

# Utility of type and screen policy for pretransfusion compatibility testing at an urban level I apex trauma center



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## Abstract

**Objective:** Type and crossmatch (TC) policy is the most common approach for pre-transfusion compatibility testing prior to issue of blood for transfusion. As it involves reserving of the blood units (usually up to 72 hours) prior to issue or un-reserving, it can lead to excessive blood cross matching, inventory management problems, undue workload, blood outdating and reagent wastage. Type and screen (TS) policy is an alternative approach without the need to cross match and reserve blood units prior to issue. The aim of the current study was to retrospectively assess the impact of the implementation of TS policy for pre-transfusion compatibility testing on blood transfusion services at an urban level I trauma center.

**Methods:** The study was done in two phases in the Department of Transfusion Medicine at Jai Prakash Narayan Apex Trauma Center AIIMS, New Delhi, India. Transfusion data was collected and compared during two phases: initial phase (Oct 2016-Mar 2017) of TC policy and second phase (Apr 2017-Sept 2017) of TS policy.

**Results:** TS policy resulted in the reduction of C:T ratio from 5.3 to 1.9. Transfusion probability increased to 29.5% during TS policy from 23.6% during TC policy. Issuable stock index (ISI) also showed reduction from 12.5 to 11.4 after TS policy. Wastage as percentage of issue (WAPI) was reduced from 2.3% (TC) to 1.3% (TS). TS policy also led to reduction in expenses incurred on pre-transfusion compatibility testing by 35%. No hemolytic transfusion reaction was reported during the study.

**Conclusion:** TS policy was found to be a safe and an efficient alternative approach to TC policy for pre-transfusion compatibility at our center. We recommend the implementation of TS policy, but each center should first assess its feasibility based on patient population, blood bank resources and staff knowledge.

**Keywords:** Blood typing, crossmatching, type and screen, crossmatch to transfusion ratio

## Introduction

Trauma has become a major public health concern in recent times especially among the age group of 5 to 44 years. Transfusion of blood and blood components remain an indispensable part of the trauma care, as up to 25% of patients require blood component therapy following trauma (1,2). Accurate prediction of transfusion requirements is difficult in these patients especially at the time of admission in the emergency department, leading to a proactive approach of sending out transfusion requests for most of these patients to blood transfusion services.

Pre-transfusion compatibility testing is done prior to issue of blood with the aim of preventing immune-

mediated red cell hemolysis to ensure maximal RBC survival post-transfusion. Type and crossmatch (TC) policy is the most common approach for pre-transfusion compatibility testing worldwide. It includes testing for ABO and Rh (D) blood typing of the recipient known as "Type" followed by "cross matching" of donor's RBCs and recipient's serum in antiglobulin phase at 37°C also known as anti-human globulin (AHG) crossmatch. Then, cross matched RBC units are reserved for the particular patient until issued or for a stipulated time duration (usually up to 72 hours) preventing their use for another patient and if not issued, are then "de-reserved" and taken back into the available inventory after 72 hours. An alternative



approach for pre-transfusion testing is type and screen (TS) method and includes ABO and Rh (D) blood typing known as “Type” and an antibody screening known as “Screen” for the detection of any unexpected antibodies in the recipient’s serum. As per American Association of Blood Banks (AABB) standards if the antibody screen is negative, RBCs can be issued after checking for ABO compatibility by Abbreviated Crossmatch (Immediate Spin Crossmatch) which takes around 3-5 minutes (3-8).

At our center we used TC policy which led to excessive blood cross matching, inventory management problems, undue workload, blood outdating and reagent wastage as many patients did not require transfusions. Since there is no reservation of RBC units in the TS policy and RBCs are cross-matched and issued when required by the patient, we adopted TS policy.

The aim of the current study was to retrospectively assess the impact of the implementation of TS policy for pre-transfusion testing for non-emergency situations at an urban level I Trauma Center.

## Methods

### Study design

This retrospective review of the pre-transfusion blood cross matching practices was conducted at the Department of Transfusion Medicine at an urban level I trauma center, Jai Prakash Narayan Apex Trauma Centre (JPNATC) AIIMS, New Delhi, India. The study was approved for ethical clearance by the institutional ethics committee (IEC – 790/08.11.2019). Data collection for the study was done in two phases. During the first phase of 6 months (October 2016-March 2017), TC policy was in place for pre-transfusion compatibility testing. In the second phase for the next 6 months (April–September 2017) TS policy was employed for pre-transfusion compatibility testing.

### Inclusion and exclusion criteria

All routine or non-emergent RBC transfusion requisitions were included in the study, whereas transfusion requisitions in patients requiring saline or uncross matched blood release were excluded.

### Testing methods

During the initial phase with TC policy, blood samples of patients were typed for ABO and Rh (D) using Microplate Testing (Neo-Immucor) and then RBC units selected were cross matched using Gel Card Technology (Bio-Rad). Thereafter the cross matched units were reserved for the intended patient for 72 hours, before being issued on request. In case the RBC units were not issued during the 72 hours storage period, they were released/returned to the available inventory for cross matching and issuance to other patients.

During the second phase with TS policy, blood samples of patients were typed for ABO and Rh (Microplate

Testing, Neo-Immucor) and antibody screening was done using solid phase red cell adherence assay (Neo-Immucor). Once the antibody screen was negative, RBC units were not cross matched or reserved for issue for a particular patient. However, in cases where RBCs were required, they were issued after checking for ABO compatibility by Immediate Spin Crossmatch (Abbreviated Crossmatch). In case of positive antibody screen, antibody identification was done (SPRCA, Neo-Immucor) and RBC phenotyping was done to find out antigen negative RBCs, which were issued after AHG crossmatch (Gel Card Technology, Bio Rad).

### Data collection

1. Patient details and transfusion data were collected from the computerized patient record system and transfusion requisition forms in the blood bank.
2. Transfusion data collected included number of RBC requests, number of patients for which blood was requested, number of patients transfused, number of RBC units cross matched, number of RBC units transfused, average daily crossmatch, transfusion probability (TP), crossmatch-to-transfusion ratio (C:T ratio), turnaround time (TAT), expiry of RBC units, wastage as percentage of issue (WAPI), issuable stock index (ISI), and expenses on testing.

Blood utilization indices were computed by using the following formulae/equations:

$$1. \text{Crossmatch-to-Transfusion Ratio (C:T Ratio)} = \frac{\text{Number of RBC units crossmatched}}{\text{Number of RBC units transfused}}$$

$$2. \text{Transfusion Probability (TP)} = \frac{\text{Number of patients transfused}}{\text{Number of patients crossmatched}} \times 100$$

$$3. \text{Issuable Stock Index (ISI)} = \frac{\text{Average issuable stock}}{\text{Average nominal stock}}$$

$$4. \text{Wastage as Percentage of Issue (WAPI)} = \frac{\text{Number of RBC units discarded / wasted}}{\text{Number of RBC units issued}} \times 100$$

$$5. \text{Turnaround Time (TAT)} = \text{Time of Issue} - \text{Time of Receipt of Requisition}$$

$$6. \text{Cost of Testing incurred per unit} = \text{Cost of Reagents used for crossmatching} / \text{Testing}$$

### Statistical analysis

Data collected during both phases of the study were entered into and analyzed by using IBM SPSS software version 20.0 for the average number of daily crossmatches being performed, average number of RBC units issued, overall crossmatch-to-transfusion ratio (C:T ratio), ISI, WAPI, RBC outdate rate, turnaround time and cost calculation during both phases of the study. Independent sample *t* test was done for continuous variables, whereas chi-square test was employed for percentage or proportions. *P* value less than 0.05 was considered as statistically significant.

## Results

### RBC requisition details

As per the study inclusion criteria, 12519 routine/non-

emergent RBC transfusions were requested for 6532 patients during the study period. The details of the requisition for RBC transfusion are shown in Table 1.

### RBC utilization and inventory details

A total of 6640 RBC units were issued to 1738 patients. The transfusion probability significantly increased from 23.6% during TC policy to 29.5% ( $P < 0.05$ ) during TS policy. The crossmatch-to-transfusion (C:T) ratio was significantly reduced from 5.3 during TC policy to 1.9 ( $P < 0.05$ ) during TS policy. The TS policy significantly reduced the average daily crossmatches from 96.8 RBC units to 32.9 RBC units ( $P < 0.05$ ).

There was a significant increase in the average daily issuable stock from 278.6 RBC units to 300.3 RBC units ( $P < 0.05$ ) and ISI also showed a significant reduction from 12.5 to 11.4 ( $P < 0.05$ ) after TS policy.

Expiry of RBC units was reduced from 72 to 45 units during TS policy, as reflected by a significant decrease in WAPI from 2.3% to 1.3% ( $P < 0.05$ ).

TS policy also resulted in 35% reduction in expenses incurred on pre-transfusion blood cross matching. No Episodes of hemolytic transfusion reaction were reported during the entire study period.

Detailed comparisons of RBC utilization indices are depicted in Table 2.

### Discussion

Pre-transfusion compatibility testing with blood grouping and cross matching were first advocated by Reuben Ottenberg in 1908 (8). Since then pre-transfusion compatibility testing has seen many modifications overtime from AHG crossmatch to abbreviation to electronic crossmatch (6). Routine use of an antiglobulin test for crossmatch is not recommended, unless clinically significant unexpected antibodies are detected or when the patient has a history of such antibodies (9,10).

This paved the way for TS followed by abbreviated crossmatch as a new method of pre-transfusion compatibility testing. Many authors have established safety of various antibody screening methods with studies predicting that more than 99.99% of the ABO compatible RBCs would be compatible on AHG crossmatch, if the patient has a negative antibody screen (11-14). Several blood centers in developed countries have adopted TS policy as a mode of pre-transfusion compatibility testing with demonstrated benefits and safety (15-20). TS has not been adopted as a preferred mode of pre-transfusion compatibility testing in developing countries including India, except in a few blood centers. They have also demonstrated safety of TS policy in pre-transfusion compatibility testing at their respective blood centers (21-25). In our blood center, we used TC policy for pre-transfusion compatibility testing. Predicting transfusion

**Table 1.** Details of the requisition for RBC transfusion

Parameter		Type & Crossmatch (TC) Policy	Type & Screen (TS) Policy	Total
No. of transfusion requests received		6074	6445	12519
No. of patients for which transfusion requested		3208	3324	6532
No. of RBCs requested		17772	18435	36207
No. of cross-matches performed	AHG	16463	1267	17730
	Saline	-	5550	5550
No. of RBC units issued		3108	3532	6640

**Table 2.** RBC utilization indices

Parameter	Type & Crossmatch (TC) Policy	Type & Screen (TS) Policy	P value <sup>a</sup>
No. of patients transfused (TP)	757 (23.6%)	981 (29.5%)	<0.05 <sup>b</sup>
C:T ratio	5.3	1.9	<0.05
Average daily issuable stock	278.6	300.3	<0.05
Average nominal stock	22.3	26.4	<0.05
ISI	12.5	11.4	<0.05
Average daily crossmatches	96.8	32.9	<0.05
Number of units expired	72	45	<0.05
WAPI	2.3 %	1.3 %	<0.05
Total cost of testing incurred per unit issued (₹)	394.7	220	35% Reduction in expenses

TP, Transfusion probability; ISI, Issuable stock index; WAPI, Wastage as a percentage of issue.

<sup>a</sup>Independent sample t test

<sup>b</sup>Chi-square test.

requirement in trauma patients is often difficult, which results in sending out transfusion requisition forms for all patients in the emergency department. This translates into increased burden of workload on blood bank resources and manpower in the form of unnecessary blood cross matching, additional inventory management, expenses, expiry of units and staff utilization. This led us to implement TS policy as a method of pre-transfusion compatibility testing. Implementation of TS policy led to many benefits to our blood bank.

#### **Better utilization of cross matched blood: improved transfusion probability**

Transfusion probability of 30% and above is indicative of significant blood usage and a value less than 30% is indicative of insignificant blood usage and unnecessary cross matching requests (26,27). In our study, although the transfusion probability significantly increased from 23.6% during TC policy to 29.5% ( $P < 0.05$ ) for TS policy, it was still below the recommended value of 30% during both periods, and thus the use of TS policy for pre-transfusion compatibility testing is justified in overall trauma settings.

#### **Reduction in crossmatch-to-transfusion ratio (C:T Ratio)**

A C:T ratio of 2.5 or less is indicative of efficient blood utilization practices and a C:T of more than 2.5 reflects over-ordering of blood and excessive cross matching of blood (26-28). Under the ideal circumstances, the C:T ratio should be 1.0 (*all cross matched blood is transfused*). In our study, following the implementation of TS, there was significant reduction in C:T ratio of 1.9 from the previous ratio of 5.3 ( $P < 0.05$ ). Reduced C:T ratio was mainly due to omission of unnecessary/repetitive cross matching for the same patients. Similar findings were reported in other studies by Alavi-Moghaddam et al (29) who demonstrated a reduction in C:T ratio from 1.41 to 1.13; Shulman et al (30) reported that the C:T ratio was reduced from 2.4 to 1.53; Aggarwal et al (31) showed a reduction in C:T ratio from 1.94 to 1.04; and Alghamdi et al (32) mentioned the C:T ratio from 2.36 to 1.56 after the implementation of TS protocol. Although the TS policy significantly reduced the C:T ratio to 1.9, but it was still far from expected, possibly because the units issued were returned back without transfusion due to postponement of surgeries or not being deemed necessary for transfusion at the time of surgeries.

As antibody screening was done beforehand for all patients, there was no need to crossmatch and reserve the RBC units. The average number of RBC units that were cross matched daily reduced from 96.8 to 32.9 ( $P < 0.05$ ) during TS duration. This indicates a significant reduction in the workload. Moreover, because of the decreased workload, the staff was also relatively free to cater to immediate demands (e.g. uncross- matched/saline crossmatch requirement for massive bleeding) of

the emergency department.

#### **Effective and efficient blood inventory management**

Blood inventory for TS policy was increased to an average of 300.3 RBC units per day from the previous 278.6 RBC units during TC period. This rise in the RBC inventory was the result of less number of units being reserved for patients who did not require transfusion, although transfusion requests were sent because of the part of the policy/protocol. Shulman et al (30) also reported that after TS policy, general blood inventory stock needs were reduced to 300 from 450 during TC policy. A decrease in blood inventory stock, also translates into overall lower requirement of RBC when TS is used. The ISI also decreased from 12.5 to 11.4 ( $P < 0.05$ ) indicating better utilization of the inventory levels.

#### **Reduced wastage of blood units**

Adoption of TS policy led to the expiry of fewer RBC units (45 units against 72 during TC policy). This was evident from the significant reduction of WAPI from 2.3% to 1.3% ( $P < 0.05$ ). Patten et al (33) reported a similar reduction in discarding of blood units due to expiry by 41% (260 vs 466). Shulman et al (30) also showed reduced expiry rate from 5% to 0.19% and Aggarwal et al (31) indicated reduced expiry of blood units from 37 to 0 with TS policy. As the RBC units were not reserved, 'first in first out' (FIFO) approach was followed for the issuance of RBC units during TS policy. Repeated cross matching and reservation-unreservation for particular patients led to expiry of blood units during TC policy.

#### **Reduction in expenses incurred on per RBC unit issued**

In our study, TS policy resulted in a decreased cost of testing from ₹394.7 to ₹220 per unit issued. This resulted in reduction of expenses on pre-transfusion compatibility testing by up to 35%. Similar results were reported by the studies conducted by Aggarwal et al (31) and Sarah Alghamdi et al (32), highlighting a reduction in expenses by 33% and 22%, respectively. A few other studies also reported savings on expenditure with TS policy (30,33). This was due to the reduced number of tests and reagent use. In this regard, the cost savings can be used for other services in transfusion centers, especially in establishing automation.

#### **Turnaround time**

The mean turnaround time (TAT) of 312.35 minutes was found to be increased during TS policy as the mean of TAT was 277.72 minutes during TC policy. Alavi-Moghaddam et al (29) and Aggarwal et al (31) showed a reduction in the mean of TAT from 79.71 to 65.62 min and from 143 to 26 min in their studies, respectively. The increase in the mean of TAT in our study was not due to delay in dispensing blood after compatibility testing, but due to the



fact that once TS was done, the patient sample was valid for 3 days and no repeat request was needed during this period for issuance of blood.

### Immunohematological safety

During TC policy, AHG crossmatch was found to be incompatible in 3 patients and TS policy antibody screen was found to be positive in 5 patients, for which antibody specificities were identified and antigen negative RBCs were issued after AHG crossmatch. No hemolytic transfusion reaction was reported to the blood bank during this study.

### Conclusion

TS has an equivalent safety when compared to the TC for pre-transfusion testing and its utility in scenarios where the chances of transfusion are less should be considered. Although the TS was found to be safe and efficient and at the same time decreased the workload and stress of the staff working at a busy trauma center, there can be concerns about readiness and immediate availability of RBC units in case of immediate demands. Thus, prior to implementation of TS policy for pre-transfusion testing, its feasibility based on patient population, blood bank resources and staff knowledge should be assessed beforehand.

### Ethical issues

This study was approved by the institution ethical clearance committee (IEC – 790/08/11/2019).

### Authors' contributions

RC: Designed the study, analyzed data, wrote the manuscript, and approved the final version. NA: Data collection and analysis and wrote the manuscript. AS: Designed the study and revised the manuscript. VA: Wrote the manuscript and revised the manuscript. SK: Wrote the manuscript and revised the manuscript.

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