Implementation of a Blood Product Conservation Project on the Cardiac Surgery Intensive Care Unit

by

Cecilia Gutwald

Under Supervision of

Maranda Jackson-Parkin

Second Reader

Renee Franquiz

A DNP Project Manuscript
Submitted in Partial Fulfillment of the Requirements for the
Doctor of Nursing Practice Degree

University of Maryland School of Nursing
May 2022

Abstract

Problem: In 2020, 16 blood products were wasted (0.34% of products issued) on a 22-bed Cardiac Surgical Intensive Care Unit (CSICU), reflecting over $2,000 in wasted revenue. Wasting these limited life-saving resources infers disrespect to donors and indicates system-related inefficiencies. Incorrect storage conditions of unused Massive Transfusion Event (MTE) products render them unsuitable for re-entry into blood bank circulation due to internal product temperatures deviating from established safe parameters, contributing to 50% of the wastage in 2020. **Purpose**: The purpose of the quality improvement (QI) project was to implement and evaluate an evidence-based blood cooler checklist presented on MTE coolers that identifies the storage and transport conditions of blood products for registered nurses (RNs) in the CSICU. **Methods**: Registered nurses (RNs) were able to access a blood product storage checklist by scanning Quick Response (QR) codes on MTE cooler lids. CSICU RNs completed and submitted these checklists through Smartsheet, a HIPAA-compliant file-sharing system, permitting data collection on RN adherence to the practice change. One-on-one education and knowledge comprehension assessments for CSICU RNs, advanced practice providers (APPs), and blood bank staff were delivered by project champions. The project outcome, blood waste, was measured using the institution's event-reporting system. **Results**: Post-implementation data revealed 100% (n=122) of CSICU RNs and 100% (n=19) of CSICU APPs were educated on blood product conservation techniques, 100% of MTE coolers issued (N=52) contained a QR-code accessible checklist, 67% (n=35) of the MTEs were associated with a completed checklist, and 13 blood products were wasted (0.86% of products issued [N=1,510]). While blood product wastage as a percentage issued increased from 0.34% pre to 0.86% post-implementation, there was a reduction in MTE blood waste due to improper storage conditions (50% pre versus 46% post-implementation). Blood waste due to improper storage was associated with only one MTE cooler post-implementation, as opposed to multiple MTE coolers pre-implementation.

Conclusions: The use of an evidence-based checklist on MTE coolers in addition to RN and APP-directed educational sessions on blood conservation techniques can serve to increase staff adherence with proper blood product storage conditions, decreasing blood product wastage.

Implementation of a Blood Product Conservation Project on the Cardiac Surgery Intensive Care Unit

The national waste rate for hospital-issued blood products is 6% (Brown, et al., 2014; Fadeyi, et al., 2017). These rates reflect an estimated 1 million wasted blood products each year in the United States, at a cost of up to $230 million (Hauk, 2018; Hannon, 2015). Hospital blood product waste is defined as blood products that must be wasted because internal temperature has exceeded the threshold for return to inventory (Bots, et al. 2016; Hannon, 2015). This is due to improper storage and failure to return packed red blood cells (PRBCs) that are not transfused back to the blood bank prior to inadvertent rises in temperature, as measured using a countertop model thermometer and color indicator on the bag (Hannon, 2015). Blood wastage is a threat to the nation's blood supply, which places all patients in need of blood transfusion at risk for inadequate care (Fadeyi, et al., 2017). Studies have shown that Black Americans and women are more likely to receive blood transfusions while hospitalized, so efforts to improve the safety of the nation's blood supply by minimizing wastage will benefit vulnerable groups (Gombotz, et al., 2016; Qian, et al., 2014).

In 2020, 16 blood products were wasted on the CSICU, equating to a cost of approximately $2,000. This is an underestimation of total cost since it does not account for the labor required for preparation, transportation, delivery, and storage. Most wastage was due to incorrect storage and transport conditions of unused products, rendering PRBCs and fresh frozen plasma (FFP) unsuitable for re-entry into blood bank circulation due to internal product temperature exceeding 10 degrees Celsius.

The need for a practice change was apparent because there were no checklists for required storage conditions for blood products on MTE coolers delivered to the CSICU (Figure

1). Nurses were not held accountable for storage of blood within MTE coolers, blood products were mishandled, and an unnecessary amount of blood waste occurred. The purpose of the QI project was to implement and evaluate an evidence-based blood cooler checklist that identified the storage and transport conditions of blood products for RNs in the CSICU. The anticipated outcome was that the checklist would serve to increase staff adherence with proper blood product storage conditions, thereby decreasing waste (Figure 2).

Evidence Review

The need for an intervention to ensure proper blood product storage and transport conditions, thereby preventing blood product waste, was the focus of this evidence review (Bots, et al., 2016; Brown, et al., 2014; Collins, et al., 2015; Levin, et al., 2019; Whitney, et al., 2019) (see Table A1). The review begins broadly with the evidence supporting a blood product storage-focused intervention to reduce blood waste. This discussion is followed by a synthesis of outcomes from these interventions (see Table A2). Finally, the review concludes with a synthesis of strengths and limitations of the evidence.

Collins, et al. (2015) and Brown, et al. (2014) implemented identification tags for blood products specifying how they should be stored. This structural change equates to a blood bank cooler checklist containing storage/transport requirements. Bots, et al. (2016), Whitney, et al. (2019), and Levin, et al. (2019) implemented changes in storage and transport protocols such disallowing transport of PRBCs with a patient transferring between units, a mandate that multiple PRBC units ordered at once should be delivered in a cooler, and blood bank to unit direct communication to ensure any currently unused blood product still needs to be on hold for a patient. All studies included education in their implementation.

The primary outcomes of the studies analyzed focused on blood component waste, financial cost, and relationship between intervention and waste reduction. Outcomes were measured in PRBC unit wastage in studies by Bots, et al. (2016) and Whitney, et al. (2019) Outcomes in studies by Collins, et al. (2015), Brown, et al. (2014), and Levin, et al. (2019) were measured in all blood product (RBC, plasma, platelet, and cryoprecipitate) wastage. All studies showed decreased wastage post-intervention. Brown, et al. (2014) was the only study to measure cost as a dependent variable, which showed that a blood conservation initiative including an educational placard attached to each blood product significantly reduced the mean monthly cost associated with RBC and plasma waste. Collins, et al. (2015), Brown, et al. (2014), and Whitney, et al. (2019) explored relationships identifying that PRBC wastage was significantly reduced in post-implementation groups as compared to pre-implementation. Levin, et al. (2019) found that total blood product wastage was reduced post-intervention (PRBC specifically was reduced post-intervention, but not significantly). Bots, et al. (2016) found PRBC wastage was reduced, but significance was not discussed. Overall, findings suggest that the interventions successfully reduced blood product wastage.

Four of the five studies were quasi-experimental, Level III, with pre and posttest designs (O'Mathuna & Fineout-Overholt, 2019). Collins, et al. (2015) and Whitney, et al. (2019) used large sample sizes and rigorous statistical methods, earning them both quality ratings of B. Collins, et al. (2015), Whitney, et al. (2019), and Bots, et al. (2016) expressed outcomes as wastage as a percentage issued, which accounts for any change in number of units issued during data collection period, decreasing confounding variables and increasing internal validity. Bots, et al. (2016) did not provide significance of results, and Brown, et al. (2014) did not report wastage based on overall units issued, both decreasing internal validity and resulting in quality ratings of

C. The study by Levin, et al. (2019) was a quality improvement design, ranking as Level IV (O'Mathuna & Fineout-Overholt, 2019; Newhouse, 2006). It was given a quality rating of C for the same limitations discussed as Brown, et al. (2014). The major strength in all studies, collectively, is consistency of results. A limitation is that all studies implemented a multi-faceted intervention at once, so the impact of one single component of an intervention cannot be determined from study results. This suggests that a multi-faceted approach is necessary to ensure a reduction in blood product wastage.

Theoretical Frameworks

The theory of planned behavior (TPB) was selected as the theoretical framework underpinning the practice problem. The TPB hypothesizes the ability to change behavior depends on both motivation and ability (Ajzen, 1991; Ajzen, 2002). *Behavioral beliefs* propose that a given behavior produces an expected outcome; for example, the belief that using a checklist will reduce blood waste. *Normative beliefs* are behavioral expectations held by a group, creating a subjective norm, such as CSICU RNs adopting the use of the blood cooler checklist. *Control beliefs* are the perceived power that an RN has over wasting blood, which can be improved via use of a checklist. Control beliefs affect *perceived behavioral control,* which translates to the RN's perception of the ease of which a checklist is completed. All aspects of the model were addressed to affect staff RN's intentions and behaviors. This was imperative to the acceptance and sustainability of the checklist, and its subsequent ability to help the CSICU reduce blood waste. The QI team addressed behavioral beliefs by training, normative beliefs by combating non-adherence, and control beliefs by reporting improved outcomes. See Figure 3.

The Implementation Process Framework by Helfrich et al. (2007) emphasizes that effective implementation starts with management support and resource availability (see Figure

4). Therefore, the structural goal of a checklist accessed via a quick response (QR) code was the best method to decrease blood waste, given its approval by blood bank and CSICU management and its low financial cost. Training fostered an implementation climate that accepted the checklist as a critical tool when administering an MTE. Training clearly enforced the connection between the checklist and the CSICU's mission to reduce waste. Nurse Practitioner (NP), RN, and blood bank champions fostered this climate by acting as the early adopters of this change. This led to implementation effectiveness (Helfrich et al., 2007).

Methods

This QI initiative was implemented on a 30-bed CSICU in an inner-city teaching hospital. There were 1,510 blood products transfused to patients within this unit during the 14-week implementation period. The interdepartmental QI initiative affected all healthcare providers working in the CSICU (N=137), consisting of RNs (n= 120) and 17 APPs (NP, n=12; physician assistants, n=5) and allied health personnel in the blood bank (n=30). The main evidence-based intervention was a blood product storage checklist on top of every MTE cooler (Figure B1). The QI team included the CSICU manager, CSICU assistant manager, Blood Bank Quality Assurance Specialist, Project Faculty Advisor, two Nurse Practitioner Champions, five RN champions, four blood bank technician champions, and one clinical informatics liaison.

To decrease the number of products wasted due to improper transport conditions, a structural change was implemented, consisting of education by project champions and quizzes on implementation and blood mitigation strategies for CSICU RNs and APPs (Figure B3). To decrease the number of products wasted due to improper storage, a checklist was implemented. This checklist prompts the RN helping with or utilizing the MTE blood cooler to verify that the cooler has no tubed products, products from a different cooler, or platelets/ cryoprecipitate products inside of it. The process measure of the project was cooler checklist completion. The outcome measure, blood waste, was tracked via the hospital's event reporting system.

Strategies and tactics to facilitate the structural change included in-person education, formal commitments from leadership and champions to help with one-on-one education, building coalitions, using train-the-trainer strategies, and developing and distributing educational materials. Strategies facilitating the process change included utilization of the checklist, revising professional roles to include the completion of the checklist as an expectation of nursing, incentive structures, obtaining staff buy-in, developing academic partnerships, sending biweekly emails to CSICU staff, one-on-one discussions, mandating change, identifying barriers and facilitators, and performing audit and feedback processes. Strategies for outcome measurement included developing and organizing quality monitoring systems for data collection, including Smartsheet, a HIPAA-compliant password-protected electronic portal, to collect checklist submissions and Epic Portfolio-generated reports to collect transfusion data.

One-on-one staff education was tracked using Training Collection Tools (Figures C6, C7, and C9). Staff knowledge assessment data were collected using QR-code-accessible quizzes within Smartsheet (Figure B3). Following training of health care providers and blood bank personnel, the checklist was implemented. Nurses accessed the checklist by using a cell phone to scan the QR code on top of all blood bank coolers destined for the CSICU. Completed blood cooler checklists were electronically submitted by an RN or tech once a blood cooler was delivered to the unit. Checklist completion data were collected via Smartsheet, only accessible by QI project lead (Figure B2). The number of blood products issued to the CSICU were collected by auditing electronic-generated reports for MTEs (Table C1) and individual blood products (Table C2) weekly. Patient MRNs were coded (Table C5) and were used in addition to the transfusing nurse's name (also coded) and the transfusion time/date to determine if a checklist has been completed for each MTE. The frequency at which blood bank staff were placing the QR code checklist on coolers was tracked using an observational audit tool, completed by project lead and blood bank QI champions daily (Table C10). Blood waste was tracked weekly via reports from the institution's event reporting system by the blood bank quality assurance specialist and recorded in audit forms (Tables C1 and C2). Patient and staff confidentiality were maintained because all project data was coded and recorded on a secure data management spreadsheet, stored on a password-protected device accessible only by QI project lead (Tables C3, C4, and C8). The project was reviewed by the University of Maryland Human Research Protections Office (HRPO) to obtain non-human subjects research determination. Anonymous data trends were displayed at regular intervals in the form of run charts.

Results

The structural goals were met as evidenced by 100% (N=141) of CSICU RNs (n=122) and 100% (n=19) of CSICU APPs completing the education on blood product conservation techniques (Figure 5) and 100% (N=52) of MTE coolers issued containing a QR-code accessible checklist during the intervention period. Adherence to the process change of blood cooler checklist completion for every MTE was 67% (n=35). The run chart for MTE checklists completed (Figure 6) had eight runs for a total of 14 data points, which was within the expected number of runs for this data set. There were no shifts or trends in the data, reflecting no consistent increase in checklist usage after education or timing interval. The outcome was that 0.86% of products issued were wasted (13 out of 1,510 products). The run chart for blood waste (Figure 7) during implementation had no shifts or trends, but there were too few runs (zero out of 14 data points), reflecting that waste occurrences were secondary to specific circumstances unrelated to the intervention itself (Institute for Healthcare Improvement, 2022). Discussion with nursing management and charge nurses revealed patient acuity on the CSICU was higher than usual in the beginning of November, which could be the special cause for variation during this time. Outcome data demonstrated one astronomical data point, representing nine wasted blood products during the week of November 8, 2021. Six of the nine products were wasted because blood products were set up to be transfused but the patient died prior to administration. Three of the nine blood products were obtained in preparation for imminent patient exsanguination after an unforeseen equipment failure, which was quickly resolved, and units were not needed. Both events that contributed to the astronomical data point were explained by rare, unforeseen cases.

The CSICU met 99.14% of target outcome goal (blood waste) and 67% of the target process goal (checklist completion adherence). The intended goal for blood product waste to decrease post-intervention was not achieved. However, the anticipated outcome that the checklist would serve to increase staff adherence with proper blood product storage conditions was achieved. Even though blood waste increased from 0.34% pre to 0.86% post-implementation, MTE blood waste due to improper storage conditions decreased (50% pre versus 46% post-implementation). In addition, MTE blood waste due to improper storage was associated with only one MTE cooler post-implementation, as opposed to multiple MTE coolers pre-implementation.

Discussion

During the weeks with 100% adherence to checklist completion, zero blood products were wasted. During the weeks that blood waste occurred, checklist adherence ranged from 50% to 80%. There was only one week in which blood waste occurred due to an MTE event. The association between 100% checklist adherence and zero overall blood product waste suggests that MTE checklist completion may have served to decrease individual blood product waste unrelated to MTE events. This could be due to an increased awareness of proper blood storage conditions in general, influenced by increased checklist usage during those weeks.

An unexpected benefit of this QI project was an unveiling of communication failures between CSICU APPs, RNs, and blood bank staff. Pre-intervention, when blood bank staff had to waste a returned blood product, they would not tell the RN or APP involved that the unit had to be wasted. APPs and RNs who were involved in the blood waste were never notified that the incident occurred. During the intervention period, blood bank staff were encouraged to disclose blood waste to the involved staff to facilitate staff awareness of how their actions can lead to waste. In addition, CSICU staff noted that many coolers did not have the date and time that they were released from the blood bank. This unveiled a breakdown in standard operating blood bank procedures, which facilitated re-education and training. Facilitators to successful implementation included the enthusiasm of project champions, the CSICU culture of openness to new evidence-based practices, and the inclusion of CSICU techs midway through implementation. It was decided that techs could be delegated by the RN to complete the cooler checklist because maintaining proper storage and transport of blood products was within their scope of practice. The main barrier to implementation was that primary and helping RNs were so overwhelmed with other tasks regarding the management of the bleeding patient, they did not have time to think about whether the blood products were being properly stored. Involving techs decreased RN burden and gave techs a more robust and valuable role during an MTE emergency. This allowed for better role distinction and facilitated team building.

Over two-thirds of the MTEs issued had a completed checklist, indicating that most CSICU staff adopted the checklist into their practice. The only waste related to improper storage conditions occurred during a rare, unforeseen event. Overall, the project had a positive impact on blood wastage due to improper storage conditions. This impact is relevant because proper storage is a modifiable factor in the prevention of blood waste. The increase in blood waste from pre- to post-intervention was related to non-modifiable factors. This is supported by the lack of runs in the blood waste run chart inferring special cause variation, as well as the rare circumstances previously described as precipitants of such episodes. It is also supported by the discrepancy between the increased waste after implementation in this project and the decreased waste after implementation in other publications (Bots, et al., 2016; Brown, et al., 2014; Collins, et al., 2015; Levin, et al., 2019; Whitney, et al., 2019). This is likely because these publications included larger sample sizes and longer data collection periods than this project, decreasing the influence of uncontrollable outliers on outcomes. The project setting, a CSICU in a large, academic teaching hospital, may contribute to a higher incidence of unforeseen emergencies due to high patient acuity, incidence of mechanical life support, frequency of high-risk procedures, and high nursing staff turnover.

Non-modifiable, unforeseen events appeared to be the primary explanation for differences between anticipated and observed outcomes. Imprecision in project design may have contributed to imprecise outcomes as well. A small sample size of total blood products issued (N= 1,510) as opposed to a more substantial size (e.g., N = 349,996 in Collins, et al. [2015]) limited internal validity. Pre-implementation data was collected over a 12-month span, whereas post-implementation data was collected over a 14-week span, increasing risk for random error and decreasing internal validity. Attrition of nurses and APPs during the data collection period and the addition of patient care tech education midway through implementation may have inflicted confounding bias. Because of the project’s quality improvement design, statistical analyses were limited to descriptive statistics, which did not account for confounding factors such as increased patient acuity.

Efforts made to adjust for limitations included calculation and expression of blood waste as a percentage of units issued, accounting for confounding variables and increasing internal validity. Ensuring that all new staff were educated on the process for scanning and completing checklists minimized the impact of staff attrition. All QR codes were consistently placed in the same location on the lid of each MTE cooler, which controlled for the confounding variable of structural change accessibility. Because of its project design, the results of this QI initiative were specific to the CSICU and cannot be considered generalizable to other units or organizations.

Conclusion

This project has shown that using an evidence-based checklist on MTE coolers with RN and APP-directed educational sessions on blood conservation techniques can increase staff adherence to proper blood product storage conditions. This initiative has improved staff accountability for proper storage, transport, and ordering of blood products through auditing of blood waste, individual feedback where appropriate, and dissemination of progress. Project champions and CSICU leadership have committed to sustaining this change via continuing education, audits, feedback, and dissemination in weekly huddles and monthly staff meetings. CSICU RN and tech preceptors are expected to teach onboarding staff the process for scanning the cooler QR code and completing the checklist for every MTE.

Because of the success of this unit-based QI project, blood bank leadership has decided to maintain QR codes on all coolers dispersed hospital-wide. Data collection on institution-wide blood waste due to improper storage conditions is underway. A project champion plans to use this data to lead a hospital-wide MTE cooler checklist implementation with the goal of reducing overall blood product waste throughout the hospital. This future QI project is expected to take place in Fall 2023.

References

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50*(2), 179–211. https://doi.org/10.1016/0749-5978(91)90020-T

Ajzen, I. (2002). Perceived behavioral control, self-efficacy, locus of control, and the theory of planned behavior. *Journal of Applied Social Psychology, 32* (665–683). https://doi.org/10.1111/j.1559-1816.2002.tb00236.x.

Akobeng, A. K. (2016). Understanding type I and type II errors, statistical power and sample size. *Acta Paediatrica, 105*(6), 605. Retrieved from http://eds.b.ebscohost.com.proxy-hs.researchport.umd.edu/eds/detail/detail?vid=5&sid=64310ab6-cffc-4888-b6d5-7f8da0bfb6a0%40sdc-v-sessmgr03&bdata=JnNpdGU9ZWRzLWxpdmU%3d#AN=115160917&db=edb

Boston University School of Public Health. (2019). The theory of planned behavior. Retrieved from https://sphweb.bumc.bu.edu/otlt/MPH-Modules/SB/BehavioralChangeTheories/BehavioralChangeTheories3.html

Bots, M., Grouw, E. P. L. M., Rooyen, S. I. H. M., Akker, G. J., Sturk, A., Klinkspoor, J. H., & Zeerleder, S. S. (2016). Strategies to reduce wastage of red blood cell units. *Vox Sanguinis, 110(*2), 143–149. https://doi.org/10.1111/vox.12351

Brown, M. J., Button, L. M., Badjie, K. S., Guyer, J. M., Dhanorker, S. R., Brach, E. J., Johnson, P. M., & Stubbs, J. R. (2014). Implementation of an intraoperative blood transport and storage initiative and its effect on reducing red blood cell and plasma waste. *Transfusion, 54(*3), 701–707. https://doi.org/10.1111/vox.12351

Collins, R. A., Wisniewski, M. K., Waters, J. H., Triulzi, D. J., & Yazer, M. H. (2015). Effectiveness of multiple initiatives to reduce blood component wastage. *American Journal of Clinical Pathology, 143*(3), 329–335. https://doi.org/10.1309/AJCP42WMHSSTPHXI

Fadeyi, E. A., Emery, W., Simmons, J. H., Jones, M. R., & Pomper, G. J. (2017). Implementation of a new blood cooler insert and tracking technology with educational initiatives and its effect on reducing red blood cell wastage. *Transfusion, 57*(10), 2477–2482. https://doi.org/10.1111/trf.14234

Gombotz, H., Schreier, G., Neubauer, S., Kastner, P., & Hofmann, A. (2016). Gender disparities in red blood cell transfusion in elective surgery: a post hoc multicentre cohort study. *BMJ Open, 6*(12), e012210. https://doi.org/10.1136/bmjopen-2016-012210

Hannon, T. (2015). Waste not, want not. American Journal of Clinical Pathology, 143(3), 318–319. https://doi.org/10.1309/AJCPM8FACVC0RPRG

Hauk, L. (2018). Approaches to minimize blood product wastage. *AORN Journal, 107*(5), 7–10. https://doi.org/10.1002/aorn.12163

Helfrich, C.D., Weiner, B.J., McKinney, M.M. & Minasian. L. (2007). Determinants of implementation effectiveness adapting a framework for complex innovations. *Medical Care Research and Review, 64*(3), 279-303. https://doi.org/10.1177/1077558707299887

Institute for Healthcare Improvement. (2022). Data Analysis. Retrieved from http://www.ihi.org/help/extranet/Pages/extHelpDataAnalysis.aspx

Levin, J. H., Collins, L., Adekunle, O., Jackson, H. T., Vaziri, K., Schroeder, M., & Davison, D. (2019). Blood product wastage reduction by utilising low-cost, low-impact multimodal physician-to-physician communication initiatives. Transfusion Medicine, 29(6), 389–393. https://doi.org/10.1111/tme.12640

Newhouse, R. P. (2006). Examining the support for evidence-based nursing practice. *The Journal of Nursing Administration, 36*(7–8), 337–340.

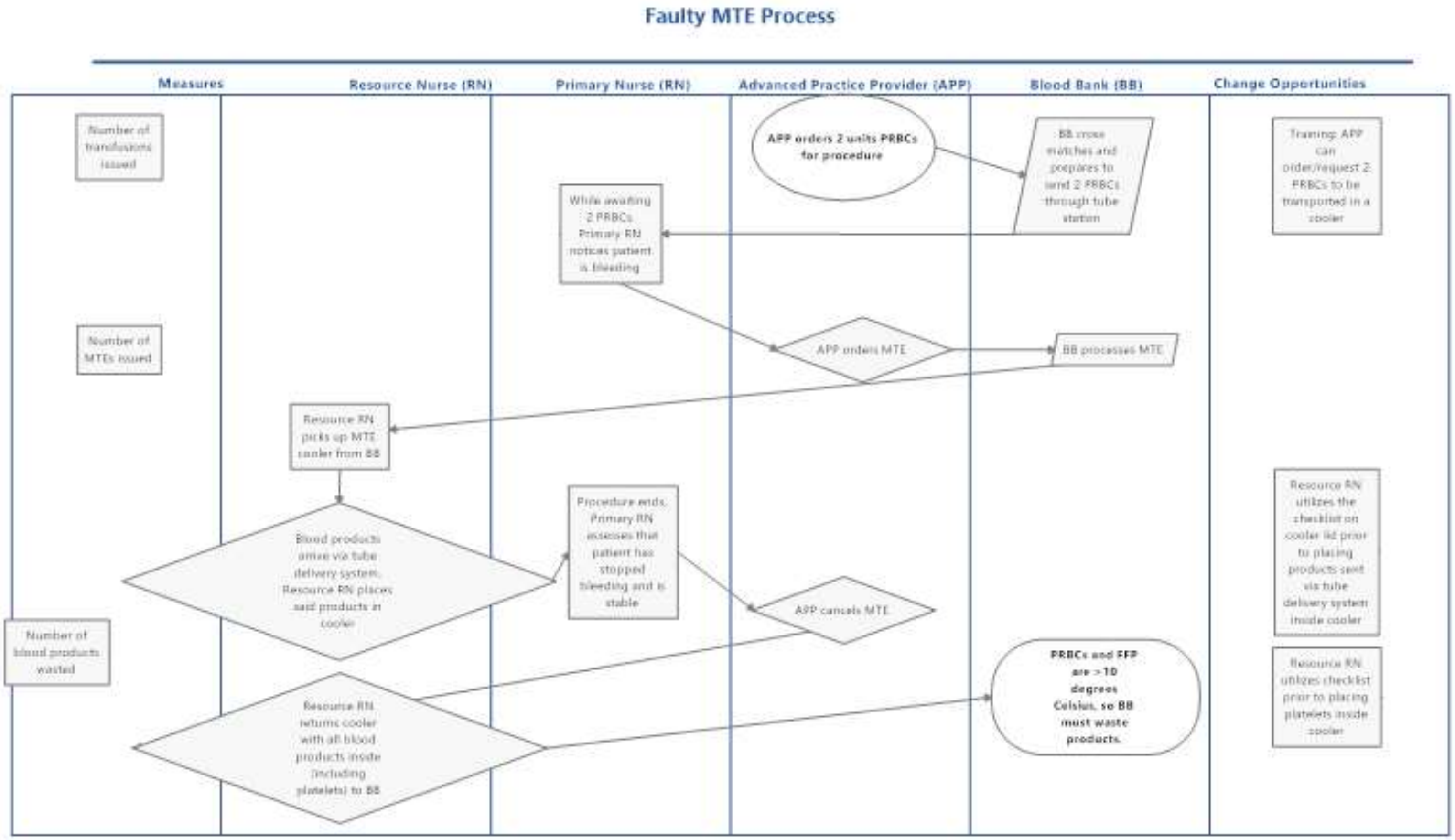
O'Mathuna, D.P. & Fineout-Overholt, E. (2019). Critically appraising quantitative evidence for clinical decision making. In B.M. Melnyk & E. Fineout-Overholt (Eds.), *Evidence-based practice in nursing and healthcare* (4th ed., pp. 124-188). Wolters Kluwer.

Qian, F., Eaton, M. P., Lustik, S. J., Hohmann, S. F., Diachun, C. B., Pasternak, R., Wissler, R. N., & Glance, L. G. (2014). Racial disparities in the use of blood transfusion in major surgery. *BMC Health Services Research, 14* (121). https://doi.org/10.1186/1472-6963-14-121

Whitney, G. M., Woods, M. C., France, D. J., Austin, T. M., Deegan, R. J., Paroskie, A., Booth, G. S., Young, P. P., Dmochowski, R. R., Sandberg, W. S., & Pilla, M. A. (2015). Reducing intraoperative red blood cell unit wastage in a large academic medical center. *Transfusion, 55*(11), 2752. https://doi.org/10.1111/trf.13214

Figure 1

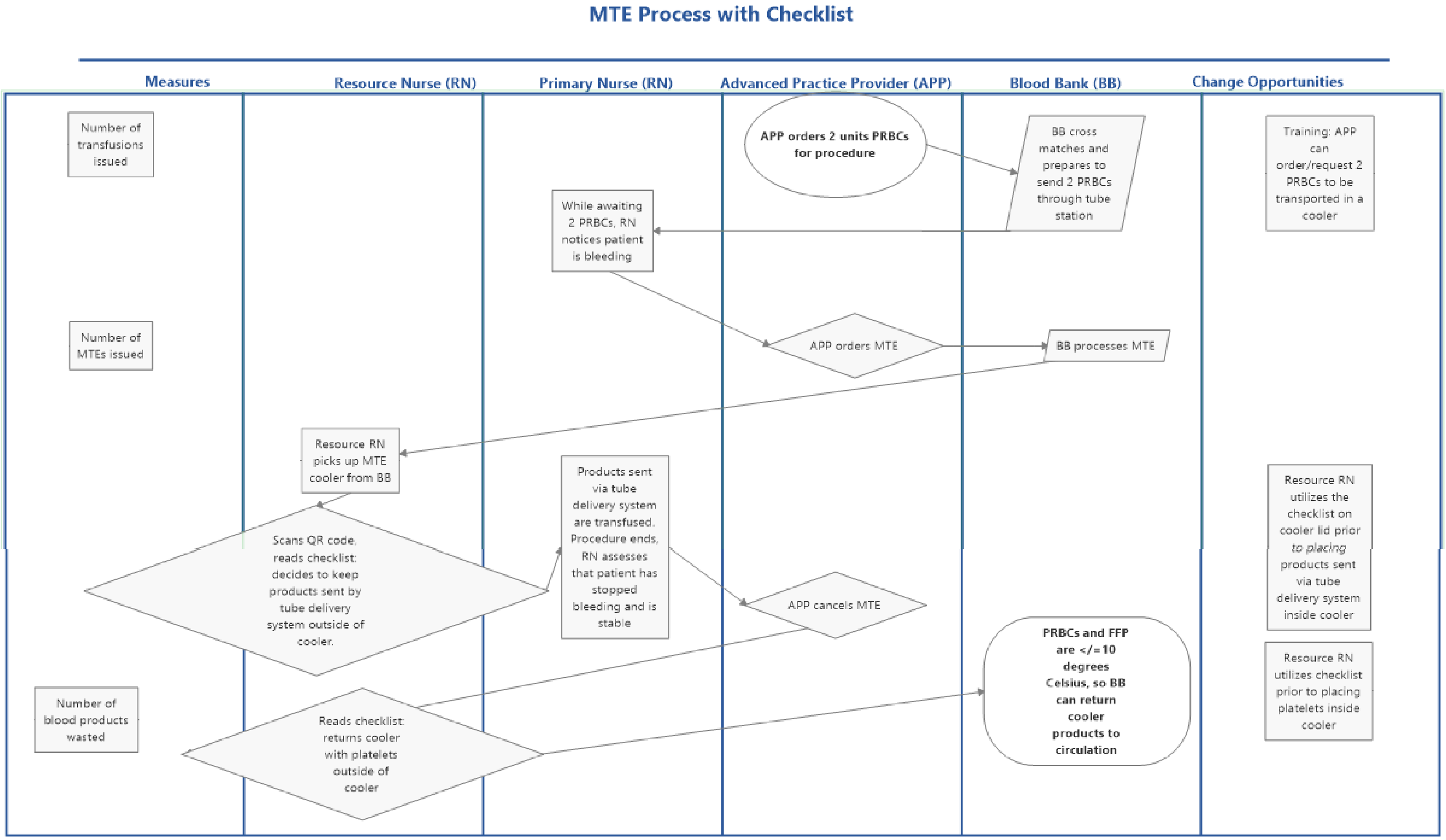
Process Map of Current State



Note. APP = advanced practice providers; BB = blood bank; RN = registered nurse; MTE = massive transfusion event; PRBC = packed red blood cell; FFP = fresh frozen plasma.

Figure 2

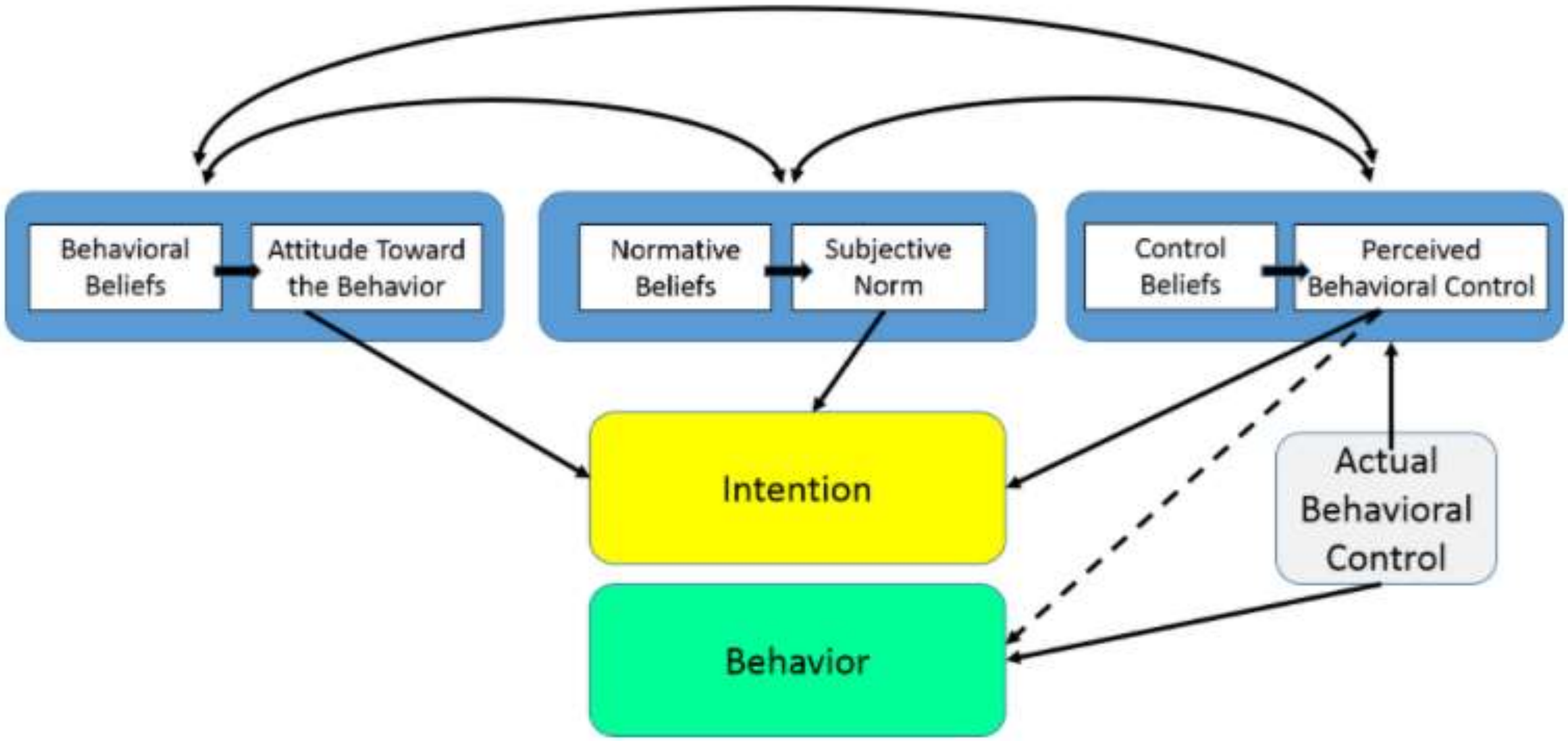
Process Map of Desired State



Note. APP = advanced practice providers; BB = blood bank; RN = registered nurse; MTE = massive transfusion event; PRBC = packed red blood cell; FFP = fresh frozen plasma.

Figure 3

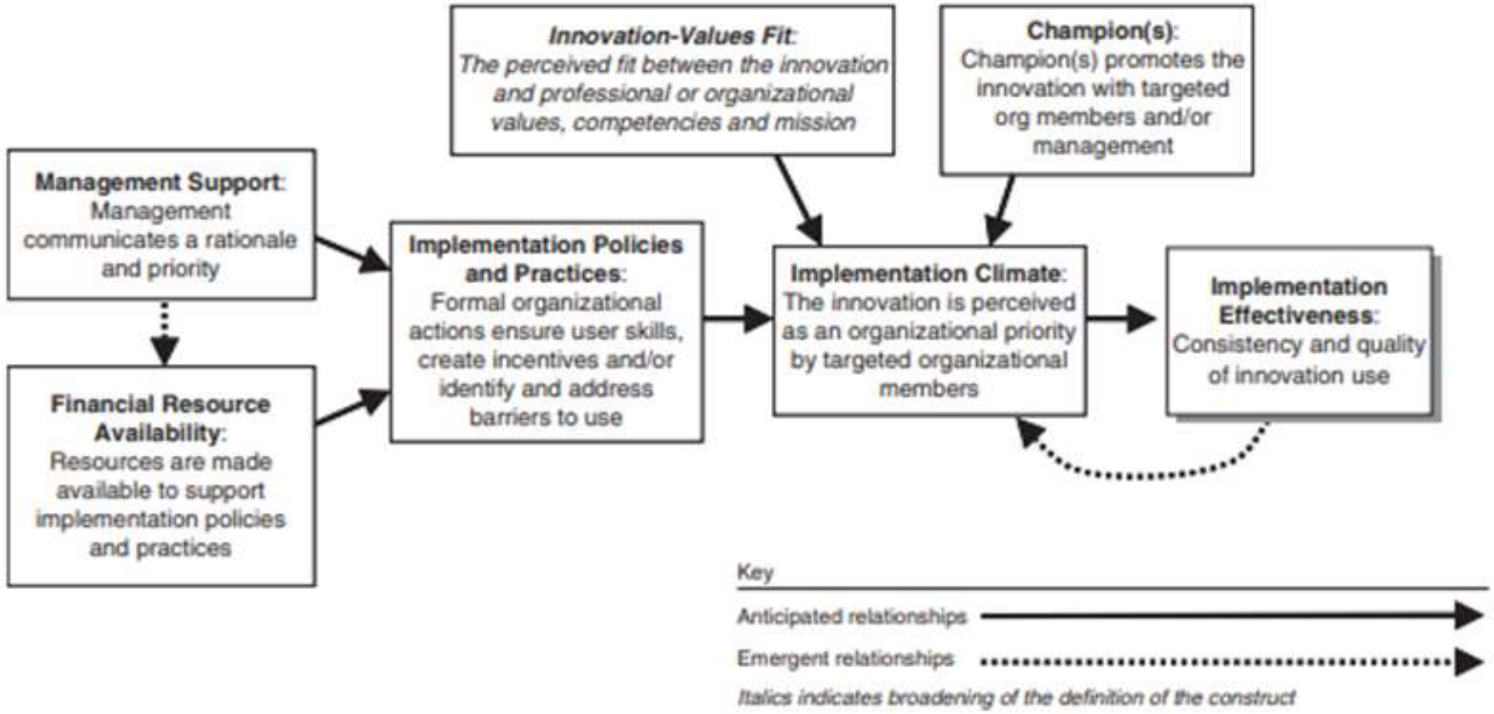
Theory of Planned Behavior



Note. This image displays Theory of planned behavior by Boston University School of Public Health (2019).

Figure 4

Conceptual Framework of Complex Innovation Implementation



Note. This image displays Conceptual Framework of Complex Innovation Implementation described by Helfrich et al. (2007).

Figure 5

Run Chart for RN, APP, and Blood Bank Staff Education

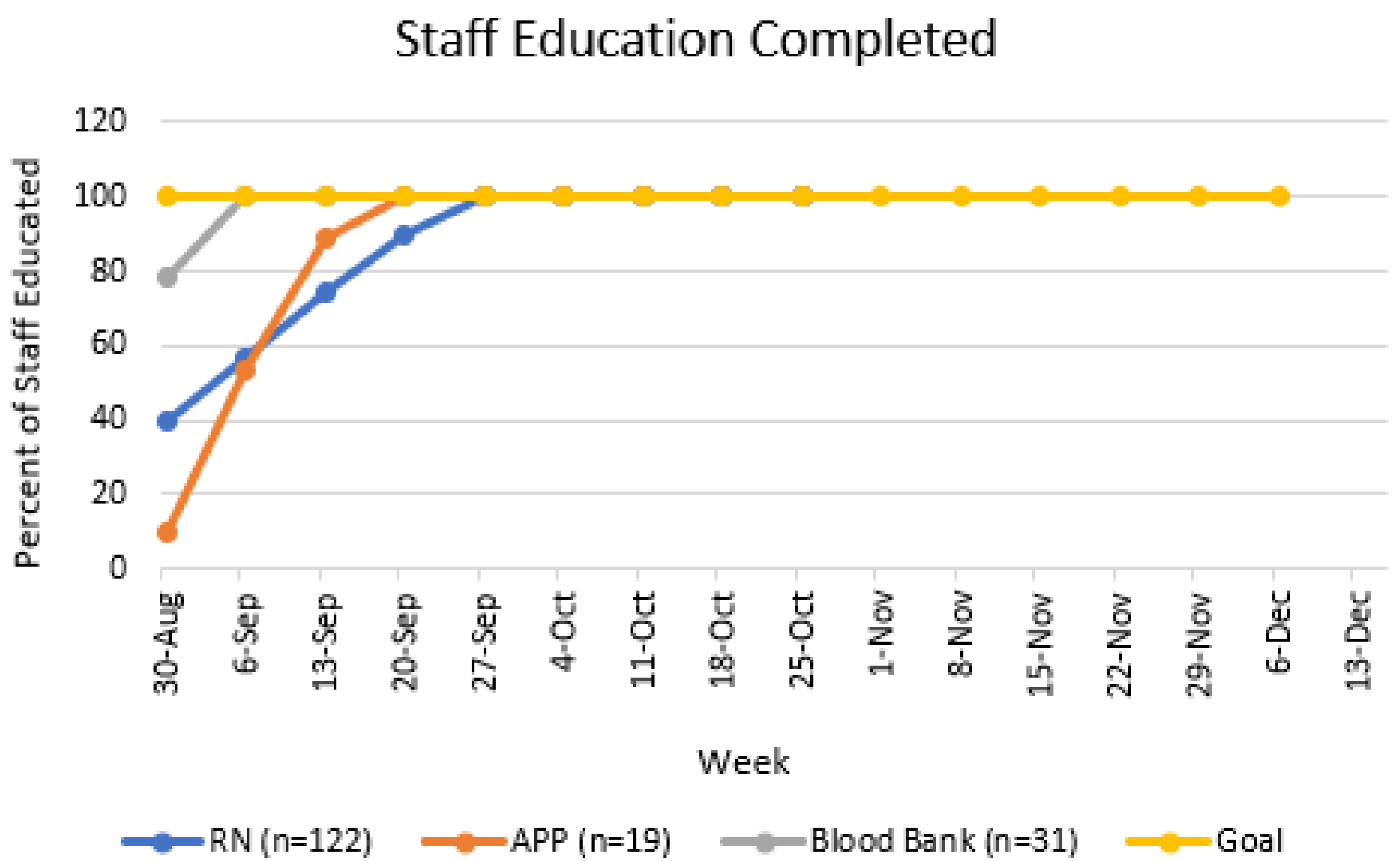


Figure 6

Run Chart for MTE Checklists Completed

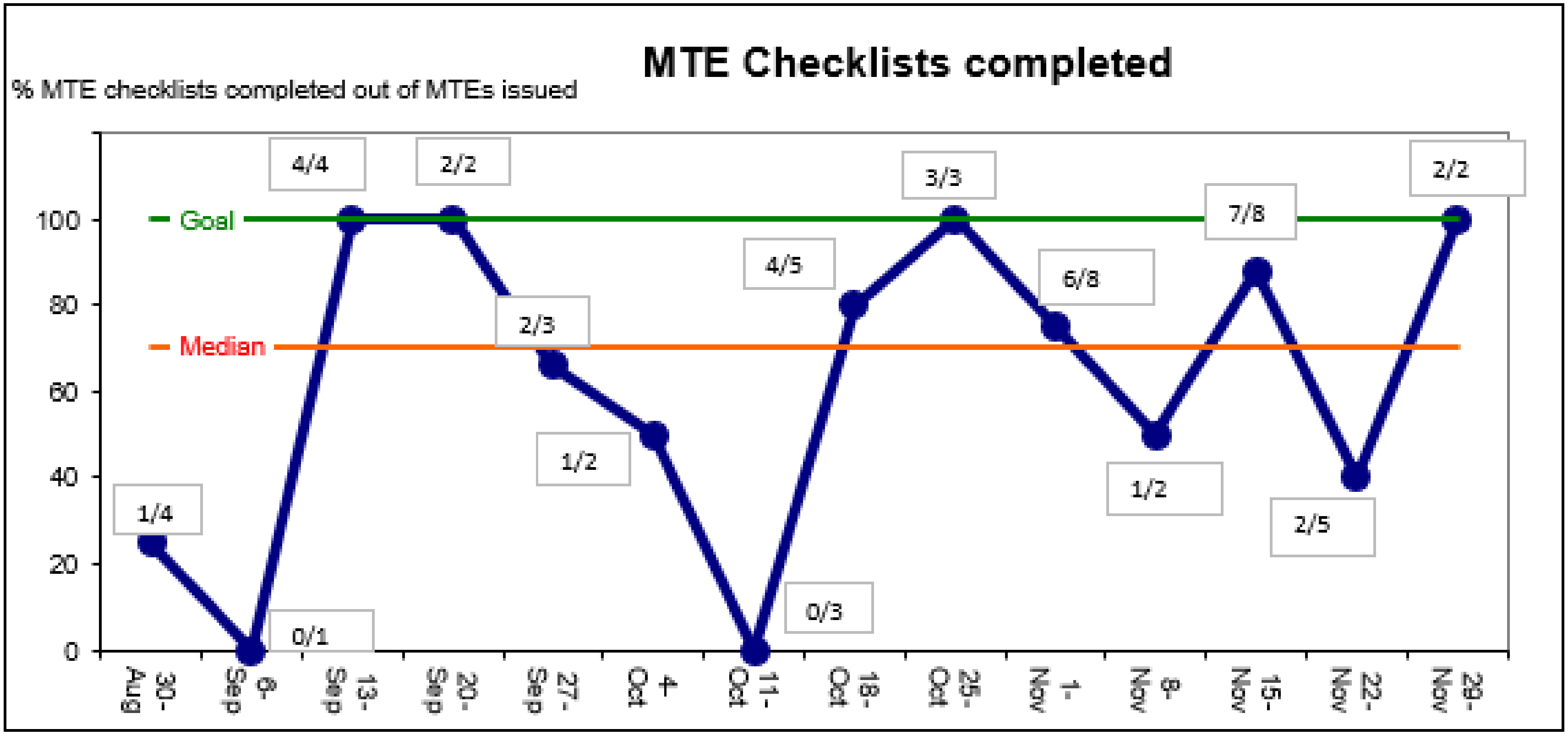
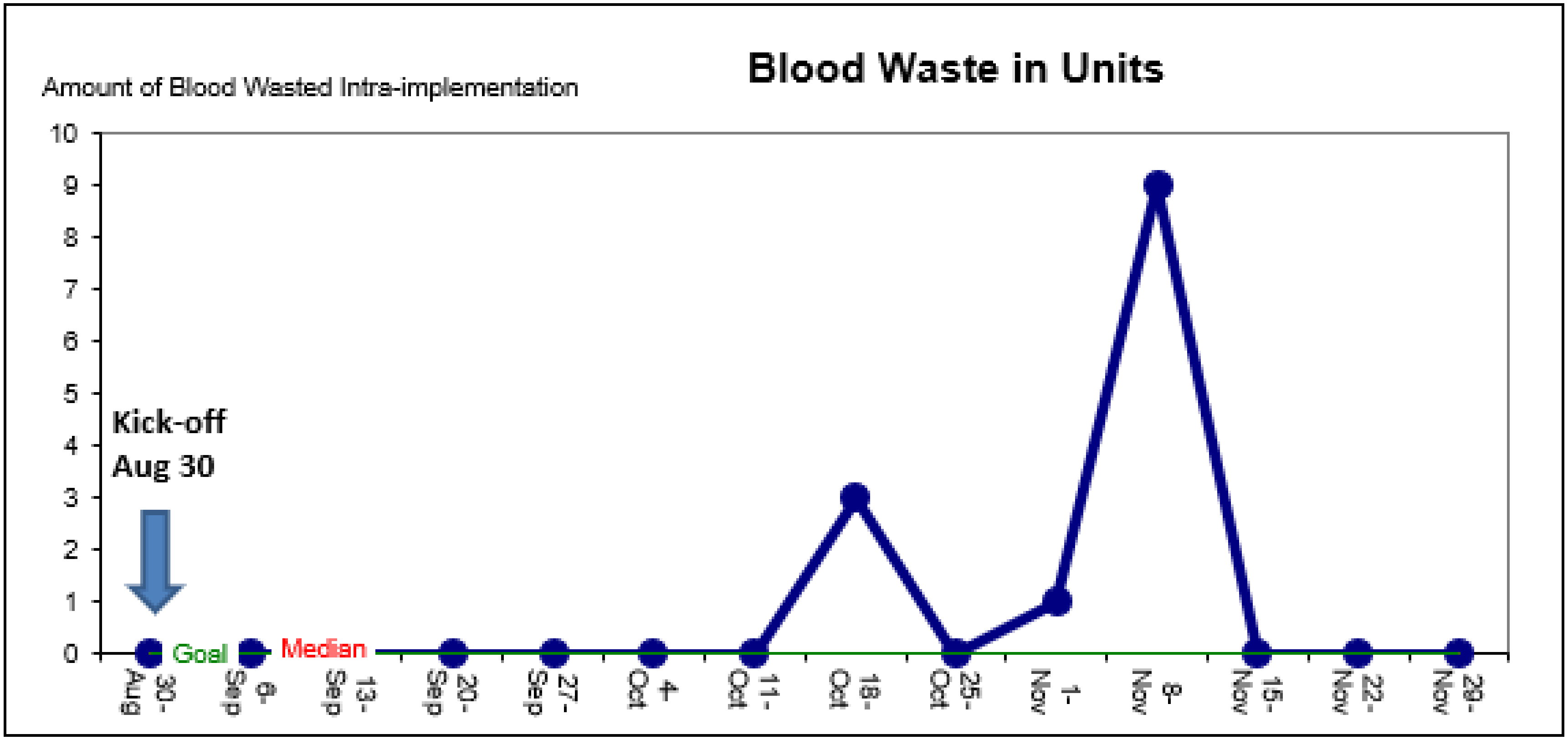


Figure 7

Run chart for Blood Waste During Implementation



Appendix A

Table A1

Evidence Review Table

Citation: Bots, M., Grouw, E. P. L. M., Rooyen, S. I. H. M., Akker, G. J., Sturk, A., Klinkspoor, J. H., & Zeerleder, S. S. (2016). Strategies to reduce wastage of red blood cell units. *Vox Sanguinis*, *110*(2), 143–149. https://doi-org.proxy-hs.researchport.umd.edu/10.1111/vox.12351					**Level III**	
Study objective	**Design**	**Sample, Setting**	**Intervention**	**Outcomes, Method of Measurement**	**Data analyses, Results**	**Limitations and Strengths**
"Aimed at identifying the extent of RBC wastage due to inappropriate handling of dispensed RBCs and evaluating the effects of interventions in reducing this wastage".	Quasi-experimental with pretest and posttest design, comparison/control group, no random assignment.	**Sampling Technique:** Non-probability: Convenience Sampling **N =** 3,685 units of PRBCs issued **Inclusion Criteria:** RBC wastage at a single hospital from Jan 2011 to March 2011 for control, and from November 2011 to March 2013 for post-intervention group. **Exclusion Criteria:** None specified. **Control**: 1,900 RBCs **Intervention**: 6,785 RBCs **Power Analysis report:** None. **Group Homogeneity:** Not addressed. Pre and post hospital staff	**Intervention groups:** RBC conservation intervention (Disallowing transport of RBCs together with patients between hospital units through change in hospital policy, temperature-sensitive color-specific indicators placed on all RBCs, utilization of transport box with pre-cooled elements to transport products, educational sessions focusing on proper handling of blood products) **Control:** No intervention. **Treatment Fidelity:** Temperature-sensitive indicators were placed on RBC units by laboratory staff specifically trained to do so. Laboratory staff	**Dependent Variable:** Number of PRBC units wasted out of the number of PRBC units dispensed **Method of Measurement**: Blood product wastage data were tracked using an automated report produced monthly by the CTS that indicated the number of wasted products, the reason for the wastage, and the hospital at which the wastage occurred	RBC conservation intervention reduced wastage of RBCs due to inappropriate handling outside the blood bank from 7% to 1% of the total units dispensed. Significance was not discussed.	**Limitations** Convenience sampling increases selection bias and decreases external validity. Focused on RBC wastage instead of all blood products, decreasing generalizability. Significance was not discussed, decreasing internal validity. **Strengths** Blood product wastage was reported as a percentage of units issued, decreasing confounding factors and increasing internal validity.

		characteristics not discussed.	utilized transport boxes for all blood dispensed to the OR. Study members delivered education to ICU, ER, and OR, but this was not discussed in further detail.			
Citation: Brown, M. J., Button, L. M., Badjie, K. S., Guyer, J. M., Dhanorker, S. R., Brach, E. J., Johnson, P. M., & Stubbs, J. R. (2014). Implementation of an intraoperative blood transport and storage initiative and its effect on reducing red blood cell and plasma waste. *Transfusion*, *54*(3), 701–707. https://doi-org.proxy-hs.researchport.umd.edu/10.1111/trf.12315					**Level III**	
Study objective	**Design**	**Sample, Setting**	**Intervention**	**Outcomes, Method of measurement**	**Data Analyses, Results**	**Limitations and Strengths**
To identify the “impact of the implementation of a blood transport and storage initiative (BTSI) on a single institution’s blood product waste”.	Quasi-experimental with pretest and posttest design, comparison/control group, no random assignment	**Sampling Technique:** Non-probability: Convenience Sampling **N=** 3,353 units of RBCs and plasma issued **Inclusion Criteria:** One hospital’s intraoperative blood product waste from Jan 1, 2011 to March 31, 2013 for control and from June 1, 2012 to March 31, 2013 for intervention. **Exclusion Criteria:** None specified **Control**: 1,806 units **Intervention**: 1,547 units **Power Analysis report:** **N**one performed.	**Intervention group:** Received BTSI (replacement of the storage cooler with a new one that had a coolant life span of 18 hours, a tightened temperature range from 1-10 degrees Celsius to 1-6 degrees Celsius was enacted, an educational cooler placard was attached to each cooler indicating appropriate packaging of product within cooler, an alert mechanism was incorporated into the electronic anesthesia medical record that alerted the anesthesia provider to return the blood cooler and any unused products back to blood bank at the end of the surgical procedure).	**Dependent Variable:** **Primary-** Monthly median number of RBC and plasma units wasted. **Secondary-** Cost associated with RBC and plasma waste was also measured. **Method of Measurement:** Number of RBC and plasma units issued, transfused, and wasted was tracked using the hospital’s transfusion service database. Associated cost related to blood waste was determined through cost analysis using the hospital’s estimated processing costs for RBCs and plasma.	**Analyses:** Mann-Whitney rank-sum test for differences in unit wastage; Paired t-tests for intrapair mean differences in waste cost **Results:** BTSI resulted in significantly reduced waste of 18 units of RBCs (18 vs. 0, $p < 0.01$) and 3 units of plasma (3 vs. 0, $p = 0.01$) per month. BTSI significantly reduced the mean monthly cost associated with RBC and plasma waste ($10,243 vs $1,134, $p<0.01$).	**Limitations** Convenience sampling increases selection bias and decreases external validity. Blood product wastage was not reported as a percentage of units issued, thereby increasing confounding variables and decreasing internal validity. **Strengths** Included cost as a secondary dependent variable and outcome, highlighting the financial significance of the outcome.

		Group Homogeneity: Not addressed. Pre and post hospital staff characteristics not discussed.	**Control:** Received no intervention. **Treatment Fidelity:** The new coolers were utilized by blood bank technicians when it was requested by provider. The tightened temperature range was enacted as a blood bank policy. Members of the study placed the placard on each cooler.			
Citation: Collins, R. A., Wisniewski, M. K., Waters, J. H., Triulzi, D. J., & Yazer, M. H. (2015). Effectiveness of multiple initiatives to reduce blood component wastage. *American Journal of Clinical Pathology*, *143*(3), 329–335. https://doi-org.proxy-hs.researchport.umd.edu/10.1309/AJCP42WMHSSTPHXI					**Level III**	
Study objective	**Design**	**Sample, Setting**	**Intervention**	**Outcomes, Method of measurement**	**Data Analyses, Results**	**Limitations and Strengths**
"The causes and extent of blood product wastage were identified, and targeted interventions to effect a reduction were implemented".	Quasi-experimental with pretest and posttest design, comparison/control group, no random assignment	**Sampling Technique:** Non-probability: Convenience Sampling **N=** 349,996 blood products issued total **Inclusion Criteria:** Eight hospitals from the same multihospital health care system from Sept 2011 to Dec 2012 for control, same hospitals for post-intervention group, but from Jan 2013 to April 2014 **Exclusion Criteria:** None specified	**Intervention group:** Received the following waste reduction interventions: platelet and cryoprecipitate-specific transport tote bag strapped to blood cooler, small identification tags color coded for storage condition with expiration date and time, and education and clinical nursing guideline was distributed to staff. **Control:** Received no intervention.	**Dependent Variable:** The number of units of blood products (PRBC, platelets, and plasma) wasted as a percentage of units issued, and the reasons why (expired after issued from blood bank, improperly transported/stored, and returned to blood bank >30 minutes after they were issued) **Method of Measurement:** RBC, platelet, plasma, and cryoprecipitate units wasted was	**Analyses:** Chi squared test used. P value <0.05 was statistically significant. **Results:** Wastage as a percentage of units issued (WAPI) was statistically significantly decreased from pre to post intervention for RBC (from 0.67% to 0.56%, p=0.001) and for platelets (from 3.71% to 2.81%, p<0.001). WAPI increased post-	**Limitations** Convenience sampling increases selection bias and decreases external validity. Multi-modal intervention decreases internal validity for each intervention alone. **Strengths** WAPI was used as the outcome, decreasing confounding variables and increasing internal validity

		Control: 189,354 units issued **Intervention:** 160,642 units issued **Power Analysis report:** **N**one performed. **Group Homogeneity:** Not addressed. Pre and post hospital staff characteristics not discussed.	**Treatment Fidelity:** Tote bags and storage identification tags were placed on PRBC coolers by blood bank technicians. Education and guidelines were distributed by Patient Blood Management Committee members.	tracked using an automated daily email report that was produced by the regional centralized transfusion medicine service (CTS)	intervention for plasma (from 1.14% to 1.40%, p<0.001). Significant reductions in wastage due to improper storage conditions occurred in all hospital locations during the postintervention period except for the emergency department, where there was a small but not significant increase in storage waste.	
Citation: Levin, J. H., Collins, L., Adekunle, O., Jackson, H. T., Vaziri, K., Schroeder, M., & Davison, D. (2019). Blood product wastage reduction by utilising low-cost, low-impact multimodal physician-to-physician communication initiatives. *Transfusion Medicine (Oxford, England)*, *29*(6), 389–393. https://doi-org.proxy-hs.researchport.umd.edu/10.1111/tme.12640					**Level VI**	
Study objective	**Design**	**Sample, Setting**	**Intervention**	**Outcomes, Method of measurement**	**Data Analyses, Results**	**Limitations and Strengths**
"To assess a multimodal physician-to-physician communication initiative to daily workflow to reduce blood product wastage".	Prospective quality improvement project (non-experimental) with pretest and posttest design	**Sampling Technique:** Non-probability: Convenience Sampling **N=** total number of units placed on reserve for patients = 840 **Inclusion Criteria:** Issued blood products no longer needed in a 371-bed tertiary care hospital over the first quarter of 2017	**Intervention:** A protocol was implemented in which a member of the study team contacted the provider ordering the blood via phone or HIPAA-compliant digital messaging application to ask if unused blood was still needed or if it could be sent back to the blood bank.	**Dependent Variable**: Number of blood products (PRBCs, plasma, platelets, and cryoprecipitate) wasted per month **Method of Measurement:** Daily user service reports generated by the hospital's blood bank showed the amount of blood products issued and wasted per day.	**Analyses**: T-test and analysis of variance **Results** Blood product wastage per month was significantly decreased in the post-intervention period than the pre-implementation period. Total wastage was 58.3 ±14.9 units on average over the pre-implementation	**Limitations** Convenience sampling increases selection bias and decreases external validity. Blood product wastage was not reported as a percentage of units issued, thereby increasing confounding variables and decreasing internal validity. **Strengths**

		Exclusion Criteria: None specified. **Control:** None. **Intervention:** 840 units **Power Analysis report:** None indicated. **Group Homogeneity:** Not addressed. Pre and post hospital staff characteristics not discussed.	**Control:** No intervention. **Treatment Fidelity**: The decision to contact provider through call or text was made by the member of the study team. This occurred daily throughout the treatment period.	Per-intervention wastage data was obtained from blood bank records from 10 months prior.	10-month period, and wastage was 40.0 ±15.7 units averaged over the 4-month post-intervention study period (P =0.05).	Included all blood products in dependent variable and outcome. (Was not limited to only one type of blood product.)
Citation: Whitney, G. M., Woods, M. C., France, D. J., Austin, T. M., Deegan, R. J., Paroskie, A., Booth, G. S., Young, P. P., Dmochowski, R. R., Sandberg, W. S., & Pilla, M. A. (2015). Reducing intraoperative red blood cell unit wastage in a large academic medical center. *Transfusion*, *55*(11), 2752.					**Level III**	
Study objective	**Design**	**Sample, Setting**	**Intervention**	**Outcomes, Method of measurement**	**Data Analyses, Results**	**Limitations and Strengths**
Hypothesis: "A quality and process improvement approach would result in sustained reductions in intraoperative RBC wastage in a large academic medical center".	Quasi-experimental with pretest and posttest design, comparison/control group, no random assignment	**Sampling Technique:** Non-probability: Convenience Sampling **N=** number of PRBC units issued total = 26,682 **Inclusion Criteria:** One hospital's blood product utilization and wastage from April 2012 to March 2013 as control and April 2013 to March 2014 as intervention. **Exclusion Criteria:** None specified **Control**: 18,600 RBCs	**Intervention group:** Experienced the intervention: A change in protocol so that all RBC orders of more than 1 unit were delivered in a cooler instead of being tubed up by the pneumatic tube system, coolers were re-designed to utilize stationary cold packs at the perimeter instead of shifting ice packs, packaging of RBCs and plasma were stored in separate containers (since plasma is a higher temperature	**Dependent Variable:** The number of units of blood products (PRBC, platelets, and plasma) wasted as a percentage of units issued, and the reasons why (expired after issued from blood bank, improperly transported/stored, and returned to blood bank >30 minutes after they were issued) **Method of Measurement:** RBC wastage events were tracked using the	**Analyses:** Simple logistic regression to determine the effect of RBC utilization on wastage; multiple logistic regression to determine correlations with all variables including total number of RBCs ordered, type of surgery, and intervention. **Results:** In the preintervention cohort, 749 units of RBCs were wasted out of 18,600 units issued	**Limitations** Convenience sampling increases selection bias and decreases external validity. **Strengths** WAPI was used as the outcome, decreasing confounding variables and increasing internal validity.

		Intervention: 8,082 RBCs **Power Analysis report: N**one performed. **Group Homogeneity:** Not addressed. Pre and post hospital staff characteristics not discussed.	than RBCs), nursing and anesthesia received education regarding the factors found to contribute to RBC wastage and its associated cost **Control:** Received no intervention. **Treatment Fidelity:** Who delivered the coolers was not mentioned (blood bank technologist or tech on unit), all new coolers and the separation of RBC from plasma protocol were utilized by blood bank techs (process measures not discussed).	institution's internal computer information system	(4.0%) while in the post intervention cohort, 162 units of RBCs were wasted out of 8,082 units issued (2.0%). This difference yielded a p value < 0.0001 on univariate analysis and a relative risk reduction of 50.4%.	

Note. Level of evidence determined using the Hierarchy of Evidence by Melnyk and Fineout-Overholt (2019).

Appendix A

Table A2

Evidence Synthesis Table

PICO: For staff in the CSICU, does the implementation of a blood product cooler storage checklist with staff education, as compared to baseline, decrease the number of blood products wasted?			
Level of Evidence	**# of Studies**	**Summary of Findings**	**Overall Quality**
III	**4**	Collins, et al. (2015) used a quasi-experimental pretest-posttest design and implemented a tote bag for platelets, storage identification tags, and education. They found that WAPI was significantly decreased from pre to post intervention for RBC and platelets, but not for plasma. Whitney, et al. (2015) used a quasi-experimental pretest-posttest design and implemented a change in protocol so all orders for more than 1 RBC unit at once would be delivered in a cooler instead of via the pneumatic tube system, coolers were re-designed with stationary cool packs, and education. They found a significant reduction in RBC waste post implementation from pre-implementation.	B. for both Collins, et al. (2015) and Whitney, et al. (2015). Both studies' outcomes were expressed as a percentage of units issued, accounting for confounding variables and increasing internal validity. Both studies' measures and results were consistent. Recommendations were consistent with included references to scientific evidence. Pre-post design did not allow for random assignment, decreasing internal validity. Convenience sampling increased risk for selection bias and was a threat to external validity. Because of this, these interventions may not have the same beneficial effect on populations from different hospitals and geographic locations. No power analysis to determine adequate sample size threatened internal validity by increasing risk of random error and Type I error. However, Collins, et al. used the largest sample size (349,996 blood products issued) and conducted the study over eight different hospitals, decreasing risk of random error and increasing generalizability of results, thereby increasing internal and external validity, respectively. Whitney, et al. (2015) used multiple logistic regression and upper and lower confidence limits to account for confounding variables, both of which increase internal validity. These studies' strengths increase the likelihood that both studies' interventions, including storage identification dissemination on blood products, enforcement of coolers for multiple products, and education, will produce favorable outcomes in reducing blood waste.

		Bots, et al. (2016) used a quasi-experimental pretest-posttest design and implemented RBC conservation intervention that disallowed transport of RBCs together with patients between hospital units, educational sessions, placed color-specific indicators on RBCs indicating temperature approved for use, transport boxes for blood going to the OR, and education. They found RBC wastage was reduced from 7% pre-intervention to 1% post intervention. Brown, et al. (2014) used a quasi-experimental pretest-posttest design and implemented an initiative that replaced the storage cooler for blood with a new one with a longer coolant life span along with an educational placard that indicated appropriate packaging of each product, as well as an alert mechanism for anesthesia to return the cooler when the procedure was complete. They found a significant reduction in post intervention mean RBC and plasma waste as compared to pre intervention.	C. for both Bots, et al. (2016) and Brown, et al. (2014). In both studies, pre-intervention data were collected for a different duration of time than post-intervention data, causing inconsistent measurement, decreasing internal validity. Pre-post design did not allow for random assignment, decreasing internal validity in both. Convenience sampling and lack of power analysis threatened internal validity in both. Recommendations were consistent with included references to scientific evidence in both. A strength of Bots, et al. was that authors expressed outcomes as a percentage of units issued (increased internal validity); however, significance was not discussed (increasing risk for Type I error). In contrast, Brown, et al. (2014) did not calculate outcomes based on overall units issued (decreasing the internal validity) and did discuss significance. This limits the applicability of the intervention's performance to an institution that issues a larger amount of blood products. Because of these studies' weaknesses, it is less likely that a combination of their interventions including change in policy, addition of color indicator on blood product bags, new coolers, and electronic alert mechanisms for anesthesia would be able to be replicated and provide the same results in a different clinical setting.
VI	**1**	Levin, et al. (2019) was a non-experimental, prospective study in which authors implemented a protocol in which the blood bank provider contacted the provider who ordered the blood to ask if it was still needed or if it could be returned to the blood bank, as well as education. They found that the monthly blood product wastage decreased significantly from before to after the intervention.	C. Did not calculate outcomes based on overall units issued, decreasing the internal validity. Pre-intervention data was collected for a longer period than post-intervention data, causing inconsistent measurement, decreasing internal validity. Pre-post design did not allow for random assignment, decreasing internal validity. Convenience sampling threatened internal validity. No power analysis decreases internal validity. These weaknesses decrease the reader's confidence that the study's interventions could decrease

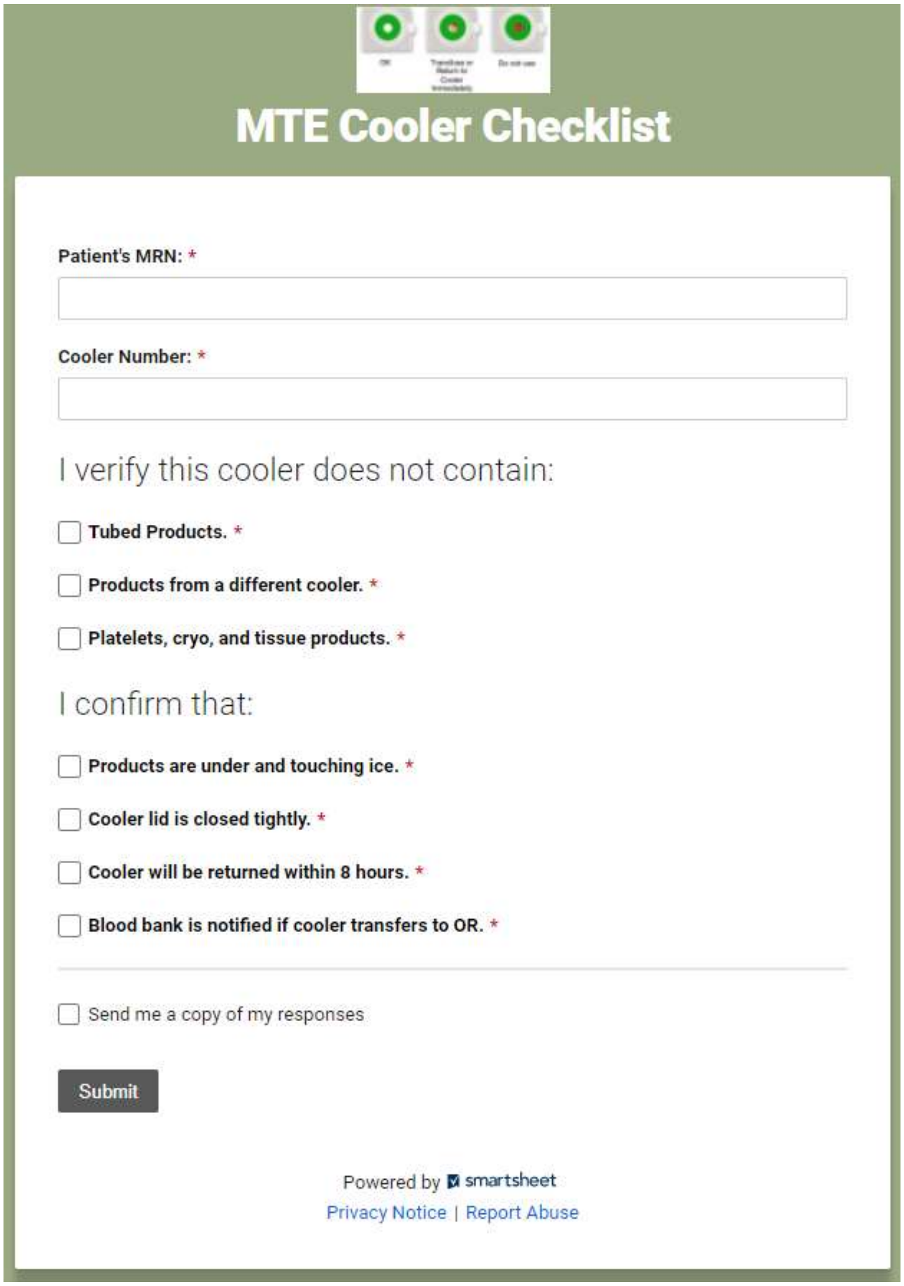
			blood waste in a different hospital. However, recommendations were consistent with included references to scientific evidence. Weaknesses indicate that this study's intervention of change in blood bank provider to medical unit provider communication protocol is not likely to be consistently replicated and produce the same improved results in a different clinical setting.

Note. Level of evidence determined using the Hierarchy of Evidence by Melnyk and Fineout-Overholt (2019). Quality rating determined using the Rating Scale for Strength and Quality of Evidence by Newhouse (2006).

Appendix B

Figure B1

MTE Cooler Checklist on Smartsheet, the project site institution's HIPAA-compliant file-sharing system



MTE Cooler Checklist

Patient's MRN: *

Cooler Number: *

I verify this cooler does not contain:

- [ ] Tubed Products. *
- [ ] Products from a different cooler. *
- [ ] Platelets, cryo, and tissue products. *

I confirm that:

- [ ] Products are under and touching ice. *
- [ ] Cooler lid is closed tightly. *
- [ ] Cooler will be returned within 8 hours. *
- [ ] Blood bank is notified if cooler transfers to OR. *

- [ ] Send me a copy of my responses

Submit

Powered by smartsheet
Privacy Notice | Report Abuse

Note. MTE = Massive Transfusion Event.

Appendix B

Figure B2

MTE Cooler Checklist Completion Tool, Capturing All User Responses in Smartsheet, audited and only seen by Project Lead

Patient's MRN:	Cooler Number:	I verify that this cooler does not contain:	Platelets, cryo, and tissue products.	Tubed Produc...	Products from a different cooler.	I confirm that:	Products are under and touching ice.	Cooler lid is closed tightly.	Cooler will be returned within 8 hours.	Blood bank is notified if cooler transfers to OR.	Color indicators on PRBCs:	Created
123	1234		☑	☑	☑		☑	☑	☑	☑		06/17/21 10:47 AM
456	123		☑	☑	☑		☑	☑	☑	☑		06/17/21 10:37 AM
789	123456		☑	☑	☑		☑	☑	☑	☑		06/16/21 12:58 PM
124	12345		☑	☑	☑		☑	☑	☑	☑		06/16/21 12:22 PM

Note. MTE = Massive Transfusion Event.

Appendix B

Figure B3

Educational Quiz Completion Collection Tool for CSICU RNs, Capturing All User Responses in Smartsheet, audited and only seen by project lead

Name	Tube back PRBCs → wasted T/F	Form Date Field	Combining in coolers T/
1234	True		False
4567	True		True

Note. RN = Registered Nurse, CSICU = Cardiac Surgery Intensive Care Unit.

Appendix C

Table C1

Audit Form: Total number of MTEs transfused on the CSICU (data retrieved from report generated in Epic Portfolio)

MTE number	RN code who acknowledged order (N###)	Patient code (P###)	Checklist done that aligns with time/date, RN code, and patient code (Yes or No)	Blood waste involved (Yes or No)
M001				
M002				
M003				
M004				
M005				
M006				
M007				
M008				
M009				
M010				
M011				
M012				
M013				
M014				
M015				
M016				
M017				
M018				
M019				
M020				
M021				
M022				
M023				
M024				
M025				
M026				
M027				
M028				
M029				
M030				

Note. CSICU = Cardiac Surgery Intensive Care Unit, RN = Registered Nurse, MTE = Massive Transfusion Event.

Appendix C

Table C2

Audit Form: Total number of individual blood products transfused on the CSICU (data retrieved from report generated in Epic Portfolio)

Individual transfusion number	Procedure order (type of blood product)	RN code who acknowledged order (N###)	APP code who ordered transfusion (A###)	Patient code (P###)	Blood wasted (yes or no)
T001					
T002					
T003					
T004					
T005					
T006					
T007					
T008					
T009					
T010					
T011					
T012					
T013					
T014					
T015					
T016					
T017					
T018					
T019					
T020					

*Note***.** CSICU = Cardiac Surgery Intensive Care Unit**,** APP = Advanced Practice Provider, RN = Registered Nurse.

Appendix C

Table C3

Data Management Spreadsheet for assessing adherence and impact of checklist and education on MTE Blood Waste on the CISCU

MTE number	Checklist used? Yes = 1 No = 0 Missing data =99	# Checklists used (continuous)	Blood products wasted? Yes = 1 No = 0 Missing data =99	Number of blood products wasted (continuous)	RN code who acknowledged order for MTE	RN educated? Yes = 1 No = 0 Missing data =99	RN completed quiz? Yes = 1 No = 0 Missing data =99	Provider code who ordered the MTE	Provider educated? Yes = 1 No = 0 Missing data =99
M001									
M002									
M003									
M004									
M005									
M006									
M007									
M008									
M009									
M010									
M011									
M012									
M013									
M014									
M015									
M016									
M017									
M018									
M019									
M020									

Note. MTE = Massive Transfusion Event, RN = Registered Nurse, CSICU = Cardiac Surgery Intensive Care Unit

Appendix C

Table C4

Data Management Spreadsheet for assessing adherence and impact of checklist and education on individual blood product Waste on the CISCU

Individual transfusion number	Type of blood product PRBC =1 FFP = 2 Platelets = 3 Cryo = 4	Blood wasted? Yes = 1 No = 0 Missing data =99	RN code who acknowledged order for transfusion	RN educated? Yes = 1 No = 0 Missing data =99	Provider code who ordered the transfusion	Provider educated? Yes = 1 No = 0 Missing data =99
T001						
T002						
T003						
T004						
T005						
T006						
T007						
T008						
T009						
T010						
T011						
T012						
T013						
T014						
T015						
T016						
T017						
T018						
T019						
T020						

Note. PRBC = packed red blood cells, FFP = fresh frozen plasma, cryo = cryoprecipitate

Appendix C

Table C5

Code key for Patient MRN (to be locked up in Clinical Nurse Educator office and destroyed after Project Completion)

Patient code	Patient MRN
P001	
P002	
P003	
P004	
P005	
P006	
P007	
P008	
P009	
P010	
P011	
P012	
P013	
P014	
P015	
P016	
P017	
P018	
P019	
P020	
P021	
P022	
P023	
P024	
P025	
P026	
P027	
P028	
P029	
P030	
P031	
P032	
P033	

Note. MRN= Medical Record Number

Form 5/5

Appendix C

Table C6

Code Key/Audit Form for CSICU RN Sign-off for In-person Training Collection Tool (to be locked up in Clinical Nurse Educator office and destroyed after Project Completion)

Nurse code (this is added to sheet after the session, stapled to the attachment piece)	**Cut Line**	Date of blood waste and cooler QR code education	Printed name of RN	**Signature of RN**
N001				
N002				
N003				
N004				
N005				
N006				
N007				
N008				
N009				
N010				
N011				
N012				
N013				
N014				
N015				
N016				
N017				
N018				
N019				
N020				
N021				
N022				
N023				
N024				
N025				

Note. QR code = Quick Response Code, CSICU = Cardiac Surgery Intensive Care Unit

Appendix C

Table C7

Code Key/Audit Form for In-person Training Completion Collection Tool for CSICU APPs (to be locked up in Clinical Nurse Educator office and destroyed after Project Completion)

APP code (this is added to sheet after the session, stapled to the attachment piece)	**Cut Line**	Date of education for blood conservation techniques	Printed name of APP	**Signature of APP**
A001				
A002				
A003				
A004				
A005				
A006				
A007				
A008				
A009				
A010				
A011				
A012				
A013				
A014				
A015				
A016				
A017				
A018				
A019				
A020				

*Note***.** CSICU = Cardiac Surgery Intensive Care Unit**,** APP = Advanced Practice Provider.

Appendix C

Table C8

Data Management Spreadsheet for In-person Training Blood Bank Staff Education Collection Tool

Date of education for QR code placement on coolers	Blood Bank Employee code
	B001
	B002
	B003
	B004
	B005
	B006
	B007
	B008
	B009
	B010
	B011
	B012
	B013
	B014
	B015
	B016
	B017
	B018
	B019
	B020
	B021
	B022
	B023
	B024
	B025
	B026
	B027
	B028
	B029
	B030

Note. QR code = Quick Response Code.

Appendix C

Table C9

Code Key/Audit form for In-person Training Blood Bank Staff Education Collection Tool (to be locked up in Clinical Nurse Educator office and destroyed after Project Completion)

Blood Bank Employee code (this is added to sheet after the session, stapled to the attachment piece)	**Cut Line**	Date of education for QR code placement on coolers	Printed name of Blood Bank Employee	**Signature of Blood Bank Employee**
B001				
B002				
B003				
B004				
B005				
B006				
B007				
B008				
B009				
B010				
B011				
B012				
B013				
B014				
B015				
B016				
B017				
B018				
B019				
B020				
B021				
B022				

Form 2/2

B023				
B024				
B025				
B026				
B027				
B028				
B029				
B030				

Note. QR code = Quick Response Code.

Appendix C

Table C10

Audit Form: Tool for Tracking QR code checklists Placed on Top of Coolers destined to CSICU, performed by Blood Bank Champions, collected daily

Week: ___________

Date	**Mon**	**Tues**	**Wed**	**Thurs**	**Fri**	**Sat**	**Sun**	**Total**
# of coolers sent to CSICU with QR code								
# of coolers sent to CSICU								
Coolers with QR code/Total CSICU coolers								

Week: ___________

Date	**Mon**	**Tues**	**Wed**	**Thurs**	**Fri**	**Sat**	**Sun**	**Total**
# of coolers sent to CSICU with QR code								
# of coolers sent to CSICU								
Coolers with QR code/Total CSICU coolers								

Week: ___________

Date	**Mon**	**Tues**	**Wed**	**Thurs**	**Fri**	**Sat**	**Sun**	**Total**
# of coolers sent to CSICU with QR code								
# of coolers sent to CSICU								
Coolers with QR code/Total CSICU coolers								

Note. QR code = Quick Response code. CSICU = Cardiac Surgery Intensive Care Unit.