Supplementary File 5. Characteristics of Included Studies

Author (Year) Country	Healthcare Setting	Target Clinician Group	Blood Component	Study Design	Type of Control	Length of Follow-up	RBC Transfusion Criteria	Definition of Inappropriate Transfusion	Types of Interventions
Multi-modal Interventions									
Abelow[33] (2017) Israel	Tertiary care centre	All physicians and nurses from transfusion service, medical, haematology –oncology, surgical and obstetric wards, and anaesthesia	RBC	Before and After	Historical Control	1 year	Hgb levels below 7 g/dL, or under 8 g/dL in the presence of active ischemia, active bleeding, or symptomatic anemia	NR	Education, Reminders
Alavi-Moghaddam[41] (2014) Iran	ED in one academic and general medical/surgical hospital	All ED staff and blood bank technicians	Blood	Before and After	Historical Control	3 months	NR	NR	Protocol, Education
Andreasen[42] (2012) Denmark	Cardiac surgeries in one academically-affiliated hospital	Anesthesiol-gists, surgeons, intensivists, and nurses	RBC, FFP, platelets	Before and After	Historical Control	24 months	NR	Defined over-transfusion as proportion of patients transfused with RBCs discharged with hemoglobin 7 mmol/L (11.3 g/dL)	Education, Guideline, Algorithm
Annan[43] (2013)	ICU in one academically	All ICU staff	RBC	Before and	Historical	1 month	NR	NR	"High-intensity ICU staffing

Author (Year) Country	Healthcare Setting	Target Clinician Group	Blood Component	Study Design	Type of Control	Length of Follow-up	RBC Transfusion Criteria	Definition of Inappropriate Transfusion	Types of Interventions
United States	-affiliated community hospital			After	Control				(HIS)", including: changes in Protocols, CPOE and Decision Support
Ansari[44] (2012) United States	One community hospital	All physicians ordering transfusions	RBC	Before and After	Historical Control	12 months	1) Acute bleeding (blood loss of >30%) with tachycardia and low blood pressure; 2) Hgb <9 g/dL in high-risk patients; 3) Hgb <7 g/dL in patients with symptomatic chronic anaemia; 4) Special circumstances (e.g. sickle cell crisis and other causes of poor oxygen delivery)	Transfusions that did not meet established criteria, including pre-transfusion hgb level greater than 9 g/dL	Guideline, Audit & Feedback
Baer[45] (2011) United States	Four neonatal ICUs in one healthcare system	All neonatal ICU staff	RBC	Before and After	Historical Control	12 months	Hematocrit falls below: • 40% for a patient on extracorporeal membrane oxygenation, • 35% for a patient on	NR	Guideline, CPOE and Decision Support, and Audit

Author (Year) Country	Healthcare Setting	Target Clinician Group	Blood Component	Study Design	Type of Control	Length of Follow-up	RBC Transfusion Criteria	Definition of Inappropriate Transfusion	Types of Interventions
							mechanical ventilation 27% for a patient on supplemental oxygen or with signs of anemia but not on mechanical ventilation, • 20% in any neonatal ICU patient		
Beaty[46] (2013) United States	Cardiac surgical ICU in one academic hospital	Cardiac surgery attendings, cardiac residents, and ICU providers (intensivists, surgery residents, and mid-level providers)	RBC	Before and After	Historical Control	17 weeks	Hgb level of less than 8 g/dL	Transfusion trigger of hgb >8 g/dL	Protocol, Audit and Feedback
Brandis[47] (1994) Australia	One acute care hospital	All medical staff that order transfusions in anesthetics, surgery and	RBC	Before and After	Historical Control	6 months	Hgb level 7 g/dL	NR	Education, Protocol, Policies

Author (Year) Country	Healthcare Setting	Target Clinician Group	Blood Component	Study Design	Type of Control	Length of Follow-up	RBC Transfusion Criteria	Definition of Inappropriate Transfusion	Types of Interventions
		ICU							
Brandt[48] (2009) United States	Surgical ICU in one hospital	Intensivists, fellows, and residents	RBC	Before and After	Historical Control	6 years	Hgb level 8 g/dL	NR	Protocol, Education (to residents)
Butler[49] (2015) United Kingdom	Inpatient hematology services in one academic hospital	Clinical hematolog-ists treating patients receiving intensive chemotherap y or hematopoie-tic stem cell transplants	RBC, platelets	Before and After	Historical Control	10 months	1) Massive bleeding with blood pressure instability; 2) Hgb 7 g/dL in a stable ICU patient; 3) Hgb 8.0 g/dL in a non-ICU patient with signs/symptoms of anemia; 4) Hgb 10 g/dL with acute cardiac ischemia; 5) Surgical blood loss anticipated	Above the recommended trigger of 8 g/dL	Education, CPOE and Decision Support, Audit and Feedback
Corwin[50] (2014) United States	One level 1 trauma centre	Clinical staff in all major clinical departments, high-volume transfusing services, and residents	RBC	Before and After	Historical Control	18 months	1) Acute hemorrhage or hemorrhagic shock; 2) Hgb <7–8 g/dL; 3) Acute MI, Hgb 8 g/dL; 4) Acute coronary syndrome Hgb 8 g/dL;	NR	Education, Guideline, CPOE and Decision Support

Author (Year) Country	Healthcare Setting	Target Clinician Group	Blood Component	Study Design	Type of Control	Length of Follow-up	RBC Transfusion Criteria	Definition of Inappropriate Transfusion	Types of Interventions
							Use of the hgb concentration alone as a trigger for RBC transfusion was recommended against; decision to order an RBC transfusion should also consider a patient's intravascular volume status, evidence of shock, duration and extent of anemia, and cardiopulmonary physiologic parameters as well as other symptomatology.		
Eindhoven[107] (2005) Netherlands	Two hospitals	All physicians and nurses treating patients undergoing elective, primary total hip replacement	RBC	Controlled Before and After	Standard of care in one hospital (i.e. patients transfused at a Hgb level below 10g/dL or haematocr-it level below 30%);	12 months	1) Presence of anaemia-related symptoms and signs; 2) Diminished oxygen uptake in the lungs due to respiratory disease; 3) Inability of the patient to	NR	Education, Guideline (referred to as "6-8-10 Flexinorm")

Author (Year) Country	Healthcare Setting	Target Clinician Group	Blood Component	Study Design	Type of Control	Length of Follow-up	RBC Transfusion Criteria	Definition of Inappropriate Transfusion	Types of Interventions
					Historical Control		compensate for the effects of haemodilution; 4) Estimated blood loss and increased risk of re-bleeding; 5) Enhanced need for oxygen delivery (high body temperature, shivering and sepsis); and (6) Presence of symptoms or signs of atherosclerosis of heart, brain or renal vessels.		
Frank[34] (2017) United States	Two academic centers and three community hospitals	All medical staff ordering blood products	RBC, FFP, platelets	Before and After	Historical Controls	30 months	Hgb less than 7 g/dL	Hgb greater than or equal to 7 g/dL	"Patient Blood Management Program", including Education, Guidelines, CPOE and Decision Support, Audit and Feedback
Gallagher-Swann[51] (2011) Australia	Two hospitals: one tertiary maternity and	All medical staff in adult, neonatal, and	Blood	Before and After	Historical Control	28 months	NR	NR	Protocol, Education, Reminders

Author (Year) Country	Healthcare Setting	Target Clinician Group	Blood Component	Study Design	Type of Control	Length of Follow-up	RBC Transfusion Criteria	Definition of Inappropriate Transfusion	Types of Interventions
	gynaecologi-cal hospital; and one tertiary paediatric hospital	antenatal, and pediatric settings							
Gardner[52] (1993) United States	One tertiary hospital	All physicians and nurses ordering blood	Blood	Before and After	Historical Control	3 months	If ordering for anemia for packed cells: hgb < 10 g/dL or hematocrit below 30%	Defined over-transfusions as those that did not meet the transfusion criteria	CPOE and Decision Support, Audit and Feedback
Garrioch[53] (2004) United Kingdom (Scotland)	One academic hospital	All physicians	RBC	Before and After	Historical Control	3 months	NR	NR	Education, Guideline, Audit and Feedback, Reminders
Geissler[54] (2015) Germany	One trauma centre	All medical staff involved in cardiac surgeries (e.g. heart transplantation, aortic surgery, valve surgery)	RBC, FFP, platelets	Before and After	Historical Control	12 months	NR	NR	"Patient Blood Management (PBM) Initiative", including Education, Guidelines Audit and Feedback, and Policies
Goodnough[29 30] (2014a; 2014b) United States	One academic hospital	All physicians ordering transfusions	RBC	Before and After	Historical Control	36 months	Hgb level of 7 g/dL stable medical and surgical inpatients who were not bleeding, or 8	NR	Education, CPOE and Decision Support

Author (Year) Country	Healthcare Setting	Target Clinician Group	Blood Component	Study Design	Type of Control	Length of Follow-up	RBC Transfusion Criteria	Definition of Inappropriate Transfusion	Types of Interventions
							g/dL for patients with acute coronary syndromes		
Gutsche[55] (2013) United States	Surgical ICU in one academic hospital	Cardiologi-sts, cardiac surgeons, anesthesiolo-gists, and intensivists involved in the care of cardiac surgery patients	RBC	Before and After	Historical Control	6 months	Transfusion associated with a pre-transfusion hgb <7.0 g/dL	Transfusion associated with a hgb from 7 mg/dL to 7.9 mg/dL without evidence of organ ischemia, shock, pressor requirement, or hemorrhage	Education, Guideline, Audit and Feedback
Haldiman[56] (2014) United States	One tertiary-care, Level I trauma hospital	All physicians ordering transfusions	RBC, FFP, platelets, cryoprecipita te	Before and After	Historical Control	36 months	Hgb level of 8 g/dL or less and a hematocrit level of 24% or less as a trigger point	Transfusions not compliant with guideline	Guideline, Audit
Handler[32] (1983) United States	One community hospital	Surgeons	RBC	Between groups	Standard of care in four hospitals	12 months	NR	NR	Education, Audit and Feedback
Harrison[57] (2015) Australia	Regional healthcare system comprised of 232 public hospitals	Surgeons in five surgical groups: cardio-thoracic, colorectal, gynaecology and obstetrics, Orthopaedic,	RBC	Before and After	Historical Control	12 months	NR	When the Hgb min ≥ 100 g/dl post-operation; when Hgb min ≥ 70 g/l and ≤100 g/l and when no clinical indications are present; and when Hgb max levels	"Blood Watch Program" that involved 21 different system and behaviour modifying interventions, including Education, Audit and Feedback

Author (Year) Country	Healthcare Setting	Target Clinician Group	Blood Component	Study Design	Type of Control	Length of Follow-up	RBC Transfusion Criteria	Definition of Inappropriate Transfusion	Types of Interventions
		and general surgery						≤70 g/l when clinically indicated	
Heyes[35] (2017) United Kingdom	Eight general medical wards at one hospital	All physicians	RBC	Before and after	Historical Control	6 months	Hgb level 7 g/dl for non-bleeding patients	Hgb 10 g/dl	Education, Policy
Hicks[36] (2017) United States	Department of surgery in one academic hospital	Attending physicians, clinical fellows, residents, and mid-level providers	RBC, plasma, platelets	Before and After	Historical Control	9 months	Hgb level 7 g/dL for standard patients, 8 g/dL for cardiovascular disease	NR	Education, Audit and Feedback
King[58] (2013) United States	One community hospital	All physicians	RBC	Before and After	Historical Control	8 months	Hgb level 7 g/dL	NR	Education, Guideline, Audit and Feedback
Larson[104] (2016) United States	One community hospital	All physicians	RBC	Before and After	Historical Control	5 months	Hgb level 7 g/dL	Hgb greater than or equal to 7 g/dL	Education, Policy Audit approval
Leahy[59] (2014) Australia	One academic hospital	All physicians	RBC	Before and After	Historical Control	36 months	NR	NR	"Patient Blood Management Programme", including Protocol, Education, Guideline, Audit and Feedback, CPOE and decision support

Author (Year) Country	Healthcare Setting	Target Clinician Group	Blood Component	Study Design	Type of Control	Length of Follow-up	RBC Transfusion Criteria	Definition of Inappropriate Transfusion	Types of Interventions
Likosky[60] (2010) United States	Departments of medicine, surgery, anesthesia, and pathology, and disciplines from nursing, cardiothorac-ic surgery, anaesthesia, perfusion, quality improve-ment, transfusion medicine and epidemiolog y in one hospital	Surgeons treating non-emergent isolated coronary artery bypass graft surgery	RBC	Before and After	Historical Control	27 months	1) Intra-operative patients: when haematocrit falls below 19% on cardiopulmonary bypass 2) Post-operative patients <75 years: when haematocrit falls below 21% after the procedure until the patient was discharged from the hospital 3) Patients >75 years: when haematocrit falls below 24% after the procedure until the patient was discharged from the hospital	NR	Protocol, Education, Audit and Feedback
Littenberg[61] (1995) United States	ICU in one hospital	Intensivists	RBC	Before and After	Historical Control	3 months	During intervention period: Hgb < 8.6 g/dL or hematocrit < 26% During follow-up period: Hgb <= 7 g/dL or hematocrit <=21%	NR	Guideline, Order Form and Decision Support, Audit

Author (Year) Country	Healthcare Setting	Target Clinician Group	Blood Component	Study Design	Type of Control	Length of Follow-up	RBC Transfusion Criteria	Definition of Inappropriate Transfusion	Types of Interventions
Lucas[62] (1997) Australia	One hospital	All physicians	Blood	Before and After	Historical Control	3 months	Hgb level 80 g/L	NR	Education, Guideline
Mahar[63] (2013) Pakistan	One tertiary care, academic hospital	All physicians	RBC	Before and After	Historical Control	12 months	NR	NR	Protocol, Education
Marconi[64] (1996) Italy	One academic hospital	All physicians	RBC	Before and After	Historical Control	6 months	NR	Post-operative haematocrit above 36%	Protocol, Education, Guideline, CPOE and Decision Support
Markel[65] (2016) United States	Orthopedic services in two "peer" hospitals	Orthopaedic service line practitioners treating patients with primary total joint arthroplasty	RBC	Before and After	Historical Control	6 months	In post-operative patients: pre-transfusion hgb of 8 g/dL or less or for symptoms of chest pain, orthostatic hypotension, tachycardia unresponsive to fluid resuscitation, congestive heart failure	NR	Education, Guideline, Audit and Feedback
McCrory[66] (2014) United States	Pediatric ICU in one children's hospital	Pediatric ICU and pediatric hematology attending physicians	RBC	Before and After	Historical Control	24 months	NR	NR	Protocol, CPOE and Decision Support

Author (Year) Country	Healthcare Setting	Target Clinician Group	Blood Component	Study Design	Type of Control	Length of Follow-up	RBC Transfusion Criteria	Definition of Inappropriate Transfusion	Types of Interventions
Meybohm[105] (2016) Germany	Four academic hospitals	All staff	RBC	Before and After	Historical Control	21 months	Hgb < 6 g/dL independent of any compensation possibility; Hgb 6-8 g/dL clinical symptoms of anemix hypoxia, limited compensation, existing risk factors	NR	"Patient Blood Management program", including Education, Guidelines, Checklist
Morrison[67] (1993) United States	Department of Obstetrics and Gynecology in one academic hospital	All staff physicians and residents	RBC, FFP, platelets	Before and After	Historical Control	10 months	NR	NR	Education, Guideline, Audit and Feedback, Paper Order Form
Murphy[68] (2016) United States	Seven ICUs in an academic healthcare system	Intensivists, advanced practice providers (APPs) (i.e. nurse practitioners and physician assistants), and physicians in training	RBC	Before and After	Historical Control	12 months	NR	NR	Education, Audit and Feedback, and Unit-based Provider Financial Incentives
Norgaard[38] (2017)	One tertiary care hospital	All physicians	RBC	Before and After	Historical Control	12 months	Hgb 7.3 g/dL for stable non-	Hgb > 9.7 g/dL	"Patient Blood Management

Author (Year) Country	Healthcare Setting	Target Clinician Group	Blood Component	Study Design	Type of Control	Length of Follow-up	RBC Transfusion Criteria	Definition of Inappropriate Transfusion	Types of Interventions
Denmark		and nurses					bleeding patients		Intervention", including Education, Guidelines, Audit and Feedback
Oliver[69] (2014) United States	One academic hospital	All physicians	RBC, FFP, platelets	Before and After	Historical Control	6 months	Hgb 7 g/dL or less in non-bleeding patients (as per TRICC trial) • Transfuse 1 unit and reassess unless ongoing blood loss (1500 - 2000ml) or hemodynamic instability • Exceptions: active coronary ischemia, ongoing blood loss, severe sepsis/septic shock	NR	Education, Guideline, Audit and Feedback
Rana[70] (2006) United States	Multidisciplinary ICU (medical, surgical, and mixed) in one tertiary academic	All ICU physicians and nurses	RBC	Before and After	Historical Control	3 months	Hgb level 7g/dL	Pre-transfusion hgb >7 g/dL in the absence of active bleeding, early septic shock, or ischemia	Education, CPOE and Decision Support, Algorithm

Author (Year) Country	Healthcare Setting	Target Clinician Group	Blood Component	Study Design	Type of Control	Length of Follow-up	RBC Transfusion Criteria	Definition of Inappropriate Transfusion	Types of Interventions
	hospital								
Rehm[71] (1998) United States	One Veteran Affairs hospital	All staff and residents in medical and surgical specialties from two local university programmes	RBC	Before and After	Historical Control	12 months	Hgb level <7 g/dL	Hgb level >10 g/dL	Paper order form and Decision Support, Audit and Feedback, Audit Approval, Reminders
Rosen[72] (1993) United States	One private tertiary care hospital	All staff	RBC, FFP, platelets, cryoprecipit-ate	Before and After	Historical Control	36 months	Hgb level <8g/dL	Transfusions not meeting transfusion criteria	Education, Guideline, CPOE and Decision Support, Audit and Feedback
Rothschild[31] (2007) United States	One academic hospital	All staff	RBC, FFP, platelets	Before and After	Historical Control	3 months	Hematocrit <21%	Transfusions not meeting transfusion criteria	Education, Guideline
Spencer[73] (2005) United States	One hospital	All anesthetic and surgical staff treating patients undergoing hip and knee arthroplasty	RBC	Before and After	Historical Control	12 months	Signs of cardiovascular instability from excessive intra-operative blood loss, was symptomatically anaemic postoperatively, or the hgb level fell below 8 g/dL	Transfusions not meeting transfusion criteria	Guideline, Paper Order Form and Decision Support, Audit and Feedback, Reminders
Tavares[74] (2014)	One academic	All staff	RBC	Before and After	Historical Control	9 years	Hgb level between 8-9 g/dL	Hgb level >9g/dL recommended for	Education, Audit Approval

Author (Year) Country	Healthcare Setting	Target Clinician Group	Blood Component	Study Design	Type of Control	Length of Follow-up	RBC Transfusion Criteria	Definition of Inappropriate Transfusion	Types of Interventions
United States	tertiary care hospital							cancellation	
Ternstrom[75] (2014) Sweden	Cardiac surgery services in one academic hospital	All staff particularly surgeons, anaesthetis-ts, residents, OR-, ICU- and ward nurses, nurse helpers, physiothera-pists and perfusionists	RBC, plasma, platelets	Before and after	Historical Control	24 months	Hgb level <6 g/dL	NR	"Blood Conservation Programme" consisting of Education, Guidelines, and Self-Audit
Tseng[106] (2016) Canada	One academic hospital	Residents or attending physicians	RBC	Before and After	Historical Control	3 months	Bleeding patients: hgb < 8 g/dL Non-bleeding patients: hgb < 6 g/dL	NR	Checklist, Order Set
Vos[76] (1994) Tanzania	Eight hospitals: four government hospitals and three missions hospitals	All physicians	All blood components	Before and After	Historical Control	24 months	1) Operated patients: hgb >10 g/dL; 2) Pregnancy: hgb >7 g/dL when >36 weeks, hgb >6 g/dL when <36 weeks; 3) children: hgb >4 g/dL; other: hgb >5 g/dL	NR	Education, Guideline
Yeh[77] (2015) United States	Surgical ICU in one tertiary care	Residents, fellows, attending	RBC	Before and After	Historical Control	6 months	Hgb level <8 g/dL	Hgb level >8 g/dL	Education, Audit and Feedback

Author (Year) Country	Healthcare Setting	Target Clinician Group	Blood Component	Study Design	Type of Control	Length of Follow-up	RBC Transfusion Criteria	Definition of Inappropriate Transfusion	Types of Interventions
	hospital	physicians of both ICU and surgical teams							
Yerrabothala[78] (2014) United States	One academic tertiary care hospital	All staff	RBC	Before and After	Historical Control	6 months	Hgb level < 7g/dL	Transfusions not meeting transfusion criteria	CPOE and Decision Support, Policy
Zelinka[79] (2010) United States	Cardiac surgery services in one community hospital	All medical staff involved in cardiac surgeries	RBC	Before and After	Historical Control	4 years	NR	NR	
Single Interventions									
Boral[80] (2015) United States	One tertiary care hospital	All medical, surgical, nursing and blood bank staff	RBC	Before and After	Historical Control	36 months	Hgb level of 7 g/dL or Hct of 21%	NR	Education
Hillman[81] (1979) United States	Twenty-two area hospitals	All physicians	RBC, whole blood	Before and After	Historical Control	6 months	NR	NR	Education
Joubert[82] (2014) South Africa	Departments of internal medicine, intensive care, obstetrics & gynaecology and general surgery in	All physicians	RBC	Before and After	Historical Control	2 weeks	Usually appropriate when Hgb ≤ 6.9 g/dL; When Hb 7.0–9.9 g/dL depends on clinical picture	Not required when Hgb level >= 10g/dL	Education

Author (Year) Country	Healthcare Setting	Target Clinician Group	Blood Component	Study Design	Type of Control	Length of Follow-up	RBC Transfusion Criteria	Definition of Inappropriate Transfusion	Types of Interventions
	one hospital								
Joyce[109] (2015) Ireland	One academic hospital	Interns	All blood components	Between Groups	Standard of Care	3 months	NR	NR	Education
Leão[83] (2015) Brazil	One academic hospital	All physicians, nurses, and nursing technicians	RBC	Before and After	Historical Control	6 months	NR	NR	Education
Paone[84] (2013) United States	Thirty-three hospitals in one state	Cardiac surgeons	RBC, FFP, platelets	Before and After	Historical Control	4 years	NR	NR	Education
Soumerai[40] (1993) United States	Surgical and medical services from two academic and two community hospitals	Surgeons in orthopedic, vascular, and general surgery and general medicine attending physicians	RBC	Cluster RCT (service-level)	Standard of Care	6 months	1) Hematocrit <24%, a fall in hematocrit of 6 percentage points or more within 24 hours, or 2) A pre-transfusion hematocrit between 24% and 30% in the presence of one of the following: angina within 24 hours prior to transfusion, myocardial infarction within 6 weeks prior to transfusion, an	Transfusions not meeting transfusion criteria	Education

Author (Year) Country	Healthcare Setting	Target Clinician Group	Blood Component	Study Design	Type of Control	Length of Follow-up	RBC Transfusion Criteria	Definition of Inappropriate Transfusion	Types of Interventions
							electrocardiogram indicating acute ischemia or acute infarction, or 3) Blood loss of 1000 mL or greater prior to transfusion		
Valentine[85] (2014) United States	Medical-surgical pediatric ICU in one children's hospital	Pediatric intensivists	RBC, whole blood	Before and After	Historical Control	24 months	Hgb level <7 g/dL	NR	Education
Yaffee[86] (2014) United States	Cardiac surgery services in one hospital	Surgeons, surgical residents, anesthesiol-ogists, perfusionis-ts, and recovery room and intensive care unit nurses, operating on aortic valve replacement patients	RBC	Before and After	Historical Control	24 months	Hgb level <8 g/dL	NR	Education
Hassan[110] (2010) United States	One children's hospital	General pediatricians and	Blood	Between Groups	Standard of Care	36 months	NR	NR	Guideline

Author (Year) Country	Healthcare Setting	Target Clinician Group	Blood Component	Study Design	Type of Control	Length of Follow-up	RBC Transfusion Criteria	Definition of Inappropriate Transfusion	Types of Interventions
		hospitalists							
Hoeg[87] (2013) Denmark	Hematology department in one university hospital	All medical staff treating patients with acute myeloid leukemia	RBC	Before and After	Historical Control	36 months	Hgb level between 7.3 and 9.7 g/dL and only in the presence of symptomatic anaemia, coronary artery disease, ongoing blood loss or sepsis	NR	Guideline
Horowitz[88] (1991) Saudi Arabia	One hospital	All physicians treating cardiac surgery patients	RBC, FFP, platelets, cryoprecipitate	Before and After	Historical Control	6 months	NR	Transfusions not justified by the results of hgb levels (not specified) and coagulation tests	Guideline
McSwiney[89] (1993) Ireland	Anesthesia department in one hospital	All physicians treating patients undergoing total hip arthroplasty	Blood	Before and After	Historical Control	NR	Hematocrit less than 30 in men and 27 in women	Discharge hematocrit exceeding 36%	Guideline
Ciccocioppo[91] (2011) Australia	One hospital	All medical staff treating patients with lower GI bleed	RBC	Before and After	Historical Control	30 months	NR	NR	Protocol
Despotis[39] (1994) United States	One hospital	Anesthesiol-ogy and surgery staff physicians treating	RBC, FFP, platelets	RCT (individual-level)	Standard of Care	NR	NR	NR	Algorithm

Author (Year) Country	Healthcare Setting	Target Clinician Group	Blood Component	Study Design	Type of Control	Length of Follow-up	RBC Transfusion Criteria	Definition of Inappropriate Transfusion	Types of Interventions
		cardiac surgery patients							
Lee[92] (2015) China	One hospital	Physicians treating patients for total knee replacement	Blood	Before and After	Historical Control	4 months	NR	NR	Protocol
Muller[90] (2004) Switzerland	Orthopedic unit and intensive care unit in tertiary care hospital	Nurses and physicians in orthopaedic, anaesthesio-logy, and intensive care treating patients underoing total joint replacement	RBC	Before and After	Historical Control	NR	Multi-criteria based on implemented guideline	NR	Algorithm
Rineau[93] (2016) France	Orthopaedic surgery service in one academic hospital	All physicians treating patients undergoing total hip arthroplasty or total knee arthroplasty	Blood	Before and After	Historical Control	6 months	Hgb level <7 or 8 g/dL depending on cormobidities	NR	Protocol
Vrotsos[94] (2015) United States	Cardiac unit in one hospital	All physicians	Blood	Before and After	Historical Control	6 months	NR	NR	Protocol
Whitney[95] (2013)	Pediatric operating	All physicians	RBC, plasma,	Before and After	Historical Control	12 months	NR	NR	Protocol

Author (Year) Country	Healthcare Setting	Target Clinician Group	Blood Component	Study Design	Type of Control	Length of Follow-up	RBC Transfusion Criteria	Definition of Inappropriate Transfusion	Types of Interventions
United States	rooms and ICU in one tertiary care children's hospital	treating pediatric cardiac surgery patients	platelets, cryoprecipitate						
Torella[96] (2002) United Kingdom	One academic hospital	All physicians treating patients undergoing coronary artery bypass graft surgery, total hip replacement, colectomy, and transurethral prostatect-omy.	RBC	Before and After	Historical Control	6 months	Hgb level <8g/dL in the absence of symptoms	NR	Policy
Adams[97] (2011) United States	Acute care and Pediatric ICU wards in one children's hospital	Pediatricians and pediatric intensivists	RBC	Before and After	Historical Control	12 months	NR	NR	CPOE and Decision Support
Fernandez Perez[98] (2007) United States	Three multi-disciplinary ICUs in one hospital	Intensivists	RBC	Before and After	Historical Control	12 months	Hgb level >7 g/dL in the presence of active bleeding, ischemia or early septic shock	NR	CPOE and Decision Support

Author (Year) Country	Healthcare Setting	Target Clinician Group	Blood Component	Study Design	Type of Control	Length of Follow-up	RBC Transfusion Criteria	Definition of Inappropriate Transfusion	Types of Interventions
McWilliams[99] (2014) United States	Eleven hospitals in a regional healthcare system, including level 1 trauma centers, a cancer treatment hospital, and one centre specializing in women's health	All physicians	RBC	Before and After	Historical Control	10 months	1) Hgb level of 8.0 g/dL or lower in a non–ICU patient with signs and symptoms of anemia 2) Hgb level of 7.5 g/dL or lower in a stable ICU patient 3) Hgb level of 10 g/dL or lower with acute cardiac ischemia 4) Surgical blood loss anticipated 5) Acute bleeding with blood pressure (BP) instability	NR	CPOE and Decision Support
Rothschild[31] (2007) United States	One academic hospital	All staff	RBC, FFP, platelets	RCT (individual-level)	Standard of Care	4 months	Hematocrit <21%	Transfusions not meeting transfusion criteria	CPOE and Decision Support
Lam[108] (1997) United States	Two "peer" non-academic hospitals	All physicians	RBC, FFP, platelets	Controlled Before and After	Standard of Care; Historical Control	4 months	NR	NR	Reminders (through self-audit)
Pentti [100] (2003) Finland	Medical-surgical ICU in one academic	All physicians	RBC, FFP, platelets	Before and After	Historical Control	3 months	Hgb level <80 g/L	Transfusions above the recommended transfusion	Reminders (through electronic audit)

Author (Year) Country	Healthcare Setting	Target Clinician Group	Blood Component	Study Design	Type of Control	Length of Follow-up	RBC Transfusion Criteria	Definition of Inappropriate Transfusion	Types of Interventions
	hospital							criteria	
Lam[111] (1996) United States	Five hospitals including three academic and two non-academic	All physicians	RBC	Between Groups	Standard of Care	34 months	Hgb level >= 90g/L	NR	Audit and Feedback
Lewis[101] (2015) United States	Cancer centre in one academic hospital	All physicians treating patients with head and neck cancer	RBC	Before and After	Historical Control	24 months	NR	NR	Audit and Feedback
Tuckfield[102] (1997) Australia	One hospital	All medical staff	RBC, FFP, platelets	Before and After	Historical Control	3 months	1) Hgb <7 g/dL for severe anemia; 2) Hgb between 7-10 g/dL for anemia, bone marrow failure, anemia and sepsis, continuing blood loss, and abnormal bleeding during an operation; 3) Hgb <8 g/dL for perioperative period	Transfusions not meeting transfusion criteria	Audit Approval
Politsmakher[103] (2013) United States	Departments of medicine, surgery, obstetrics/	All physicians	RBC, FFP, platelets, cryo-	Before and After	Historical Control	24 months	1) Symptomatic anemia Hgb <7 g/dL; 2) Active	Transfusions not meeting transfusion	Audit Approval

Author (Year) Country	Healthcare Setting	Target Clinician Group	Blood Component	Study Design	Type of Control	Length of Follow-up	RBC Transfusion Criteria	Definition of Inappropriate Transfusion	Types of Interventions
	gynecology, pediatrics, and emergency medicine in one community-based academic hospital		precipitate				bleeding, blood loss 15% of blood volume; 3) Chronic transfusion in sickle cell/ thalassemia patients; 4) Before major elective procedure Hgb <8 g/dL 5) Red cell exchange in sickle cell patients to attain Hgb ¼ 10g/dL and Hgb S <30%	criteria	
Madrigal[37] (2017) United States	Two tertiary hospitals, one trauma centre	All physicians	RBC	Interrupted Time Series	Historical Control	3.5 years	Symptomatic anemia with Hgb less than 7 g/dL; or acute bleed with shock; or symptomatic anemia with Hgb less than 8 g/dL for patients on chemotherapy or with MDS diagnosis; or anemia with Hgb less than 9 with cardiac symptoms, angina, ischemic	NR	Prospective Audit

Author (Year) Country	Healthcare Setting	Target Clinician Group	Blood Component	Study Design	Type of Control	Length of Follow-up	RBC Transfusion Criteria	Definition of Inappropriate Transfusion	Types of Interventions
							EKG changes		

ED: emergency department; CPOE: computerized physician order entry; FFP: fresh frozen plasma; GI: gastrointestinal; Hgb: hemoglobin; ICU: intensive care unit; NR: not reported; RBC: red blood cell; RCT: randomized controlled trial;