Electronic blood transfusion: improving safety and efficiency of transfusion systems

Provided by: Oxford University Hospitals

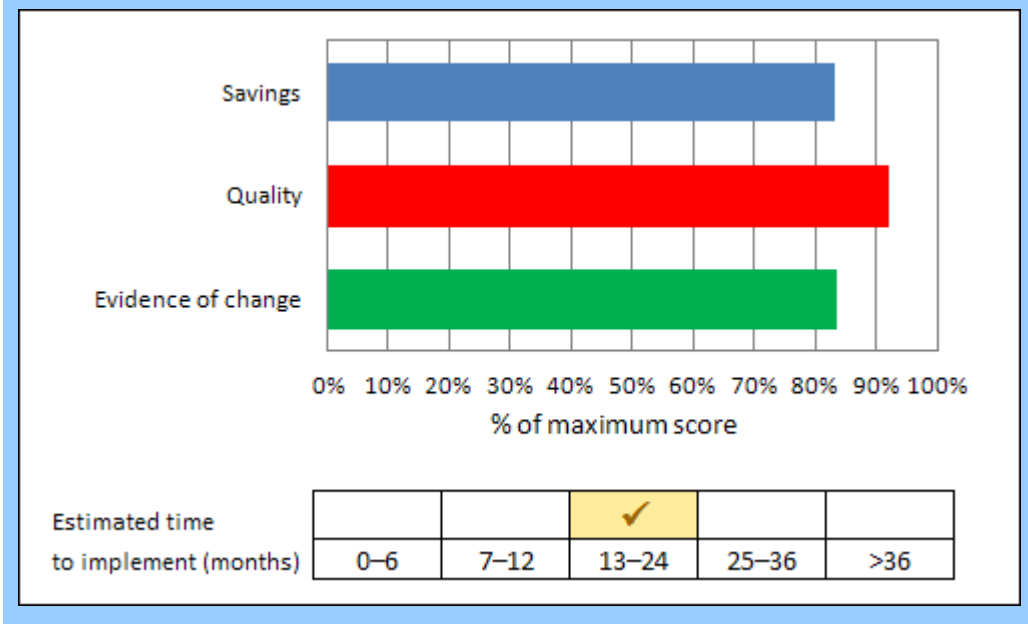
Publication type: Quality and productivity example

Sharing good practice: What are 'Proven Quality and Productivity' case studies?

The NICE Quality and Productivity collection provides users with practical case studies that address the quality and productivity challenge in health and social care. All examples submitted are evaluated by NICE. This evaluation is based on the degree to which the initiative meets the NICE Quality and Productivity criteria: savings, quality, evidence and implementability. The assessment of the degree to which this particular case study meets the criteria is represented in the summary graphic below.

Proven Quality and Productivity examples are case studies that show evidence of implementation and can demonstrate efficiency savings and improvements in quality.

Evidence summary



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Changes since the previous version

Published Quality and Productivity case studies are reviewed annually. Every year after publication in the Local Practice Collection, the submitter of the case study is contacted to ask if there is further information relevant to the case study, and the case study updated as required. The case study has been amended to meet NICE style and any additional changes to this case study are outlined in the table below.

Case study section	Update
Introduction	Added details of a new decision support module for blood ordering, the improved compliance with transfusion guidelines and the resulting savings.
Savings	Added details of costs and savings associated with the new blood ordering decision support module.
Quality	No change
Evidence	Added that NICE Guideline NG24 Transfusion supports using electronic patient identification systems to improve the safety and efficiency of the blood transfusion process.
Implementation	Added details of implementation of the decision support system.

Details of initiative

Purpose

- To address poor implementation of clinical blood transfusion procedures as documented in incident reports to the Serious Hazards of Blood Transfusion scheme (SHOT) (for example, blood sample mislabelling, poor patient identification and mismatched transfusions), and minimise the resulting clinical risks.
- To improve the efficiency of hospital blood transfusions: for example, more rapid availability of blood for urgent cases, reduced staff time in checking blood, less waste and reduced

use of blood.

An ‘end-to-end’ electronic clinical and laboratory transfusion process has already been developed and implemented in 1 large, multi-site Trust. This could be implemented in other Trusts, perhaps throughout a region. A similar approach and equipment could be used for other clinical bedside procedures.

The reasons for the change are to:

- improve transfusion safety in hospitals – fewer errors
- reduce the inappropriate use of blood – cost savings
- facilitate monitoring of transfusion practice
- improve compliance with regulatory requirements and
- improve the efficiency of hospital transfusion (including the rapid availability of blood for those patients who need it urgently, less waste and improved use of staff time).

Description (including scope)

Transfusion errors are an important, avoidable, serious hazard. Wrong transfusion is one of the two leading causes of death from transfusion reported to Serious Hazards of Transfusion (SHOT) in the United Kingdom (SHOT steering committee 2011).

The initiative ‘re-engineers’ hospital transfusion services using new technology:

- Redesign of hospital blood transfusion, incorporating barcode patient identification and bedside handheld computers to prompt staff through every step and verify the correct blood is transfused. The electronic transfusion system uses 2-dimensional barcodes on patient wristbands, on blood samples and on blood units, within which is encoded the patient core identity data. The patient is identified by the staff member scanning the barcodes using a handheld computer. The staff member is then prompted to follow the key steps of the transfusion process, and this makes sure the correct protocol is followed and that patients receive the correct blood. Staff members are also required to identify themselves on the system by scanning barcodes on their identity badges.
- Use of an automated system for collecting blood from blood fridges enabling accurate blood tracking and a complete audit trail, and a remote issue function at the fridges for the collection of previously unallocated blood, speeding its delivery to patients.
- The process requires the transfusion laboratory to be linked with other information technology (IT) systems, providing robust documentation and transfer of data relevant to transfusion practice at all stages of the transfusion process. This includes blood sample collection, laboratory testing,

	blood unit collection from fridges and transfusion of blood to the patient. Full documentation is required at every stage and all data are returned to the laboratory transfusion management system. • An additional decision support module was added to the system in April 2014. It provides the most recent blood results to clinicians when orders are made, and alerts them to orders falling outside agreed guidelines for transfusion. Compliance with red cell transfusion guidelines increased from 41% in April 2014 to 94% in March 2015, and compliance with platelet transfusion guidelines increased from 76% to 98% in the same period. This system further reduced gross costs for transfusion by £122,000 in 2014/15, as stated in the 'Savings delivered' section. • A next step would be to link blood transfusion records between Trusts to provide access to historical information of patients' blood group, antibody, transfusion reactions and any special transfusion requirements. • There are opportunities for using a similar approach and equipment for other clinical bedside procedures, such as for administering drugs and for monitoring patients to identify changes that might indicate the need for more intensive care. • Electronic blood transfusion systems will help the centralisation of transfusion services in line with pathology modernisation planning.
Topic	Clinical support rationalisation, productive care, right care, safe care and urgent and emergency care.
Other information	The evaluation of the benefits of this work was carried out in a series of pilots from 2001 to 2005, and then in a full implementation throughout the Oxfordshire hospitals over 18 months in 2006 and 2007. Developments since the initial submission include the addition of an alarm triggered by incompatibility between the blood type indicated on patient wristbands and compatibility labels on blood units. The alarms sounds both in the handheld computer used to scan patient wristbands, and the central bloodbank.

Savings delivered

Amount of savings delivered	The savings delivered are a combination of cash-releasing savings and productivity savings. Expenditure on blood has decreased by 10% as access to blood is much quicker, meaning less blood is ordered at once and waste is reduced. Productivity savings are through reduced nursing/laboratory time.

	A decision support module was added to the system in 2014, which provides clinicians with the latest blood count results and checks blood orders against local guidelines. This further reduced gross costs by £122,000 per year as less red cell and platelet units were ordered inappropriately. Training for clinicians is provided by a 0.4 whole-time equivalent band 7 nurse. The gross savings are £1,042,000. After taking account of a new managed service contract and a system manager, plus the cost of providing training to clinicians, the net savings are £625,000 or £101,000 per 100,000 population.
Type of saving	A mixture of cash-releasing savings and improved productivity were achieved. A net productivity saving of £520,000 results from reduced laboratory and nursing time. A net cash saving of £105,000 occurs from reduced blood use and wastage, equivalent to around 10% of expenditure.
Any costs required to achieve the savings	Change requires significant recurrent resources, but these are heavily outweighed by the productivity gains and cost savings. The current costs for the Oxford University Hospitals for the electronic transfusion management system are £350,000 per annum in a managed service contract with the supplier for the hardware, including bedside handheld computers, software, and some support with troubleshooting, training and monitoring of the correct use of the system. In addition, the Trust employs a senior manager to ensure the correct day-to-day running of the system, and a 0.4 whole-time equivalent nurse to train clinicians on the system.
Programme budget	Other (cross-cutting initiative in secondary care)
Supporting evidence	A business case was approved in 2005 by the Oxford University Hospitals Executive Board to fully implement the electronic transfusion process throughout the hospitals in Oxfordshire after a number of successful pilots in specific clinical areas such as haematology, cardiac surgery and critical care. An accompanying journal publication (Murphy et al. 2009) describes this initiative.

Quality outcomes delivered

Impact on quality of care or population health	The quality of this service has improved greatly. • Factors enabling the correct use of the electronic system and good transfusion practice included addressing technical problems as they arose, monitoring the use of the system and feeding back information on correct use to individual staff and their managers, and identifying poor practice and following it up by providing further training where appropriate. • Bedside wristband/compatibility label mismatches result in a

loud alarm from the handheld device and cause an alert in the blood bank in real-time via the wireless link. These mismatches were unidentified before the implementation of the electronic transfusion management system but are now recorded and acted on. Most are due to minor errors in the non-electronic parts of the process that would not result in the wrong blood being transfused (such as a spelling error when the pre-transfusion sample was booked in to the blood bank IT system). However, occasionally the alerts prevent transfusion of the wrong blood, usually a result of a lack of attention to the non-electronic elements of the bedside checking procedures (such as patient misidentification before the electronic check was carried out).

- There have been no group ABO incompatible red-cell transfusions (the most serious type of wrong blood transfusion event) at the Oxford University Hospitals in the 4 years before or the 4 years after the full implementation of the electronic transfusion system (approximately 230,000 red-cell units transfused; the benchmark based on national data from SHOT for the same period is 1 in 183,000 red-cell units).
- Only 2 wrong blood transfusion events have been documented at the Oxford University Hospitals in the 4 years after the full implementation of the electronic transfusion system (1 in 85,000 blood components transfused; the national benchmark based on SHOT data for the same period is 1 in 13,000). Both events were minor errors in the use of emergency group O blood in the Emergency Department and neither caused adverse patient outcomes. They are being addressed by changes in the process for providing emergency blood in the Emergency Department, and further training.
- The annual rate of 'wrong blood in tube' (where the blood sample for compatibility testing has been taken from the wrong patient or labelled with another patient's identification details) has decreased from 1 in 12,322 to 1 in 26,690 (the benchmark taken from a national study is 1 in 3000 samples). These events occur because of disregard for the correct use of the electronic transfusion process, and those staff responsible are identified and re-trained.
- Blood samples rejected by the transfusion laboratory because of inaccurate, incomplete or illegible labelling have decreased from 3.1% to 1.2%, greatly reducing the need for patients to be re-bled.
- A reduction in the number of blood components whose ultimate fate was unknown ('unfated units') (a key indicator of compliance with blood regulations) was reduced from 16% to 0.5%.
- Wastage of blood has been reduced.
- Blood use has reduced, producing a benefit of reduced

	inappropriate blood use and cost savings.
Impact on patients, people who use services and/or population safety	The safety of the hospital transfusion process was improved, that is, there were fewer errors: • pre- and post-implementation audits showed improvement from 11.8% to 100% of transfusions where staff followed the process for correct patient identification at the bedside • the electronic system provides a simple mechanism for compliance with UK regulatory requirements for the traceability of blood and the documentation of transfusion and training. There have been no serious transfusion errors in the Trust involving misidentification since the system was fully implemented.
Impact on patients, people who use services, carers, public and/or population experience	Feedback from patients was positive. No patients objected to a barcode on their identification wristband. Feedback from nursing staff has also been very positive because the system allows the pre-transfusion bedside checking process to be conducted 'right first time every time', halves the time for the bedside check and involves 1 nurse rather than 2.
Supporting evidence	There was rapid uptake of the electronic transfusion system after its Trust-wide implementation in 2006; within a few months it was used for about 80% of blood samples for compatibility testing and units of blood administered. Progress to 100% usage was slower, but was achieved over the next 2–3 years, allowing compliance with the national requirement for traceability of blood from donor to patient without a cumbersome and time-consuming paper-based process. The process documents competency of staff in blood transfusion procedures, in compliance with National Patient Safety Agency (NPSA) requirements without the need for additional staff to carry out the regular competency assessments. The Oxford University Hospitals developed a process to enable rapid provision of blood from electronically controlled blood fridges ('electronic remote blood issue'). This process is now being used worldwide.

Evidence of effectiveness

Evidence base for case study	This initiative is underpinned by the following standards and guidance: • NICE Guideline NG24 Transfusion (NICE 2015) states that hospitals should consider using electronic patient identification systems to improve the safety and efficiency of the blood

transfusion process.

- The NPSA adopted this solution in 2006 as the only technology-based system for further exploration to reduce wrong transfusion incidents.

  Right patient, right blood: advice for safer blood transfusions

- Connecting for Health in 2006 provided the Oxford group with funding of £70,000 as part of the 'Do once and share' initiative to develop a national specification based on the Oxford University Hospitals electronic process for transfusion on behalf of the Chief Medical Officer's National Blood Transfusion Committee, SHOT and the NPSA.

  Electronic clinical transfusion management system

- The 'NHS Live' initiative. The Chief Executive of the National Health Service (NHS) referred to it as the best example of a joint NHS/commercial project in 'NHS Live', and as a model for national haemovigilance.
- The Department of Health's initiative Better blood transfusion: safe and appropriate use of blood (health service circular 2007/001) recommends the development of electronic systems to improve transfusion safety and monitor the appropriate use of blood.
- Standards for hospital transfusion laboratories from SHOT, the National Blood Transfusion Committee, professional societies and the Royal College of Pathologists (Chaffe et al. 2009).

Evidence of deliverables from implementation

Oxford University Hospitals:

- demonstrated that re-engineering a clinical process using appropriate technology works in practice, improves patient safety, saves staff time and saves money
- took a project from conception through to full local implementation, and onwards from project status to the routine way of working for all staff
- worked well as a multidisciplinary team, and engaged successfully with commercial suppliers, local hospital management, the Strategic Health Authority, professional organisations involved in blood transfusion, the NPSA and Connecting for Health
- have published this work in 5 papers in the premier international transfusion journal 'Transfusion'.

Consistent >95% use of the electronic process at the Oxford University Hospitals for blood sample collection and pre-transfusion checking at the bedside. Currently >99% use for both processes.

Where implemented	Oxford University Hospitals
Degree to which the actual benefits matched assumptions	More than expected. The main expected outcome was improved patient safety, which has been achieved. The benefits of improved efficiency and cost savings were anticipated but have been greater than expected (see 'Quality outcomes delivered'). The difficulty of full implementation through a multi-site NHS Trust was unknown at the outset of the project, but was found to be possible and sustainable.
If initiative has been replicated how frequently/widely has it been replicated	• The electronic blood fridges are in wide use for blood collection in hospitals in England, but the electronic bedside process is only in widespread use in a very small number of hospitals (see below). • A requirement of the NPSA's Right patient, right blood initiative was to appraise the use of electronic systems for blood transfusion. A recent survey carried out as part of the Department of Health's initiative Better blood transfusion: safe and appropriate use of blood found that only 25/150 (17%) of NHS Trusts are using barcode or other electronic systems for patient identification for blood transfusion, and only 6 Trusts reported using bedside electronic systems for >90% of their transfusions. Only 20 Trusts administer >10% of transfusions using bedside electronic systems (13 Trusts in 2008), and only 8 Trusts use electronic patient identification systems to collect >10% of blood samples for transfusion (the equivalent figure in 2008 was 5 Trusts). • A hospital in Toronto replicated the findings of this initiative in terms of rapid provision of blood for patients needing it quickly. The relevant publication for the Oxford findings is Staves et al. (2008).
Supporting evidence	There is considerable potential for other centres to take advantage of the technology the Oxford University Hospitals have developed for transfusion and the process for electronically controlled remote blood issue that enables the provision of a centralised transfusion service (CTS) for Oxfordshire. The Oxford CTS might provide a model for CTS elsewhere in the UK, and indeed worldwide. Partnerships could be explored with NHS Blood & Transplant and private providers such as Haemonetics which currently supplies the software and equipment for the Oxford University Hospitals transfusion system. Although CTS are not widely used in the UK, the concept of a CTS is not new. There are excellent examples in the USA and elsewhere. The basic idea is simple: to have 1 organisation (or collaborative) responsible for the transfusion services for multiple hospitals, enabling improved quality by standardisation, improved technology, the availability of medical and technical expertise in

transfusion medicine, achieving cost reduction through economies of scale, and enhanced patient safety and appropriate blood usage. CTS in Seattle and elsewhere are beginning to implement the process for electronically controlled remote blood issue developed in Oxford.

Further developments of the Oxford CTS will be explored, including the involvement of NHS Blood & Transplant, particularly for more effective blood stock management, its widening to include other hospitals, the development of 'decision support' to promote adherence to guidelines for the appropriate use of blood and further reduce costs, a 'data mining' tool to provide clinical teams with regular comparative data on their blood use, and inclusion of information on intra-operative cell salvage and near-patient haemostasis testing to increase the effectiveness of blood-conservation activities.

Details of implementation

Implementation details

The Oxford University Hospitals have learnt a lot from the Trust-wide implementation of the electronic transfusion management system in Oxford in terms of infrastructure requirements for IT systems, training and a staged approach to its implementation, with regular monitoring of progress. They have also learnt from supporting the implementation of the electronic blood fridge system in the Trusts in the Thames Valley.

Stage 1: Blood sample collection and the pre-transfusion bedside check

The first stage addressed the 2 bedside processes involved in blood transfusion: blood sample collection for compatibility testing and pre-transfusion checking. The electronic process was designed to compel users to complete certain actions (for example, checking patient identification wristbands at the bedside), helping to reduce the likelihood of staff becoming distracted. Its simplicity encourages staff to complete it once they have started.

Stage 2: Adaptation of the electronic process for an acute clinical service and integration of an automated system for the collection of blood from blood refrigerators

Significant improvements were found after the introduction of the electronic process, including an increase from 8% to 100% in checking that the blood group and unit number on the blood pack matched the compatibility label and the pack was in date ($p=0.0001$).

Stage 3: Electronic remote blood issue

Transferring the issue of red-cell units from the blood transfusion laboratory to a site closer to the clinical areas both reduces the

risk of delays and the workload of the laboratory.

The results showed that electronic remote blood issue (ERBI) reduced the time to make blood available for cardiac surgery patients and improved the efficiency of hospital transfusion. Before the implementation of ERBI, the median time to deliver urgently required red-cell units to the patient was 24 minutes. After its implementation, red-cell units were obtained from nearby blood refrigerators in a median time of 59 seconds.

Requests for blood that was then not used reduced significantly from 42% to 20%, the number of red-cell units issued reduced by 52% and the percentage of issued units that were transfused increased from 40% to 62%. In addition, ERBI significantly reduced the workload of both the blood transfusion laboratory and clinical staff.

Stage 4: Implementation of the electronic transfusion process in all acute hospital sites in Oxfordshire

The next stage was to implement the electronic transfusion process throughout the acute hospitals in Oxfordshire; 2 in Oxford itself and a district general hospital in Banbury about 30 miles from Oxford. Together, they form 1 of the largest healthcare organisations in England, providing a wide range of general and specialist services and a base for medical education, training and research. There are 1500 inpatient beds. This was the most challenging part of the whole project because of its complexity and scale.

The implementation of the electronic transfusion process initially for a total of 82 clinical areas clearly required additional staff. A key enabler was the appointment of a project management team made up of a full-time project manager working on behalf of the Oxford hospitals as well as a project manager working for the original commercial supplier, Olympus UK Ltd. The implementation was planned in phases involving up to 10 clinical areas per phase, each of 6 weeks' duration.

Since 2007, the electronic transfusion process has been extended even to those clinical areas where only occasional transfusions are administered, making a total of 124 clinical areas where the process is used.

In April 2014 an electronic decision support system for blood ordering was implemented in haematology inpatients. It provides the most recent blood results to clinicians when orders are made and alerts them to inappropriate orders. This was combined with the existing electronic transfusion process incorporating barcode patient identification and handheld computers at the bedside to verify the correct blood is transfused. Every transfusion is audited for compliance with local guidelines, and all non-compliant transfusions are reviewed at a monthly meeting with the clinicians ordering the transfusions. This has further reduced the gross cost of transfusions by £122,000 per year. Training for clinicians is

	provided by a 0.4 whole-time equivalent band 7 nurse.
Time taken to implement	Implementation throughout the Oxford University Hospitals Trust, which took approximately 18 months, was completed by September 2007, and so the Trust-wide benefits have been realised since then. Pilots of the electronic process were carried out successively in key clinical areas, beginning with a day-case haematology unit in 2001, and here benefits were realised earlier.
Ease of implementation	Affects a whole organisation across a number of teams or departments.
Level of support and commitment	The hospital senior management had to be persuaded of the clinical and financial benefits for the organisation and the feasibility of its implementation. They were already familiar with the programme because every opportunity had been taken to provide information about the work throughout the stages. A detailed business case was developed in July 2005 by the deputy director of finance and Olympus UK Ltd in collaboration with the director of nursing and the lead consultant for transfusion medicine. This business case was provided for assessment.
Barriers to implementation	• Senior management buy-in was obtained by demonstrating benefits from successful pilots and achieving success in winning regional and national awards for innovation: 2004 Thames Valley Health Care Awards. Winner, Working Smarter Category. 'Barcode technology for safer transfusion'. 2007 Government Computing Awards. Winner, Government to Citizen Category and overall Winner of Innovation Award. 'Wireless enabled blood tracking at John Radcliffe Hospital'. 2007 Information Age Effective IT Awards. Winner, Most Effective Use of Communication Technology Category. 'Wireless blood tracking'. 2007 European Government ePractice Good Practice Label Award. 'Transformational improvement in clinical practice using wireless-enabled bedside technology'. 2008 Association for Informatics Professionals in Health and Social Care. Winner, Use of Technology category. 'Transformational improvement in bedside clinical practice using wireless enabled bedside technology'. 2008 Guardian Public Service Awards. Winner, Innovation and Progress: Transformation category. 'Electronic patient identification and blood tracking'. 2009 British Computer Society and Computing UK IT Awards. Winner, Public Sector Project of the Year.

BloodTrack.

2009 Health Service Journal Awards. Winner, Improving Care with Technology category. 'Transformational improvement in bedside clinical practice using wireless enabled bedside technology'. Shortlisted for Secretary of State's Award for Excellence in Healthcare Management.

- Obtaining funding for a full Trust-wide implementation by presentation of a successful business case (2005).
- Building an implementation team and an implementation plan with a phased approach (up to 10 clinical areas in each phase of about 6 weeks) and a strategy for training (ensuring that at least 50% of the staff in a clinical area were trained at the end of each phase).
- Good project management for the implementation stage to avoid loss of momentum.
- Development of an electronic process for monitoring the use of different aspects of the electronic process and identification of clinical areas or individual staff experiencing difficulties.
- Rapid and effective troubleshooting to avoid loss of confidence in the process by staff.

Risks

The initiative does rely on a functional Trust IT network. Purchasing the hardware for the system and expecting existing transfusion staff to implement and maintain it is unrealistic.

In 5 years the Oxford University Hospitals have only had very few occasions (less than 5) when the network has 'gone down' for short periods. In these circumstances, the hospitals have had to revert to standard manual processes for blood transfusion, but this contingency is recognised in hospital blood transfusion policy.

Supporting evidence

Through all stages of this work, the Oxford University Hospitals re-evaluated practice after each stage to demonstrate the benefits and identify any problems and endeavoured to set the evaluations in a rigorous research framework. This work is summarised in Murphy et al. (2009).

Further evidence

Dependencies

IT, adequate staffing of the implementation team and its continuation as a 'Blood Safety and Conservation Team' once the implementation was completed to ensure continuation of the correct use of the electronic system for blood transfusion, as described above in 'Quality outcomes delivered', as well as blood conservation activities such as intra-operative cell salvage and

near-patient haemostasis testing.

Contacts and resources

Contacts and resources

If you require any further information please email: qualityandproductivity@nice.org.uk and we will forward your enquiry and contact details to the provider of this case study. Please quote reference 11/0033r2 in your email.

Chaffe B, Jones J, Milkins C et al. (2009) UK Transfusion Laboratory Collaborative: recommended minimum standards for hospital transfusion laboratories. Transfusion Medicine 19: 156–8

Davies A, Staves J, Kay J et al. (2006) End-to-end electronic control of the hospital transfusion process to increase the safety of blood transfusion: strengths and weaknesses. Transfusion 46: 352–64

National Institute for Health and Care Excellence (2015) NG24 Transfusion

Murphy MF, Staves J, Davies A et al. (2009) How do we approach a major change program using the example of the development, evaluation, and implementation of an electronic transfusion management system. Transfusion 49: 829–37

Murphy MF, Fraser E, Miles D et al. (2012) How do we monitor hospital transfusion practice using an end-to-end electronic transfusion management system. Transfusion 52: 2502–12

National Patient Safety Agency (2006) Electronic clinical transfusion management system

Serious Hazards of Transfusion Steering Committee (2011) Serious hazards of transfusion: annual report 2010.

Staves J, Davies A, Kay J et al. (2008) Electronic remote blood issue: a combination of remote blood issue with a system for end-to-end electronic control of transfusion to provide a 'total solution' for a safe and timely hospital blood transfusion service. Transfusion 48: 415–24

Turner CL, Casbard A, Murphy MF (2003) Barcode technology: its role in increasing the safety of transfusion. Transfusion 43: 1200–9

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