REDUCING BLOOD BANK WORKLOAD THROUGH EFFECTIVE REMOTE ELECTRONIC BLOOD ISSUE

Geoffrey F. Auchinleck, P.Eng.
Neoteric Technology Ltd., a Haemonetics Company

INTRODUCTION

Blood banks in acute care hospitals are facing major challenges. In addition to increasing demands and shrinking resources, blood banks are facing a growing shortage of qualified staff [1]. Various approaches are being taken to address this problem, including simplification of processes in blood issue and the application of technologies to increase the productivity of the blood bank [2][3].

Productivity is only one of the challenges faced by blood banks. Adequacy of supply of blood is a continuing challenge; blood is a limited, precious resource that is only going to get more scarce in the future [4][5]. It is the duty of blood banks to ensure that blood is transfused only when necessary and is that it is transfused safely when required.

Recent developments in electronic cross matching, coupled with automated refrigerators offer an opportunity for hospital blood banks to address many of these problems.

A TRANSFUSION PRIMER

There are several reasons why a patient may require a blood transfusion during a hospital stay, including acute bleeding due to injury, replacement of blood lost during surgery, or transfusion to treat a disease state.

For all but emergency transfusions, a rigorous process is followed. This begins with the taking of a blood sample from the patient. This sample is tested to determine the patient's ABO blood type and Rh factor. An antibody screen is also performed at this step, to identify if the patient has any significant levels of clinically significant antibodies. This test is known as a 'Type and Screen'.

Crossmatching

Patients who have screened positive for antibodies, or who have had previous blood transfusions have a risk of serious reactions to donor blood. For these patients, type-compatible donor blood is directly tested against the patient's blood sample to detect any clinically significant antibody reactions, using an indirect Coombs test. This is a relatively lengthy and complex process known as a 'Crossmatch'

Immediate Spin

Fortunately, a majority of patients show no antibodies in the Type and Screen, and have no history of antibodies in their blood. For these patients, a rapid test known as 'Immediate Spin' is used to confirm the suitability of the donor blood. In this test, the patient and donor blood are combined and centrifuged. Evidence of agglutination or hemolysis indicates an ABO mis-match or antibody reaction.

Electronic Crossmatch

Long experience with serological crossmatches has shown that very few antibody reactions are detected in the vast majority of patients having no detected antibodies or history of antibodies. In recognition of this, the American Association of Blood Banks sanctioned a new approach to cross matching in 1993 – the 'Electronic Crossmatch'[6].

The Electronic Crossmatch is based on the assumption that it is safe to provide the patient with any donor blood of the correct ABO group and Rh type, as long as there are no detected antibodies or history of antibodies in the patient's blood. To ensure the safety of this process, the AABB set the following rules for an electronic crossmatch:

- A least two blood samples must have been collected from the patient for Type and Screen, one of which must have been taken within a set time period
- There must have been no discrepancies between the ABO and Rh results between the two tests
- There must be no detected antibodies or history of antibodies

If these three criteria are met, there is no need for a serological crossmatch.

As the records required for this process are generally held within the Blood Bank's computer system, this is called an Electronic Crossmatch. Electronic Crossmatch can be used for more than 90% of patients, vastly reducing the need for any form of serological crossmatching by the Blood Bank.

BLOOD BANK PRACTICE

It is the duty of the hospital Blood Bank to ensure that blood is available for any patient who may need it. In many cases, such as cardiac or orthopedic surgery, blood loss is expected. Blood Banks anticipate this need and prepare blood accordingly. This involves:

- Checking the surgical slate in advance
- Obtaining blood samples from the patients and performing a Type and Screen
- Using the 'Minimum Surgical Blood Order' standards to determine the right number of blood units to reserve
- Choosing donor blood units suitable for the patient, preferably by using Electronic Crossmatch,
- Retrieving the blood units from stock
- Printing and applying compatibility labels to the selected blood units
- Placing blood units in a portable cooler and delivering to the operating room in time for the procedure
- Retrieving blood units that are not used
- Removing the compatibility labels
- Checking the unused blood units back into stock.

On average, Blood Banks will crossmatch about two blood units for every blood unit actually transfused. Clearing this means that there is a lot of unproductive work being done.

REMOTE ELECTRONIC ISSUE

Examination of current blood bank practice identified an interesting opportunity for improving the process and reducing the amount of unproductive work being done. By using Electronic Crossmatch and moving blood stocks close to where they are needed, it seemed likely that blood units could be crossmatched for a patient and issued only when actually required, rather than in advance. By moving from preparing blood units 'Just in Case' to preparing them 'Just in Time', it should be possible to reduce the ratio of blood units crossmatched to blood units transfused from 2:1 to 1:1.

To achieve this, several practical concerns have to be met:

- The stock of un-allocated blood located near the point of use must be stored in a secured, temperature controlled location.
- There must be a way of positively identifying the patient for whom blood is required.
- There must be a way to ensure that the person picking up the blood is given access only to the correct type of blood for the patient
- A compatibility label for the blood bag, identifying the intended recipient must be printed and applied to the blood unit

A system meeting these requirements was designed and constructed. It consists of a blood bank refrigerator having multiple compartments under the control of electronic locks, connected to a touch-screen computer kiosk incorporating a barcode scanner and a label printer.

System Operation

The Remote Electronic Blood Issue system uses barcodes to perform most data entry tasks, avoiding typing and mouse operations as much as possible. This decreases the likelihood of errors in data entry.

To retrieve a blood unit for a patient

- The person collecting the blood scans their bar-coded ID tag at the kiosk to ensure they are trained an authorized to collect blood
- The kiosk displays two options "Collecting Blood' and 'Returning Blood'. The person collecting the blood touches the 'Collecting Blood' button.
- They then scan a barcode containing the patient's ID
- The kiosk sends a query over the computer network to ask for an 'Electronic Crossmatch' for the identified patient.
- If the patient is eligible for Electronic Crossmatch, and there is blood of the correct group and type in the refrigerator, the appropriate compartment of the refrigerator is unlocked.

- The person collecting the blood removes the blood unit and scans the blood unit barcode so that they system can confirm that the right type of blood was selected
- The system prints a compatibility label and prompts the user to apply the label to the blood unit.
- The person collecting the blood is then instructed to scan a barcode on the compatibility label to ensure that the label printed correctly and that it matched the blood unit.

This process takes about one minute.

If a blood unit is removed from the refrigerator using Remote Electronic Issue, but is not used, it may be returned to the refrigerator following a similar process.

To return an unused unit of blood

- The person returning the blood scans their bar-coded ID tag at the kiosk to ensure they are trained an authorized to return blood
- They then touch the 'Returning Blood' button
- The person returning the blood then scans the blood unit barcode
- The refrigerator unlocks a compartment of the refrigerator suitable for storage of blood that has been allocated for a patient (the same compartment may be used for blood that is serologically crossmatched and pre-labeled for patients)
- The system calculates the length of time that the blood unit has been out of refrigeration. If this time is greater than 30 minutes, the blood is electronically marked as 'unusable' and an alert is sent to the blood bank.

Blood that is labeled using Remote Electronic Issue and is returned within the time limit is available for collection for the same patient if it is required at a later time. In this case, the labeled unit is treated like a serologically crossmatched blood unit labeled in the blood bank.

At regular intervals, blood bank staff update the inventory of the refrigerator by adding inventory, removing blood units that are deemed 'unusable' and removing blood units labeled for a particular patient that are no longer needed. Viable units are stripped of their compatibility labels and placed back into blood bank stock.

RESULTS

Systems like the one described above have been put into clinical use in several hospitals in Canada, England and the United States. Over the last five years, we have amassed considerable data on the impact of such systems on hospital Blood Banks. The data provided here is drawn from individual hospitals, but is typical of the results observed in every location.

Table 1 shows a comparison of one month of data before and after the installation of Remote Electronic Issue in the operating suite of a large Canadian hospital.

Table 1: Typical Impact of Remote Electronic Issue [7]

	Before	After	Change
Number of Patients	947	1090	15%
Red Cell Units Transfused	443	212	-52%
Units per Patient	0.47	0.19	-60%
Crossmatch to Transfused Ratio (entire hospital)	1.68	1.37	-18%

Table 2 shows the length of time after a request for red blood cell units to be available for the clinical staff to use at the bedside, before and after implementation of Remote Electronic Issue in the Cardiac operating suite of a large English teaching hospital.

Table 2: Time required for blood to be available [8]

	Time (Mean)
Before implementation	23 Minutes
After implementation – Operating rooms	54 Seconds
After implementation - Recovery	64 Seconds
After implementation - combined	59 Seconds

ANALYSIS

Implementation of 'Just in Time' issue of blood in high-volume areas of the hospital can reduce the workload on a Blood Bank by 50% or more, without compromising blood safety or availability. This reduction in workload is achieved in part through reducing the Crossmatched to Transfused ratio, but also through the unexpected reduction in the number of blood units transfused.

It is not clear why implementation of Remote Electronic Issue of blood units should reduce the overall demand for blood. One theory is that the timely availability of blood (t=60 seconds versus t=23 minutes) means that physicians are able to be more conservative in making the decision to transfuse a patient. Regardless, introduction of Remote Electronic Issue consistently reduces the strain on a limited blood supply.

CONCLUSIONS

Remote Electronic Issue provides a viable means for hospital Blood Banks to respond to increasing demands and decreasing budgets without compromising the quality of service or safety of the patient.

REFERENCES

[1] U.S. Bureau of Labour Statistics, "Occupational outlook handbook 2010-11 edition: Clinical laboratory technologists and technicians" www.bls.gov December 17 2009

[2] Marian Petrides "When less is more: cost-containment in transfusion medicine" *Transfusion Science* vol 18 pp 603-612 December 1997

[3] S.H.Butch, W.J. Judd, E.A. Stiener, M. Stoe, H.A. Oberman "Electronic verification of donor-recipient compatibility: the computer crossmatch" *Transfusion* vol 34, pp 105-109 February 1994

[4] Lesley Kresie "Artificial blood: an update on current red cell and platelet substitutes" *Baylor University Medical Center Proceedings* vol 14(2) pp 158-161, April 2001

[5] Andreus Greinacher,Konstanze Fendrich, Ulf Alpen and Wolfgang Hoffmann "Impact of demographic changes on the blood supply: Mecklenburg-West Pomerania as a model region for Europe" *Transfusion* vol 47, pp 395-401 March 2007

[6] Widmann, F.K. (ed), "Standards for blood banks and transfusion services, 15th edition", American Association of Blood Banks, 1993.

[7] Callum JL, Halliday A, Merkley L, Colavecchia C, Leeksma A, Snellen K, Pendergrast J, Karkouti K, Cserti C, and LaFlamme C, "Remote release of red blood cells by electronic crossmatch in the operatin room at a large, academic trauma centre: improving the speed of blood delivery while decreasing workload", *Abstract,* AABB Annual Conferece, October 6 2008, Montreal.

[8] Julie Staves, Amanda Davies, Jonathan Kay, Oliver Pearson, Tony Johnson, and Michael F. Murphy, "Electronic remote blood issue: a combination of remote blood issue with a system for end-to-end electronic control of transfusion provide a "total solution" for a safe and timely hospital blood transfusion service", *Transfusion* vol 48, pp 415-424, March 2008