Electronic blood transfusion:

Improving safety and efficiency of transfusion systems

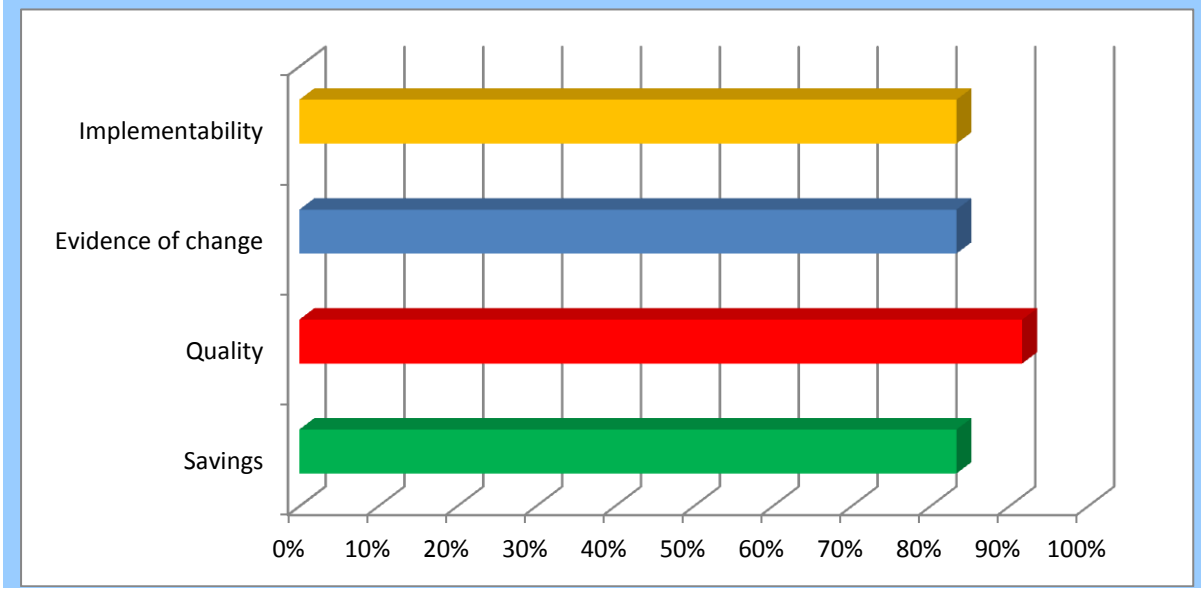
Provided by: Oxford Radcliffe Hospitals

Publication type: Quality and productivity example

QIPP Evidence 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 QIPP criteria of savings, quality, evidence and implementability; each criterion is given a score which are then combined to give an overall score. The overall score is used to identify the best examples, which are then shown on NHS Evidence as 'recommended'.

Our assessment of the degree to which this particular case study meets the criteria is represented in the evidence summary graphic below.

Evidence summary



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 minimising 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 one 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
- 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)

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 two-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 module is in development which will provide doctors with real-time blood counts through a wireless link from laboratory systems to the bedside handheld computers or ward computer. Algorithms incorporated in the handheld will guide blood prescription, based on the patient's recent results, and will be used to promote adherence to guidelines for the appropriate use of blood and reduce costs. • 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, right care for patients, 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.

Gate 1: Savings delivered/anticipated

Amount of savings delivered/anticipated	The savings delivered are a combination of cash-releasing savings from a reduction in blood use (reduction of 10% of existing blood expenditure) and waste, and productivity savings through reducing nursing/laboratory time. The gross savings are £920,000, and after taking account of a new managed service contract and a system manager, the net savings are £528,000 or £86,000 per 100,000 of population.
Type of saving	A mixture of cash-releasing savings and improved productivity gain was achieved. There are gross savings of £920,000, of which £420,000 are cash-releasing.
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 Radcliffe 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.
Programme budget	Cross-cutting initiative in secondary care.
Details supporting Gate 1	A business case was approved in 2005 by the Oxford Radcliffe 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.

Gate 2: Quality outcomes

Impact on clinical quality	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 the correct use of the system to individual staff and their managers, and identifying poor practice and following it up by providing further training where appropriate. • There have been no group ABO incompatible red-cell transfusions (the most serious type of wrong blood transfusion event) at the Oxford Radcliffe Hospitals in the last 5 years (approximately 125,000 red-cell units transfused; the benchmark based on national data from

	SHOT for the same period is 1 in 230,000 red-cell units). • Only two wrong blood transfusion events have been documented at the Oxford Radcliffe Hospitals in 5 years (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 2.0% to 0.1%, greatly reducing the need for patients to be re-bled. • Wastage of blood has been reduced. • Blood use has reduced, producing a benefit of reduced inappropriate blood use and cost savings.
Impact on patient 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 patient and carer 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 one nurse rather than two.

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 Radcliffe 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.

Gate 3: Evidence of effectiveness

Evidence base for initiative	This initiative is underpinned by the following standards and guidance: • The NPSA adopted this solution in 2006 as the only technology-based system for further exploration to reduce 'wrong transfusion incidents' incidents. Right patient, right blood: advice for safer blood transfusions. DH Gateway 9652, 2006. http://www.nrls.npsa.nhs.uk/resources/?entryid45=59805 • 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 Radcliffe 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 http://www.nrls.npsa.nhs.uk/EasySiteWeb/GatewayLink.aspx?alId=60047 • 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 'Better blood transfusion initiative: 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.

	http://www.dh.gov.uk/en/Publicationsandstatistics/Lettersandcirculars/Healthservicecirculars/DH_080613 • Standards for hospital transfusion laboratories from SHOT, the National Blood Transfusion Committee, professional societies and the Royal College of Pathologists. 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
Evidence of deliverable from implementation	Oxford Radcliffe 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 four papers in the premier international transfusion journal 'Transfusion'. Consistent > 95% use of the electronic process at the Oxford Radcliffe Hospitals for blood sample collection and pre-transfusion checking at the bedside. Currently > 99% use for both processes.
Where implemented	NHS England, Oxford Radcliffe 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 Gate 2). 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 blood, right patient' initiative (SPN 14, 2006) was to appraise the use of electronic systems for blood transfusion. In a recent survey carried out as part of the Department of Health's 'Better blood transfusion' initiative, it was found that only 25/150 (17%) of NHS Trusts

	are using bar code or other electronic systems for patient identification for blood transfusion, and only six 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 eight Trusts use electronic patient identification systems to collect > 10% of blood samples for transfusion (the equivalent figure in 2008 was five 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 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
Supporting evidence for Gate 3	There is considerable potential for other centres to take advantage of the technology the Oxford Radcliffe 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 who currently supply the software and equipment for the Oxford Radcliffe 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 United States, and elsewhere. The basic idea is simple: to have one 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 of intra-operative cell salvage and near-patient haemostasis testing to increase the effectiveness of blood-conservation activities.

Gate 4: Details of implementation

Implementation details

The Oxford Radcliffe Hospitals have learnt a lot from the Trust-wide implementation of the electronic transfusion management system in Oxford in terms of infrastructure requirements for the IT, training and a staged approach to its implementation, with regular monitoring of progress, and then in 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 two 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 blood transfusion laboratory and clinical staff.

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

The next stage was to implement the electronic transfusion

	process throughout the acute hospitals in Oxfordshire; two in Oxford itself and a district general hospital in Banbury about 30 miles from Oxford. Together, they form one 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.
Time taken to implement	Implementation throughout the Oxford Radcliffe 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 benefits were realised earlier in those areas.
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.
Overcoming 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 Radcliffe Hospitals have only had very rare occasions (less than 5) where the network has 'gone down' for short periods. In these circumstances, the hospitals have had to revert to standard manual processes for blood transfusion. This

	contingency is recognised in the hospital policy for blood transfusion.
Supporting evidence for Gate 4	Through all stages of this work, the Oxford Radcliffe 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 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

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 in Gate 2, 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: contactus@evidence.nhs.uk and we will forward your enquiry and contact details to the provider of this case study. Please quote QIPP reference 11/0033 in your email. 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 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 National Patient Safety Agency (2006) Electronic clinical transfusion management system. Available from www.nrls.npsa.nhs.uk/EasySiteWeb/GatewayLink.aspx?alId=60047 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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