



¹ Temerty Faculty of Medicine, University of Toronto, Toronto, Ontario, Canada

² Institute of Health Policy, Management and Evaluation, University of Toronto, Toronto, Ontario, Canada

³ Oxford University Hospitals NHS Foundation Trust, Oxford, UK

⁴ NHS Blood & Transplant, John Radcliffe Hospital, Oxford, UK

⁵ Radcliffe Department of Medicine, University of Oxford, Oxford, UK

⁶ Choosing Wisely Canada, Toronto, Ontario, Canada

Correspondence to: W Levinson
wendy.levinson@utoronto.ca

Cite this as: *BMJ* 2021;373:n830
<http://dx.doi.org/10.1136/bmj.n830>

Published: 06 April 2021

PRACTICE POINTER

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}

What you need to know

- Red blood cell (RBC) transfusions are frequently overused, and are associated with increased risk of patient harm and added healthcare costs, without conferring additional value
- Evidence from clinical trials shows that restrictive transfusion strategies (transfusing one unit at a time, and using a lower haemoglobin threshold) do not increase morbidity or mortality among diverse populations of hospitalised patients
- A variety of interventions are shown to reduce the rate of inappropriate RBC transfusions, including audit and feedback, clinician education, organisational policy change, and clinical decision support tools

Transfusion of red blood cells (RBC) is used to treat patients with severe anaemia or bleeding. Supplies of blood for transfusion need to be protected, as countries have experienced a decline in donation rates during the covid-19 pandemic.¹ However, published international audits describe inappropriate

rates of RBC transfusion of 22-57% in a variety of clinical settings, including hospitalised inpatients, operative units, and emergency departments.²⁻⁴ Unnecessary blood transfusions may expose patients to harms, including allergic, febrile, or haemolytic reactions; circulatory overload associated with transfusion (seen in up to 1-6% of transfused patients); and acute lung injury.⁵ These complications may occur without the transfusion adding any clinical benefit. Blood products are costly to collect and administer. Their overuse wastes a limited precious resource donated by the public.⁶

Conservative blood use, often referred to as “restrictive transfusion practice,” is recommended in stable, non-bleeding patients by the National Institute for Health and Care Excellence (NICE) and the Choosing Wisely campaigns in Canada, the UK, and the US.⁷⁻¹⁰ Recommendations focus on two major clinical decision points: the haemoglobin concentration (Hb) at which blood transfusion is considered, and the number of RBC units administered at a time (table 1).

Table 1 | When to transfuse RBCs in the adult inpatient⁷⁻¹⁰

Clinical setting	Recommendation and dose
Hb less than 70 g/L	Consider transfusion Transfuse 1 unit and recheck patient symptoms and Hb before giving second unit
Hb less than 80 g/L	Consider transfusion in patients with acute coronary syndrome, or pre-existing cardiovascular disease Transfuse 1 unit and recheck patient symptoms and Hb before giving second unit
Hb 80 to 90 g/L	Likely inappropriate
Hb greater than 90 g/L	Likely inappropriate
Bleeding patient	Maintain Hb greater than 70 g/L If pre-existing cardiovascular disease, maintain Hb greater than 80 g/L
Chronic anaemia	Consider setting individual thresholds and haemoglobin concentration targets for each patient who needs regular blood transfusions for chronic anaemia, with the goal of managing symptoms of chronic anaemia
Hb=haemoglobin	
Do not transfuse on Hb value alone. Transfusion of RBC is indicated in treatment of symptomatic anaemia. Depending on the cause of anaemia, alternative therapies (eg, iron) may be more appropriate than transfusion. Safety of these thresholds has been studied in clinical conditions including critical care, surgical, trauma, and acute gastrointestinal bleeding.	

How safe are restrictive transfusion strategies?

Evidence from systematic reviews and meta-analyses suggests no increase in morbidity or mortality with restrictive transfusion practices compared with liberal transfusion in a variety of clinical settings and patient populations.¹¹⁻¹³ The definition of restrictive

transfusion practice varies. Clinical studies have typically considered a haemoglobin range of 70-90 g/L for restrictive transfusion compared with 90-130 g/L for liberal transfusion.^{12,13}

In a 2018 meta-analysis (26 clinical trials, 15 681 patients) 30 day mortality was no different between restrictive and liberal transfusion strategies (risk ratio

1.0, 95% confidence interval 0.86 to 1.16).¹² No significant differences in mortality were identified ($P=0.15$) after stratifying results by clinical subgroups, including patients undergoing cardiac surgery and those with hip and knee fractures.¹² An earlier meta-analysis in 2015 (31 trials, 9813 patients) found that restrictive transfusion strategies were not associated with increased risk of death (0.86 relative risk, 95% CI 0.74 to 1.01; 9 trials) or overall morbidity (RR 0.98, 95% CI 0.85 to 1.12, 4517 patients; 6 trials) compared with liberal transfusion strategies.¹³ Trials have included patients with a variety of clinical conditions or settings, such as critical care, cardiac, and general and orthopaedic surgery.^{12,13} Most studies use mortality as an endpoint for the safety of restrictive transfusion. Other outcomes important to patients, such as quality of life, symptoms of anaemia (eg, fatigue, shortness of breath), and length of hospital stay are less well studied.

Uncertainty remains around the optimal transfusion threshold in patients with acute coronary syndrome or chronic cardiovascular disease.¹⁴ Most studies in patients with acute coronary syndrome support restrictive transfusion with a haemoglobin threshold less than 80 g/L.^{15,16} Further, no firm criteria exist for RBC transfusion

during pregnancy, and the decision to provide blood transfusion should be made on clinical and haematological grounds.¹⁷

What interventions may reduce the overuse of RBC transfusions?

Relatively simple and feasible interventions can successfully reduce unnecessary RBC transfusions. A systematic review and meta-analysis summarised 84 behavioural interventions to reduce RBC transfusions.¹⁸ Table 2 lists the major intervention types. Among the 33 studies eligible for meta-analysis, the odds of a patient receiving an inappropriate RBC transfusion decreased substantially with these interventions (pooled odds ratio 0.46; 95% CI 0.36 to 0.59; 11 trials), and the total number of RBC units transfused also decreased (weighted mean difference before and after intervention -0.35; 95% CI -0.38 to -0.32; 14 trials).¹⁸ Studies that used multiple interventions together showed the greatest decrease in likelihood of inappropriate blood transfusion (OR 0.54; 95% CI 0.41 to 0.71; 20 trials).¹⁸ Among single intervention studies, the implementation of a guideline resulted in the lowest odds of inappropriate transfusion (OR 0.07, 95% CI 0.02 to 0.19), but this was a point estimate from a single study.¹⁸ Box 1 provides examples of successful multimodal interventions.

Table 2 | Interventions to reduce unnecessary RBC 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

* Adapted from Sorli LJ et al¹⁸

Box 1: Examples of successful multimodal interventions to reduce unnecessary blood transfusions

- The START study took place across 13 sites in Ontario, Canada. It employed guideline development, clinician education, prospective order screening (approval of RBC orders by medical laboratory technicians to ensure they met appropriateness criteria), immediate feedback to ordering physicians for potentially inappropriate orders, and monthly feedback on appropriateness to clinical teams.¹⁹ These efforts resulted in an increase in single unit orders from 46% to 68%, and overall reduction of 458 (8.6%) RBC units transfused per month.¹⁹
- A health system-wide initiative in Australia used clinician education, individual clinician practice audit and feedback, and a single unit RBC transfusion policy to achieve a reduction in pre-transfusion haemoglobin from 79 g/L to 73 g/L, and an increase in single unit RBC transfusions from 33% to 64%, over a 6 year period.²⁰

In addition to restrictive transfusion practices, patient blood management approaches to minimise the use of transfusion are important—for example, for preventing anaemia, treating iron deficiency with iron supplementation, and reducing blood loss during procedures.²¹

How can restrictive transfusion practices be implemented?

The implementation of strategies to reduce the unnecessary use of transfusion is the responsibility of the individual clinician and the

transfusion team in the hospital. An informed clinician can assess their own practice against standards and provide leadership for their clinical unit to improve transfusion practice.

Identify key stakeholders—Bringing together multidisciplinary representation, perhaps as a hospital transfusion or patient blood management committee, is beneficial. The group can include departments of medicine, transfusion medicine, surgical services, anaesthesia, critical care, nursing, pharmacy, quality and safety, and information technology.²² The inclusion of patients and families in these discussions provides an important perspective.

Audit practice against evidence based standards—Data showing the gap between present practices and evidence based standards are helpful in motivating change.^{23,24} An audit of baseline rates of RBC transfusion compared with key performance indicators, such as the percentage of single unit transfusions and the percentage of RBC transfusions with a restrictive transfusion threshold, can be undertaken. This can identify clinical settings with opportunities for improvement and create motivation to change through comparisons with similar settings that perform better. Electronic medical records and health data analytics available at some centres can aid the audit.²⁵ Supplemental file 1 provides an audit tool developed by Choosing Wisely Canada.

Tailor interventions for your settings and context—Once opportunities for improvement are identified, select and tailor interventions to the specific needs and available local resources. Supplemental file 2 provides an assessment tool to assist in identifying which

interventions are best suited to the organisation. Clinicians may require reassurance about concerns that restrictive transfusion will come at the expense of other clinical or patient goals (eg, slowing time to patient recovery or discharge).²⁴ Organisational transfusion practices embedded in hospital order sets or clinical protocols may not align with best transfusion strategies.²³ These barriers can be minimised through consultation and education of physicians, and using multiple intervention strategies.

Some interventions may be more appropriate than others, depending on factors such as existing awareness of the problem, baseline performance, and technological capability.²⁶ For example, education and audit interventions may be best suited to organisations in which clinicians are unfamiliar with the problem, have a very low baseline adherence rate, or believe they are performing well.²⁶ Electronic clinical decision support interventions may be helpful where education efforts may not reach all clinicians (eg, academic centres with frequent staff and trainee turnover), or when education alone has not led to change.²⁵⁻²⁷

How to support shared decision making with patients and families

Conversations to guide shared decision making should highlight where evidence exists (or does not) for good transfusion practice. Individualised assessment of transfusion appropriateness must consider patient risk factors, comorbidities, and preferences. Transfusion decisions should be made not solely on haemoglobin concentrations, rather must consider the patient's symptoms.

The Choosing Wisely UK campaign recommends “*Don’t give a patient a blood transfusion without informing them about the risks and benefits*,” meaning that patient consent should be central to the decision to transfuse.⁸ Recently published guidelines outline important elements of a consent discussion for transfusion, which include the reason for the transfusion, benefits, short and long term risks, available alternatives, explaining the transfusion process, and offering an opportunity to ask questions.²⁸ Information leaflets for patients may aid in informed decision making (box, Additional resources).^{29 30}

Education into practice

- How would you identify whether you or your clinical organisation is overusing RBC transfusions?
- What interventions are best suited to your organisation to adopt restrictive transfusion strategies?
- What barriers to change might your organisation encounter in adopting restrictive transfusion strategies?

How this article was created

We searched Medline for evidence of inappropriate RBC transfusion rates and for available interventions to reduce RBC transfusions. We prioritised published randomised controlled trials and systematic reviews. We consulted widely among experts in transfusion medicine and haematology on effective interventions and relevant published evidence.

Choosing Wisely is a clinician led campaign, present in more than 25 countries, which partners with national clinician societies to develop evidence based recommendations about unnecessary tests, treatments, and procedures.⁷ The RBC audit tool and organisational assessment tool included as supplemental files are components of a national initiative of Choosing Wisely Canada (www.usingbloodwisely.ca). These tools are designed to support practice change efforts and are based on literature reviews, environmental scans, and expert consultation.

Additional resources

- Guidelines from the expert advisory committee on the safety of blood, tissues, and organs (SaBTO) on patient consent for blood transfusion: <https://www.gov.uk/government/publications/blood-transfusion-patient-consent/guidelines-from-the-expert-advisory-committee-on-the-safety-of-blood-tissues-and-organs-sabto-on-patient-consent-for-blood-transfusion#informed-and-valid-consent>
- Using Blood Wisely patient pamphlet for patients: <https://usingbloodwisely.ca/intervention/>
- NHS Patient leaflet about blood transfusions: <https://hospital.blood.co.uk/patient-services/patient-blood-management/patient-information-leaflets/>

How patients were involved in the creation of this article

Lawrie Kaplan, a coauthor on this article, is a patient and family adviser with Choosing Wisely Canada. He has a special interest in avoiding unnecessary blood transfusions owing to his experiences with blood donation, and blood transfusion of a family member. LK reviewed and edited the section on shared decision making with patients, and reviewed and commented on subsequent versions of the full manuscript. LK emphasised that family members often play a large part in assisting a patient to understand a certain procedure.

Competing interests *The BMJ* has judged that there are no disqualifying financial ties to commercial companies. The authors declare the following other interests: none.

Further details of *The BMJ* policy on financial interests are here: <https://www.bmj.com/about-bmj/resources-authors/forms-policies-and-checklists/declaration-competing-interests>

Contributorship statement: NM conducted the initial literature reviews and prepared the first draft of the article in consultation with WL. MM and LK reviewed and revised the manuscript. WL is the guarantor and suggested the article topic. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

Acknowledgments: We thank Karen Born for her insights and assistance in preparation of this manuscript. We also thank Andrea Patey who developed the Assessment Tool for Selecting an Intervention.

Provenance and peer review: commissioned, based on an idea from the author; externally peer reviewed.

- 1 Baron DM, Franchini M, Goobie SM, et al. Patient blood management during the COVID-19 pandemic: a narrative review. *Anaesthesia* 2020;75:1105-13. doi: 10.1111/anae.15095 pmid: 32339260
- 2 Barr PJ, Donnelly M, Cardwell CR, Parker M, Morris K, Ballie KE. The appropriateness of red blood cell use and the extent of overtransfusion: right decision? Right amount? *Transfusion* 2011;51:1684-94. doi: 10.1111/j.1537-2995.2011.03130.x pmid: 21470238
- 3 Joy PJ, Bennet SJ. The appropriateness of blood transfusion following primary total hip replacement. *Ann R Coll Surg Engl* 2012;94:201-3. doi: 10.1300/003588412X13171221501384 pmid: 22507728
- 4 Spradbury J, Cohen R, Lin Y, et al. Evaluating appropriate red blood cell transfusions: a quality audit at 10 Ontario hospitals to determine the optimal measure for assessing appropriateness. *Transfusion* 2016;56:2466-76. doi: 10.1111/trf.13737 pmid: 27465485
- 5 Bosboom JJ, Klanderman RB, Zijp M, et al. Incidence, risk factors, and outcome of transfusion-associated circulatory overload in a mixed intensive care unit population: a nested case-control study. *Transfusion* 2018;58:498-506. doi: 10.1111/trf.14432 pmid: 29238981
- 6 Shander A, Hofmann A, Ozawa S, Theusinger OM, Gombotz H, Spahn DR. Activity-based costs of blood transfusions in surgical patients at four hospitals. *Transfusion* 2010;50:753-65. doi: 10.1111/j.1537-2995.2009.02518.x pmid: 20003061
- 7 Choosing Wisely Canada. Transfusion Medicine—Choosing Wisely Canada. 2020. <https://choosingwiselycanada.org/transfusion-medicine/>
- 8 Royal College of Pathologists. Recommendations for transfusion medicine—Choosing Wisely Initiative. <https://www.rcpath.org/profession/patient-safety-and-quality-improvement/patient-safety-resources/choosing-wisely/recommendations-for-transfusion-medicine.html>.
- 9 American Association of Blood Banks. Choosing Wisely. 2017. <https://www.choosingwisely.org/societiesamerican-association-of-blood-banks/>
- 10 Padhi S, Kemmis-Betty S, Rajesh S, Hill J, Murphy MF Guideline Development Group. Blood transfusion: summary of NICE guidance. *BMJ* 2015;351:h5832. doi: 10.1136/bmj.h5832 pmid: 26581483
- 11 Goodnough LT, Murphy MF. Do liberal blood transfusions cause more harm than good? *BMJ* 2014;349:g6897. doi: 10.1136/bmj.g6897 pmid: 25501327

- 12 Carson JL, Stanworth SJ, Alexander JH, et al. Clinical trials evaluating red blood cell transfusion thresholds: an updated systematic review and with additional focus on patients with cardiovascular disease. *Am Heart J* 2018;200:96e101.
- 13 Holst LB, Petersen MW, Haase N, Perner A, Wetterslev J. Restrictive versus liberal transfusion strategy for red blood cell transfusion: systematic review of randomised trials with meta-analysis and trial sequential analysis. *BMJ* 2015;350:h1354. doi: 10.1136/bmj.h1354 pmid: 25805204
- 14 NIH US National Library of Medicine. Myocardial Ischemia and Transfusion (MINT) Trial. <https://clinicaltrials.gov/ct2/show/NCT02981407>
- 15 Docherty AB, O'Donnell R, Brunskill S, et al. Effect of restrictive versus liberal transfusion strategies on outcomes in patients with cardiovascular disease in a non-cardiac surgery setting: systematic review and meta-analysis. *BMJ* 2016;352:i1351. doi: 10.1136/bmj.i1351 pmid: 27026510
- 16 Ducrocq G, Gonzalez-Juanatey JR, Puymirat E, et al REALITY Investigators. Effect of a restrictive vs liberal blood transfusion strategy on major cardiovascular events among patients with acute myocardial infarction and anemia: The REALITY Randomized Clinical Trial. *JAMA* 2021;325:552-60. doi: 10.1001/jama.2021.0135 pmid: 33560322
- 17 Royal College of Obstetricians and Gynaecologists. Blood transfusion in obstetrics. Green-top Guideline 47. 2015. <https://www.rcog.org.uk/globalassets/documents/guidelines/gtg-47.pdf>
- 18 Soril LJ, Noseworthy TW, Dowsett LE, et al. Behaviour modification interventions to optimise red blood cell transfusion practices: a systematic review and meta-analysis. *BMJ Open* 2018;8:e019912. doi: 10.1136/bmjopen-2017-019912 pmid: 29776919
- 19 Kron AT, Collins A, Cserti-Gazdewich C, et al University of Toronto Quality in Utilization, Education and Safety in Transfusion (QUEST) Research Program. A prospective multi-faceted interventional study of blood bank technologist screening of red blood cell transfusion orders: The START study. *Transfusion* 2021;61:410-22. doi: 10.1111/trf.16243. pmid: 33423316
- 20 Leahy MF, Hofmann A, Towler S, et al. Improved outcomes and reduced costs associated with a health-system-wide patient blood management program: a retrospective observational study in four major adult tertiary-care hospitals. *Transfusion* 2017;57:1347-58. doi: 10.1111/trf.14006 pmid: 28150313
- 21 Mueller MM, Van Remortel H, Meybohm P, et al ICC PBM Frankfurt 2018 Group. Patient blood management: Recommendations from the 2018 Frankfurt Consensus Conference. *JAMA* 2019;321:983-97. doi: 10.1001/jama.2019.0554 pmid: 30860564
- 22 Sadana D, Pratzer A, Scher LJ, et al. Promoting high-value practice by reducing unnecessary transfusions with a patient blood management program. *JAMA Intern Med* 2018;178:116-22. doi: 10.1001/jamainternmed.2017.6369 pmid: 29159367
- 23 Soril LJ, Noseworthy TW, Stelfox HT, Zygun DA, Clement FM. Facilitators of and barriers to adopting a restrictive red blood cell transfusion practice: a population-based cross-sectional survey. *CMAJ Open* 2019;7:E252-7. doi: 10.9778/cmaj.20180209 pmid: 31018970
- 24 Islam R, Timmouth AT, Francis JJ, et al. A cross-country comparison of intensive care physicians' beliefs about their transfusion behaviour: a qualitative study using the Theoretical Domains Framework. *Implement Sci* 2012;7:93. doi: 10.1186/1748-5908-7-93 pmid: 22999460
- 25 Staples S, Salisbury RA, King AJ, et al. How do we use electronic clinical decision support and feedback to promote good transfusion practice. *Transfusion* 2020;60:1658-65. doi: 10.1111/trf.15864 pmid: 32643142
- 26 Solh Z, Brouwers M, Florez ID. Knowledge translation in transfusion medicine. Part 3: Interventions and tools. *Transfusion* 2018;58:1835-7. doi: 10.1111/trf.14653 pmid: 29667202
- 27 Hibbs SP, Nielsen ND, Brunskill S, et al. The impact of electronic decision support on transfusion practice: a systematic review. *Transfus Med Rev* 2015;29:14-23. doi: 10.1016/j.tmr.2014.10.002 pmid: 25535095
- 28 UK Department of Health and Social Care. Guidelines from the expert advisory committee on the safety of blood, tissues, and organs (SaBTO) on patient consent for blood transfusion. 2020. <https://www.gov.uk/government/publications/blood-transfusion-patient-consent/guidelines-from-the-expert-advisory-committee-on-the-safety-of-blood-tissues-and-organs-sabto-on-patient-consent-for-blood-transfusion#informed-and-valid-consent>.
- 29 Using Blood Wisely. Planning survey. <https://usingbloodwisely.ca/intervention/>
- 30 NHS Blood and Transplant. Information for patients about blood transfusion. <https://hospital.blood.co.uk/patient-services/patient-blood-management/patient-information-leaflets/>