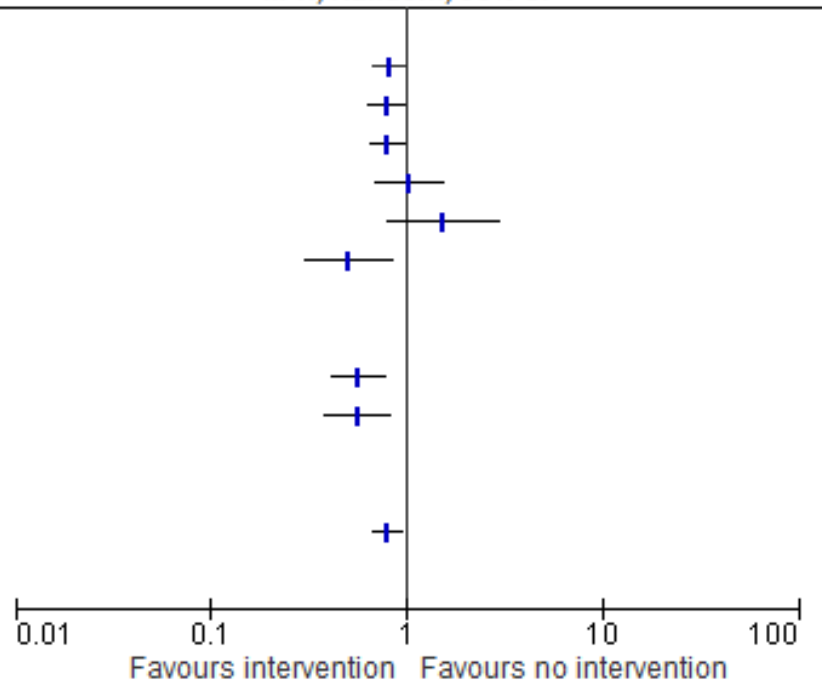
Effect on blood product utilization

RBC utililization

Behavioural intervention versus no behavioural intervention (PICO 16)

Outcome: Number of patients/admissions that received RBC transfusions

Study or Subgroup	Behavioral intervention Events	Total	No intervention Events	Total	Risk Ratio M-H, Random, 95% CI
1.8.1 Guideline					
Fontana 2004 - Number of patients transfused	151	896	258	1238	0.81 [0.67, 0.97]
Mimica 2008 - proportion of infants transfused	48	78	54	69	0.79 [0.63, 0.97]
Torella 2002 (CABG) - Nr of patients transfused	90	200	114	200	0.79 [0.65, 0.96]
Torella 2002 (Colectomy) - Nr of pts transfused	22	40	24	45	1.03 [0.70, 1.53]
Torella 2002 (prostatectomy) - Patients transfused	18	78	12	80	1.54 [0.79, 2.98]
Torella 2002 (THR) - Nr of patients transfused	15	57	26	50	0.51 [0.30, 0.84]
1.8.2 Guideline + Education					
Müller 2004 - operations requiring transfusion	44	222	79	226	0.57 [0.41, 0.78]
Spencer 2005 - transfusion rate	18	45	45	63	0.56 [0.38, 0.83]
1.8.3 Guideline + Education + Form + Audit/feedback					
Garrioch 2004 - patients transfused	257	7336	320	7262	0.80 [0.68, 0.93]



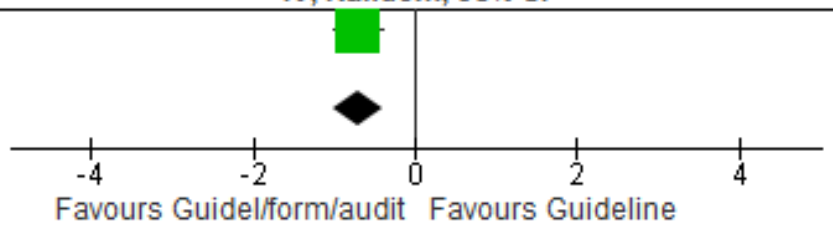
Behavioural intervention versus other behavioural intervention (PICO 16)

Guideline + Form + Audit versus Guideline only

Outcome: Number of RBC units transfused (per patient)

Study or Subgroup	Guideline + form + audit Mean	SD	Total	Guideline Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Eindhoven 2005	0.3	0.9	186	1	2	186	100.0%	-0.70 [-1.02, -0.38]
Total (95% CI)			**186**			**186**	**100.0%**	**-0.70 [-1.02, -0.38]**

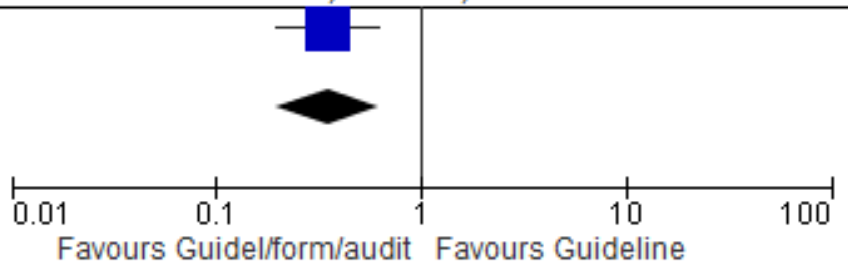
Heterogeneity: Not applicable
Test for overall effect: Z = 4.35 (P < 0.0001)



Outcome: proportion of patients receiving RBC transfusion

Study or Subgroup	Guideline + form + audit Events	Total	Guideline Events	Total	Weight	Risk Ratio M-H, Random, 95% CI
Eindhoven 2005	14	186	40	186	100.0%	0.35 [0.20, 0.62]
Total (95% CI)		**186**		**186**	**100.0%**	**0.35 [0.20, 0.62]**
Total events	14		40			

Heterogeneity: Not applicable
Test for overall effect: Z = 3.59 (P = 0.0003)



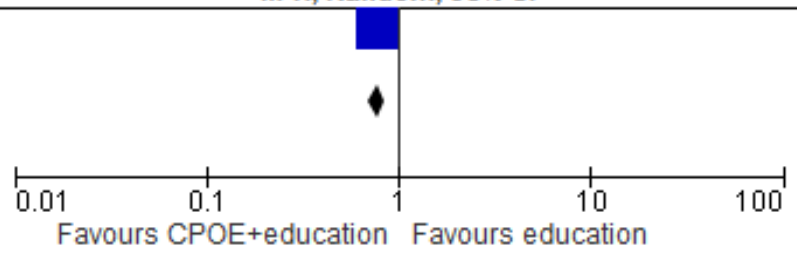
Behavioural intervention versus other behavioural intervention (PICO 16)

Education + DSS (CPOE) versus Education only

Outcome: Number of RBC units transfused (per 1000 discharges)

Study or Subgroup	CPOE + Education Events	Total	Education Events	Total	Weight	Risk Ratio M-H, Random, 95% CI
Tavares 2014 - Nr RBC transf per 1000 discharges	394	1000	512	1000	100.0%	0.77 [0.70, 0.85]
Total (95% CI)		**1000**		**1000**	**100.0%**	**0.77 [0.70, 0.85]**
Total events	394		512			

Heterogeneity: Not applicable
Test for overall effect: Z = 5.25 (P < 0.00001)



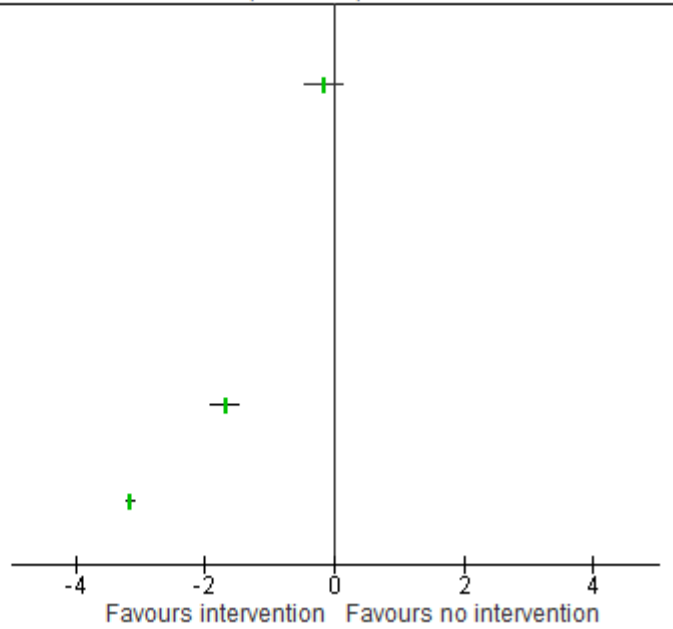
Outcome: % RBC orders with a pretransfusion Hb level >8 g/dL

No statistical significant results (6.1% vs 6.3%, p>0.05) (Patel 2016)

Behavioural intervention versus no behavioural intervention (PICO 16)

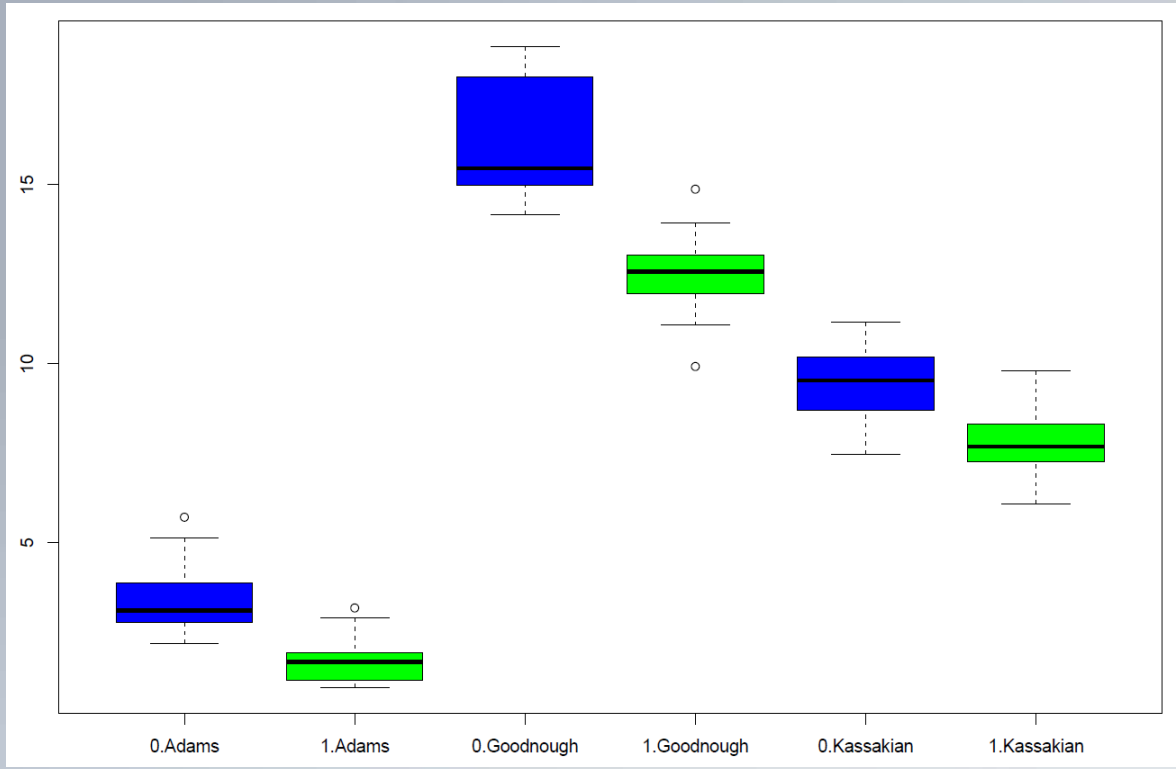
Outcome: Number of RBC units transfused (continuous)

Study or Subgroup	Behavioral intervention Mean	SD	Total	No intervention Mean	SD	Total	Std. Mean Difference IV, Random, 95% CI
1.1.1 Guideline							
Fontana 2014 - RBC units per patient	0.4	0	0	0.5	0	0	Not estimable
Lee 2015 - RBC units transfused	1.67	0.58	96	1.8	0.92	97	-0.17 [-0.45, 0.11]
Mimica 2008 - median volume RBC transfused	15	0	48	36	0	54	Not estimable
Torella 2002 (CABG) - median units transfused	0	0	0	1	0	0	Not estimable
Torella 2002 (Colectomy) - median units transfused	0	0	0	2	0	0	Not estimable
Torella 2002 (THR) - median units transfused	2	0	0	2	0	0	Not estimable
1.1.2 Guideline + Education							
Patel 2016 - %RBC orders Hb 8 g/dL	6.36	0	0	16.64	0	0	Not estimable
1.1.3 Guideline + Education + Form + Audit/feedback							
Morrison 1993 - RBC units transfused monthly	40.7	17.2	144	107.9	45.96	336	-1.69 [-1.92, -1.47]
1.1.4 Form + Audit/feedback							
Yeh 2006 - Nr of RBC units transfused monthly	3,769	271.3	3769	4,442.3	147.6	4442	-3.15 [-3.22, -3.09]

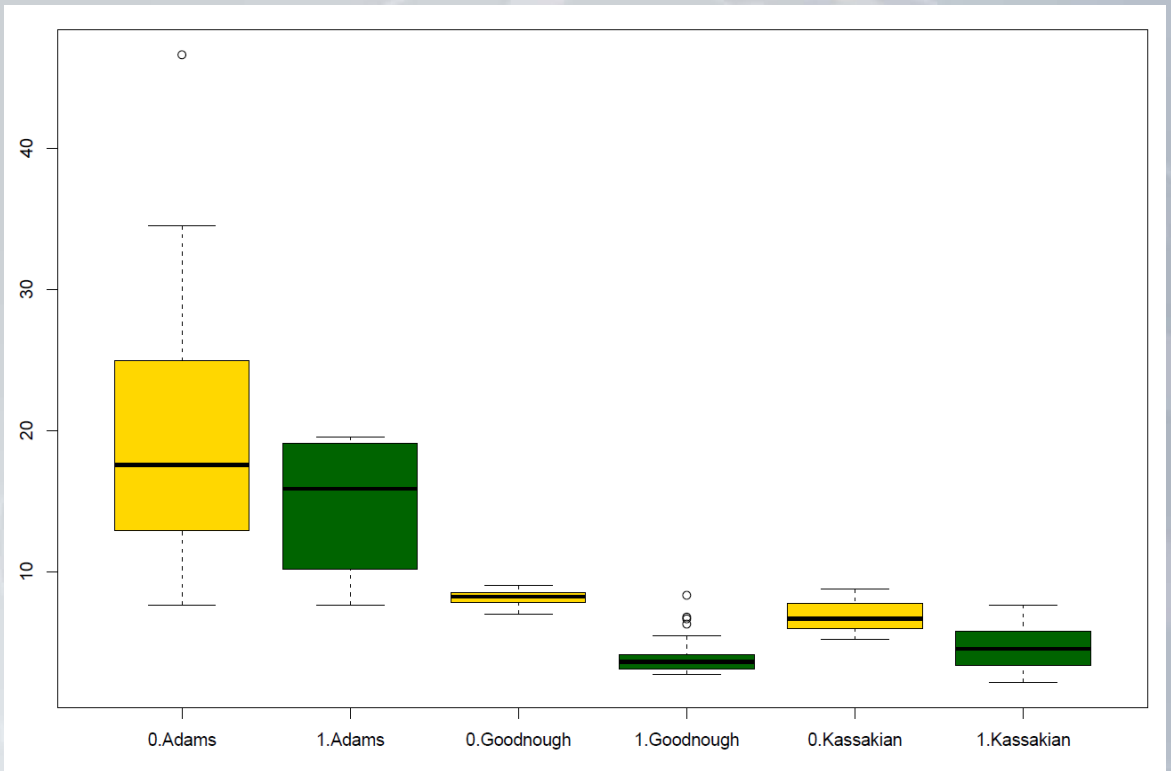


Decision support system versus no decision support system (PICO 17)

Outcome: Overall RBC usage: number of RBC transfusion per 100 inpatient days



Outcome: Inappropriate RBC usage: number of RBC transfusion per 100 inpatient days



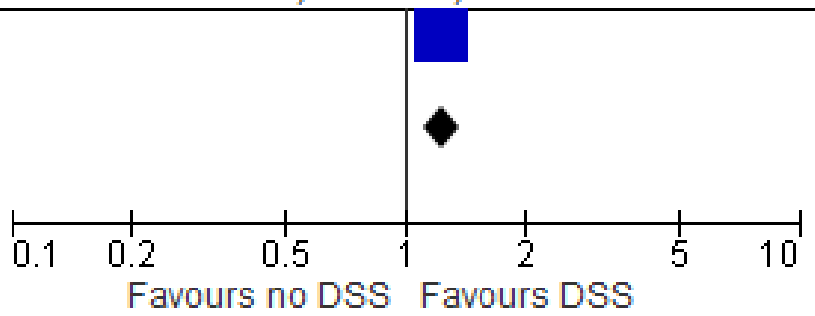
Decision support system versus no decision support system (PICO 17)

Outcome: Appropriate RBC transfusions

Study or Subgroup	DSS Events	DSS Total	no DSS Events	no DSS Total	Weight	Risk Ratio M-H, Random, 95% CI
Rothschild 2007	546	1350	503	1546	100.0%	1.24 [1.13, 1.37]
Total (95% CI)		**1350**		**1546**	**100.0%**	**1.24 [1.13, 1.37]**
Total events	546		503			

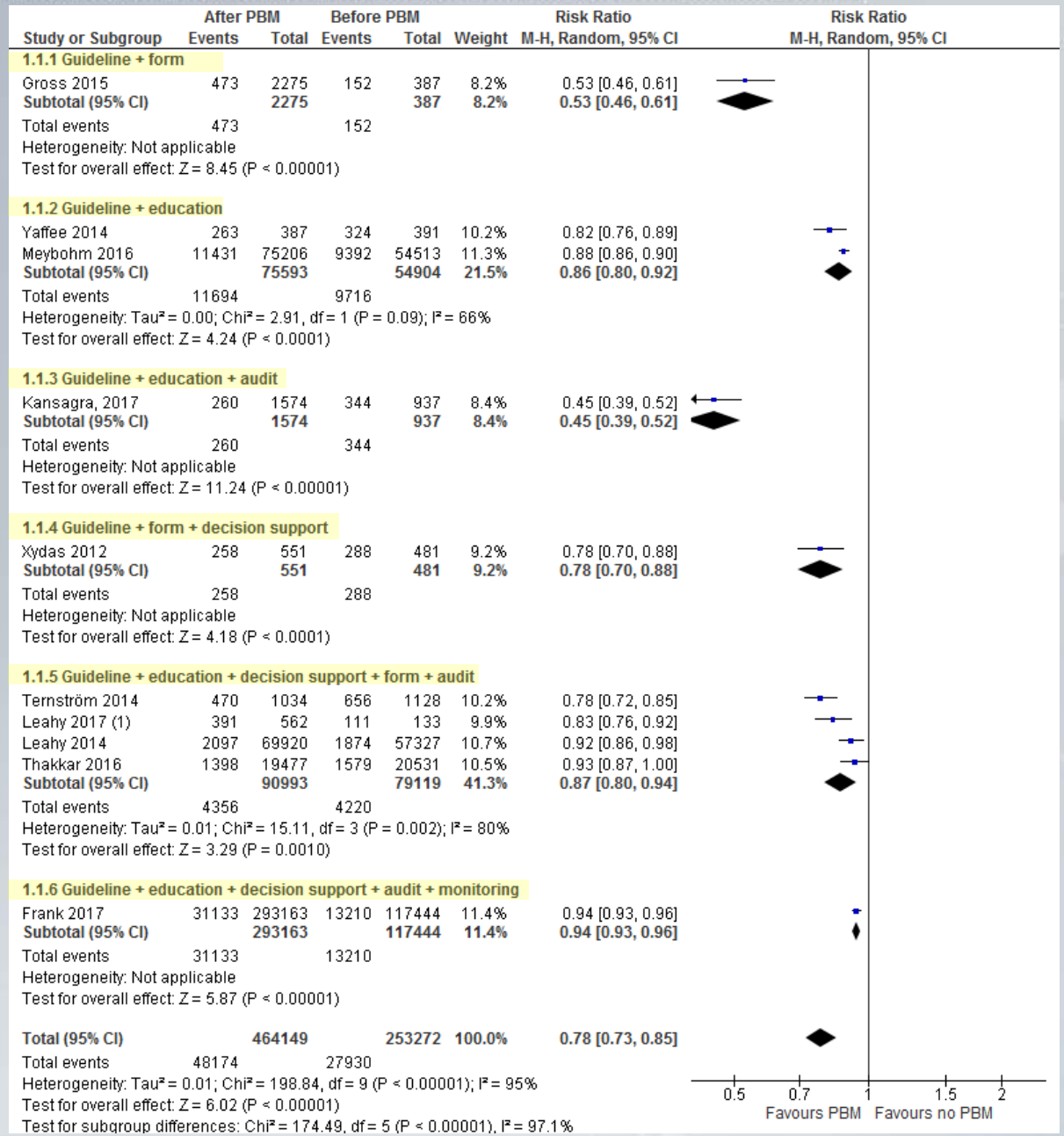
Heterogeneity: Not applicable

Test for overall effect: Z = 4.41 (P < 0.0001)



Behavioural interventions/DSS/monitoring in comprehensive PBM programs (PICO 15)

Outcome: Number of patients/admissions that received RBC transfusions



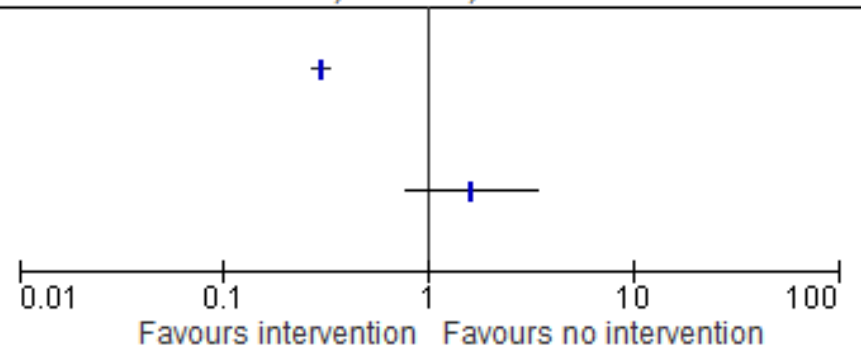
Effect on blood product utilization

FFP utililization

Behavioural interventions (PICO 16)

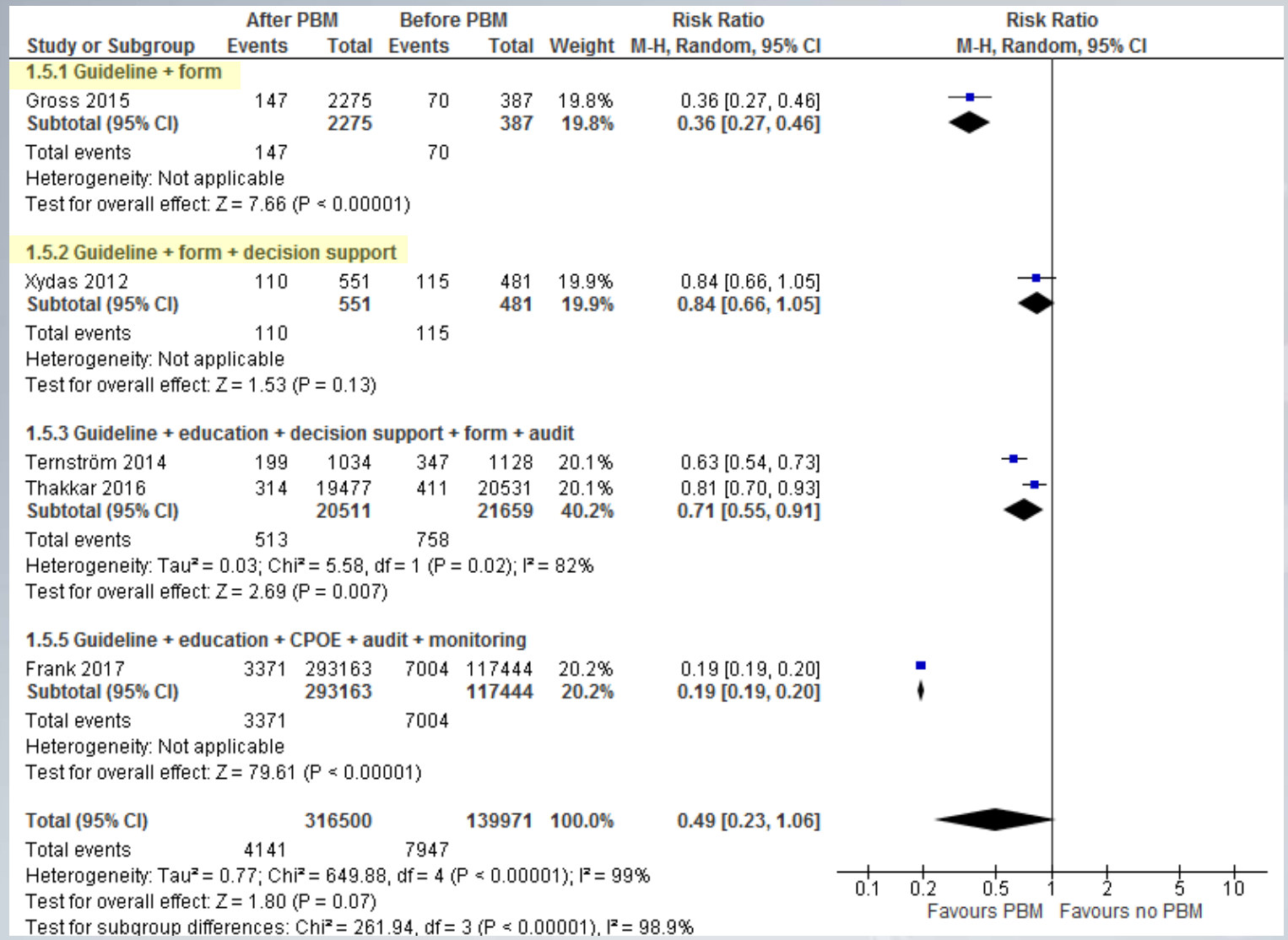
Outcome: Number of patients/admissions that received FFP transfusions

Study or Subgroup	Behavioral intervention Events	Total	No intervention Events	Total	Risk Ratio M-H, Random, 95% CI
1.9.1 Audit/approval + Form					
Cheng 1996 - inappropriate FFP transfusions	293	1375	1424	2005	0.30 [0.27, 0.33]
1.9.2 Guideline + Form + Audit/feedback					
Hui 2005 - inappropriate FFP transfusions	17	137	10	131	1.63 [0.77, 3.42]



Behavioural interventions/DSS/monitoring in comprehensive PBM programs (PICO 15)

Outcome: Number of patients/admissions that received FFP transfusions



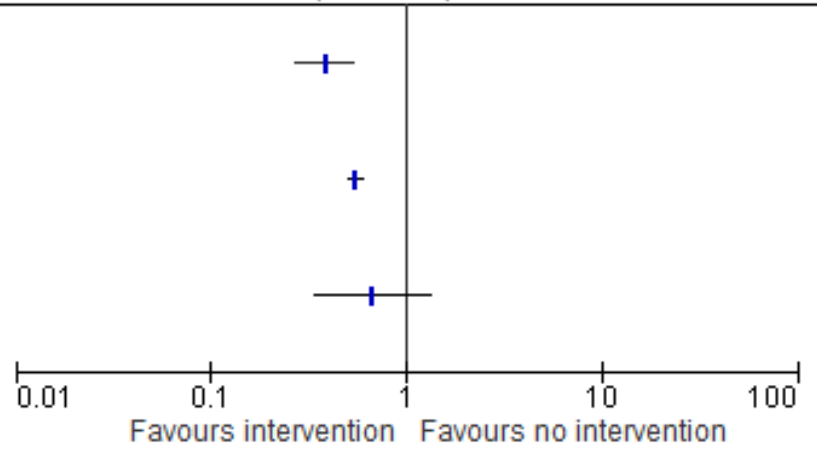
Effect on blood product utilization

PLT utililization

Behavioural interventions (PICO 16)

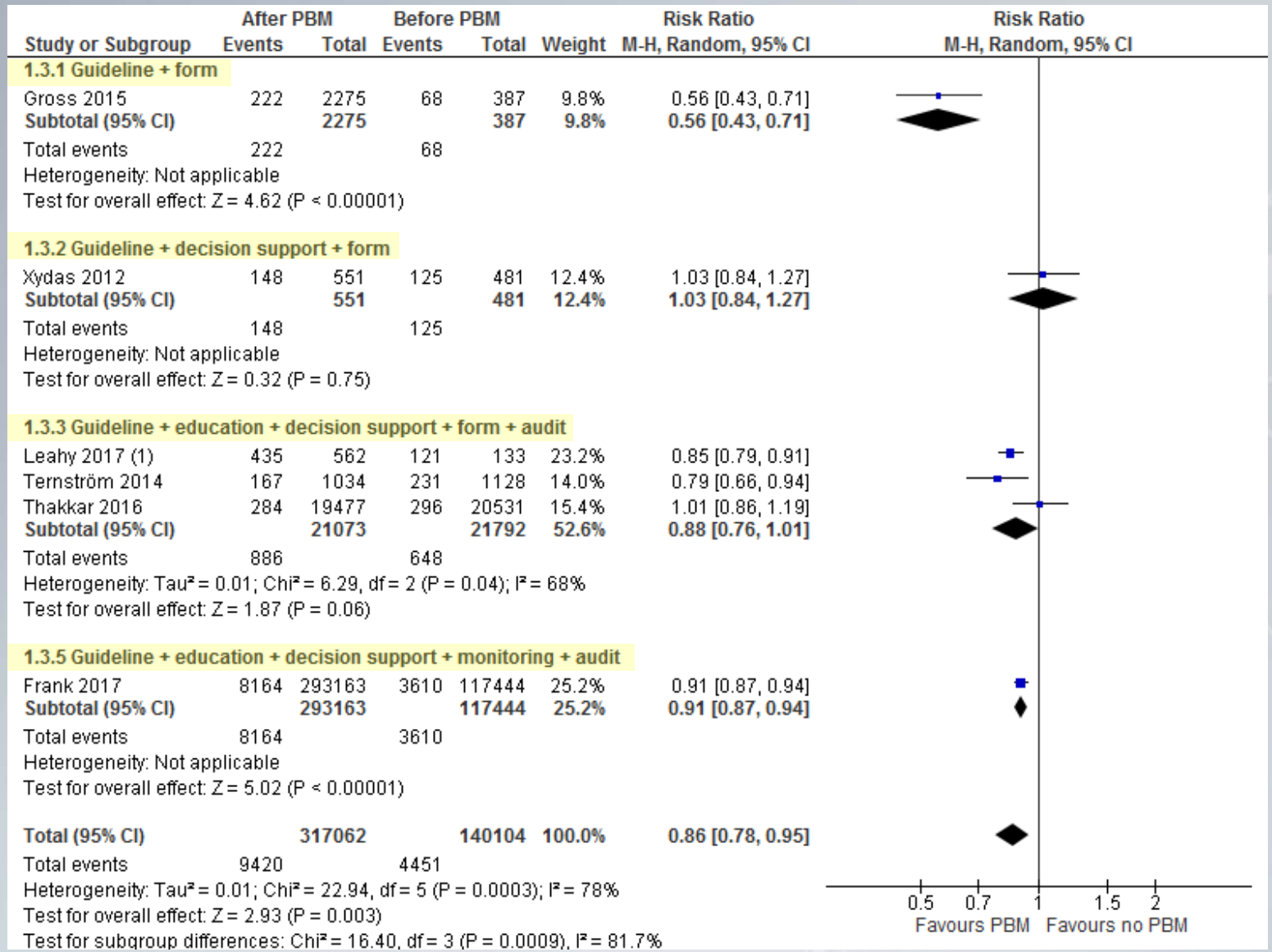
Outcome: Number of patients/admissions that received PLT transfusions

Study or Subgroup	Behavioral intervention Events	Total	No intervention Events	Total	Risk Ratio M-H, Random, 95% CI
1.10.1 Guideline					
Ballantyne 2004 - transfusion rate	35	295	122	393	0.38 [0.27, 0.54]
1.10.2 Audit/approval + Form					
Cheng 1996 - inappropriate PLT transfusions	673	5427	1488	6586	0.55 [0.50, 0.60]
1.10.3 Guideline + Form + Audit/feedback					
Hui 2005 - inappropriate PLT transfusions	14	444	18	385	0.67 [0.34, 1.34]



Behavioural interventions/DSS/monitoring in comprehensive PBM programs (PICO 15)

Outcome: Number of patients/admissions that received PLT transfusions

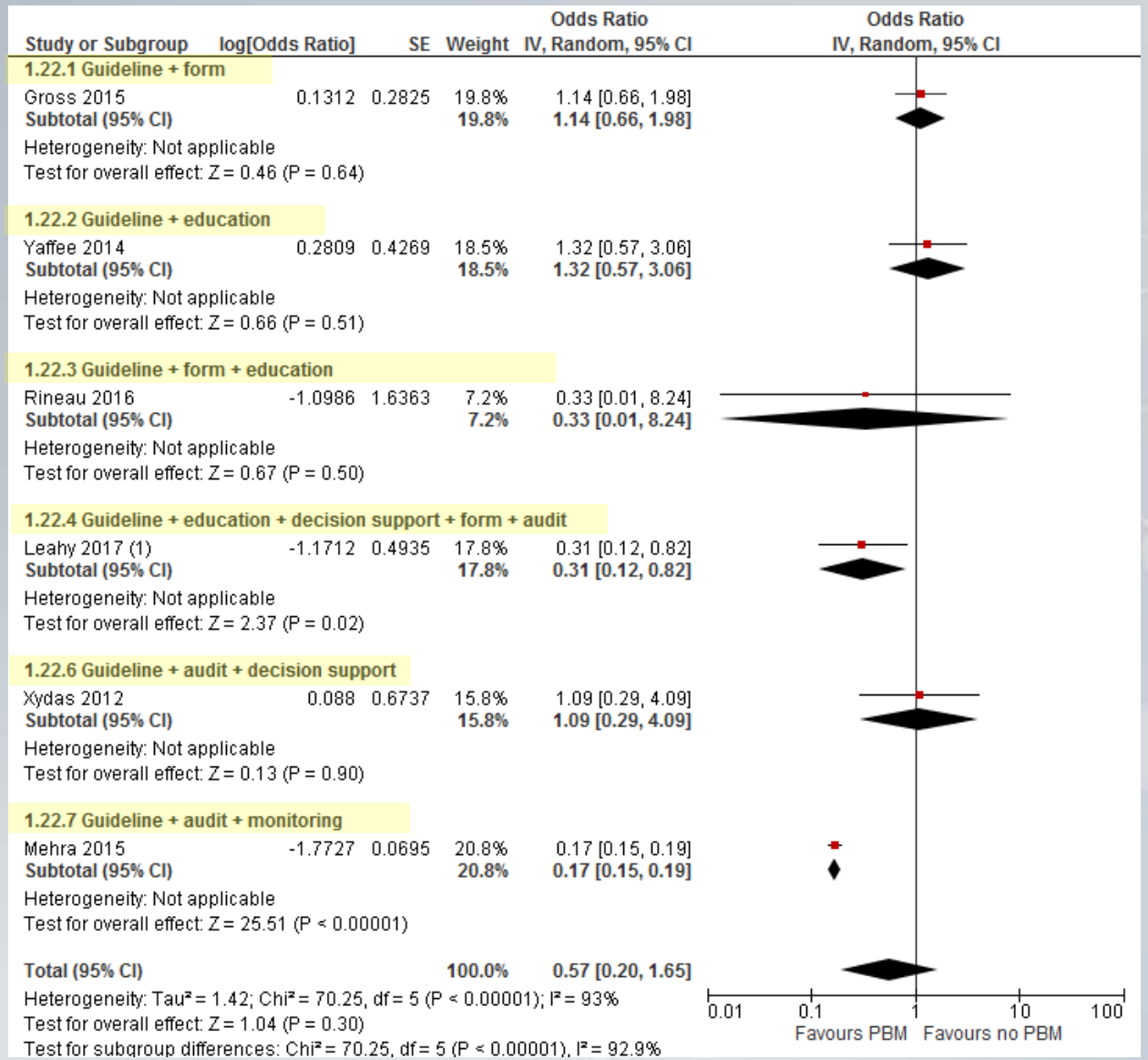


Effect on clinical outcomes

Hospital mortality

Behavioural interventions/DSS/monitoring in comprehensive PBM programs (PICO 15)

Outcome: hospital mortality



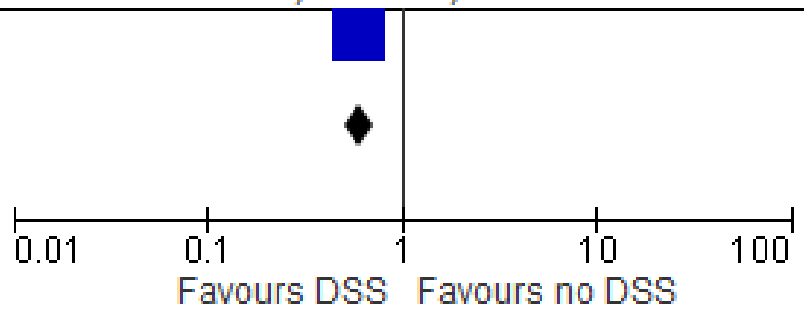
Decision support system versus no decision support system (PICO 17)

Outcome: Mortality

Study or Subgroup	DSS Events	DSS Total	no DSS Events	no DSS Total	Weight	Risk Ratio M-H, Random, 95% CI
Goodnough 2014	347	10528	199	3622	100.0%	0.60 [0.51, 0.71]
Total (95% CI)		**10528**		**3622**	**100.0%**	**0.60 [0.51, 0.71]**
Total events	347		199			

Heterogeneity: Not applicable

Test for overall effect: Z = 5.89 (P < 0.00001)



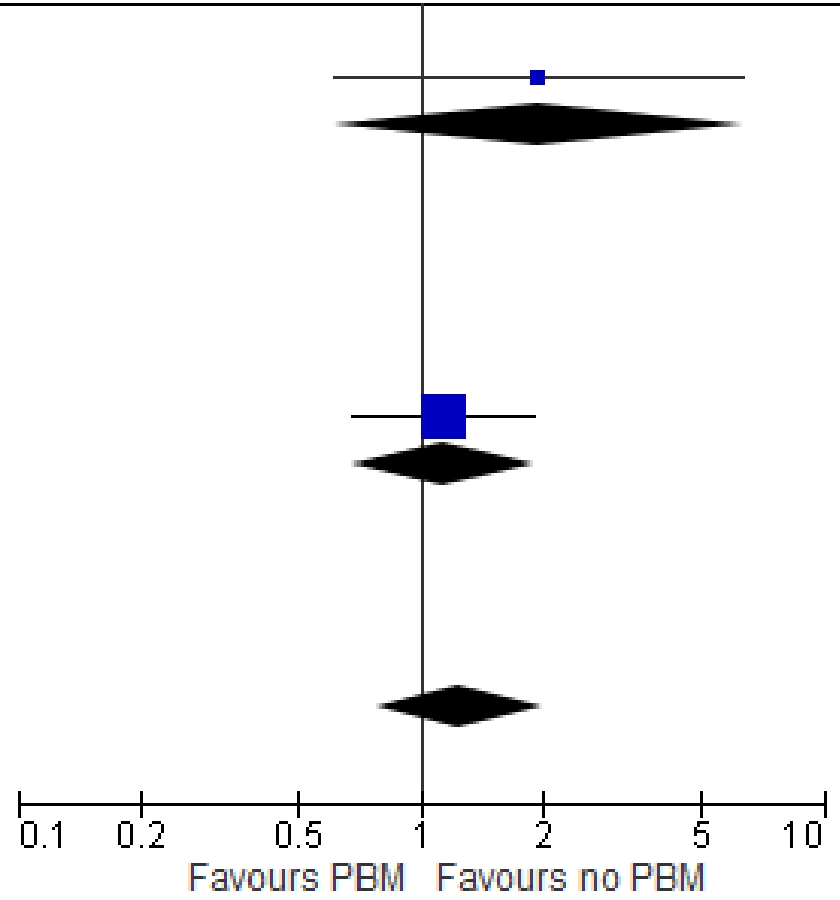
Effect on clinical outcomes

30-day mortality – 30-day readmission

Behavioural interventions/DSS/monitoring in comprehensive PBM programs (PICO 15)

Outcome: 30-day mortality

Study or Subgroup	After PBM Events	After PBM Total	Before PBM Events	Before PBM Total	Weight	Risk Ratio M-H, Random, 95% CI
1.23.1 Guideline + decision support						
Xydas 2012	9	551	4	481	16.6%	1.96 [0.61, 6.34]
Subtotal (95% CI)		**551**		**481**	**16.6%**	**1.96 [0.61, 6.34]**
Total events	9		4			
Heterogeneity: Not applicable						
Test for overall effect: Z = 1.13 (P = 0.26)						
1.23.2 Guideline + education + form						
Ternström 2014	27	1034	28	1228	83.4%	1.15 [0.68, 1.93]
Subtotal (95% CI)		**1034**		**1228**	**83.4%**	**1.15 [0.68, 1.93]**
Total events	27		28			
Heterogeneity: Not applicable						
Test for overall effect: Z = 0.51 (P = 0.61)						
Total (95% CI)		**1585**		**1709**	**100.0%**	**1.25 [0.78, 2.02]**
Total events	36		32			
Heterogeneity: Tau² = 0.00; Chi² = 0.68, df = 1 (P = 0.41); I² = 0%						
Test for overall effect: Z = 0.92 (P = 0.36)						
Test for subgroup differences: Chi² = 0.68, df = 1 (P = 0.41), I² = 0%						



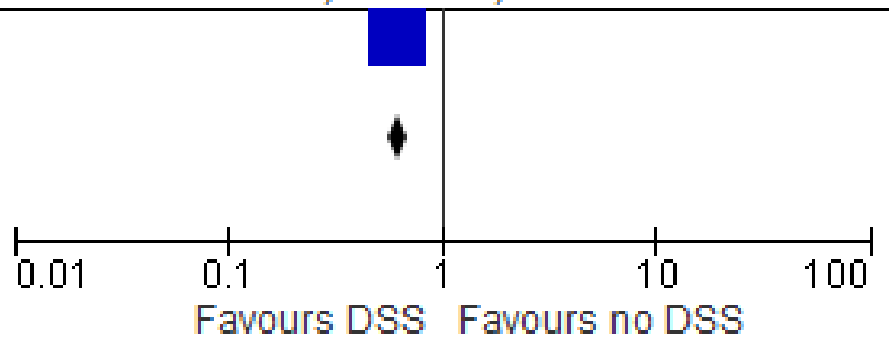
Decision support system versus no decision support system (PICO 17)

Outcome: 30-day readmission

Study or Subgroup	DSS Events	DSS Total	no DSS Events	no DSS Total	Weight	Risk Ratio M-H, Random, 95% CI
Goodnough 2014	894	10528	496	3622	100.0%	0.62 [0.56, 0.69]
Total (95% CI)		**10528**		**3622**	**100.0%**	**0.62 [0.56, 0.69]**
Total events	894		496			

Heterogeneity: Not applicable

Test for overall effect: Z = 9.09 (P < 0.00001)



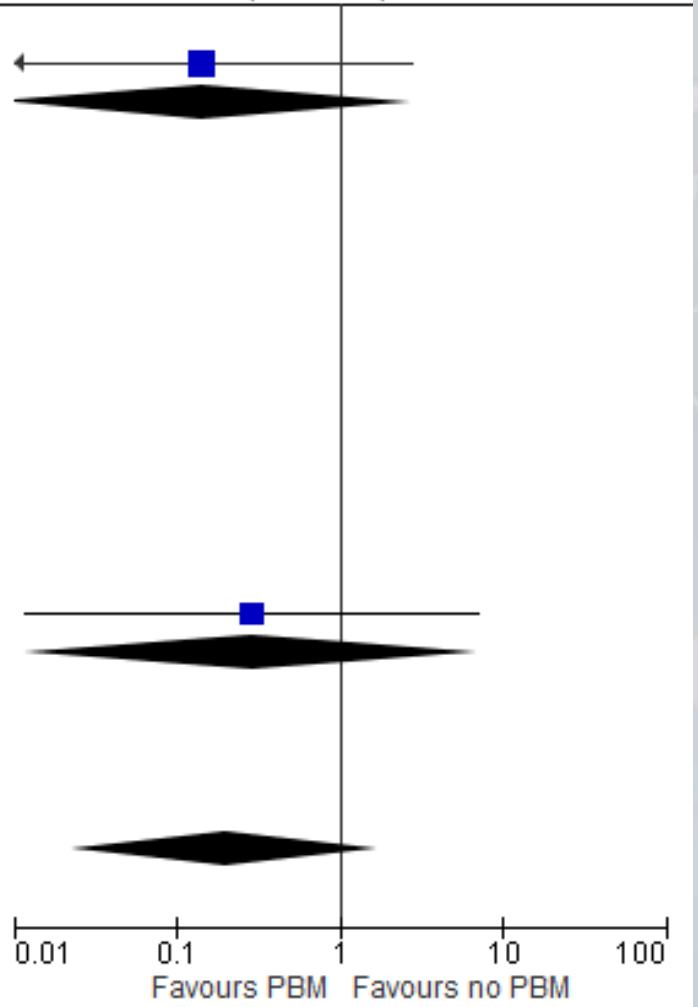
Effect on clinical outcomes

Acute myocardial infarction

Behavioural interventions/DSS/monitoring in comprehensive PBM programs (PICO 15)

Outcome: acute myocardial infarction

Study or Subgroup	After PBM Events	After PBM Total	Before PBM Events	Before PBM Total	Weight	Risk Ratio M-H, Random, 95% CI
1.19.1 Guideline						
Kopanidis 2016	0	100	3	100	54.0%	0.14 [0.01, 2.73]
Subtotal (95% CI)		**100**		**100**	**54.0%**	**0.14 [0.01, 2.73]**
Total events	0		3			
Heterogeneity: Not applicable						
Test for overall effect: Z = 1.29 (P = 0.20)						
1.19.2 Guideline + education						
Yaffee 2014	0	387	0	391		Not estimable
Subtotal (95% CI)		**387**		**391**		**Not estimable**
Total events	0		0			
Heterogeneity: Not applicable						
Test for overall effect: Not applicable						
1.19.3 Guideline + decision support						
Xydas 2012	0	551	1	481	46.0%	0.29 [0.01, 7.13]
Subtotal (95% CI)		**551**		**481**	**46.0%**	**0.29 [0.01, 7.13]**
Total events	0		1			
Heterogeneity: Not applicable						
Test for overall effect: Z = 0.76 (P = 0.45)						
Total (95% CI)		**1038**		**972**	**100.0%**	**0.20 [0.02, 1.73]**
Total events	0		4			
Heterogeneity: Tau² = 0.00; Chi² = 0.10, df = 1 (P = 0.75); I² = 0%						
Test for overall effect: Z = 1.46 (P = 0.14)						
Test for subgroup differences: Chi² = 0.10, df = 1 (P = 0.75), I² = 0%						

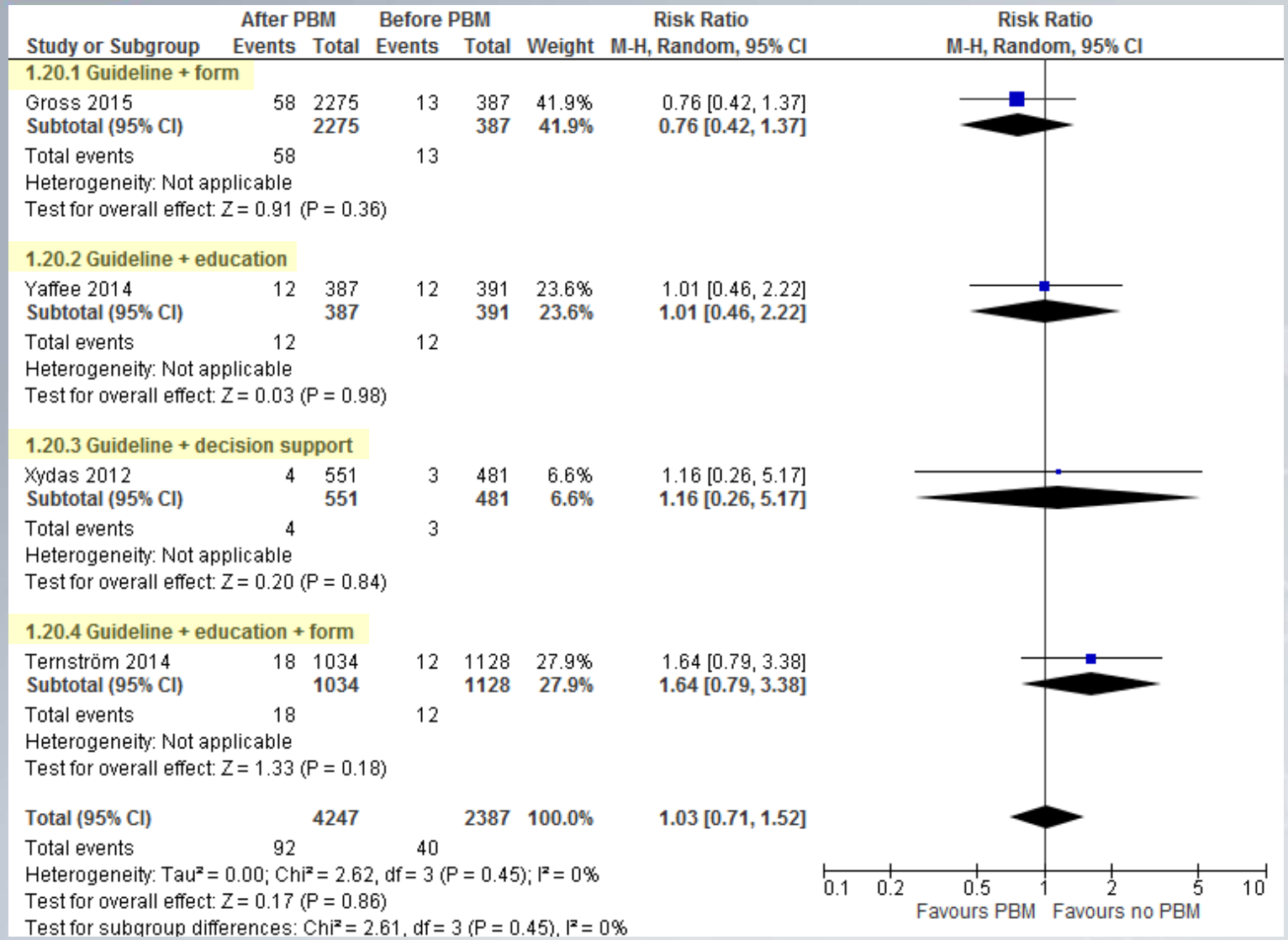


Effect on clinical outcomes

Acute ischaemic stroke

Behavioural interventions/DSS/monitoring in comprehensive PBM programs (PICO 15)

Outcome: acute ischaemic stroke



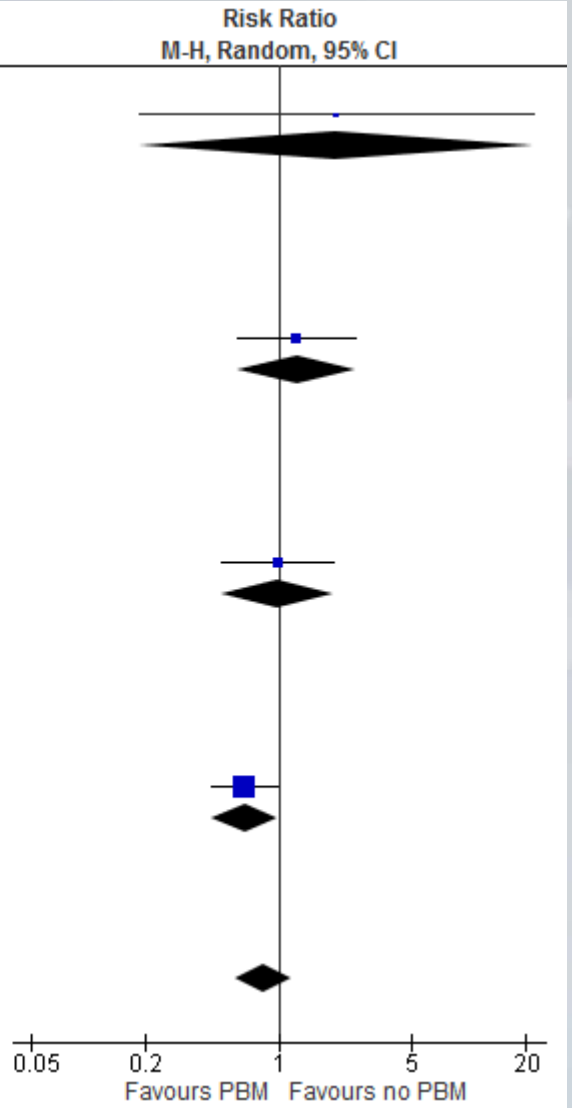
Effect on clinical outcomes

Acute kidney injury

Behavioural interventions/DSS/monitoring in comprehensive PBM programs (PICO 15)

Outcome: acute kidney injury

Study or Subgroup	After PBM Events	After PBM Total	Before PBM Events	Before PBM Total	Weight	Risk Ratio M-H, Random, 95% CI
1.21.1 Guideline						
Kopanidis 2016	2	100	1	100	2.0%	2.00 [0.18, 21.71]
Subtotal (95% CI)		**100**		**100**	**2.0%**	**2.00 [0.18, 21.71]**
Total events	2		1			
Heterogeneity: Not applicable						
Test for overall effect: Z = 0.57 (P = 0.57)						
1.21.2 Guideline + education						
Yaffee 2014	16	387	13	391	20.0%	1.24 [0.61, 2.55]
Subtotal (95% CI)		**387**		**391**	**20.0%**	**1.24 [0.61, 2.55]**
Total events	16		13			
Heterogeneity: Not applicable						
Test for overall effect: Z = 0.59 (P = 0.55)						
1.21.3 Guideline + decision support						
Xydas 2012	17	551	15	481	21.9%	0.99 [0.50, 1.96]
Subtotal (95% CI)		**551**		**481**	**21.9%**	**0.99 [0.50, 1.96]**
Total events	17		15			
Heterogeneity: Not applicable						
Test for overall effect: Z = 0.03 (P = 0.98)						
1.21.4 Guideline + form						
Gross 2015	113	2275	29	387	56.2%	0.66 [0.45, 0.98]
Subtotal (95% CI)		**2275**		**387**	**56.2%**	**0.66 [0.45, 0.98]**
Total events	113		29			
Heterogeneity: Not applicable						
Test for overall effect: Z = 2.05 (P = 0.04)						
Total (95% CI)		**3313**		**1359**	**100.0%**	**0.84 [0.60, 1.17]**
Total events	148		58			
Heterogeneity: Tau² = 0.01; Chi² = 3.27, df = 3 (P = 0.35); I² = 8%						
Test for overall effect: Z = 1.03 (P = 0.30)						
Test for subgroup differences: Chi² = 3.24, df = 3 (P = 0.36), I² = 7.4%						



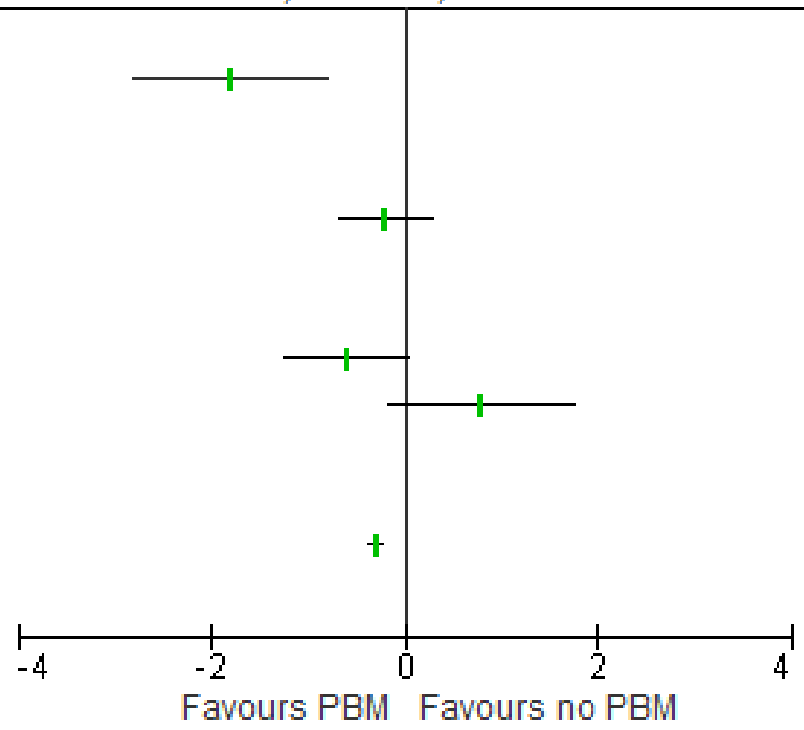
Effect on clinical outcomes

Length of hospital stay

Behavioural interventions/DSS/monitoring in comprehensive PBM programs (PICO 15)

Outcome: length of hospital stay

Study or Subgroup	After PBM Mean	SD	Total	Before PBM Mean	SD	Total	Mean Difference IV, Random, 95% CI
1.25.1 Guideline + form							
Gross 2015	10.4	8	2275	12.2	9.6	387	-1.80 [-2.81, -0.79]
1.25.2 Guideline + education							
Meybohm 2016	10.2	46.6	75206	10.4	39.7	54513	-0.20 [-0.67, 0.27]
1.25.3 Guideline + form + education							
Rineau 2016 (THA)	8.8	2.3	115	9.4	2.5	103	-0.60 [-1.24, 0.04]
Rineau 2016 (TKA)	10.1	3.4	68	9.3	2.5	81	0.80 [-0.17, 1.77]
1.25.4 Guideline + decision support							
Loftus 2016	3.02	1.76	6593	3.32	1.91	5997	-0.30 [-0.36, -0.24]



What is the overall certainty of the evidence of effects? (= how good an indication does the research provide of the likely effects across all of the critcal outcomes; i.e. the likelihood that the effects will be different enough from what the research found that it might affect a decision about the intervention?)

- Very low
- Low
- Moderate
- High

- No included studies

Quality of body of evidence: critical outcomes

Behavioural interventions (PICO16)

Outcomes	Certainty of the evidence (GRADE)
Behavioural intervention(s) versus no intervention: RBC utilization	⊕◯◯◯ VERY LOW[a]
Behavioural intervention(s) versus no intervention: FFP utilization	⊕◯◯◯ VERY LOW[a]
Behavioural intervention(s) versus no intervention: PLT utilization	⊕◯◯◯ VERY LOW[a]
Behavioural intervention(s) versus no intervention: Cryoprecipitate	⊕◯◯◯ VERY LOW[a,b]
Guideline + Form + Audit versus Guideline: RBC utilization	⊕◯◯◯ VERY LOW[a,b]
Computerized decision support (CPOE) versus Guideline + Educaton: RBC utilization	⊕◯◯◯ VERY LOW[a,b]

a. Risk of bias (inappropriate eligibility criteria, not controlled for confounding and/or inadequate/incomplete follow-up)
b. Imprecision: Limited sample size

DSS vs no DSS (PICO 17)

Outcomes	Certainty of the evidence (GRADE)
Appropriate transfusions follow up: 4 months	⊕⊕◯◯ LOW[a,b]
Overall RBC usage (RBC transfusions per 100 inpatient days) follow up: range 12 months to 42 months	⊕◯◯◯ VERY LOW[c,d]
Inappropriate RBC usage (RBC transfusions per 100 inpatient days) follow up: range 12 months to 42 months	⊕◯◯◯ VERY LOW[c,d]
Mortality follow up: 42 months	⊕◯◯◯ VERY LOW[b,c]
30-day readmission follow up: 42 months	⊕◯◯◯ VERY LOW[b,c]

a. Risk of bias: reporting bias, selection bias (allocation concealment) unclear, attrition bias unclear
b. Indirectness: 1 single-centre US trial (limited generaliziblity to other settings/countries)
c. Risk of bias: Inappropriate eligibility criteria and not controlled for confounding
d. Indirectness: 3 single-centre US trials (limited generalizibility to other settings/countries)

Quality of body of evidence: critical outcomes

Behavioural interventions – DSS – monitoring in comprehensive PBM programs (PICO 15)

Outcomes	Certainty of the evidence (GRADE)
Blood product utilization - number of patients/admissions receiving RBC transfusion follow up: median 22.5 months	⊕⊕◯◯ LOW
Blood product utilization - number of patients receiving PLT transfusion follow up: median 21 months	⊕◯◯◯ VERY LOW[a]
Blood product utilization - number of patients receiving FFP transfusion follow up: median 12 months	⊕◯◯◯ VERY LOW[a,b,c]
Morbidity - acute kidney injury follow up: median 24 months	⊕◯◯◯ VERY LOW[c]
Mortality - hospital mortality follow up: median 24 months	⊕◯◯◯ VERY LOW[a,c]
Mortality - 30-day mortality follow up: median 9 months	⊕◯◯◯ VERY LOW[b,c]
Morbidity - acute ischaemic stroke follow up: median 18 months	⊕◯◯◯ VERY LOW[d]

a. Inconsistency: all parameters (statistical and visual) are positive
b. Risk of bias: Inappropriate eligibility criteria (Xydas 2012), inappropriate methods for exposure and outcome variables (Ternström 2014), not controlled for confounding (Gross 2015, Ternström 2014 and Thakkar 2016) and other limitations (all studies)
c. Imprecision: Large variability in results
d. Imprecision: Low number of events

RESOURCE USE

Effect of comprehensive PBM programs on economic outcomes

-> no cost info on behavioural interventions/DSS/monitoring systems, only direct (acquisition/activity-based) cost info on blood products/iron/EPO/tranexamic acid.

Outcome	Absolute Cost (after PBM versus before PBM program) in euros	Author, year, country
Direct cost of EPO, iron, tranexamic acid and blood transfusion	+5,457€ (30,572€ vs 25,097€)	Rineau, 2016, France
Total direct costs	-4,075€ (44,300€ vs 48,375€)	Gross, 2015, USA
Total costs (all blood products per 1000 cases)	-70,697€ (211,164€ vs 281,861€)	Mehra, 2015, Switzerland
Direct cost RBC units (annually)	-952,660€	Meybohm, 2016, Germany
Direct cost RBC units + costs RBC transfusion process (annually)	-3,000,000€	Meybohm, 2016, Germany
Direct cost of iron, EPO, tranexamic acid, RBC units, bed days saved	-576,409€	Frew, 2016, UK
Direct cost of RBC units	-244,509€	Leahy 2017, Australia
Direct cost of PLT units	-191,690€	Leahy 2017, Australia
Total direct product-acquisition cost (all blood products)	-11,623,032€	Leahy 2017 (2), Australia
Total cost avoidance	-586,863€	Loftus, 2016, USA
Total direct cost (all blood products) (annually)	-161,623€	Ternström 2014, Sweden
Total direct cost RBC transfusion	-274,246€	Yaffee, 2014, USA
Total acquisition cost per year	-147,172€	Thakkar, 2016, USA
Total activity-based cost per year (3.2-4.8 times the acquisition cost)	-471,008€ to -706,572€	Thakkar, 2016, USA
Total direct product-acquisition cost (all blood products) (per year)	-1,715,961€	Frank, 2017, USA
Total acquisition cost per year (182€/unit)	-87,421€	Kansagra, 2017, USA
Total activity-based cost per year (809€/unit)	-388,688€	Kansagra, 2017, USA

Recommendations for the design of future studies of PBM implementation e.g. decision support

Recommendations for future studies on decision support in transfusion

- Clearly state the algorithm used by the DSS.
- Report the number and proportion of transfusions given outside the guidelines used by the DSS.
- Report the amount of orders cancelled following recommendations provided by the DSS.
- Report the effect of DSS on average blood count or coagulation parameter preceding and following transfusion.
- Report data on physician workflow such as time taken to enter an order.
- Clearly define the inclusion and exclusion criteria of patients to whom the DSS applied and which clinical staff were using it.
- State clearly whether the DSS was mandatory or voluntary. If the latter, state the percentage of blood orders using DSS.
- Give detailed descriptions of any co-interventions, such as teaching, training, and other patient blood management initiatives.
- Report standardized measures for blood usage, to include percentage of patient population transfused and number of transfusions per patient and/or number of transfusions per transfused patient. Consider also giving transfusions per 1000 patient-days.
- Consider investigating effect of DSS on plasma, platelet, and cryoprecipitate usage as well as RBC usage.
- Consider reporting units of blood products per order (eg, single-, double-, or multi-unit) as well as number of transfusions.
- Consider reporting more detailed clinical outcome measures, such as mortality, length of stay, incidence of transfusion associated circulatory overload, infection rates, and ischemic events.

Hibbs et al. Transfusion Medicine Reviews 2015:29; 14-23

FINALLY……

The key aim is to make judgments by the panelists (during the closed session) to formulate:

1) a strong/conditional recommendation for/against implementation of comprehensive PBM programs and/or specific behavioural/decision support interventions, or

2) no recommendation, or

3) a research recommendation.