The immunohematologic and patient safety benefits of a centralized transfusion database

Meghan Delaney, Steve Dinwiddie, Theresa N. Nester, and James A. AuBuchon

BACKGROUND: The transfusion medical record is an important tool for providing safe and appropriate blood. However, many patients seek care at more than one hospital and this record is usually not portable. We posited that a centralized transfusion service database (CTS-D) offers benefits through tracking blood types, transfusion requirements, and detecting wrong blood in tube (WBIT).

STUDY DESIGN AND METHODS: Records held in the CTS-D from 1997 to 2010 were queried to enumerate those seen at more than one hospital versus one hospital only. Transfusion-related attributes were collected including red blood cell (RBC) antibodies, transfusion requirements, and reactions. WBITs detected due to historical ABO typing were tallied. A review of blood orders that required alteration based on requirements held in the CTS-D was completed.

RESULTS: There were 724,584 records; 10.9% of patients had been tested or received blood transfusion at more than one hospital. Of the 63,973 records with RBC alloantibodies, a greater proportion of patients were seen at more than one hospital versus one hospital only (7.11% vs. 3.97%, \( p < 0.005 \)). Of the 97,687 patient records that required special processing, patients seen at one hospital had a lower rate than those at more than one hospital (12.13% vs. 24.59%, \( p < 0.005 \)). There were 77 WBITs (0.18 WBITs per 1000 patients). An in-depth review of WBITs found an additional 26.3% (5 of 19) were detected because the current and historical ABO types were from two different hospitals within the CTS.

CONCLUSIONS: The CTS-D provides a universal transfusion record that improves patient safety. As health care systems are enlarged, centralization of the transfusion component of the medical record should be considered.

The use of records of past testing to increase the safety of transfusion for recipients is well accepted. For example, AABB Standards and the College of American Pathologists accreditation checklists require that past records of a patient be checked for previous ABO and Rh determination and antibody screen results.\(^1\)\(^2\) Such steps help detect mislabeling of pre-transfusion testing samples and prevent an evanescent antibody from causing accelerated removal of transfused red blood cells (RBCs).

In health care systems lacking a centralized transfusion information database or in cases where patients receive care at more than one institution, the value of performing a medical record check diminishes. The existence or location of information from prior determinations is often unknown to laboratory staff, and, as a result, optimal care is precluded, and thus, testing and blood preparation are carried out without knowledge of the past. Easy, online availability of prior antibody determinations from a regional reference laboratory may help address one part of the problem in those circumstances where all hospitals use a common source of assistance to resolve immunohematologic problems.\(^3\) Such a system would not, however, assist in detecting mislabeled samples from a majority of recipients nor track special processing requirements that they might need.\(^4\) We posited that a centralized transfusion service (CTS), serving an entire medical community

ABBREVIATIONS: CTS = centralized transfusion service; CTS-D = centralized transfusion service database; DHT(s) = delayed hemolytic transfusion reaction(s); WBIT = wrong blood in tube.

From the Puget Sound Blood Center, and the Department of Laboratory Medicine, the Department of Pediatrics, and the Department of Medicine, Hematology Division, University of Washington, Seattle, Washington.

Address reprint requests to: D.O. Meghan Delaney, MPH, Puget Sound Blood Center, 921 Terry Avenue, Seattle, WA 98104; e-mail meghand@psbc.org.

Received for publication November 22, 2011; revision received May 8, 2012, and accepted May 30, 2012.


with pretransfusion testing, component preparation, and immunohematologic reference services, would be in a better position to provide a more complete record and prevent these gaps in communication as patients moved between institutions.

Puget Sound Blood Center runs a large CTS that serves 19 hospitals and medical facilities in King County, Washington. Every day the transfusion service provides 400 patients across metropolitan Seattle with blood components and/or related testing. The operational and financial benefits deriving from a centralized approach to transfusion services related to its efficiency of scale and concentration of knowledge and resources have previously been documented.\(^5\)

We postulate that in the era of patients seeking care at multiple institutions, a CTS has safety benefits by facilitating selection of safer and appropriate blood components for transfusion. We therefore set out to enumerate the proportion of patients receiving treatment at more than one institution in our service area and then test whether these patients had a higher proportion of RBC antibodies, process requirements, and transfusion reactions than those who sought care at only one hospital. We also used the centralized database to quantify the number of misidentified specimens that had been detected through discrepant ABO typing when compared to the historical type on record to document the additional safety afforded by the centralized record. Using this approach, we found that the group of patients that were seen at more than one hospital had a higher proportion of RBC antibodies, specialized blood component processing requirements, and transfusion reactions and thus likely realize benefit from having a centrally held record that follows them from facility to facility. To better understand the effect of the CTS on individual blood orders, we used an audit approach to enumerate blood orders in which corrections were made to the order using the CTS database (CTS-D) in patients seen at one hospital only or more than one hospital.

**MATERIALS AND METHODS**

The study was determined to be exempt by the University of Washington Human Subjects Division in accordance with federal regulations. Records held in Puget Sound Blood Center’s centralized computer database (Blood Bank Computer Systems, Auburn, WA) were queried to identify patient records that had been seen at more than one hospital. Unless otherwise noted, the records dated were from January 1997 to November 2010. Patient records were defined as those that had at least one hospital identification number in the database that correlated to having had testing and/or blood transfusion performed at least once previously.

**RBC antibodies, transfusion reactions, and processes**

Patient records were stratified to determine the number with antibodies. Records were further scrutinized to determine the number of records that had a requirement for specialized processes such as leukoreduction, cytomegalovirus (CMV) seronegativity, irradiation, reduced RBC volume, or plasma-reduced (platelets [PLTs]) as well as those requiring washed cellular products. Transfusion reaction laboratory evaluation results and medical assessment of the reaction are held in the centralized transfusion record so that patients in need of transfusion are provided with components that match requirements based on their history of reaction(s). Records were queried to find patients who had experienced a transfusion reaction. Transfusion reactions were classified into the following types: acute hemolytic, physical hemolysis, delayed hemolytic, mild allergic, moderate allergic, severe allergic, possible febrile nonhemolytic, febrile nonhemolytic first time, febrile nonhemolytic repeat, citrate reaction or reaction due to fast infusion of cold cells (usually pediatric patients), bacterial contamination, transfusion-related acute lung injury (TRALI), volume overload, not related to transfusion, and other.

Proportions of records of patients seen at one hospital and those seen at more than one hospital were compared using the two-sample binomial test for proportions, \(Z\) statistic, and 95% confidence level. Descriptive statistics were used to summarize results.

**Mistyped specimens**

A patient’s record is notated whenever a specimen is received that can be shown to have been collected from someone else. This is usually detected through RBC typing and antibody screening results that are discordant with historical records. To ascertain the potential patient identification benefits of CTS-D, we enumerated the number of specimens termed “wrong blood in tube” (WBIT) that were registered in the system.\(^6\) The WBIT terminology and definition was used in the database beginning in July 2003 and the search queried records through November 2010. We further reviewed all of the WBIT instances since 2009, which marked the advent of the current occurrence management database (EtQ Reliance, Farmingdale, NY) to determine which were detected due to historical and current ABO typing coming from two hospitals within the CTS.

**Blood ordering corrections**

The policy of the CTS is to provide blood components according to the patient’s CTS-D transfusion medical record. We aimed to determine how often incoming blood orders were altered based on the CTS-D. Using an audit
approach we enumerated blood orders in which corrections were made to the blood order using the CTS-D in patients seen at one hospital only or more than one hospital for 7 days at one CTS laboratory.

RESULTS

The total number of patient records in the CTS-D was 724,584. Of this, 78,883 (10.9%) had been tested for, or received, blood transfusion at more than one hospital (Table 1). There were 645,701 patients seen at one hospital only. When reviewing these data from the perspective of one large cancer center in the CTS with a wide referral base, 100% of the 2028 patients with blood orders at the cancer center in 2011 also had blood orders placed at another CTS hospital between 2007 and 2011.

Table: Table 1. Number of patients seen at one or more hospitals in the King County CTS grouped by the number of hospitals a patient visited

<table>
<thead>
<tr>
<th>Number of hospitals a patient visited for transfusion or transfusion testing</th>
<th>Number of patient records (n = 724,584)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>645,701</td>
</tr>
<tr>
<td>2</td>
<td>68,203</td>
</tr>
<tr>
<td>3</td>
<td>9,156</td>
</tr>
<tr>
<td>4</td>
<td>1,301</td>
</tr>
<tr>
<td>5</td>
<td>173</td>
</tr>
<tr>
<td>6</td>
<td>38</td>
</tr>
<tr>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>10</td>
<td>2</td>
</tr>
</tbody>
</table>

Table: Table 2. Number of clinically significant RBC alloantibodies found in 724,584 patients

<table>
<thead>
<tr>
<th>Number of RBC alloantibodies per patient record</th>
<th>Patients with one hospital record (n = 645,701)</th>
<th>Patients with more than one hospital record (n = 78,883)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>20,426</td>
<td>4230</td>
<td>&lt;0.005</td>
</tr>
<tr>
<td>2</td>
<td>4,104</td>
<td>1033</td>
<td>&lt;0.005</td>
</tr>
<tr>
<td>3</td>
<td>847</td>
<td>263</td>
<td>&lt;0.005</td>
</tr>
<tr>
<td>4</td>
<td>200</td>
<td>63</td>
<td>&lt;0.005</td>
</tr>
<tr>
<td>5</td>
<td>34</td>
<td>18</td>
<td>0.003</td>
</tr>
<tr>
<td>6</td>
<td>9</td>
<td>4</td>
<td>&lt;0.005</td>
</tr>
<tr>
<td>7</td>
<td>3</td>
<td>0</td>
<td>1.64</td>
</tr>
<tr>
<td>Total number of patients</td>
<td>25,623</td>
<td>5611</td>
<td>&lt;0.005</td>
</tr>
</tbody>
</table>

Overall, 63,973 (8.82%) of patient records had a positive antibody screen due to clinically significant and/or insignificant RBC alloantibodies. Those patients who sought care at multiple medical centers had a higher proportion of having antibodies (13.27%) than those that only had one system record (8.26%, Z = 43.954, p < 0.005). There were 31,234 (4.31%) patient records with clinically significant antibodies; these were more common in patients seen at one or more hospital (7.11%) compared to those seen at one hospital (3.97%, Z = 42.184, p < 0.005). This difference was also true for patients with any number of clinically significant RBC antibodies (Table 2). There were 39,974 clinically significant antibodies detected. Anti-D was the most frequent antibody detected; however, most anti-D was weakly reactive and detected in prenatal samples, likely reflecting RhIG administration. Antibodies to E and K antigens were the next most common specificities identified, respectively.

Patient records with any specialized processing requirement was 97,687 (13.48%). Over the time span of the analysis, some hospitals transitioned from requiring CMV-seronegative products to allowing leukoreduction for CMV risk reduction if CMV-seronegative products were not available, although both requirements remain on the patient record. Those patients seen only at one hospital had a significantly lower rate (12.13%) for all types of specialized processing of blood products versus those seen at more than one hospital (24.59%, Z = 96.723, p < 0.005; Fig. 1).

There were 4831 patients (0.67%) who experienced 5263 reported transfusion reactions. Most reactions (acute hemolytic, mild allergic, moderate allergic, possible febrile nonhemolytic, febrile nonhemolytic first time, febrile nonhemolytic repeat, citrate or cold reaction, bacterial, TRALI, volume overload, not related to transfusion, and other) were seen in a higher proportion of patients who sought care at more than one hospital (2.41%) when compared to those who sought care at one hospital only (0.49%, Z = 53.733, p < 0.005; Table 3). Physical hemolysis and delayed hemolytic and severe allergic reactions were not seen more frequently in patients who sought care at more than one hospital.

Mistyped specimens

During July 2003 to November 2010, a total of 855,030 samples were received from 418,333 patients at 19 CTS participating hospitals. There were a total of 77 WBIT specimens, or 0.9 per 1000 samples. Of these, 25 were from patients who were seen at more than one hospital, and 52 were from patients seen at one hospital only (Z = 4.961, p < 0.005). An in-depth review of WBITs from 2009 to 2012 found 18 specimens with full records available. Five of 19 (26.3%) of these WBITs were detected because the current and historical ABO types were obtained from two different hospitals within the CTS. Specifically, four of these WBIT specimens were detected retrospectively because a subsequent
sample from another CTS hospital provided the correct ABO blood type (on repeat testing). The time to retrospective detection ranged from 1 day to 11 years. None of the retrospectively detected WBITs led to RBC ABO mistransfusion. One of the WBITs was prospectively detected: the original sample in 2007 typed as A– from one hospital; a subsequent sample 4 years later typed as B– (confirmed B– on repeat testing) from another hospital. This could have led to an ABO mistransfusion if not detected.

Blood ordering corrections
The audit of 728 blood orders found that 148 orders (19.5%) were corrected to align with the CTS-D patient record. Of the corrected orders, 49 (34.5%) were for patients seen at one hospital, and 86 (60.6%) were for patients seen at more than one hospital. The specific transfusion requirements that were updated on incoming blood orders were as follows: 78 orders for leukoreduction (54.9%), 52 orders for CMV seronegative (36.6%), 58 orders for irradiation (40.8%), seven orders for plasma reduction or washing (4.9%), and 19 RBC alloantibodies (13.4%).

DISCUSSION
Over the years, approaches to provision of transfusion services have been studied to determine the best approach with respect to patient care, safety, and financial concerns. Many feel that centralization or nationalization of medical records affords many types of benefits. Western Washington patients, who seek medical care at the institutions participating in the King County CTS,
likely benefit from having access to an electronic, centrally held transfusion record. Besides the overall efficiency of the system, the quantitative data presented here provide valuable information to support that a centralized database allows subsequent transfusions to proceed with increased safety and decreased amount of rework in the laboratory. It is also critical to note that regions without a CTS can still gain large inroads with a multicenter database that allows participation of hospitals with distinct transfusion services.3

For those patients with RBC antibodies, having a patient record with a complete history of previously detected antibodies allows the transfusion service to continually provide antigen-negative units, even in the case of antibodies that decrease in titer over time and especially when patients change their hospital of choice.10 This record may decrease the incidence of delayed hemolytic transfusion reactions (DHTR), although this was not able to be tested using a retrospective analysis approach. In regions without a database, each time a patient seeks care at a different institution, the blood bank technologists must perform a complete antibody identification without knowledge of past testing at other institutions. In situations where the blood bank is told of previous hospitalization(s), they may contact the previous hospital for records. However, there is continued risk of short-lived alloantibodies not being detected or identified without seamless communication with all hospitals from which the patient has ever received blood. For this reason, Community Blood Center in Kansas City developed a centralized patient database for alloantibody information for hospital clients that has been shown to decrease DHTRs.3 The database provides evidence that sharing transfusion information, within regulatory requirements, tangibly improves patient care.

The patients who sought care at more than one hospital were more likely to have RBC alloantibodies and warm autoantibodies than those seen at one hospital only. This is likely because patients with complex medical needs seek specialized care, such as transplantation, oncologic, or surgical procedures at tertiary care facilities in the area. During the blood ordering audit, all of the patients seen at a large cancer center in the city were also seen at another institution in the CTS, often more than one. Thus transfusion care at the tertiary care centers (including the cancer center) and the smaller community-based hospitals is bolstered by having the same record for complex patients who may be hospitalized while undergoing treatment at either type of facility. In our experience we have also found that the medical directors in the CTS often serve as the crucial point of information exchange for hospital medical providers when a complex antibody patient is transferred from one hospital to the next.

Special laboratory processes used to prepare blood components are important in increasing the safety of transfusion. For example, patients at risk for transfusion-associated graft-versus-host disease due to absent or altered T-cell immunity must receive irradiated cellular components. However, those patients who seek care at more than one institution are at risk for not having this prescription uniformly applied when multiple providers write orders for one patient. This is especially important when considering that 24.19% of patients accessing medical care at more than one institution required specialized processing for their transfusions in this analysis and up to 7.9% of blood orders failed to include irradiation when the patient’s CTS-D record required irradiation.

Those patients who have suffered transfusion reactions and subsequently require specialized processing of their blood components gain a measure of safety by having a central repository for this information. In fact, there is a higher rate of transfusion reactions in patients who seek care at more than one hospital than those seen at one hospital only. The database aids the ordering providers; for example, if a previous history of an allergic transfusion reaction requires the patient to receive only plasma-reduced PLTs, this processing will be provided even if the ordering physician is not aware of the history and requirements.

A weakness of the study, and of the centralized system, is that the reported rate of transfusion reactions is below what is recognized nationally. Although many centers suffer from the same lack of reporting of transfusion reactions, the transfusion service being located off site in the centralized model may add to this underreporting. However, the wide and growing use of transfusion safety officers in King County mitigates this through their bedside educational and audit activities.11 Some transfusion reactions were reported at very low numbers, namely, physical hemolysis, delayed hemolytic, and severe allergic (Table 3). It is likely that rarity does explain the low numbers in the categories of physical hemolysis and severe allergic reactions. DHTRs are rarely, if ever, described first by the clinical teams who report the transfusion reactions to the blood bank. Rather, DHTRs are usually reported by the blood bank to the hospital medical provider and a transfusion reaction form is not completed. The manner in which these data were available is a weakness of the analysis.

The measure of safety gained by the CTS-D is clearly provided by the long-term database for blood group ABO typing. As others have shown, this can prevent mis-transfusions and typing errors, which could be life-threatening.4 This study documented WBIT incidents at a rate of 0.18 per 1000 patients who had an episode of WBIT. An additional five WBITs were detected due to information gained by having a centralized database in which multiple hospitals participate. Thus, we believe that the patient record in King County is exerting some tangible
safety benefit in this realm. Because WBIT can be fatal for the patient and also financially expensive for the institution, continued focus on specimen labeling should remain a priority for all transfusion services.\textsuperscript{12,13}

This study quantified the safety benefits of a long-standing, centralized transfusion patient medical record. In the time of increasing pressures for containment of medical costs, a database may be able to provide cost savings not only through more efficient operation but also through improved patient care.\textsuperscript{5,14}

ACKNOWLEDGMENT

We thank Jeff Siddons for his assistance in record review and retrieval.

CONFLICT OF INTEREST

None.

REFERENCES
