

## Barcode technology: its role in increasing the safety of blood transfusion

C.L. Turner, A.C. Casbard, and M.F. Murphy

**BACKGROUND:** Incorrect blood component transfusion is the most frequent serious incident associated with transfusion. Errors responsible for these incidents frequently involve patient misidentification.

**STUDY DESIGN AND METHODS:** This study evaluated a barcode patient identification system involving hand-held computers for blood sample collection for compatibility testing and the administration of blood. Audit of practice was carried out before and after its introduction.

**RESULTS:** The baseline audit revealed poor practice, particularly in patient identification. Significant improvements were found in the procedure for the administration of blood following the introduction of barcode patient identification, including an improvement from 11.8 to 100 percent in the correct verbal identification of patients ( $p \leq 0.001$ ). Similar significant improvements were found in matching verbally stated identification details with details on patient identification wristbands, in correct patient identification before the collection of blood samples, and in the proportion of correctly labeled samples. Staff found the barcode identification system easy to operate and preferred it to standard procedures.

**CONCLUSIONS:** A barcode patient identification system was found to simplify the clinical transfusion process and improve practice. These results provide support for further work on the development of such systems for transfusion and for other hospital procedures requiring patient identification.

**B**lood transfusions save lives but are not without risk. An incorrect blood component transfused (IBCT) is the most frequent serious incident associated with blood transfusion. Over its 5 reporting years 1996 to 2001, the Serious Hazards of Transfusion (SHOT) scheme has reported 11 deaths and 60 cases of major morbidity due to IBCT.<sup>1</sup> During the 2000 to 2001 reporting year, the scheme received reports from 379 hospitals that among them transfused 92 percent of the blood used in the UK.<sup>1</sup> A total of 213 IBCT incidents, including 3 deaths and 6 cases of major morbidity, were reported. Errors frequently occurred, involving all stages of the process and many different types of staff. A total of 190 incidents were analyzed in detail; multiple errors were found in 103 cases (54%), and a single error, in the remainder. A total of 344 errors were identified; 15 percent were due to errors during requesting, prescription, or sample collection; 29 percent occurred in the blood bank; and 50 percent were due to errors when collecting and/or administering blood.

The single most important factor in IBCT incidents is misidentification of the patient during the transfusion process.<sup>2-6</sup> One of the main reasons underlying these errors is that the clinical transfusion process, in common with other routine hospital procedures requiring patient

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**ABBREVIATIONS:** BCSH = British Committee for Standards in Haematology; IBCT = incorrect blood component transfused; PDF = portable data format.

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From the National Blood Service; the Department of Haematology, Oxford Radcliffe Hospitals; and the Medical Research Council Clinical Trials Unit, London; and the University of Oxford, Oxford, UK.

*Address reprint requests to:* Mike Murphy, MD, National Blood Service, John Radcliffe Hospital, Oxford, OX3 9DBQ, UK; e-mail: mike.murphy@nbs.nhs.uk.

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identification, is complex and laborious. The Serious Hazards of Transfusion (SHOT) scheme has recommended the evaluation of computerized transfusion aids and barcode technology for confirmation that the correct unit of blood is administered.<sup>1</sup>

The objective of this study was to establish whether the use of barcode technology could have a role in increasing transfusion safety. One system was evaluated to determine whether the technology actually performed as intended and whether its application would provide a more secure transfusion process than the existing standard manual procedure.

## MATERIALS AND METHODS

This study was carried out in a hematology outpatient clinic. The project was later extended to a hematology inpatient ward. The hematology department was chosen because a large number of transfusions are given in a nonurgent setting. Staff and patient satisfaction questionnaires and the time spent on procedures were also studied.

### Standard transfusion procedure

The standard transfusion procedure was as described in the Oxford Radcliffe Hospitals transfusion policies and procedures documents, which are based on the recommendations in the British Committee for Standards in Haematology (BCSH) guidelines for the administration of blood.<sup>7</sup>

The Oxford Radcliffe Hospitals use an additional system of patient identification in which a unique number is allocated to each patient at the time of collection of the blood sample for compatibility testing. This number is printed on labels on a red strip, with 10 red labels with the same unique number per strip. At the time of sample collection, one red label from the same strip is attached to the patient (by means of an additional wristband), the sample tube, the request form, and the current descriptive section of the medical notes. After crossmatching, the blood bank computer prints the red label number on the compatibility label attached to the unit of blood and the transfusion report form.

Patient identification before the administration of blood is carried out in the following steps:

- The patient is asked to state his or her first name, surname, and date of birth.
- These details are checked against the same details on the prescription chart, the medical notes, the transfusion report form, and the patient's wristband.
- The patient's hospital and red label numbers on the wristbands are checked against the numbers on the prescription chart, medical notes, and transfusion report form.

Patient identification before blood sample collection for compatibility testing is carried out in the following steps:

- The patient is asked to state his or her first name, surname, and date of birth.
- These details are checked against the same details on the request form.
- The patient's hospital number on the wristband is checked against the number on the request form.

### The barcode patient identification system

The system involves the use of hand-held computers that scan information from barcodes (Fig. 1). The manufacturers of the hardware were Symbol (New York, NY; hand-held computers) and Zebra (Buckinghamshire, UK; portable label printers and wristband printers). The software (Safe Track) was produced by IBG Datalog (Sussex, UK). The procedure used in this study was as follows:

- On admission to hospital, patients were allocated a barcoded identification wristband. The barcode used was in portable data format (PDF); its appearance is different from the familiar linear barcode (Fig. 1). PDF barcodes can accommodate much more information than linear barcodes; in this study, each patient's wristband PDF barcode included his or her surname, first name, date of birth, sex, and hospital number. Wristband printers in hospital admissions and clinical areas were networked to the hospital's patient administration system.
- During the process of collecting the blood sample for compatibility testing, the patient was identified verbally, and the sample of blood was collected. The phlebotomist with the hand-held computer scanned his or her user identification barcode to confirm that he or she was a verified user. Next, the barcode on the patient's wristband was scanned and a label contain-



Fig. 1. Safe Track equipment, including wristband with PDF barcode, label printer, and hand-held computer.

ing the patient's details was generated with the portable printer. Finally, the label was attached to the patient's crossmatch sample. The scanning and barcode label printing were carried out within 1 minute to ensure that it was carried out at the bedside, and the process for one patient was completed before the operator moved on to another patient.

- When a sample was delivered to the blood bank, the receptionist manually input the hospital number into the blood bank computer.
- When crossmatched blood was allocated to a specific patient, a compatibility label incorporating the patient's unique identification barcode was generated and applied to the blood bag. The PDF barcode at this stage also included the unit number of the allocated blood. Before administering blood, the member of staff with the hand-held computer made four scans prompted by the device:
  1. The member of staff's user identification barcode;
  2. The identification barcode on the patient's wristband;
  3. The compatibility label on the blood bag;
  4. The unit number on the blood bag.
- The hand-held computer confirmed whether the bag was the correct one for the patient; if not, it would indicate "Do Not Transfuse" and sound an audible alert.
- Users were prompted by the hand-held computer to seek verbal clarification of a patient's identification details, that is, first name, surname, and date of birth, during sample collection and the administration of blood and to visually check all details displayed on the hand-held computer screen.
- The hand-held computer also prompted the user to carry out other essential pretransfusion checks, including the expiration date of the unit and any special requirements such as gamma-irradiated or CMV-seronegative blood (Fig. 2).
- The user was prompted to enter pretransfusion patient observations into the hand-held computer before the computer allowed the administration of the transfusion to proceed.
- Only once all these checks were carried out was the user prompted that it was safe to commence the transfusion.
- Further observations could be entered into the hand-held computer during and after the transfusion.
- A final report, including observations carried out during and after the transfusion, was printed and kept as a record in the patient's notes.
- The software included:
  1. An "End Transfusion" module, compelling the user to record the time the unit transfusion finished and whether there were any problems associated with the transfusion;

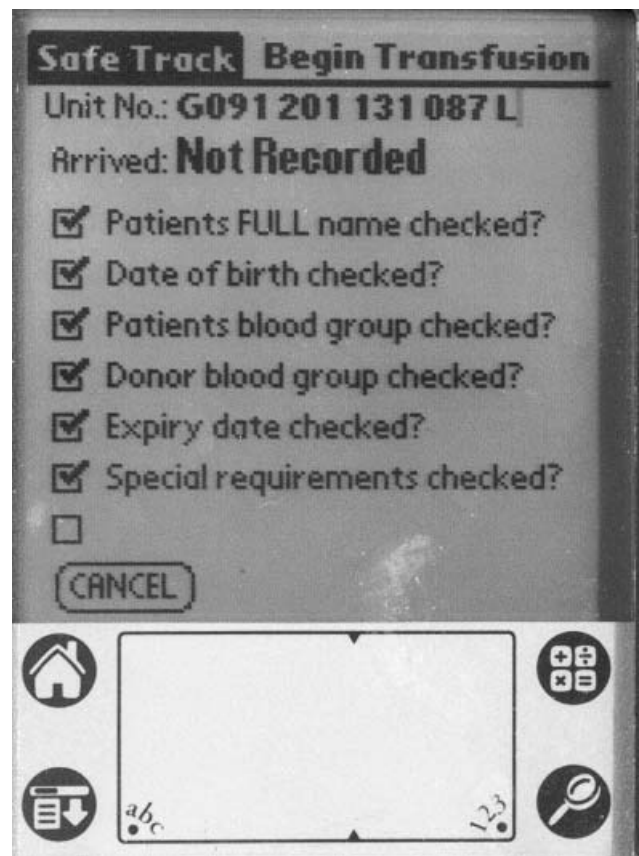


Fig. 2. Prompts on the hand-held computer for the user to carry out pretransfusion checks.

2. An "Observations" module, allowing the user to add 15-minute observations to an existing transfusion report.
- The red label system was not used after barcode technology was introduced.

### Audit measures

Audit tools were developed based on the Oxford Radcliffe Hospitals transfusion policies and procedures and the BCSH guidelines.<sup>7</sup> Detailed auditing of specific stages of the transfusion process was carried out to serve as a baseline for comparison with audits conducted after the introduction of the new technology. It was unrealistic to expect to document a reduced number of IBCT incidents because of the small scale of the project, which was carried out within one clinical department (adult hematology) in a large teaching hospital. Surrogate output measures were used to determine better performance of aspects of the transfusion sequence.

The number of individual steps for blood sample collection and the administration of blood were calculated for both the standard system and the barcode patient

identification system. It should be noted that the number of audit measures shown in the tables is not identical to the number of steps in the transfusion process. In some cases more than one audit measure was used for an individual step in the process; for example, there were seven audit measures for the correct labeling of a blood sample; this involved seven individual steps in the standard system but only one with the barcode patient identification system because of the generation of a printed label.

### Education and training

Once the baseline audit had been completed, staff involved in the project were provided with training. This included the aims and objectives of the project and the use of the barcode patient identification system, some discussion about safe transfusion practice, and why and how IBCT incidents occur. After a 1-month familiarization period, repeat auditing was carried out. The objective at this stage was to assess what impact the barcode technology and allied training had had on the correct performance of the procedures. When the technology was later introduced into the inpatient hematology ward, auditing was carried out after the provision of training in good transfusion practice, but before the use of the barcode technology started, in an attempt to assess the effect of training alone; preliminary results from a limited data set are presented in the Discussion.

### Statistical analysis

To determine whether the introduction of the new barcode technology improved compliance with procedures for the administration of blood and blood sample collection, the proportion of transfusions for which each part of the process was carried out correctly was compared before and after the introduction of the barcode patient identification technology. The results were expressed as percentage of improvement in each case. Statistical analysis was carried out on a smaller consolidated set of the key parts of each process with exact tests of independent proportions.

## RESULTS

### Estimation of the number of steps in the transfusion process

In the baseline audit, the "standard" procedure for checking and administering a unit of blood was found to have 27 individual steps, confirming the complexity of the transfusion process that involves multiple steps of cross-referencing patient identification details on several written documents, for example, prescription chart, medical notes, transfusion report form, label on the blood

pack, and patient wristbands (standard and red label wristband), and confirming that they are identical. The introduction of barcode patient identification technology reduced the process to 16 steps and limited the final bedside checking process to the prescription chart, transfusion report form, label on the blood pack, and one patient wristband.

### Audit of the administration of blood

A total of 51 first-unit RBC transfusions were audited before and after the introduction of barcode patient identification technology (Table 1). The baseline audit found that only seven (14%) patients were asked to verbally identify themselves by stating their surname and first name before the administration of blood. Forty-five (88%) of the patients were positively identified by being asked to state their date of birth. Six (12%) patients were not wearing an identification wristband at the time their identification checks were carried out. Of the 45 (88%) patients who were wearing an identification wristband, not 1 of these patients had the details on their wristband checked. After introduction of barcode patient identification technology, 51 (100%) patients were asked to state their surname, first name, and date of birth; 50 (98%) patients were wearing identification wristbands when the identification checks were carried out (1 was on the patient's bedside table) and all patients had the details on their identification wristband checked as part of the identification process.

The administration of blood involves bedside checking that the blood group and unit number of blood are the same as on the transfusion report form and the label attached to the blood after crossmatching. The baseline audit demonstrated that 51 (100%) patients had a unit number on their blood bag checked with the unit number on their transfusion report form. After the introduction of barcode patient identification technology, 51 (100%) patients correctly had the unit number on their blood bag matched with the unit number on the compatibility label on the blood bag.

The baseline audit demonstrated that during seven (14%) of the transfusions audited there was no audible communication between the two staff members in relation to special blood requirements, for example, the need for gamma-irradiated blood for the prevention of transfusion-associated GVHD and CMV-seronegative blood for the prevention of transmission of CMV by transfusion. In these cases it was very difficult for the auditor to determine whether the check had been carried out but not articulated or whether no check was made. After introduction of barcode patient identification technology, it was found that 49 (96%) patients with special requirements stipulated on either their prescription or their transfusion report form had these matched with information on the blood bag.

TABLE 1. Blood administration audit measures

| Audit measures  | Standard system<br>(n = 51)* | Barcode patient<br>identification (n = 51)* | Percentage of<br>improvement |
|---|------------------------------|---|------------------------------|
| Patient asked to state first name   | 7 (14)                       | 51 (100)                                    | 86                           |
| Patient asked to state surname  | 7 (14)                       | 51 (100)                                    | 86                           |
| Patient asked to state date of birth  | 45 (88)                      | 51 (100)                                    | 12                           |
| Patient wearing an ID† wristband  | 45 (88)                      | 50 (98)                                     | 10                           |
| Patient wearing a red label wristband   | 49 (96)                      | NA  | NA                           |
| Patient ID on wristband cross-referenced with patient-stated ID§  | 0/45 (0)                     | 51 (100)                                    | 100                          |
| First name on transfusion report form checked and correct   | 51 (100)                     | NA  | NA                           |
| Patient's first name on blood pack checked and correct  | 51 (100)                     | 51 (100)                                    | 0                            |
| Patient's first name on prescription checked and correct  | 0                            | 5 (10)                                      | 10                           |
| Patient's surname on wristband checked and correct  | 0                            | 51 (100)                                    | 100                          |
| Patient's surname on the transfusion report form checked and correct                                      | 51 (100)                     | NA  | NA                           |
| Patient's surname on the blood pack checked and correct   | 51 (100)                     | 51 (100)                                    | 0                            |
| Patient's surname on the prescription checked and correct   | 0                            | 5 (10)                                      | 10                           |
| Patient's DOB‡ on their ID wristband checked and correct  | 0                            | 51 (100)                                    | 100                          |
| Patient's DOB on the transfusion report form checked and correct  | 51 (100)                     | NA  | NA                           |
| Patient's DOB on the blood pack checked and correct   | 51 (100)                     | 51 (100)                                    | 0                            |
| Patient's DOB on the prescription checked and correct   | 0                            | 0   | 0                            |
| Patient's hospital number on his or her ID wristband checked  | 0                            | 51 (100)                                    | 100                          |
| Patient's hospital number on the transfusion report form checked and correct                              | 51 (100)                     | NA  | NA                           |
| Patient's hospital numbers on the blood pack checked and correct  | 51 (100)                     | 51 (100)                                    | 0                            |
| Patient's hospital numbers on the prescription checked and correct  | 0                            | 0   | 0                            |
| Patient's red label number on their wristband checked and correct   | 44 (86)                      | NA  | NA                           |
| Patient's red label number on the transfusion report form checked and correct                             | 51 (100)                     | NA  | NA                           |
| Patient's red label number on the blood bag checked and correct   | 51 (100)                     | NA  | NA                           |
| Blood group on the blood pack cross-referenced with blood group on compatibility label                    | 51 (100)                     | 51 (100)                                    | 0                            |
| Unit number on the blood pack cross-referenced with unit number on the compatibility label                | 51 (100)                     | 51 (100)                                    | 0                            |
| Blood group on the blood pack cross-referenced with blood group on the transfusion report form            | 51 (100)                     | 51 (100)                                    | 0                            |
| Unit number on the blood pack cross-referenced with unit number on the transfusion report form            | 51 (100)                     | 51 (100)                                    | 0                            |
| Expiration date of the blood checked  | 49 (96)                      | 51 (100)                                    | 4                            |
| Special requirements on the blood pack cross-referenced with any indicated on the transfusion report form | 44 (86)                      | 49 (96%)                                    | 10                           |
| Special requirements on the blood pack cross-referenced with any requested on the prescription            | 5 (10)                       | 21 (41)                                     | 31                           |
| All the checks carried out at the bedside   | 51 (100)                     | 51 (100)                                    | 0                            |
| Blood prescribed  | 48 (94)                      | 45 (88)                                     | 0                            |

\* Data presented as number (%).

† ID = surname, first name, date of birth, sex, and hospital number.

‡ DOB = date of birth.

§ Patient-stated ID = surname, first name, and date of birth.

In the baseline audit, 46 (90%) of patients had pretransfusion observations (pulse, blood pressure, and temperature) taken, and 15 (29%) patients had observations taken and recorded 10 to 20 minutes after the start of the transfusion. After the introduction of barcode patient identification technology, 51 (100%) patients had the appropriate pretransfusion observations taken and recorded and 11 (22%) patients had observations taken and recorded 10 to 20 minutes after the transfusion had started.

The baseline audit demonstrated that the date and time of the transfusion, the unit number of the blood, and the identification of the person administering the blood were well documented, as was the number of units transfused. However, this information was frequently fragmented and often duplicated. After the introduction of barcode patient identification technology, documentation

was complete, with a report label printed for inclusion in the patient's medical records.

Statistical analysis was carried out on a smaller set of key parts of the process involving consolidation of a number of the steps in Table 1. The results are shown in Table 2 and show significant improvement in the performance of these key steps after the introduction of barcode patient identification technology. For example, there was an improvement from 11.8 to 100 percent in the correct verbal identification of the patient ( $p \leq 0.001$ ) and from 0 to 96 percent in the proportion of patients where their stated identification details were matched with the details on their identification wristband before transfusion ( $p \leq 0.0001$ ). There was an improvement from 10 to 41 percent in the correct performance of the bedside checking procedure before the administration of blood ( $p = 0.0005$ ).

**TABLE 2. Consolidated audit measures for blood administration**

| Audit measures  | Standard system<br>(n = 51)* | Barcode patient<br>identification<br>(n = 51)* | Percentage of<br>improvement | p value |
|---|------------------------------|--|------------------------------|---------|
| Patient asked to state FULL name AND date of birth  | 6 (11.8)                     | 51 (100.0)                                     | 88.2                         | <0.0001 |
| Patient-stated ID† cross-referenced with ID on the wristband AND hospital number on wristband checked   | 0 (0.0)                      | 49 (96.1)                                      | 96.1                         | <0.0001 |
| Patient's ID‡ on blood pack checked   | 51 (100.0)                   | 51 (100.0)                                     | 0                            | NA      |
| Blood group and unit number on blood pack cross-referenced with those on compatibility label AND expiration date checked AND patient's special requirements requested on prescription and transfusion report form cross-referenced with those on blood pack | 5 (9.8)                      | 21 (41.2)                                      | 30.4                         | 0.0005  |

\* Data presented as number (%).

† Patient-stated ID = surname, first name, and date of birth.

‡ ID = surname, first name, date of birth, sex, and hospital number.

**TABLE 3. Blood sample collection audit measures**

| Audit measures  | Standard system<br>(n = 30)* | Barcode patient<br>identification (n = 30)* | Percentage of<br>improvement |
|---|------------------------------|---|------------------------------|
| Patient asked to state first name   | 17 (57)                      | 25 (83)                                     | 26                           |
| Patient asked to state surname  | 17 (57)                      | 25 (83)                                     | 26                           |
| Patient asked to state date of birth  | 15 (50)                      | 25 (83)                                     | 33                           |
| Patient wearing an ID† wristband  | 3 (10)                       | 30 (100)                                    | 90                           |
| Patient ID on wristband checked   | 1/3 (33)                     | 30 (100)                                    | 67                           |
| Phlebotomist placed a red label on the sample tube  | 30 (100)                     | NA  | NA                           |
| Phlebotomist placed a red label on the request card   | 30 (100)                     | NA  | NA                           |
| Phlebotomist placed a red label in the medical notes  | 29 (97)                      | NA  | NA                           |
| Red label wristband attached to the patient   | 3 (10)                       | NA  | NA                           |
| Phlebotomist advised the patient to retain his or her red label for later hospital attendance | 14 (47)                      | NA  | NA                           |
| Sample tube labeled immediately   | 28 (93)                      | 30 (100)                                    | 7                            |
| Sample tube labeled with an addressograph   | 0                            | NA  | NA                           |
| Patient's hospital number entered correctly on the sample tube                                | 30 (100)                     | 30 (100)                                    | 0                            |
| Patient's surname entered correctly on the sample tube  | 30 (100)                     | 30 (100)                                    | 0                            |
| Patient's first name entered correctly on the sample tube                                     | 30 (100)                     | 30 (100)                                    | 0                            |
| Patient's DOB‡ entered correctly on the sample tube   | 29 (97)                      | 30 (100)                                    | 3                            |
| Patient's sex entered correctly on the sample tube  | 16 (53)                      | 30 (100)                                    | 47                           |
| Date the sample taken entered correctly on the sample tube                                    | 30 (100)                     | 30 (100)                                    | 0                            |
| Phlebotomist signed the sample tube   | 30 (100)                     | 30 (100)                                    | 0                            |
| Correct red label number applied to the sample tube   | 30 (100)                     | NA  | NA                           |

\* Data presented as number (%).

† ID = surname, first name, date of birth, sex, and hospital number.

‡ DOB = date of birth.

### The sample collection audit

The standard sample collection process involves 17 individual steps. This was reduced to 8 steps after the introduction of barcode patient identification technology. Thirty sample collection procedures were audited before and after the introduction of barcode patient identification technology.

The baseline audit demonstrated that 17 (57%) patients were asked to verbally identify themselves by stating their full name before the collection of their blood sample for compatibility testing (Table 3). Following the introduction of barcode patient identification technology, 25 (83%) patients were asked to verbally identify themselves by stating their full names (Table 3). In the baseline

audit, 3 (10%) patients were wearing identification wristbands at the time their identification checks were carried out, but only 1 out of 3 (33%) of these patients had the details on their wristband checked. Following the introduction of barcode patient identification technology, all patients wore a wristband and had the details on the wristband checked.

Sample labeling was carried out correctly in most cases with both the standard and barcode patient identification technology procedures, except for 2 cases of delayed labeling, 1 case of omission of the date of birth, and 14 cases of omission of sex with the standard system. The phlebotomist signed the sample bottle in all cases with the standard and barcode patient identification technology procedures.

**TABLE 4. Consolidated audit measures for blood sample collection**

| Audit measures  | Standard system<br>(n = 30)* | Barcode patient<br>identification (n = 30)* | Percentage of<br>improvement | p value |
|---|------------------------------|---|------------------------------|---------|
| Patient asked to state FULL name AND date of birth  | 6 (20.0)                     | 24 (80.0)                                   | 60                           | <0.0001 |
| Sample tube labeled immediately with hospital number, surname, first name, DOB,† sex, AND sample date | 15 (50.0)                    | 30 (100.0)                                  | 50                           | <0.0001 |

\* Data presented as number (%).  
† DOB = date of birth.

Statistical analysis was carried out on a smaller set of key parts of the process involving consolidation of a number of the steps in Table 3. The results are shown in Table 4 and show an improvement from 20 to 80 percent in the correct verbal identification of the patient ( $p \leq 0.0001$ ) and 3 to 100 percent in the proportion of patients who had the details on their identification wristbands checked ( $p \leq 0.0001$ ). In the baseline audit, 15 (50%) patients did not have the minimum identification details (surname, first name, date of birth, sex, and hospital number) labeled on their sample tubes. Following the introduction of barcode patient identification technology, all 30 (100%) samples were labeled correctly with the minimum patient identification details ( $p \leq 0.0001$ ).

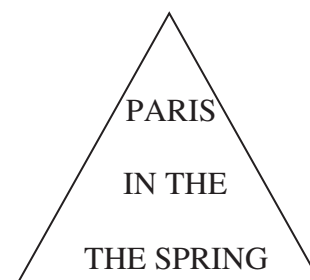
## DISCUSSION

This study found significant improvements in the performance of blood sample collection and the administration of blood after the introduction of barcode technology into the clinical transfusion process. Whether this was as a direct result of the technology, the reduced complexity of the procedure or the allied education and training is a matter for debate and for further study and is likely to be a combination of all these factors. While 45 (88%) patients were found to be wearing identification wristbands in the baseline audit of administration of blood, none of the patients actually had the details on their wristband checked. The design of the barcode patient identification system used in this study is such that the user is compelled to abide to certain actions, for example, the checking of patient identification wristbands. During the baseline audit, it was observed that individuals were frequently distracted and interrupted while checking blood, for example, interrupting a procedure to answer the phone or respond to questions from patients and colleagues. The use of the barcode patient identification system appeared to dissuade individuals from becoming distracted and interrupted. The reason for this is not clear. There was no time limit for the completion of the procedure. Its simplicity seem to encourage staff to complete it once they had started it.

One of the main issues raised by the results of this study is “why is compliance with procedures for the clinical

transfusion process so poor?” One major factor is its complexity; there are many steps in the apparently simple process of requesting, matching, delivering, and transfusing blood involving a number of different departments and staff. This complexity is shared with many other routine hospital procedures requiring patient identification. A second factor is the lack of any formal regular education and training with regard to blood transfusion, certainly within the hospital used in the study. This is probably typical of other hospitals; a recent national audit of the blood transfusion process in the UK demonstrated that a significant proportion of hospitals do not provide training in the procedures for the administration of blood to relevant staff.<sup>8</sup> A third factor is that humans inevitably make errors.<sup>9</sup>

While one might expect the nurses in a hematology day case unit setting to be familiar with hospital transfusion policy, this was not translated into a high compliance rate with carrying out the procedure correctly in this study. It would appear that their practice has resulted in a false sense of security, possibly because they frequently transfuse blood. For example, while staff are aware that the policy stipulates that they ask a patient to state his or her name, they do not see a need to ask for this information when they already “know” the patient. Even if a member of staff is familiar with an individual patient, there is always scope for human error. Humans inevitably make errors and as Reason<sup>6</sup> observes, error is the price we pay for having a psyche, which is creative and which can receive inputs from many sources and can interpret and make sense of much of what impinges on our consciousness but cannot do everything at any one time and is prone to distraction. It also tends to organize input to fit into familiar patterns, for example, most people reading:



do not notice that the word “the” occurs twice. In a similar way, when checking a patient’s identification details the member of staff often sees what they want to see rather than what is in fact there.

A key step in the pretransfusion checking procedure is to check that the unit number on the blood bag is identical to the unit number on the patient’s compatibility label, that is, that the patient’s compatibility label has been applied to the correct bag of blood in the blood bank. The baseline audit demonstrated that the unit number on the blood bag was checked with the unit number on the transfusion report form in 51 (100%) of transfusions. However, it was not possible to establish which unit number on the blood bag the checker(s) were referring to. On questioning later, it became clear that some staff were actually looking at the unit number on the Blood Service label on the blood bag rather than the label attached by the blood bank. They were unclear what numbers they were supposed to be checking or the purpose of the check. The barcode patient identification system automated the unit number check and after its introduction the correct unit numbers in the correct location were checked in all cases. Indeed, the hand-held computer would not accept the data on the linear barcode Blood Service label as correct. If the patient’s compatibility label had been applied to the wrong blood bag in the blood bank, this error would have been detected whereas it might not have been detected with the standard checking procedure.

Observations of a patient’s temperature, blood pressure, and pulse are considered to be important in the early detection of transfusion reactions, but baseline auditing carried out in an inpatient setting demonstrated that a quarter of patients did not have any pretransfusion observations recorded (data not shown). As with the wearing of identification wristbands, the barcode patient identification system used in this study compels the users to input pretransfusion observations before it will allow them to continue with the checking procedure. Following the introduction of barcode patient identification technology, all patients had a set of pretransfusion observations taken and recorded.

Severe transfusion reactions often occur during the first half-hour of transfusing a unit of blood. For this reason, hospital policy and the BCSH guidelines<sup>7</sup> recommend that patients have their temperature and pulse repeated 15 minutes after starting a transfusion. Baseline auditing demonstrated that compliance with this requirement of the policy was poor. The barcode patient identification system had little impact on this. While the design of the system is such that it provides an option to record “15-minute observations,” it would appear that because the checker is not compelled to carry out this stage, he or she often chooses not to, particularly when the clinical environment allows him or her to observe the patient easily.

The checker is not compelled to carry out all of the steps with the barcode patient identification system, but rather he or she is provided with prompts for some of them, for example, checking the expiration date of the blood. The checker must indicate that he or she has carried out this check by ticking the appropriate box before proceeding to the next step. Individuals can indicate that they have done something when in fact they have not. However, when individuals omit part of a complex procedure, it is not because of a conscious decision; more likely, it is that they simply forget. In the detailed audit following the introduction of the barcode patient identification system, compliance was only 41 percent with all the steps of the bedside checking procedure. Noncompliance was mainly related to poor checking of special blood requirements. This emphasizes the need for continued staff training of and possibly further amendments in the design of the barcode patient identification procedure.

In our view, technology should be used to help individuals rather than take over their thinking. The technology should serve as a training aid and should encourage users to think about what they are doing and why. When the technology fails, which it may do from time to time, individuals must still have the knowledge and understanding to check blood safely. Simply investing in technology is not a solution in itself. Computerized transfusion aids cannot eliminate human error, but the less complicated and more “user-friendly” the “system” is, the less scope there is for error. Transfusion aids and barcode technology have the potential to increase the safety of blood transfusion, but they should be accompanied by comprehensive education, training, and continued support.<sup>10</sup>

Was the positive impact on compliance with policy as a direct result of the technology or the allied education and training? Could we achieve a comparable result with education alone, which is possibly a cheaper option? The initial cost to provide a 1500-bed hospital with the necessary equipment and support was estimated to be in the region of \$0.75 million. An additional audit was conducted on the hematology inpatient ward to compare compliance with policy before education, after education, and then again after education and with the support of the barcode patient identification system (data not shown). An audit of 20 transfusions demonstrated that education and training had a positive impact on compliance with policy, but that this was further improved following the introduction of the barcode identification system. One of the conclusions from this later audit is that it is very hard to get individuals to change practice that is entrenched. For example, pretransfusion checking was carried out at the bedside in only 5 percent of transfusion episodes (data not shown). This figure rose to 40 percent after education and training, but it was not until the operation of the barcode

patient identification system compelled individuals to carry out bedside checking that compliance with this requirement of the policy was adhered to in 100 percent of cases. The performance of pretransfusion checking away from the bedside has been documented as a significant contributor to IBCT events;<sup>1</sup> this practice in inpatient hematology was in contrast to day case hematology, where bedside checking was carried out in 100 percent of transfusion episodes.

In general, staff preferred the new technology once they were familiar with it, feeling that it provided “a good, safe, and logical system.” Ten members of staff filled in an evaluation form and all 10 reported that they preferred the new system. Staff reported that the new technology “makes me think more about what I’m doing” and enabled them to “gain confidence” with the transfusion process. Maintenance of the equipment, for example, charging of batteries and loading wristband kits and report labels, was an extra demand in an already busy working environment, making it essential to have one or more members of staff designated to support systems of this type.

Patients were interested in the new technology. Some were initially alarmed to hear that errors occur, but developed confidence in the new technology and the staff operating it once they understood it. One patient commented, “if it makes the procedure more accurate then the safer it is for all of us.” No patients objected to being barcoded, but some did comment on how they had “felt more secure” when they had had two nurses checking their blood.

The baseline audit identified that documentation of the transfusion was often poor. In addition, the audit identified a number of steps associated with documenting the transfusions that merely add to the complexity of the procedure rather than increasing safety, including transcribing unit numbers from transfusion report forms to prescription charts. The barcode patient identification system used in this study addressed these issues with the printing of a self-adhesive transfusion record for the patient’s notes. This improved documentation provided a thorough audit trail, which is a mandatory requirement of the clinical transfusion process.

After the introduction of barcode patient identification, checking of the prescription charts was still poor. As the system does not include a prescription check, it is still possible that errors associated with patients receiving blood that is not necessary may occur. This could be easily addressed if the system was linked to a system for electronic prescribing of blood according to algorithms incorporating agreed guidelines for the use of blood.

There were some initial challenges to introducing barcode patient identification technology, mainly associated with the absence of interfaces between different computer systems, but these were all overcome relatively easily and the technology worked as intended. A number of minor changes were made to the software to guide the

user easily through the transfusion process. The system used in this study was designed to simplify and guide the user through the sample collection, checking, and administration stages of the transfusion process. The introduction of the technology had a positive impact on compliance with the correct performance of these procedures. However, the high costs of implementing such a system in a hospital mean that to become accepted, the technology is likely to have to be multifunctional for other procedures requiring patient identification and known to be prone to error, such as drug administration. Medication errors occur at all stages of the drug delivery process<sup>11</sup> and have been estimated to be responsible for 19 percent of adverse events in hospital patients.<sup>12</sup>

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