The impact of the type and screen test policy on hospital transfusion practice

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The requirements of pretransfusion testing have undergone repeated modification, and those of the type and screen policy are currently the most widely accepted. The type and screen test policy, together with the abbreviated crossmatch procedure, was implemented in the United Christian Hospital in January 1997. This paper discusses the impact of the type and screen test policy on clinicians and patients, on the blood bank and hospital, and on the future of the hospital transfusion services.

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Introduction

Pretransfusion compatibility testing has gone through many changes. In early 1900s, when blood transfusion was initially practised, major crossmatches (ie donor's erythrocytes tested against the recipient's serum) as well as minor crossmatches (ie donor serum tested against the recipient's erythrocytes) were considered necessary. In the 1950s, anti–human globulin reagent was being used in immunohaematological tests, and knowledge about red blood cell antigens proliferated. Furthermore, as increasing numbers of individuals around the world were receiving transfusions, the body of knowledge about transfusion therapy and the clinical significance of crossmatching also increased. There was a growing consensus that compatibility testing could be simplified without increasing the risk of transfusing incompatible blood.[1] In 1981, during a meeting of the Blood Products Advisory Committee of the Food and Drug Administration (FDA) of the United States, studies were presented that showed a 1 in 17 000 chance of missing a clinically significant antibody when antibody screening was incorporated into the compatibility tests.[2] As a result of the meeting, the FDA's Office of Biologics Research and Review issued a memorandum allowing the major crossmatch step to be eliminated, provided that the recipient's serum be tested for unexpected alloantibodies by an "equally sensitive method that demonstrates clinically significant antibodies reactive at 37°C".[3] In 1984, the American Association of Blood Banks (AABB) recommended that the full crossmatch (FXM) test be replaced by an 'abbreviated' crossmatch in patients who were negative for cross-reactive antibodies, and declared that the minor crossmatch was unnecessary.[4] These recommendations led to the development of the type and screen (TS) test policy.

The TS test policy has been widely adopted by blood banks in North America and Europe in the mid-1980s. As for Hong Kong, only two major hospitals were performing the TS test by 1993.[5,6] More recently, the computerisation of many hospitals has helped in the implementation of the TS test policy in their blood banks. The United Christian Hospital (UCH) implemented the TS test policy, following laboratory computerisation in January 1997. For the past 2 years, we have experienced a sustained impact of the TS test policy on the transfusion practice at the UCH.

What is the type and screen test?

In the TS test, each recipient's blood sample is typed for its ABO and Rh D blood groups and screened for unexpected but clinically significant antibodies. The recipient's serum is incubated with three different group-O screening red cells, which carry important and representative blood group antigens such as C, c, D, E, e, K, k, Fy^a, Fy^b, Jk^a, Jk^b, M, N, S, s, P_1, Le^a, and Le^b—all preferably in the homozygous state.[7] The

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presence of irregular antibodies is detected by a direct agglutination test at 37°C and an indirect antiglobulin test. If the antibody screen gives negative results, no blood will be crossmatched for reserve. Should transfusion become necessary, an abbreviated crossmatch is done by using the immediate-spin method to demonstrate ABO compatibility. If, however, the recipient has blood-group alloantibodies, an FXM test using antigen-negative donor blood is performed before the unit of blood is issued for transfusion.

In the conventional FXM procedure, the recipient's serum is incubated with erythrocytes from the donor at 37°C; a direct agglutination test and an indirect antiglobulin test are performed after ABO and Rh D blood-group typing. In contrast to the TS test practice, units of compatible blood are reserved for the specific patient, as requested by the clinician.

The effect of the type and screen test policy on clinicians

When the traditional FXM test was practised, blood units were reserved for a designated patient for 2 days. If the reserved units had been depleted or had exceeded the reservation date, repeat blood sampling and crossmatching would have been required if additional units were needed. This arrangement led to additional blood-taking by the front-line clinicians. In addition, as a repeat crossmatch required at least another 1 to 2 hours, depending on the FXM methodology used, there was a tendency to overestimate the number of units that would be required. Hence, not only was the workload of the blood bank staff increased, but the blood stock needed for emergency use was also jeopardised.

Under the TS test policy, blood units are no longer reserved for a patient if the results from the antibody screen are negative. Instead, a validity period is given to an individual for their negative antibody screen status, so that within such a time period, as many units as possible can be issued after performing an abbreviated crossmatch, depending on the amount of serum available. For patients who have received a transfusion or who have been pregnant within the preceding 3 months of the transfusion, or whose history is unknown, the validity period given is 3 days, because antibodies may develop within that time.[7] Thus, for three consecutive days, no additional blood sampling is performed, even if repeated transfusions are required. In addition, as the abbreviated crossmatch takes less than 10 minutes to perform, compatible blood units can be made available within a short time; consequently, the overordering of blood units no longer exists.

The TS test policy also avoids the need for repeated crossmatching of neonatal blood when blood transfusion is required to replace blood drawn from the newborn for laboratory studies, including crossmatching. Because the immune system of the newborn is immature and relatively unresponsive to antigenic stimulation during the first 4 months of life, AABB standards permit a reduction in the stringency of pretransfusion compatibility for neonates. If the antibody screen and direct antiglobulin tests are both negative, compatibility testing may be omitted during any one hospitalisation, provided that the red blood cells transfused are group O- or ABO-identical, or compatible with both the mother and child.[8] This procedure reduces unnecessary blood-taking for crossmatching and allows the freshest units to be selected when transfusion is required.

The effect of the type and screen test policy on patients

The implementation of the TS test policy provides many benefits to patients. The blood issued is safe and compatible. According to the conventional FXM policy, blood units are randomly crossmatched without information about the patient's antibody status.[6] The presence of weak antibodies may be missed if donor blood is heterozygous for an antigen. This deficiency is corrected by the TS test policy, which stipulates that antibodies must be systematically screened using selected group-O reagent erythrocytes that harbour representative antigens. Patients who require a massive transfusion will benefit most from the TS test, because as many additional compatible blood units as required can be issued quickly without the need for taking a new blood sample for repeating the crossmatch. The use of unmatched group-O or group-specific blood is no longer practised in this group of patients. Neonates who are younger than 4 months are another group of patients who can benefit significantly from the TS test policy. For neonates with negative antibody screens, blood units can be issued without further crossmatching during the entire hospital stay up to 4 months of age. The problem of requiring maternal blood samples for repeated crossmatching (as previously required for an FXM) now no longer exists.

For patients with positive antibody screens, antibody identification will be performed. When specific antibodies are identified, antigen-negative units will be selected for the FXM. These antigen-negative

crossmatch-compatible units can usually be reserved for up to 7 days and will not compromise the daily blood stock that has been allocated for emergency use. Previously, when the traditional FXM test was practised, blood stock control was inflexible; thus, a blood unit could be reserved for a patient for only 3 to 4 days, depending on individual hospital policy.

For patients with multiple alloantibodies or auto-immune haemolytic anaemia, the TS test policy offers the opportunity to promptly detect the existence of alloantibodies or auto-antibodies. Alloantibodies can be correctly identified or excluded and phenotype-specific units can be transfused. In contrast, according to the conventional FXM test, antibodies may not be suspected until blood units are repeatedly incompatible, a situation which would have resulted in at least a 3- to 4-hour delay. Finding compatible units thus remains difficult and if the implicated antibodies are not identified, patient care becomes compromised.

For the past 2 years at the UCH, a total of 468 positive antibody screens were detected among 25 471 crossmatch requests, giving a positive antibody rate of 1.83%. This rate includes false-positive antibody screens as well as antibodies which are rarely clinically significant, such as anti-Le^a, anti-Le^b, anti-P_1, and other 'cold' antibodies. As for the clinically significant antibodies encountered, the most common is anti-Mi, followed by anti-E. These findings agree with those reported among Taiwanese[9] and Thai patients.[10] In fact, the number of clinically significant antibodies that are detected among the Chinese population is less than 1%,[11] whereas for Caucasians the rate of obtaining positive antibody screen is between 3% and 5%, with anti-K, anti-E, and anti-D being the most commonly detected antibodies.[12-14] This finding illustrates the fact that the TS procedure is even more cost-effective among the Chinese population due to their unique antigen frequencies.

The effect of the type and screen test policy on the blood bank

The blood bank staff at the UCH anticipated the change from the conventional FXM to the TS test in 1997 because several other hospitals were already performing the TS test at that time. However, not only were the advantages of using the TS test not fully understood, there was also a general fear among the technical staff towards using the abbreviated crossmatch test, because the test required them to be quick (within 10 minutes) and accurate. This apprehension was the major obstacle of initiating the use of the TS test. From the management's point of view, the ability of the blood bank to issue blood quickly is essential, so as to gain clinicians' confidence in the TS method. Thus, as well as giving blood bank staff educational seminars and training about the antibody screen and abbreviated crossmatch techniques, the UCH put much emphasis on the development of skills needed to perform the abbreviated crossmatch test. After the staff were given time to practise the abbreviated crossmatch technique until they felt competent, a time study was performed. The results of the study showed that blood units could be readily issued within 10 minutes in most situations and allayed the fear previously held by the staff. At the UCH, this time study is currently part of a regular internal audit, which monitors the response time of the blood bank staff.

By implementing the TS test policy, the number of unnecessary crossmatch tests is reduced, as is the number of blood returns and extensions. Human resources can be redirected to providing ward consultation and better transfusion services, especially to patients who have special needs (eg major transfusion or treatment for trauma). For some hospitals such as the UCH, the use of the TS test has necessitated extra financial and human resources to investigate serological problems derived from positive antibody screens. Both the American and British standards stipulate that when an irregular antibody is detected, its specificity should be determined and its clinical significance assessed.[7,15] Furthermore, for transfusion purposes, antigen- negative blood should be selected for crossmatching if the recipient has a clinically significant antibody.[7,15] Based on these standards, it is clear that any hospital providing the TS test should have in place means for investigating serological problems.

The effect of the type and screen test policy on the hospital

The aim of the TS test policy is to raise efficiency without compromising patient safety. The latter has been validated in a number of studies.[16-18] Boral and Henry[16] examined 12 848 blood specimens using the TS and FXM tests; 283 types of antibodies were detected in 247 patients. The screening cells used were able to detect 96.11% of the antibodies. If the antigen frequencies corresponding to the antibodies that were not detected by the screening cells were also taken into consideration, the TS test was calculated to be 99.99% effective in preventing the transfusion of serologically incompatible blood.[16] Reports of data concerning the safety of abbreviated compatibility

testing have recently suggested that the FXM could be omitted from the pretransfusion testing without putting patients at risk.[12,19,20] Since the implementation of TS test policy, no major haemolytic transfusion reactions have been reported at the UCH; meanwhile, a local hospital has reported a 0.005% risk of incompatibility due to the presence of an anti-Mi antibody.[6]

The efficiency of the TS test may be measured by calculating the crossmatch to transfusion (C/T) ratio. The more accurately that clinicians predict a patient's blood needs, the closer the C/T ratio will approach 1:1. Thus a low C/T ratio signifies efficient hospital transfusion policy and practice, and vice versa. The number of red blood cell units crossmatched and the number of units actually transfused at the UCH in 1996, 1997, and 1998 are presented in the Table. The C/T ratio decreased from 2.9 to 1.3 and remained at the latter low level since the implementation of TS policy in 1997. Because the total number of transfused units has remained approximately equal, the drop in the C/T ratio must be due to the significant reduction in the number of blood units crossmatched and issued, and not due to a reduction in patient requests. In addition, the implementation of the TS method has also allowed an improvement in the management of the red blood cell stock. The number of expired red blood cell units has decreased by more than 50% and the red blood cell expiry rate has improved from 2.5% to 0.9% since the TS test policy was adopted (Table).

The effect of the type and screen test policy on the future

Based on the foundation of the TS test policy, the 15th edition of the AABB Standards for Blood Banks and Transfusion[21] described radical changes in the requirements for serological confirmation of ABO compatibility. Specific guidelines were outlined such that a computer can be used to determine which units of red blood cells can be given to a patient without having to perform an abbreviated crossmatch test. This procedure is commonly referred to as a 'computer crossmatch' or an 'electronic crossmatch' (EXM). The EXM may be economically advantageous provided that the computer system has been fully validated to prevent the issue of ABO-incompatible blood units. Significant time savings can be accrued by replacing the immediate-spin crossmatch with a computer crossmatch, as less time will be needed to prepare donor and recipient cells for testing.[22] This is especially advantageous to patients who require a large amount of blood in a short time—for example, liver transplant recipients—as unlimited number of blood units can be issued efficiently without the need for a new sample to be taken. The EXM is currently being practised in several local hospitals. The UCH currently uses the computer crossmatch method to issue blood to massively transfused patients and neonates. This practice will enable the UCH computer system (which is still under modification) to be evaluated. It is expected that the computer crossmatch will replace the immediate-spin crossmatch at the UCH in the near future.

The concept of the EXM can be adapted to a centralised transfusion programme that uses the electronic allocation of blood at a site remote from the blood bank. This can be achieved through a networked electronic blood release system[23] or through a computer-generated list of crossmatch-compatible blood units for a patient.[24] With the electronic blood release system, an out-of-hours blood bank service can be made available to small hospitals without the need for staff. In addition, blood availability can be improved, and the C/T ratio and laboratory workload reduced.[24]

The principles of the TS method, other than EXM, can be extended to allow preadmission pretransfusion work-up, especially for patients undergoing elective surgery, who can be admitted on the morning of the operation and still have blood available when required. The same-day admission policy is commonly used for patients undergoing minor surgical operations that

Table. Comparison of full crossmatch and type and screen test policies of the United Christian Hospital Blood Bank, 1996 to 1998

Feature	1996	1997	1998
Crossmatch policy	Full crossmatch	Type and screen	Type and screen
No. of requests	12 205	12 067	12 106
No. of crossmatched units	27 353	12 807	11 453
No. of units issued	9536	9552	8891
Crossmatch to transfusion ratio	2.9	1.3	1.3
No. of units crossmatched but not transfused	17 817	3255	2562
No. of antibody screens	-	13 365	12 106
No. of positive antibody screens (%)	-	244 (1.82%)	224 (1.85%)
No. of units expired (%)	243 (2.5%)	91 (0.9%)	82 (0.9%)

do not require blood crossmatching. As for other operations that may necessitate a blood transfusion, patients are commonly admitted on the preceding evening for pretransfusion work-up. According to the TS test policy, the need to obtain a blood sample within 3 days of the intended transfusion date can be avoided if the patient has not been transfused or become pregnant within the preceding 3 months, because the antibody status is expected to remain unchanged in the absence of alloimmunisation.[25] A modification of TS test policy is to give patients their pretransfusion test while they attend the preadmission clinic, which can be 2 to 4 weeks before the planned date of operation. If the antibody screen is negative, the patient can be admitted to hospital on the morning of the operation and the antibody validity period extended such that blood units can be released immediately if required. On the other hand, if the antibody screen is found to be positive during the preadmission work-up, ample time will be available for resolving the antibody. Antibody-positive patients may also be admitted on the day of surgery with antigen-negative units readily available for a crossmatch test. The incorporation of the TS protocol into the preadmission work-up will enable a larger group of patients with elective operation to enjoy the benefit of same-day admission. Furthermore, allowing more same-day admissions will no doubt be economically advantageous. At the UCH, a pilot study on performing the preadmission TS procedure is currently being conducted on patients from selected surgical specialties.

Conclusion

The TS test policy has proven to be safe, efficient, and beneficial to the transfusion practice of the UCH. Hospitals that are currently experiencing a high C/T ratio and blood expiry rate or that have a large workload of elective surgeries should consider adopting such a policy to allow better transfusion management.

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