Effectiveness of Multiple Initiatives to Reduce Blood Component Wastage

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Key Words: Wastage; Waste; Blood components; Intervention; Plasma; RBC; Platelets

ABSTRACT

Objectives: Blood component waste is an important issue at all hospitals. As an initiative of the patient blood management program at a regional health care system, the causes and extent of blood product wastage were identified, and targeted interventions to effect a reduction were implemented.

Methods: Multiple low-cost interventions, including educational outreach, print and digital messaging, and improved transportation and component identification modalities, were implemented beginning in January 2013. The impact on reducing RBC, platelet (PLT), and plasma wastage in the 16 months after intervention implementation was compared with the wastage rates in the 16 months before these interventions had been implemented.

Results: Overall, the RBC wastage rate as a percentage of the number of units issued decreased from 0.67% to 0.56% (P = .001) after the interventions were implemented, while the PLT wastage rate decreased from 3.71% to 2.81% (P < .001). The plasma wastage rate increased from 1.14% to 1.40% (P < .001). The initial cost of these interventions was approximately $310. The net cost savings of the reduced waste was estimated at $131,520, excluding intervention costs.

Conclusions: Relatively inexpensive interventions can have a prompt and dramatic impact on reducing blood wastage with regard to both cost and resource savings.

Wastage of all blood components, including RBCs, platelets (PLT), and plasma, is an important issue for hospitals worldwide. Waste is not limited to blood products and is present throughout the health care system. One study suggested that the overall cost of waste to the American health care system was perhaps as high as $910 billion.1 Studies of systemic waste have examined the importance of workflows in the health care environment2 and have focused on minimizing operational sources of waste when issuing a variety of medications.3-9 In many of these studies, relatively simple interventions resulted in marked reductions in waste.

Ideally, outdating and wastage of blood products would never occur. However, inevitably a low level of outdating of components in the blood bank is accepted due to the inherent need to have stock on hand at all times and the often unpredictable demands on the inventory.10 Studies of the supply chain and blood usage benchmarking have demonstrated that while some outdating does occur in the blood bank, significant reductions in the wastage of issued blood components may be achieved through targeted interventions.11,12 The first major study focusing on reducing blood wastage using Lean and Six Sigma techniques was performed by Heitmiller et al,13 who demonstrated that wastage of RBCs could be reduced by more than 60% over 4 years, resulting in a savings of more than $800,000. Ideally, institutional RBC wastage should be less than 1% of the units issued.14 Calculating wastage as a percentage of units issued (WAPI) accounts for differences between hospital transfusion volumes and allows for benchmarking.15 Several hospitals within the United Kingdom have analyzed their RBC wastage using this method, and the WAPI rates were noted to range between 0.26% and 6.7%.
annually,\textsuperscript{10,15} while on a national level, the RBC WAPI rates for hospitals in England and North Wales, Northern Ireland, and Scotland ranged from 2.1% to 4.8% in 2011-2012.\textsuperscript{16} In absolute terms, this translates into a staggering 19,687 wasted RBC units in 2012. Similarly, one study of a large institution within the United States had a WAPI RBC wastage rate of 4.4%.\textsuperscript{13}

The US Food and Drug Administration and the AABB require that RBCs must be stored between \(2^\circ\)C and \(6^\circ\)C. If an RBC unit that has been issued but not transfused is to be returned to the blood bank for use in a different patient, one of the criteria for accepting it back into the inventory is that the unit must have remained within that temperature range. Although controversial,\textsuperscript{17-19} many blood banks have adopted a “30-minute” rule to be in compliance with this standard and will not accept an RBC unit that has been outside of the blood bank (and not in a validated ice chest) for more than 30 minutes. Thus, wastage can occur if the transfusion of an RBC unit has not started within 30 minutes of its issue. Platelet components must be maintained at room temperature and should be discarded if refrigerated. Noncompliance with these temperature guidelines once the products have been issued can result in high levels of wastage. Multiple interventions focused on reducing blood waste have been attempted by various institutions, including education of providers, enhanced transport containers, robust temperature monitoring systems, and alteration of RBC storage protocols.\textsuperscript{12-14} Continued follow-up, including monthly meetings with clinical staff, distribution of blood wastage audits, and retraining of blood bank staff, was also identified as being effective in reducing waste.\textsuperscript{10,13,14} In addition, by focusing on the donors’ commitment of time, money, and resources in making their donation, as well as the moral duty to prevent the waste of a donated component, one group was able to make marked improvements in their wastage rates in the operating rooms (ORs) and on the wards.\textsuperscript{10}

As an initiative of the patient blood management (PBM) committee at a multihospital regional health care system, the extent and causes of blood product wastage were identified, and then targeted interventions to address the causes of wastage were implemented.

Materials and Methods

Hospital System

Data for this project were obtained from eight hospitals that are part of a multihospital health care system. These hospitals are serviced by a regional centralized transfusion medicine service (CTS),\textsuperscript{20} briefly, each hospital has a transfusion laboratory on site and maintains an inventory of product commensurate with its transfusion activity. All hospital transfusion laboratories are linked through a common recipient electronic database, and a larger inventory of blood products and an RBC serology reference laboratory support the hospital laboratories from an offsite location. These eight hospitals range in size from small community hospitals to large, quaternary care academic centers, including hospitals specializing in pediatrics and women’s health. Three of these hospitals have a trauma center and maintain thawed plasma in their emergency department refrigerators. The two largest hospitals in the health system account for more than 50% of all blood components used systemwide. This health care system features a PBM committee that is tasked with implementing the best transfusion practices at all of its hospitals. This committee has wide representation from anesthesia, transfusion medicine, trauma surgery, and critical care medicine, as well as nursing representatives from the OR, emergency department, and hematology/oncology wards. The PBM committee also features a change specialist who acts as a liaison between the committee and executives of the hospital system.\textsuperscript{21} For this waste reduction initiative, a subcommittee of the PBM committee was established that was composed of the chief nursing officers from all of the hospitals in the system, the change specialist from the hospital network, and representatives from transfusion medicine and anesthesia.

Baseline Blood Product Wastage Data

RBC, PLT, and plasma wastage data at these eight hospitals from September 2011 through December 2012 (16 months) were analyzed to identify the root causes of the wastage. Wastage was tracked using an automated daily email report that was produced by the CTS for these eight hospitals. This report included information on all of the products that had been wasted on the previous day, such as the in-hospital location (eg, OR) where the product was wasted, and the name and specialty of the ordering physician. Compiling the information in these reports informed the design of programs directed at reducing wastage, as described below. The main emphasis of these programs was on reducing the wastage of products that had been issued for transfusion, as opposed to those that were outdated in the blood bank. All of these hospitals use mainly pools of whole-blood PLTs. Depending on the patient’s clinical situation and PLT inventory, the pool sizes ranged from three to five whole-blood units. The actual number of issued, transfused, and wasted PLT pools is not known. Therefore, the total number of whole-blood PLT equivalents, calculated by multiplying the number of issued apheresis PLT units by 5 and then adding that value to the number of individual whole-blood PLT units issued, is herein reported.
Interventions

Multiple waste reduction interventions were implemented beginning in January 2013 across all hospitals in the system. These included initiatives to improve temperature storage compliance for products that had been issued for transfusion, to better track blood products in the OR, and to generally raise awareness of the problem of blood product waste among clinical staff. All interventions were implemented across the eight hospital sites simultaneously; this was possible due to the participation of the chief nursing officers at each hospital, the presence of the CTS at each hospital, and the common information system throughout the health care system. Data on blood wastage at these eight hospitals were collected from January 2013 through the end of April 2014 (16 months) using the automated daily reports.

In addressing temperature storage compliance for issued products, it was noted that OR staff often returned all blood products in the cooler that had been used to issue the RBCs. This led to the unnecessary wastage of PLTs. To address this, a platelet- and cryoprecipitate-specific transport tote bag was developed. This tote bag is made of a lightweight fabric, is easy to disinfect with sodium hypochlorite, and has a strap allowing it to be hung on an RBC cooler.

To help reinforce the different storage requirements for the various blood products issued to the OR, small cardboard identification tags were created for each blood component. These tags feature cartoons and are color coded to allow for ease of identification, even at a distance. Each tag lists the appropriate storage conditions for that particular blood product. Below the blood product symbol, that product’s specific expiration date and time are printed. These tags are attached to each component as it is being issued to the OR without significant disruption of the technologist’s work flow and are maintained on the unit until use or their return to the blood bank.

Educational interventions were also introduced to increase clinician awareness of blood waste and transfusion guidelines. Members of the PBM committee presented the baseline wastage data at all of the major specialty-specific professional staff meetings and transfusion committee meetings, raising awareness of blood product wastage and improving communication with clinical staff. A special focus was placed on the disrespect to the donors that is shown when their donations are unnecessarily wasted. Emphasis was placed on the time and resources that a donor commits while making his or her donation, encouraging clinicians to take care of the donor’s gift and prevent blood waste. Posters and screensaver images were also created to increase the awareness of the new blood component tags and to emphasize the importance of proper blood component storage. Clinical nursing guidelines on blood product storage requirements were developed and made available on the institutional intranet. Last, auditing of waste was performed on a daily basis, with the automated wastage reports forwarded to the nursing units and chief nursing officers for further investigation and education when excessive waste occurs.

This protocol was approved by the University of Pittsburgh Medical Center’s Total Quality Council, which is a section of the Institutional Review Board of the University of Pittsburgh. US dollar cost estimates were made using the following approximations: $200/RBC unit, $70/whole-blood PLT unit, and $70/plasma unit.
Table 1
Number of Units Wasted, by the In-Hospital Location Where the Wastage Occurred, in the 16-Month Preintervention and Postintervention Periods

<table>
<thead>
<tr>
<th>Waste Location</th>
<th>No. of Units Wasted</th>
<th>Outdate, No. (%)</th>
<th>Storage, No. (%)</th>
<th>Returned &gt;30 min, No. (%)</th>
<th>Other, No. (%)</th>
<th>Change in % of Outdate Waste Between Time Periods (P Value)</th>
<th>Change in % of Storage Waste Between Time Periods (P Value)</th>
<th>Change in % of Returned &gt;30 min Waste Between Time Periods (P Value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preintervention</td>
<td>Floor</td>
<td>2,401</td>
<td>1,877 (78.18)</td>
<td>223 (9.29)</td>
<td>121 (5.04)</td>
<td>180 (7.50)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>OR</td>
<td>1,306</td>
<td>998 (76.42)</td>
<td>251 (19.22)</td>
<td>12 (0.92)</td>
<td>45 (3.45)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ICU</td>
<td>866</td>
<td>661 (76.33)</td>
<td>118 (13.63)</td>
<td>47 (5.43)</td>
<td>40 (4.62)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ED</td>
<td>352</td>
<td>278 (78.98)</td>
<td>24 (6.82)</td>
<td>19 (5.40)</td>
<td>31 (8.81)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Unknown</td>
<td>118</td>
<td>74 (62.71)</td>
<td>30 (25.42)</td>
<td>8 (6.78)</td>
<td>6 (5.08)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Postintervention</td>
<td>Floor</td>
<td>1,567</td>
<td>1,194 (76.20)</td>
<td>89 (5.68)</td>
<td>189 (12.06)</td>
<td>95 (6.06)</td>
<td>-2.53 (.16)</td>
<td>-38.86 (&lt;.001)</td>
</tr>
<tr>
<td></td>
<td>OR</td>
<td>1,028</td>
<td>860 (83.66)</td>
<td>122 (11.87)</td>
<td>20 (1.95)</td>
<td>26 (2.53)</td>
<td>+9.47 (&lt;.001)</td>
<td>-38.24 (&lt;.001)</td>
</tr>
<tr>
<td></td>
<td>ICU</td>
<td>638</td>
<td>502 (78.68)</td>
<td>58 (9.09)</td>
<td>41 (6.43)</td>
<td>37 (5.80)</td>
<td>+3.08 (.29)</td>
<td>-33.31 (.007)</td>
</tr>
<tr>
<td></td>
<td>ED</td>
<td>195</td>
<td>131 (67.18)</td>
<td>22 (11.28)</td>
<td>27 (13.85)</td>
<td>15 (7.69)</td>
<td>-14.94 (.003)</td>
<td>+65.40 (.078)</td>
</tr>
<tr>
<td></td>
<td>Unknown</td>
<td>141</td>
<td>83 (58.87)</td>
<td>32 (22.70)</td>
<td>8 (5.67)</td>
<td>18 (12.77)</td>
<td>-6.12 (.61)</td>
<td>-10.70 (.66)</td>
</tr>
</tbody>
</table>

ED, emergency department; ICU, intensive care unit; OR, operating room.

The number of units issued by hospital location was unavailable. Outdate refers to units that expired after issue from the blood bank but prior to transfusion and were otherwise stored in temperature compliance. The storage waste category refers to units that were improperly transported, iced incorrectly, or were otherwise not stored in compliance with temperature requirements. Items in the “returned >30 min” category represent units that were returned to the blood bank more than 30 minutes after they were issued. Examples of wastage in the “other” category include units that were broken, contaminated, or transported by pneumatic tube with tube system failure.

Table 2
Number of Units Wasted, by Product Type, in the 16-Month Preintervention and Postintervention Periods

<table>
<thead>
<tr>
<th>Product (No. of Units Issued)</th>
<th>No. of Units Wasted</th>
<th>Outdate, No. (%)</th>
<th>Storage, No. (%)</th>
<th>Returned &gt;30 min, No. (%)</th>
<th>Other, No. (%)</th>
<th>Change in % of Outdate Waste Between Time Periods (P Value)</th>
<th>Change in % of Storage Waste Between Time Periods (P Value)</th>
<th>Change in % of Returned &gt;30 min Waste Between Time Periods (P Value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preintervention</td>
<td>RBC (110,335)</td>
<td>742</td>
<td>245 (33.02)</td>
<td>227 (30.59)</td>
<td>144 (19.41)</td>
<td>126 (16.98)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PLT (97,407)</td>
<td>3,614</td>
<td>3,222 (89.15)</td>
<td>274 (7.58)</td>
<td>0 (0.00)</td>
<td>118 (3.27)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Plasma (60,180)</td>
<td>687</td>
<td>421 (61.28)</td>
<td>145 (21.11)</td>
<td>63 (9.17)</td>
<td>58 (8.44)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Postintervention</td>
<td>RBC (93,879)</td>
<td>524</td>
<td>169 (32.25)</td>
<td>83 (15.84)</td>
<td>176 (33.59)</td>
<td>96 (18.32)</td>
<td>-2.33 (.81)</td>
<td>-48.22 (&lt;.001)</td>
</tr>
<tr>
<td></td>
<td>PLT (82,970)</td>
<td>2,333</td>
<td>2,114 (90.61)</td>
<td>167 (7.16)</td>
<td>0 (0.00)</td>
<td>52 (2.23)</td>
<td>+1.64 (.077)</td>
<td>-5.54 (.56)</td>
</tr>
<tr>
<td></td>
<td>Plasma (50,737)</td>
<td>712</td>
<td>487 (88.40)</td>
<td>73 (10.25)</td>
<td>109 (15.31)</td>
<td>43 (6.04)</td>
<td>+11.62 (.006)</td>
<td>-51.44 (&lt;.001)</td>
</tr>
</tbody>
</table>

PLT, platelet.

The total number of units issued is included for comparison. Outdate refers to units that expired after issue from the blood bank but prior to transfusion and were otherwise stored in temperature compliance. The storage waste category refers to units that were improperly transported, iced incorrectly, or were otherwise not stored in compliance with temperature requirements. Items in the “returned >30 min” category represent units that were returned to the blood bank more than 30 minutes after they were issued. Examples of wastage in the “other” category include units that were broken, contaminated, or transported by pneumatic tube with tube system failure.

Statistical Analysis

The $\chi^2$ test was used for statistical analysis, conducted on Prism 6.04 software (GraphPad Software, La Jolla, CA). All statistical tests were two-tailed, and a $P$ value less than .05 was considered statistically significant.

Results

Table 1 demonstrates the causes of waste during the 16-month baseline period (September 2011 through December 2012) and the 16-month postintervention period (January 2013 through April 2014) by in-hospital location. Outdated units were defined as those that had been issued from the blood bank but then either expired or were not transfused within the specified amount of time and were particularly applicable to pools of whole-blood PLTs. This was the primary mechanism of wastage in both time periods. The storage waste category refers to units that were improperly transported, iced incorrectly, or were otherwise not stored in compliance with temperature requirements. Compared with the preintervention period, there were significant reductions in wastage due to improper storage conditions in most hospital locations during the postintervention period except for the emergency department, where there was a small but not significant increase in storage waste. Changes in wastage rates caused by product outdated varied by hospital location during the postintervention period, with a significant increase in OR wastage.

Table 2 demonstrates the causes of waste during the baseline and postintervention period by product type. There
were significant reductions in storage waste of RBCs and plasma during the postintervention period, with small and not significant reductions in PLT waste. Overall platelet waste decreased during the postintervention period, with a similar magnitude of decrease in each examined category. To determine if the causes of wastage were different between large and small hospitals, the wastage of the two hospitals with the largest transfusion volumes in the health care system were compared with the wastage at the two hospitals with the smallest transfusion volumes. For both pairs of hospitals, the number of products issued and their wastage rates were combined Table 3. The mechanisms of wastage between these pairs of hospitals were generally quite similar.

Discussion

This multifaceted approach to blood product wastage reduction using relatively simple and inexpensive interventions produced significant reductions in RBC and PLT wastage over a short period. By focusing on the areas where wastage was occurring frequently and understanding the root cause, these interventions could be designed to address the specific challenges faced in different parts of the hospital while also raising awareness of the wastage issue throughout the hospital in general. In particular, by identifying that temperature storage noncompliance in the ORs was a major source of wastage, targeted efforts to remind OR staff about the proper storage conditions for RBCs and PLTs were introduced and helped to reduce wastage.

By raising awareness of blood wastage and transfusion guidelines among both nurses and physicians, through teaching sessions and through more passive teaching techniques (including posters and screensavers), the message about blood product wastage was disseminated throughout the hospital system. Educational sessions with clinicians often must be repeated to maintain vigilance and to ensure the exposure of the constantly changing cadre of faculty and residents, but the passive teaching techniques and available guidelines seem to have been effective in maintaining the focus on blood waste reduction over the course of this study. Moreover, by focusing on the role of the donor in the blood management process, it appears that the target population took these messages seriously and perhaps was a factor in the waste reduction. Many health care workers are also blood donors, and pointing out the time and commitment it takes to donate regularly might provide...
a resonating rationale to work to reduce unnecessary waste. Building this “head to heart” connection may be one key to engaging clinical staff in reducing blood wastage; although our postintervention RBC and PLT WAPI rates were low at 0.56% and 2.81%, respectively, this still represents 524 and 2,333 respective wasted donations from volunteers, altruistic donors who had hoped that their donations would have benefited a recipient.

It is interesting to note the varied wastage rates seen between components. By increasing awareness about appropriate storage conditions and taking steps to prevent inappropriate usage, the wastage rate of RBCs was significantly reduced by about 16% to a WAPI rate of 0.56% in the postintervention period. In comparison, while the rate of platelet wastage decreased by almost 25%, there is still room for improvement on the postintervention WAPI rate of 2.81%. Moreover, it seems that there is still room for improving PLT storage waste, since there was a minimal decrease in storage waste seen during the postintervention period. This PLT wastage rate, although relatively low, still cost these eight hospitals approximately $163,000. For comparison, the PLT WAPI rate in England/North Wales and Northern Ireland hospitals in 2011-2012 was 4.0% and 7.6%, respectively. Platelets, given their 5-day shelf life and the necessity of using the product within 4 hours after pooling, may be more recalcitrant to waste reduction. It would be of interest to compare the wastage rates of apheresis vs pooled PLTs to determine if apheresis products provide an advantage in reducing wastage due to product expiration and outdating. It is unclear what caused the slight increase in the plasma wastage rate during the postintervention period, although perhaps it relates to an increased number of apheresis procedures that are cancelled after the plasma had been thawed; the data also indicate that more units were wasted because they were returned to the blood bank more than 30 minutes after they were issued during the postintervention period. The reason for this increased wastage is not clear, but having identified it as a specific category of wastage, steps will be taken to reduce this type of wastage. Although not formally analyzed in this study, it is unlikely that having thawed plasma available at three of the hospitals with trauma centers contributed significantly to the wastage. This is because the plasma for these patients is group AB and can be administered to any recipient toward the end of the 5-day shelf life, and by protocol, only 16 units in total are kept thawed between these hospitals at any one time. It is evident that the above interventions have been effective in reducing storage-related waste but have led to minimal changes in waste caused by outdating. In fact, a significantly higher amount of waste due to outdating was observed in the OR after the interventions were implemented. It is unclear why the OR is outdating so many products, and thus further investigation and focused interventions will be needed to reduce this type of wastage.

Comparing the WAPI wastage rates between the first 4 months after the interventions were implemented and the most recent 4 months demonstrated that the reductions in RBC and plasma wastage were durable and not simply a result of transiently increased attention to the problem of blood product wastage. Moreover, the PLT wastage rate demonstrated a significant decline from the first third of 2013 to the first third of 2014, suggesting that the effectiveness of these interventions may have improved as the postintervention period progressed.

Introducing rapid auditing and accountability into this process also appears to have been useful in reducing waste. The chief nursing officers who received the daily wastage reports could conduct a prompt investigation of episodes of excessive wastage and provide feedback to both the hospital’s transfusion committee and the systemwide PBM committee regarding if areas for improvement are detected in their root cause analyses. The nature of these investigations was not standardized and was dependent on the extent and type of wastage but generally involved interviewing the people involved in the wastage incident, reviewing the timing of the order placement and the blood product delivery from the blood bank, and any relevant laboratory parameters that prompted the blood product order. A prompt investigation also allowed for rapid staff remediation while they might still remember the waste event. These nonpunitive root cause analyses will be an important element of maintaining and improving on the waste reduction improvements that have been achieved.
There are several limitations to this study. This study did not examine the impact that these interventions had on cryoprecipitate waste, although since cryoprecipitate is issued less frequently than the other three components studied, the impact of the waste reduction strategies is expected to be less. Due to a limitation of the electronic information systems, it was not possible to determine the rate of wastage by in-hospital location, since data on the number of units issued to each in-hospital location are not available. Thus, the reductions in waste noted on the floors or in the intensive care unit, OR, and emergency department could have been caused by a lower transfusion volume in the postintervention period. As multiple interventions were introduced simultaneously, it is difficult to identify which one had the greatest impact. Thus, it is hard to draw any conclusions about the effectiveness of any individual intervention from this study. Furthermore, although the preliminary data support the durability of these interventions, given the relatively short time frame examined in this project, it is not yet clear if these savings will be sustainable or if previous habits will return, with concomitant wastage. The initial cost of the interventions was small: $200 for 200 tote bags, $10 for 500 component tags, and $100 for 20 posters, for a total of $310. As components are issued to the OR and as the totes and posters are destroyed or require updating, additional small costs will be incurred to replace them. These minor costs are readily offset by the savings achieved through reduced blood product wastage. Last, a direct comparison of wastage between the eight different hospital sites is not possible because this health care system operates on a center of excellence basis. Thus, many of the procedures and treatments that are provided are hospital specific. This renders a direct comparison of wastage between sites not meaningful.

Wastage of blood components will continue to be an issue at all hospitals. This study demonstrates the impact that relatively easy and inexpensive interventions can have on reducing wastage, including costs and products. Given the dramatic cost savings seen, these interventions can easily pay for themselves in terms of cost and contribute to the conservation of blood resources, which is important for both ethical and PBM reasons. Furthermore, these results demonstrate the value that a collaborative effort between the multidisciplinary PBM committee and blood product prescribers can have on wastage reduction. Through the PBM committee’s engagement of blood product prescribers, the already low wastage rates became even lower.

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