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WIDER PERSPECTIVES

Transforming transfusion practice in the National Health Service to enhance safety, efficiency and clinical outcomes

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Summary

There is an urgent need to improve transfusion services in the National Health Service. Current transfusion practice remains largely paper-based, labour-intensive and error-prone, contributing to rising adverse events. Inappropriate blood use is common, measures for the avoidance of transfusion are underutilised and both blood wastage and shortages are at unacceptable levels. There have been many national initiatives to improve transfusion practice over the last 25 years, but the implementation of their recommendations has been poor, as evidenced by the disturbing results of the annual national audits of compliance with the National Institute for Health and Care Excellence Quality Standards for Blood Transfusion. This article discusses these issues and argues for investment in the transfusion workforce, a modernised digital infrastructure and greater oversight of transfusion practice. It is now time to renew efforts to modernise transfusion practice to standards of safety, efficiency and clinical effectiveness, which our patients should reasonably expect.

KEYWORDS

clinical outcomes, infected blood inquiry, patient safety, recommendations, transformation, transfusion, transfusion practice

INTRODUCTION

Blood transfusion is a vital, life-saving procedure that touches nearly every corner of modern medical care. Yet, despite its clinical importance, transfusion practice remains outdated in many hospitals. Transfusion procedures and processes are still largely paper-based, labour-intensive and error-prone, unchanged in many ways for over half a century. While most areas of healthcare have embraced digital transformation and modern clinical governance, transfusion services lag behind, putting patients and staff at unnecessary risk and failing to meet modern standards of efficiency and safety. Transfusion care is therefore overdue for fundamental transformation and the urgency for this is underscored by the findings of the Infected Blood Inquiry.[1] Since the report's publication in May 2024, transfusion-related adverse events and deaths have continued to rise,[2,3] and resilience in the blood supply has weakened, as evidenced by a second national blood shortage alert in England in just 5 years.

The objective of this article is to describe the current state of transfusion practice in the National Health Service (NHS) in England, and current efforts to address its shortcomings. The observations about current transfusion practice and the recommendations to improve it are very likely to be relevant to health services worldwide facing the same challenges.

WHAT SHOULD GOOD TRANSFUSION PRACTICE LOOK LIKE?

A clear vision of good practice is essential. Transfusion care must be patient-centred, evidence-based and supported by robust systems at every stage of the process from the decision to transfuse and consideration of alternatives to transfusion, the bedside and laboratory procedures for safe and timely transfusion, the monitoring for adverse events and the documentation of the outcomes of transfusions (Table 1).

Effective governance is essential, particularly given the NHS's reliance on a single national blood provider, which charges hospitals for its products. The Department of Health and Social Care (DHSC) must ensure robust oversight of transfusion practice, while hospital leaders should uphold transfusion safety and the appropriate use of blood through well-functioning hospital transfusion committees. Nearly all hospital staff play a role in transfusion, whether in clinical decision-making, bedside procedures, laboratory work or logistics in delivering blood to patients. To support them to perform safely and efficiently, they need clear and simple processes and systems, structured support, adequate training and regular feedback. Strengthening these elements will foster confidence and reduce risks across the entire transfusion pathway.

TABLE 1 What should good transfusion practice look like?

Informed decision-making: Clinicians should assess whether transfusion is truly necessary, considering alternatives such as intravenous iron, tranexamic acid and cell salvage. Patient involvement in these decisions is essential
Safe and standardised procedures: The practical elements of transfusion, that is, sample labelling, blood administration, monitoring, should be simple, standardised and supported by systems that reduce human error
Emergency readiness: Blood should be readily available in major haemorrhage scenarios without compromising safety
Effective monitoring: Patients must be monitored for adverse reactions, with clear protocols for intervention
Outcome tracking: Outcomes following transfusions must be documented to support continuous improvement
Staff training and support: Continuous feedback, education and training should empower staff to provide high-quality care

THE CURRENT STATE OF TRANSFUSION PRACTICE IN THE NHS

Despite many past initiatives, current transfusion practice in the NHS frequently falls short. Data highlighting systemic issues for concern include:

Persistent and preventable errors

According to Serious Hazards of Transfusion (SHOT) data, preventable errors, including ABO-incompatible transfusions, remain unacceptably common, with some indicators worsening in recent years (Figure 1).[2,3] Transfusion-related deaths in the United Kingdom have quadrupled over the past decade, reaching a record high up to 59 in 2024 from 38

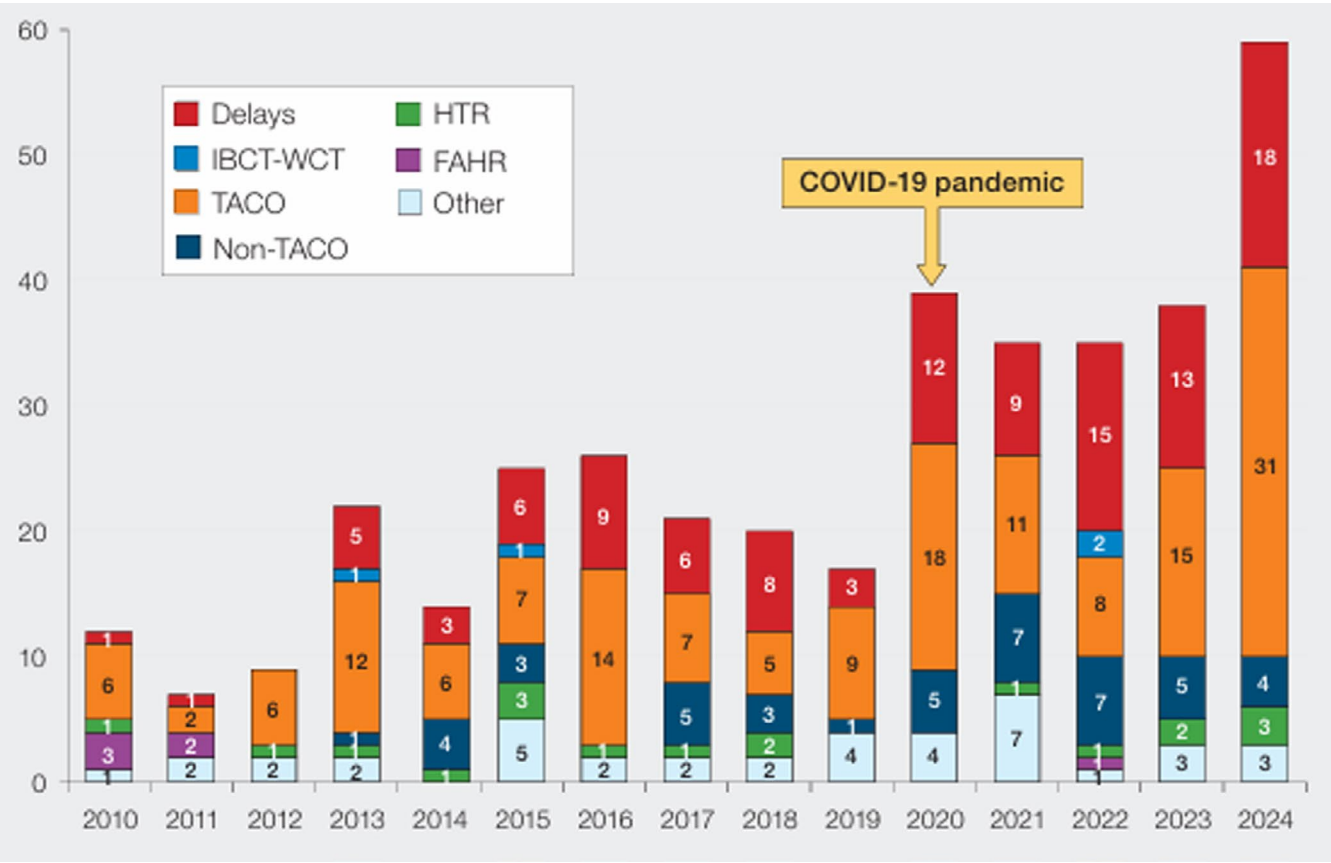


FIGURE 1 Transfusion-related deaths reported to Serious Hazards of Transfusion 2010–2024 ($n = 379$).[2]

TABLE 2 Results of the national comparative audit of compliance with National Institute of Health and Care Excellence Quality Standard QS138.[8]

Standard	2021	2023	2024	
1: People with iron deficiency anaemia are treated with iron supplementation before surgery	659/1105 (59.6%)	594/881 (67.4%)	776/1206 (64.3%)	
2: Adults who are having surgery and expected to have moderate blood loss receive tranexamic acid	1067/1564 (68.2%)	885/1207 (67%)	1137/1481 (76.8%)	
3: People are clinically reassessed and have their haemoglobin levels checked after each unit of red blood cells they receive, unless they are bleeding or are on a chronic transfusion programme	873/1485 (58.8%)	746/1172 (63.7%)	968/1371 (70.6%)	
4: People who have had a transfusion are given verbal and written information about blood transfusion	420/1564 (26.9%)	459/1321 (34.7%)	476/1413 (33.7%)	
5: Restrictive haemoglobin thresholds are used to guide transfusion decisions in adults who are not actively bleeding or on a chronic transfusion programme	Not assessed	Not assessed	586/1238 (47.3%)	

in 2023, an increase of 55%. The leading causes of mortality are transfusion-associated circulatory overload (TACO) and delays in transfusion.[2] Despite safety measures, ABO-incompatible transfusions persist alongside a concerning rise in laboratory errors. Errors in the transfusion process leading to 'wrong transfusions' are similar to medication errors,[4] in that they are caused both by 'human factors' such as fatigue and poor communication and by inadequate processes or equipment.

Inappropriate use

An estimated 20% or more of transfusions are clinically inappropriate.[5,6] This is evidenced by national audits of the use of red cell and platelet transfusions in different clinical scenarios including a broad range of medical indications and specific uses such as adult haematology and gastrointestinal haemorrhage.[5] The recent national audit of compliance with National Institute of Health and Care Excellence (NICE) Quality Standards in transfusion found 47% compliance with restrictive haemoglobin thresholds in adults who are not actively bleeding or on a chronic transfusion programme (Table 2).[7,8] The audit also found poor compliance with the quality standard on the use of 'single unit' red cell transfusions, requiring patients to be clinically reassessed and have a check of their haemoglobin concentration before proceeding to transfusion of another unit of blood; this standard also does not apply to patients who have major blood loss or who are on a regular transfusion programme (Table 2).

Underuse of alternatives to transfusion

Proven alternatives to transfusion like tranexamic acid and cell salvage remain underutilised. The recent national audit of compliance with NICE quality standards in transfusion found that 77% of adults who are having surgery and expected to have moderate blood loss receive tranexamic acid (Table 2).[7,8] Compliance with this standard has improved from 68% to 77% in 3 years driven through significant efforts by the UK Royal Colleges to promote awareness of the use of tranexamic acid in surgical patients,[9] but it still means that over 20% of eligible surgical patients are not receiving a simple measure to reduce blood loss and the need for transfusion.

The audit did not explore the use of intraoperative cell salvage which the NICE guidelines for transfusion[10] recommended to be combined with tranexamic acid for patients who are expected to lose a very high volume of blood, for example, in cardiac and complex vascular surgery, major obstetric procedures and pelvic reconstruction. However, it is highly likely that this intervention is also poorly used.

The audit found even less compliance, only 64% of eligible patients, with the quality standard to treat patients with iron deficiency anaemia with iron supplementation before surgery (Table 2).[8]

Blood stock management: Wastage of blood and use of O D negative red cell units

Blood products are wasted at high rates, undermining the sustainability of the blood supply and donor goodwill. Data for wastage of blood in hospitals are provided to hospitals by the Blood Stocks Management Scheme (BSMS). The BSMS does not provide data on wastage in the collection, processing and testing of blood by NHS Blood & Transplant, England's blood supplier.[11]

Over the last 10 years, red cell wastage in hospitals has been steady at around 2.5%, but platelet wastage is increasing and is now over 5% (Figure 2). Wastage of 'universal' O D negative red cells and A D negative platelets is increasing. Other BSMS data show that 31% of wasted red cells are O D negative and 21% of wasted platelets are A D negative. The main cause of wastage is time expiry which is an indicator of poor management of blood stocks, primarily over-ordering of 'universal' blood components.

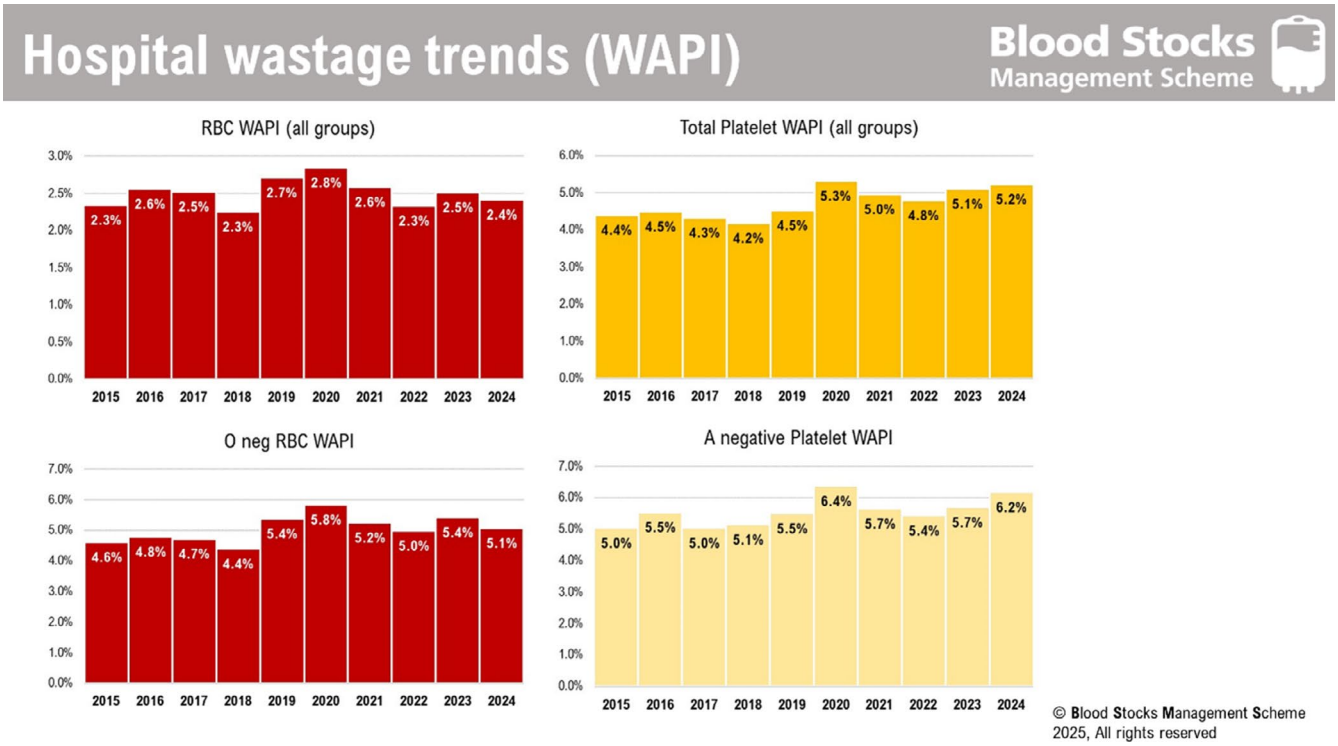


FIGURE 2 Data on the wastage of units of red cells and platelets from the Blood Stocks Management Scheme.[11] WAPI, wastage as a proportion of issues.

A survey conducted by the National Blood Transfusion Committee (NBTC) of the use of O D negative red cell units, conducted over a 2-week period in September 2024, captured data from 203 hospitals, accounting for 5653 O D negative red cell units. The transfusion of O D negative red cell units to O D negative patients decreased to 46% in 2024 compared to 59% in 2018 and 70% in 2010. 17% of O D negative red cell units were used as a substitute for another blood group; 40% of those cases involved Ro patients, primarily those with sickle cell disease, where group O D negative units were used for transfusion as fully matched Ro units were unavailable. O D negative units were also used for non-O D negative patients for other reasons, including emergency use for patients with an unknown blood group (13%) and the avoidance of time expiry (13%).

High blood wastage and inappropriate use of O D negative red cell units indicate worsening hospital blood stock management, reflecting known staffing issues in transfusion laboratories. Data on blood stock management and blood wastage are regularly provided to hospital transfusion teams by the BSMS, but there has been limited progress in reducing blood wastage. This lack of action likely reflects inadequate support for the hospital transfusion team's work from the local hospital transfusion committee and hospital management.

Workforce shortages

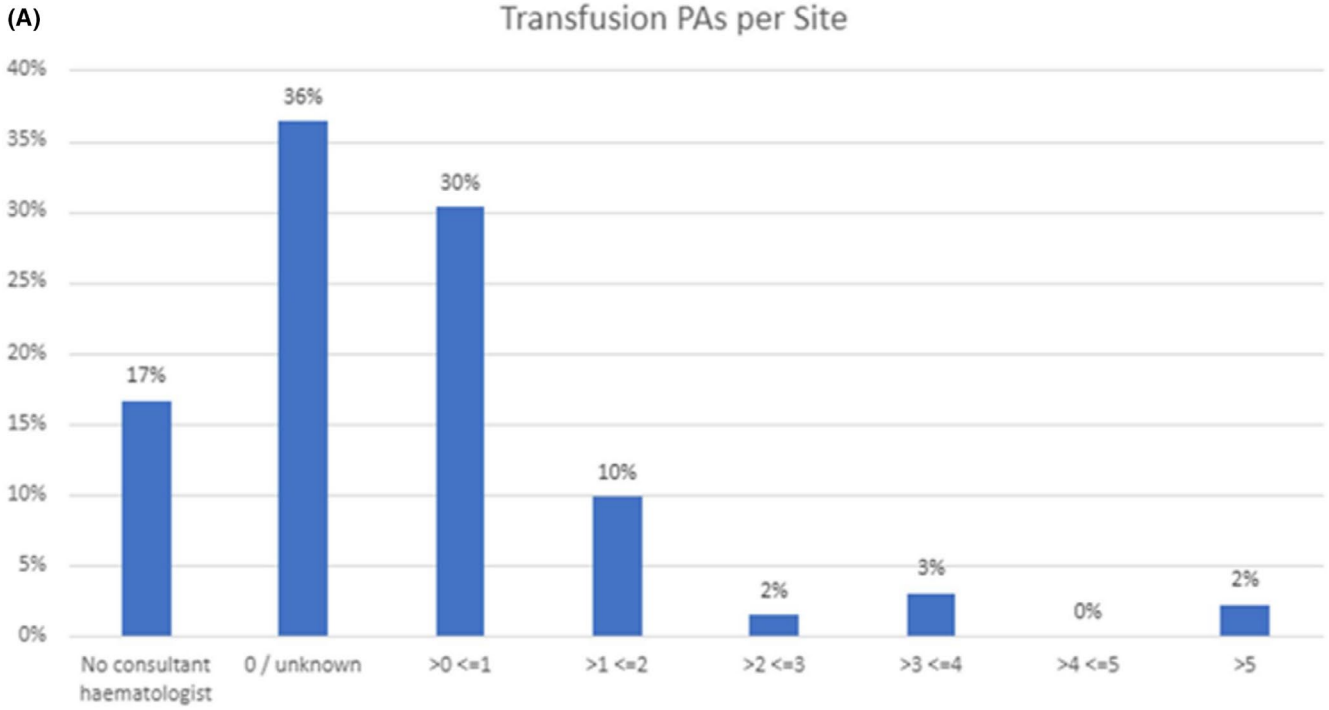
Workforce surveys show that many hospitals lack adequate haematology, laboratory and transfusion practitioner support.[12] They find a striking lack of leadership which should be provided by consultant haematologists in the NHS. Many hospitals have either no or very limited allocated time for transfusion for consultant haematologists and similarly inadequate time for transfusion practitioners (Figure 3A,B). Transfusion practitioners still spend a considerable amount of time on paper-based traceability, a task that could be automated. The same survey found a lack of support services for transfusion such as information technology and data collection and analysis.

Workforce concerns also apply to blood transfusion laboratories where surveys consistently show that they carry a high proportion of vacancies (Figure 3C).[13] On the day of the last survey, only 50% of laboratories had staffing numbers and skill mix compliant with their capacity plan.

Training gaps

Many staff members involved in some aspect of transfusion practice lack adequate, up-to-date training and competency assessments. A survey of hospital transfusion laboratories in 2023 found that 63% of respondents considered there were knowledge gaps in their department.[14] The commonest reasons given were insufficient time for teaching in the laboratory and for attending courses, lack of experience in the laboratory and lack of training resources. The Infected Blood Inquiry report in 2024 remarked on the need to improve transfusion training.[1,15]

A recent survey identified variable levels of overall satisfaction with the transfusion training provided for specialist trainees in haematology: very satisfied/satisfied (30%), neutral (31%), dissatisfied/very dissatisfied (39%).[16] The most



(B)

	2021	2018	2015
Whole time	1.16	1.19	1.02
Part time	0.69	0.78	0.74

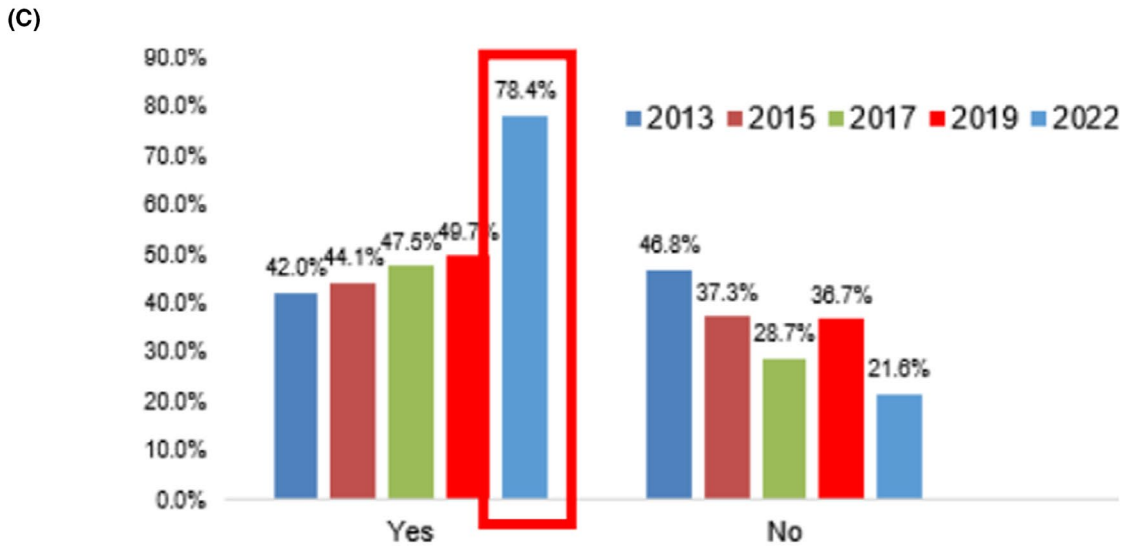


FIGURE 3 (A) Number of programmed activities (PAs, that is half days) for consultant haematologists to undertake leadership in transfusion medicine in National Health Service (NHS) hospitals.[12] (B) Average number of transfusion practitioners in NHS hospitals.[12] (C) Vacancies in hospital blood transfusion laboratories 2013–2022.[13]

common barriers to training were lack of exposure to the blood transfusion laboratory, clashing clinical commitments taking priority and lack of provision of dedicated transfusion training. The authors recommended the need for protected time for transfusion training including laboratory time for all haematology trainees.

The poor response rate in these surveys is a significant limitation to a full understanding about the workforce for transfusion in hospitals. The response rates were 76% (114/149) in the survey of consultant haematologists and transfusion practitioners,[12] 64/241 (27%) in the transfusion laboratory survey[14] and 150/625 (24%) in the trainee survey.[16] However, their findings about an inadequate hospital transfusion workforce agree with those in the final report of the infected blood inquiry.[1]

Inadequate information technology

A lack of integrated electronic systems contributes to inefficiencies and risks. There is huge variability in the adoption of electronic blood transfusion systems in NHS hospitals. A recent survey found that, of the 76 responding hospitals, 67% had implemented at least one component of an electronic blood transfusion system, but mostly only electronic blood fridges (58%) and not bedside patient identification systems (26%).[17] Electronic blood ordering and clinical decision support were rarely implemented, and only two hospitals had the full range of electronic transfusion systems. Many of the hospitals who had invested in electronic systems did not use them in all clinical areas and for all transfusions. Barriers to the adoption of electronic transfusion systems among the survey responders included financial constraints, limited senior management support and engagement and technical challenges.

Patient involvement

The lack of the provision of information to patients about transfusion and their involvement in decision-making about the need for transfusion and/or alternatives to transfusion are missed opportunities. The 2024 national audit of compliance with the NICE quality standards for transfusion found that informed patient consent to transfusion was sporadic and compliance was generally low; only 36% of patients had documentation that they were given verbal and written information about blood transfusion (Table 2).[8] There has been a slight improvement from 26% in the 2021 audit.

Blood shortages and rising costs

Despite a 25% drop in issues of red cell units in the NHS over 25 years (Figure 4), there have been blood shortages in 2022,[18] and more recently in 2024 which took over 12 months to resolve. These periods of blood shortage put huge pressure on hospitals in planning elective medical treatments and surgical procedures that usually require transfusion. Concerns that hospitals have about blood shortages are compounded by the escalating price of blood in recent years. A standard unit of red cells is now £187, an increase of around 35% in the last 10 years.

Lack of governance and oversight of transfusion in hospitals

A likely persistent cause of the lack of progress in improving hospital transfusion practice in the NHS is the lack of governance and oversight of transfusion in hospitals. Transfusion appears to be low down in the priorities for quality improvement perhaps because transfusion is viewed as 'safe' because of the improvements in the microbiological safety of blood products.

Hospital transfusion committees, which are tasked with monitoring patient safety and transfusion practice, consistently report frustration at their inability to get attention from senior governance committees, hospital executives and boards of directors. Most hospital transfusion committees lack formal mechanisms to escalate risks and concerns. Instead, many have been downgraded to forums without appropriate links to the formal governance structure in hospitals. There is a huge gap between executive insight and the

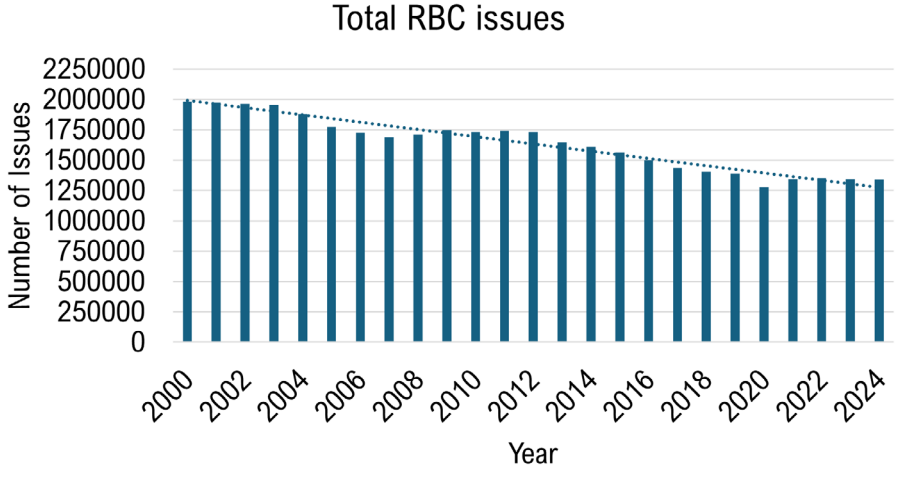


FIGURE 4 Reduction in issues of red cell units in the National Health Service 2000–2025 (data provided by the Blood Stocks Management Scheme).

need to implement recommendations from SHOT and guidelines from NICE, Royal Colleges and specialist societies and to respond actively to other national initiatives for improving transfusion practice.

This lack of oversight of transfusion practice is surprising, given the significant potential for hospitals to save money by reducing wastage and unnecessary transfusion, especially when considering the recent increases in the cost of red cell units provided to hospitals.

Shared decision-making with patients

There is evidence from successive audits of the implementation of NICE Quality Standards that only about a third of patients receive verbal and written information on transfusion (Table 2).[8] This limited ability for patients to engage in shared decision-making about transfusion may remove an opportunity to encourage the clinical team to reconsider the need for transfusion, which would result in a reduction in unnecessary transfusions.

Choosing Wisely is an initiative encouraging patients to engage in discussions about the tests and treatments they receive. Choosing Wisely recommendations were made for blood transfusion,[19,20] but have received little attention for their implementation in the United Kingdom, again missing an opportunity to involve patients in decision-making about transfusion. The Advisory Committee for the Safety of Blood, Tissues and Organs (SaBTO) has recently updated its guidelines for consent to transfusion with a primary objective of encouraging shared decision-making about transfusion with patients.[21]

WHAT HAS BEEN DONE SO FAR AND WHAT WERE THE OUTCOMES?

Several national efforts have been made to improve transfusion practice. They include efforts to improve transfusion safety,[22–24] the use of blood and alternatives to transfusion,[7,10,25,26,27] the provision of information to patients[1,7,10,15] and the use of electronic transfusion systems[1,15,27] (Table 3).

While these initiatives may have raised awareness of the need to improve transfusion practice and established frameworks for discussion of transfusion matters both locally and nationally, the implementation of their recommendations and widespread transformation of transfusion practice remain elusive.

WHAT NEEDS TO BE DONE NOW TO TRANSFORM TRANSFUSION CARE?

To modernise transfusion care, coordinated action is needed across five key areas, backed by accountable leadership at all levels of the health service:

TABLE 3 Key national efforts to improve transfusion safety.

Better Blood Transfusion (1998–2007)[22–24]
A landmark programme led by the Department of Health laid the foundation for safe transfusion practice. Major recommendations included the establishment in every hospital of Hospital Transfusion Committees and Hospital Transfusion Teams, the latter comprising the lead consultant haematologist for transfusion, the senior biomedical scientist in the transfusion laboratory and the transfusion practitioner team. Other recommendations were audit of all aspects of transfusion practice, reporting of adverse events and reactions to Serious Hazards of Transfusion and the establishment of the National Blood Transfusion Committee (NBTC)
Patient blood management (PBM) (2012)[25]
This initiative focussed on promoting evidence-based appropriate use of blood and alternatives to transfusion. PBM became an international movement in the following years with recommendations to support its implementation.[26] However, as already indicated in this review, there has been an inadequate adoption of PBM in the National Health Service (NHS)
National Institute of Health and Care Excellence (NICE) Guidelines (2015) and Quality Standards (2016)[7,10]
The NICE Guidelines for Blood Transfusion provided comprehensive best practice guidance for transfusion. However, the implementation of the guidance has been inconsistent as assessed by audits of compliance with the subsequent NICE Quality Standards.[7]
Transfusion 2024 (2019)[27]
This 5-year programme was launched by the NBTC and NHS Blood & Transplant with the aim of future-proofing clinical and laboratory transfusion services but few resources were provided and its impact was limited
Infected Blood Inquiry (2024)[1,15]
The final report highlighted critical governance failures and underscored the urgency of reform and the greater involvement of patients in decision-making. It is as yet unclear what resources, if any, will be provided to implement its recommendation
Transfusion Transformation (2024)
A further national seminar was held in London in June 2024 with the intention of energising improvement in NHS transfusion services. This was led by the national Medical Director of NHS England and its final report and recommendations are yet to be issued

1. Workforce development
   - Define and implement ideal staffing levels, informed by data from the UK Transfusion Laboratory Collaborative, SHOT and the NBTC.
   - Invest in the recruitment, training and retention of haematologists focussed on transfusion medicine, biomedical scientists in blood transfusion laboratories and transfusion practitioners.
2. Training and competency
   - Establish mandatory, regular competency assessments for all staff involved in transfusion.
   - Integrate e-learning and simulation-based training programmes.
   - Improve the transfusion training of transfusion laboratory staff and specialist trainees in haematology.
3. Technology and digital systems
   - Implement electronic blood transfusion systems in electronic patient record (EPRs), at the bedside and in

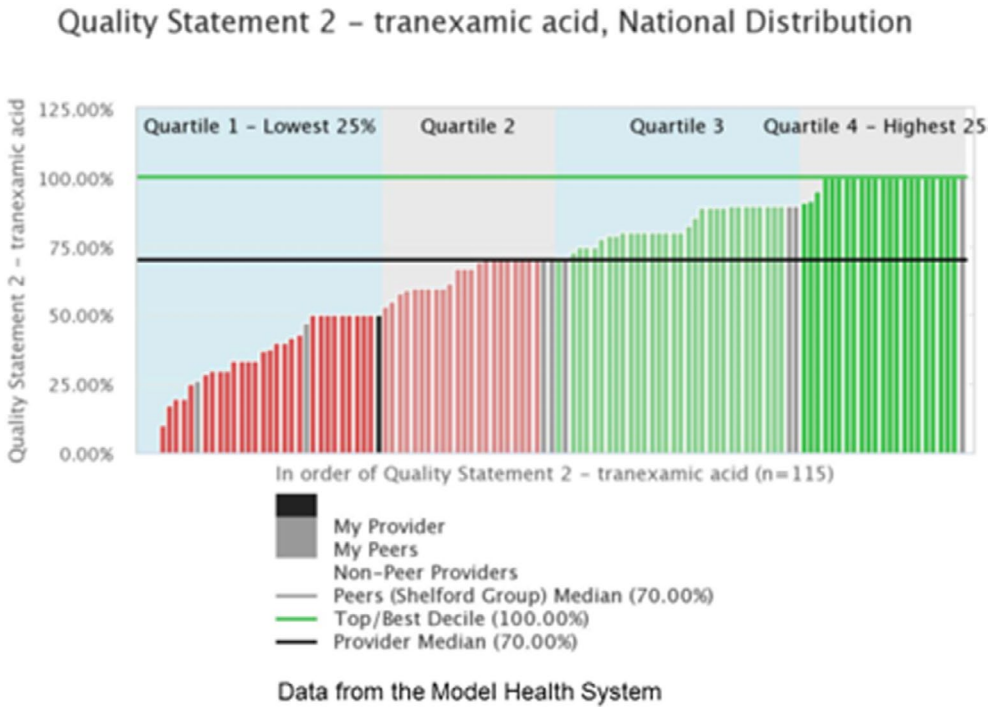


FIGURE 5 Example of a Model Health report showing the result of a national comparative audit of the use of tranexamic acid for surgical patients in one hospital 'my provider' in comparison to 'peer' (similar size) hospitals and other hospitals.

blood transfusion laboratories. They should support safe and appropriate transfusion practice throughout the whole hospital transfusion pathway including:
    - Discussion with the patient about their transfusion care and consent to transfusion.
    - Decision-making about the use of blood and alternatives to transfusion.
    - Blood ordering and timely delivery of blood to wherever it is needed.
    - Transfusion procedures at the bedside and in the laboratory.
    - Monitoring of transfused patients, and management of any adverse events.
    - Full documentation of all the above.
  - Integrate artificial intelligence (AI)-driven decision support tools in EPRs and laboratory information systems to improve the appropriateness of transfusions and reduce the wastage of blood.
  - Support data transfer between hospital systems regionally and nationally to ensure continuity and oversight.
  - Cost-effectiveness analyses are urgently needed to justify advanced electronic blood transfusion systems and to overcome organisational barriers.
4. Service coordination
  - Promote collaborative models for regional consolidation and coordination of transfusion services, particularly to support smaller hospitals with limited resources and expertise in transfusion.
5. Governance and oversight
  - A culture shift, as highlighted in the Infected Blood Inquiry report,[1] is necessary to drive much needed and long overdue improvement in transfusion services and to avoid preventable deaths from transfusion.
  - Enhance national audit coverage and benchmarking, for example, using Model Health (Figure 5).
  - Establish stronger regulatory oversight of transfusion services, possibly via the Care Quality Commission (CQC) and/or the National Quality Board.
  - Hold leadership accountable for their transfusion services, including NHS Trust senior executives and NHS Trust Boards.
  - Consider the establishment of a national body with oversight of both hospital transfusion services and the national blood supplier(s) to support their integration, transfusion safety and operational efficiency.

PATIENT BLOOD MANAGEMENT

Patient blood management (PBM) is a patient-centred, systematic, evidence-based approach to improve patient outcomes by managing and preserving a patient's own blood, while promoting patient safety and empowerment.[28] This definition emphasises the critical role of informed choice. PBM involves the timely, multidisciplinary application of evidence-based medical and surgical concepts aimed at:

- Screening for, diagnosing and appropriately treating anaemia.
- Minimising surgical, procedural and iatrogenic blood losses and managing coagulopathic bleeding throughout the care of the patient.

- Supporting the patient using transfusion triggers and thresholds to reduce patient exposure to blood components and the associated risks of transfusion.

PBM interventions include the effective use of preoperative clinics, active management of perioperative anaemia and haemostasis, use of tranexamic acid to reduce surgical blood loss, reductions in blood sample volumes and implementation of restrictive transfusion triggers and single-unit transfusion policies. Large PBM programmes have demonstrated improved patient outcomes, including length of hospital stay, hospital-acquired infections and mortality, a reduction of 40% in transfusions and huge cost savings.[29–31]

ELECTRONIC BLOOD TRANSFUSION SYSTEMS

Electronic blood transfusion systems have demonstrated superior safety over traditional manual methods for essential transfusion processes such as blood sample collection, collection of blood from blood fridges and the administration of blood. They now encompass clinical decision support and prompts and alerts to support PBM and actions such as obtaining informed consent to transfusion.

Health Technology Wales looked for evidence on the use of electronic blood management systems in settings where transfusions take place. It found that, compared with paper-based systems, they reduce the rates of blood sample rejection and blood wastage and recommended the routine adoption of electronic blood management systems.[32]

Bedside electronic transfusion systems

Bedside electronic transfusion systems such as barcode-enabled patient ID for blood sample collection and the administration of blood have demonstrated measurable reductions in transfusion-related errors in multiple settings.

The Oxford group reported a drop in sample rejection rates and improved traceability of blood following implementation of bedside electronic transfusion system in a large NHS group of hospitals.[33] An international study of hospitals using electronic identification during pre-transfusion sampling found they had an adjusted wrong blood in tube (WBIT) rate of 1 in 14 606 compared to 1 in 3046 at hospitals using non-electronic (manual) identification, a fivefold difference ($p < 0.0001$).[34] A UK-wide assessment supported by SHOT found that no wrong component transfusions (WCTs) occurred at the sample collection or administration stages in hospitals using electronic identification, compared to 17 WCTs in hospitals using manual procedures.[35] Although not specifically focussed on transfusion, Lee et al. (2017) demonstrated that barcode-based nursing systems could improve workflow efficiency, reduce drug and blood sampling errors and lower nursing turnover.[36]

While these studies demonstrate that bedside electronic transfusion systems have a demonstrable impact on transfusion safety, they are predominantly observational, and improvements may partly reflect co-interventions such as training. Technical issues and inconsistent usage can limit their impact in practice. The Oxford group from their early experience of a large implementation of electronic transfusion systems strongly recommended that the maintenance of a post-implementation team to provide continuous troubleshooting, training, user engagement and governance is needed to maintain their effectiveness.[37]

Electronic blood fridges and remote blood issue

Incorporating electronic blood fridges within a bedside electronic transfusion system led to a fall in red cell wastage from 1.8% to 1.3%, improved traceability (unfated units reduced to ~1%), and contributed to annual cost saving.[38] These improvements were facilitated through real-time data linkage between the blood fridges and the transfusion laboratory information system ensuring the correct collection of red cell units from remote blood fridges.

An enhancement of electronic blood fridges is to allow the safe collection of as yet unallocated and unlabelled red cell units, as well as those already allocated and labelled for a specific patient, from blood fridges remote from the blood transfusion laboratory (this is termed 'electronic remote blood issue'). This process considerably reduced the time for providing blood when it is needed urgently, for example, in operating theatres.[39] In the same study, usage of red cell units decreased in surgery after the implementation of electronic remote blood issue, perhaps due to greater confidence among clinical staff that they would be readily available whenever they were needed. A later international multisite evaluation reported that use of electronic remote blood issue reduced blood collection time by over 6 min per unit and was cost saving.[40] Electronic remote blood issue enables consolidation of transfusion services as it is no longer essential to have a blood transfusion laboratory on each site where patients may require blood transfusion. This may be hugely cost saving for the provision of transfusion services in a large city with several closely located hospitals or in a region where a large hospital can provide support for smaller hospitals.

Electronic clinical decision support systems

Electronic clinical decision support systems (CDSS) have been developed to guide clinicians to adhere to evidence-based blood count thresholds for appropriate transfusion and conservative transfusion practices such as single-unit transfusions for patients who do not have major bleeding or who are on a regular transfusion programme. CDSS can also prompt consideration of the use of alternatives to transfusion such as tranexamic acid for surgical patients, the

provision of information to patients about blood transfusion and provide alerts for patients at risk of TACO.

Staples et al. (2020) described a multifaceted programme incorporating CDSS, real-time alerts, monthly education sessions, feedback dashboards and daily audits across several hospital sites. This was associated with a 26% reduction in blood product costs over 6 years.[41] However, the authors cautioned that such reductions likely reflected the combined effect of multiple interventions, including other PBM strategies, and that the specific contribution of CDSS alone was difficult to determine.

A systematic review found that CDSS can improve ordering behaviour for red cell transfusions, although evidence for their long-term effectiveness and a sustained improvement in clinical outcomes was limited.[42] The included studies were largely single site or a small number of sites and retrospective in nature, often conducted in high-resource hospitals with motivated staff and well-coordinated transfusion teams. Further evaluation is needed to determine their cost-effectiveness.

USE OF DATA TO DRIVE PRACTICE IMPROVEMENT

Accurate and timely data on all aspects of transfusion are vital to understand current performance and to support determination of what needs to be done to improve practice. However, these data are often not readily available. Greater use of data within EPRs has huge potential for identifying variation in transfusion practice and for developing measures to promote appropriate use of blood, reduce blood wastage, improve blood stock management and reduce healthcare costs.[6] There are numerous examples of this approach using dashboards of transfusion data.[43–45]

Pilot work has already established the feasibility of electronic collection of transfusion datasets from multiple hospitals in England, demonstrating value for more efficient and timely benchmarking of practices.[46] The National Institute for Health Research (NIHR) has funded a Blood and Transplant Research Unit (BTRU) programme focusing on the use of data to improve transfusion practices with the aim of accelerating the development of data-driven methods to optimise blood use and integrate them within routine practice to improve patient outcomes.[6] Such initiatives have the capability of capitalising both on the increasing capacity for the collection of routine patient data and on the development of interactive electronic systems to provide real-time machine-driven learning and effective feedback to individual clinicians and clinical teams to ensure optimal transfusion practice.

One goal might be to replicate the Scandinavian Donations and Transfusions (SCANDAT) database, which includes all electronically available data on blood donors, donations and transfusions since the late 1960s in Sweden and the early 1980s in Denmark. It has been used to characterise disease occurrence among blood donors and transfused patients, as well as the investigation of the possible health effects of blood donations, aspects of transfusion care and transmission of disease by transfusion.[47]

IS THERE EVIDENCE THAT TRANSFORMATION OF HOSPITAL TRANSFUSION SERVICES WOULD BE EFFECTIVE AND COST-EFFICIENT?

Emerging evidence, although more is needed, suggests that transformation of the management of hospital transfusion services can both enhance safety and reduce costs. These objectives, as already described above, can be achieved by reducing blood wastage, minimising unnecessary transfusions and modernising the transfusion pathway using digital technology. In practice, the robust implementation and optimal impact of measures to realise these aims depend heavily on local leadership, provision of an adequate workforce, teamwork and a supportive clinical culture.

FINAL RECOMMENDATIONS

Meaningful and lasting transformation in transfusion services in the NHS and worldwide is urgently needed. Patient lives, staff well-being, efficient resource use and the sustainability of the blood supply all depend on robust governance and systemic reform. Where evidence gaps exist, targeted research must guide large-scale implementation, with key metrics tracking safety, cost-effectiveness, clinical outcomes and patient and staff satisfaction.

To drive this change, we propose:

1. Immediate investment in workforce capacity and digital infrastructure to modernise transfusion services.
2. Mandatory adoption of electronic transfusion systems for all hospitals providing transfusion care.
3. Standardised training and competency assessments for all staff involved in the transfusion pathway.
4. A dedicated national oversight body to co-ordinate hospital transfusion services and blood supplier performance.
5. Rigorous evaluation of new interventions to ensure clinical and cost-effective improvements.

A strategic plan for transformation of transfusion practice has been prepared by the DHSC in partnership with the NBTC, NHS Blood and Transplant and patients, and is currently under consideration by the UK government. It will require their strong support and considerable investment for its successful implementation. In this respect, it is encouraging that blood transfusion is included in the NHS England Pathology Transformation and Digital Diagnostic Capability programmes. Hospital transfusion laboratories are being asked to ensure they are actively represented in their local pathology network discussions. This will help ensure that transfusion requirements, including blood tracking, stock

visibility, interoperability with NHS Blood and Transplant systems and the adoption of shared national standards, are included in network digital roadmaps and appropriately prioritised.

AUTHOR CONTRIBUTIONS

Michael F. Murphy: Conceptualization; writing – original draft; writing – review and editing. **Cheng Hock Toh:** Conceptualization; writing – review and editing.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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