The Crossmatch/Issue Ratio

Use of a Novel Quality Indicator and Results of an International Survey on RBC Crossmatching and Issuing Practices

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ABSTRACT

Objectives: To understand the worldwide scope of RBC crossmatching and issuing practices and measure efficiency using a novel quality indicator, the crossmatch/issue (C/I) ratio.

Methods: An electronic survey was disseminated to hospital transfusion services collecting details about RBC crossmatching and issuing practices. Respondents were asked to enumerate the number of RBCs crossmatched and issued at their institutions during the 2014 calendar year to calculate the C/I ratio.

Results: Fifty-two survey responses were received, mostly from North American transfusion services (28/52, 54%). The electronic crossmatch was the most common technique (n = 29), and most respondents performed the crossmatch at the time that an order for RBCs was received in the transfusion service (even if an order to issue the RBCs was not received). Data to calculate the C/I ratio were supplied by 22 respondents, and the mean ± SD was 1.30 ± 0.34. There was no difference in C/I ratios between services that use the electronic or serologic crossmatch techniques (P = .49). The ratio was the same at the four sites that crossmatch RBCs at the time of issue compared with the time of order receipt (mean ± SD, 1.11 ± 0.09 vs. 1.35 ± 0.36, respectively; P = .19).

Conclusions: Electronic crossmatching is common, and the C/I ratio can be an indicator of efficiency.

Hospital transfusion services are always searching for ways to improve efficiency. A major advancement in efficiency is the use of the electronic crossmatch (EXM); this is an electronic system whereby patients with a valid type and screen who lack active or historical antibodies can have RBC units crossmatched for them using a computer that has logic to permit the issue of a unit that is ABO compatible and prevent the issue of one that is incompatible. As this crossmatch technique is performed entirely electronically, it can be completed in minutes. With the serologic safety of the EXM now well established,1-3 the question becomes when should RBCs for patients be
crossmatched. Many transfusion services, apprehensive of causing delays in supplying crossmatched RBCs, perform the EXM as soon as an order for RBCs is received on a patient, even if the order does not specify when the RBCs will be requested for transfusion. These crossmatched units are thus designated for that particular recipient and remain in the transfusion service’s inventory until another order is received to actually issue them. Thus, these units are effectively not available for use in other patients in anticipation of them being issued for a specific recipient. Other transfusion services wait until an order to issue the RBCs is received and then perform the crossmatch as part of the issuing process. This crossmatching policy should optimize the fluidity of the transfusion service’s inventory as RBCs are not designated for a specific recipient until an order to issue them is received. Transfusion services that routinely use the serologic crossmatch (SXM), whereby the potential RBC donor’s cells are physically mixed with the recipient’s plasma or when RBCs are ordered on patients who do not qualify for the EXM, most likely do not wait until an order to issue RBCs has been received before performing the crossmatch due to the extra time required to prepare and perform the SXM.

A novel method of measuring crossmatching efficiency is the crossmatch/issue (C/I) ratio. Proposed by Lin et al., the C/I ratio is a metric of how often a crossmatched unit is actually issued. Thus, it is a measure of how efficiently the RBC inventory is managed within the transfusion service. This ratio is independent of whether the unit is transfused, wasted, or returned as these events are out of the control of the transfusion service once the RBC has been issued. A low C/I ratio is desirable and indicates that the transfusion service’s RBC inventory is not assigned unnecessarily to patients on whom RBCs are ultimately not issued. The C/I ratio, as a measure of efficiency, is analogous to the crossmatch/transfusion (C/T) ratio by which clinical services’ RBC ordering practices are evaluated. In their study, Lin et al. demonstrated that when their transfusion service changed their crossmatch timing policy for EXM-eligible patients from being performed when the RBCs were ordered to when they were actually issued, the adjusted median turnaround time for RBC issuing was a clinically insignificant (albeit statistically significant) 1 minute longer, and their C/I ratio decreased from 1.15 to 1.0 as expected.

To better understand the current trends in hospital transfusion service RBC crossmatching and issuing policies, the Biomedical Excellence for Safer Transfusion (BEST) Collaborative undertook an international survey of these practices and collected C/I data to determine if there is an ideal timing and method of performing RBC crossmatches that optimizes this novel quality indicator.

Materials and Methods

RBC Crossmatching and Issuing Survey

A working party comprising BEST members designed a web-based (REDCap software) survey that collected basic hospital demographic information, along with details about how and when RBCs are crossmatched and issued, as well as how RBCs are distributed from the transfusion service to patient areas throughout the hospital for transfusion. The survey was initially piloted using selected BEST members from around the world who provided feedback on the flow of the survey, its comprehensibility, and nature of the questions posed. After refining the survey based on this feedback, the survey link was electronically distributed to the entire BEST membership. Members were encouraged to send the link to other hospital-based colleagues who could contribute data. The survey link became active on January 1, 2015, and remained open for approximately 1 year.

C/I Data Collection and Calculation

Data were retrospectively collected for the 2014 calendar year. A list of all crossmatched RBCs that were issued was obtained, representing all crossmatches that had been performed during 2014. From this list, the following crossmatches were excluded:

1. Serologically crossmatched units for patients with active or historical antibodies (even if the main crossmatch technique was the serologic crossmatch)
2. RBC units that were issued to hospital wards where a different crossmatch policy was applied relative to the rest of the hospital
3. Uncrossmatched RBCs issued from remote refrigerators in emergencies (since they were crossmatched at a time following their issue)
4. Crossmatches that were, for any reason, not performed using the routine crossmatching technique (such as patients with an ABO discrepancy whose RBCs were crossmatched using the immediate spin technique at a center that routinely used the electronic crossmatch)

The number of study-eligible crossmatches was thus the number of crossmatches performed during 2014, after these exclusions had been subtracted. From the list of study-eligible crossmatches, the number of crossmatched RBCs that were issued was determined. The C/I ratio was calculated by dividing the number of study-eligible crossmatches by the number of issued RBCs.

Descriptive statistics and the Mann-Whitney test were performed using Prism version 6 (GraphPad Software, San Diego, CA). Appropriate ethics board approvals were obtained at all participating institutions.
Results

RBC Crossmatching and Issuing Survey

There were 52 usable survey replies received. Most replies (28/52, 54%) were from transfusion services in North America, followed by 15 (29%) of 52 responses from Europe, six (12%) of 52 from Asia, two (4%) of 52 from South America, and one (2%) of 52 from the Middle East (Israel). Most hospitals (17/52, 33%) issued between 5,001 and 10,000 RBCs per year, while 15 (20%) of 52 issued between 10,001 and 20,000 RBCs per year, and 13 (25%) of 52 issued more than 20,000 per year. For seven (13%) of 52 respondents, the transfusion services issued fewer than 1,001 RBCs per year. The type of hospital from which these 52 transfusion services responded is shown in Figure 1.

Fifty of 52 respondents reported the nature of their main (ie, performed ≥50% of the time) technique for performing the crossmatch. The EXM was the main crossmatch technique for 29 (58%) of 50 respondents, followed by the immediate spin serologic crossmatch (13/50, 26%) and the antiglobulin serologic crossmatch (8/50, 16%). A variety of different serologic crossmatch techniques was performed at these respondents’ transfusion services, even if it was not their main crossmatching method, as demonstrated in Figure 2.

Among the 49 of 52 respondents who indicated when they actually performed the crossmatch, the number was similar between those who crossmatched RBCs at the time that an order for RBCs was received in the transfusion service (even if an order to issue the RBCs was not yet received) (25/49, 51%) and those who performed the crossmatch at the time the RBCs were issued (20/49, 41%). Four (8%) of 49 respondents either did not perform any form of crossmatch if the antibody screen was negative or performed the crossmatch at different times depending on the patient’s clinical situation.

Many sites reported using combinations of methods for distributing RBCs, such as having RBCs picked up by the clinical ward staff, delivered by transfusion service personnel, and/or the use of pneumatic tube or blood lift.
Forty-seven of 52 sites reported their percentages of use for these different distribution methods; the main (ie, used >50% of the time) single method of distributing RBCs to patient wards was by having nontransfusion service personnel pick up the units (29/47, 62%), followed by delivery of the RBCs by a pneumatic tube (11/47, 23%) and delivery of the RBCs to wards by transfusion service personnel (6/47, 13%). One (2%) site reported using a pneumatic tube and pickup by nontransfusion service staff equally.

Of the 52 respondents, 49 supplied the timing for when RBCs were considered “issued” by the transfusion service. The survey offered three timing options: (1) when RBCs are packed in a cooler, picked up, or placed in a pneumatic tube or blood lift; (2) at the time that the crossmatch is performed (regardless of whether it is issued immediately after cross-matching); and (3) at the time the RBCs arrive at a patient ward. Many different combinations of timings were observed. Figure 3 demonstrates the number of times that a respondent indicated that at least one of those timing options described their transfusion service’s RBC issue time. Note that the total number of replies exceeds 49 because in many cases, combinations of issue timing options were reported.

C/I Data Collection and Calculation

Twenty-two respondents submitted data on the number of crossmatches performed and RBCs issued in 2014. Most of these hospitals (16/22, 73%) were from the United States, while three (14%) were from Asia, two (9%) were from Europe, and one (5%) was from South America. The type of hospital, number of beds, and their calculated C/I ratios are shown in Figure 4. The mean ± SD C/I ratio for these 22 hospitals was 1.30 ± 0.34 (dashed horizontal line in Figure 4). Fifteen of these transfusion services performed EXM as their main crossmatch technique, and their mean ± SD C/I ratio was 1.23 ± 0.19; the remaining seven hospitals performed the SXM as their main crossmatch technique, and their mean ± SD C/I ratio was 1.46 ± 0.53 (P = .49).

Eighteen transfusion services performed the crossmatch at the time of receipt of the RBC order, and their mean ± SD C/I ratio was 1.35 ± 0.36; the remaining four transfusion services performed the crossmatch at the time of RBC issue, and their mean ± SD C/I ratio was 1.11 ± 0.09 (P = .19). At one of these four sites, the C/I ratio was 1.0; the mean ± SD C/I ratio at the other three sites was 1.14 ± 0.06 (Figure 4).

Discussion

This survey revealed the widespread use of the EXM throughout the world, although the SXM is still commonly employed as the main crossmatch method. Furthermore, there is a fairly even divide between when RBC units are crossmatched (at the time of order receipt vs at the time of issue). While the numbers were small, these results suggest that perhaps the transfusion service might operate more efficiently if the crossmatch was performed at the time that RBCs are being issued.

The C/I ratio could be a useful transfusion service quality indicator, since it reflects how often a crossmatch is performed compared with how many RBCs are actually issued. Interestingly, among the four sites in this study that reported performing the crossmatch at the time the RBCs are issued, one site uses the SXM as its main method. This indicates that it is not essential to use the EXM for time of issue cross-matching, although the extra time required to perform the SXM must be factored into the clinical decision making when placing an RBC order. Furthermore, among these four sites, only one had a C/I ratio of 1.0. The most likely explanations for not having a 1.0 ratio at the other three sites include the possibility that some of the RBCs were crossmatched before the time of issue and were subsequently not issued or that an order to issue the RBCs had been received in the transfusion service and the RBCs...
crossmatched, but the patient’s condition had rapidly changed such that the RBCs were not actually issued. Although there was perhaps only a trend toward significance due to the small sample size, the mean C/I ratio of the four sites that perform the crossmatch at the time of issue appeared to be lower than that of the other 18 sites that crossmatch RBCs at the time the order is received. It should be noted that two sites that crossmatch RBCs at the time that an RBC order is received had C/I ratios of 1.0. Overall, though, these data suggest that the time of issue might be a more efficient time to perform the crossmatch.

That the C/I ratio for the sites that performed the crossmatch at the time of issue was not always 1.0 suggests that this figure (1.0) is too stringent a benchmark and that some leeway should be allowed if the C/I ratio is to be used as a quality indicator, given the fluid nature of the recipients’ clinical conditions and/or changes in the timing of procedures (much the same way that a C/T ratio of 1.0 is unrealistic). Thus, perhaps the benchmark figure for the C/I ratio should be considered less than 1.15 to both optimize inventory management and account for changing clinical situations.

This study has some limitations. The main limitation is the relatively small number of respondents who provided data to calculate the C/I ratio, especially for those sites that perform the crossmatch at the time of issue. A larger sample size would have permitted a more accurate assessment of any statistical difference in C/I ratio between sites that perform the crossmatch at different times. However, even with this small sample size, a lower mean C/I ratio was appreciated among the sites that perform the crossmatch at the time of issue, as expected. As with any survey, it is also possible that some questions were misinterpreted or misunderstood, which could have led to some respondents providing incorrect answers or not providing RBC crossmatch and issue data in accord with the study protocol. This latter possibility seems unlikely given the relatively small standard deviation for the overall C/I ratio for the 22 sites that reported C/I data. Thus, the statistical analysis presented in this article must be interpreted with caution; it is provided
to give the reader a sense of the differences between the groups. With a larger sample size, different trends might become apparent.

The C/I ratio can be used to measure the efficiency of different crossmatching techniques and the time at which the crossmatch is performed. A larger study will be required to definitively establish the benchmark value for this quality indicator, but these data suggest that a C/I ratio of less than 1.15 is achievable from both clinical and inventory management perspectives.

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References