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Wrong-Patient Blood Transfusion Error: Leveraging Technology to Overcome Human Error in Intraoperative Blood Component Administration

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Background: Confirmation of match between patient and blood product remains a manual process in most operating rooms (ORs), and documentation of dual-signature verification remains paper based in most medical institutions. A sentinel event at Johns Hopkins Hospital in which a seriously ill patient undergoing an emergent surgical procedure was transfused with a unit of incompatible red blood cells that had been intended for another patient in an adjacent OR led the hospital to conduct a quality improvement project to improve the safety of intraoperative blood component transfusions.

Methods: A multidisciplinary quality improvement project team led a four-phase implementation of bedside bar code transfusion verification (BBTV) for intraoperative blood product administration. Manual random sample audits of blood component transfusions were used to examine accuracy of documentation from July 2014 through June 2016. After the transition to the Epic anesthesia information management system (AIMS) in July 2016, automated Epic reports were generated to provide population-level audits.

Results: After initiation of BBTV and the addition of Epic AIMS, compliance with obtaining three metrics on documentation of patient identification (two electronic signatures, start and stop times of transfusion, and blood volume transfused) was improved during a one-year period to > 96%. Pre-Epic audits had shown a mean compliance of only 86%, mainly reflecting a lack of paper blood component requisitions.

Conclusion: By implementing BBTV and using a novel intraoperative documentation process within the Epic AIMS, a safer process of blood transfusion in the ORs was initiated and documentation improved.

Approximately 21 million blood components are transfused in the United States each year.[1] The US Food and Drug Administration (FDA) is responsible for regulating how blood donations are collected and how blood components are transfused.[2,3] Today, the blood supply is considered to be relatively safe, owing to recent advances in screening techniques for infectious agents in donated blood.[4] However, other risks of transfusions, such as transfusion-related acute lung injury, transfusion-associated circulatory overload, acute and delayed hemolytic reactions, and non-hemolytic immune reactions, remain.[5] According to the FDA, the number of hemolytic transfusion reactions has remained low in recent years.[2] With regard to ABO-incompatible hemolytic transfusion reactions, the error is most frequently caused by preventable misidentification of patient samples and patient identification at time of transfusion.[6–9]

Wrong-patient errors occur in virtually all stages of diagnosis and treatment.[10] Errors involving the final verification of the identity of the patient and the product at the bedside immediately before administration have been shown to be the greatest source of incorrect blood component transfusion.[11] Historically, signatures of two credentialed providers have been required to document performance of a visual and verbal pretransfusion identification (ID) check. Even since the introduction of electronic intraoperative anesthesia data records in the 1980s, confirmation of match between patient and blood product remains a manual process in most operating rooms (ORs) across the United States.[10] In addition, documentation of dual-signature verification remains on paper in most medical institutions.

A number of investigations have reported that manual visual and verbal pretransfusion check of patient ID and blood product match is vulnerable to human error.[7,12,13] Accordingly, bedside bar code technology has been beneficial for reducing errors during blood administration and enhancing overall safety of the process.[8] In 2013 Nuttall and colleagues reported that instituting bar code scanning of blood components reduced transfusion errors from 1.5 per 100,000 transfusions to 0.3 per 100,000 transfusions and increased the number of near-miss events.[9] Their explanation for the increase in near-miss events was related to an automated computer-generated alert if incompatibility was detected between the patient's armband bar code and the blood product bar code. Previously, these near-miss events were self-reported, and likely underreported.[9]

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Murphy and colleagues in the United Kingdom reported that it was easier to comply with national regulations for traceability of blood units and assessment of quantity and quality of blood product transfusions when they transitioned to bedside bar coding of blood components.[14] The University of Iowa Hospitals and Clinics, which deployed a bar code–based patient and blood product ID system in 2005, reported reductions in clerical error–caused sample rejection rates from 1.82% to 0.17%. Furthermore, they estimated that the electronic system was 10 times safer than the previous manual system because patient-blood product misidentification errors were detected earlier.[15]

In September 2013 at Johns Hopkins Hospital (JHH), a seriously ill patient underwent an emergent surgical procedure and was transfused with a unit of incompatible red blood cells (RBCs) that had been intended for another patient in an adjacent OR. The blood was retrieved from an automated refrigerator that stores, delivers, and assigns the correct blood product to patients and is designed to eliminate human error. The patient had a history of congestive heart failure and severe peripheral vascular disease, had presented to a non-JHH–affiliated hospital with evidence of lower extremity ischemia, where he went into cardiac arrest. During the emergent surgery at JHH, because of large blood volume loss and hemodynamic instability, transfusion of RBCs was indicated. Intraoperatively, the patient suffered another cardiac arrest, and even though return of spontaneous circulation was obtained, the patient later died of multi-organ failure. On the basis of staff interviews, policies and procedures, and other pertinent documentation, it was determined that the hospital had an opportunity to improve safety practices related to administration of blood and blood components in the OR. In this article, we describe a quality improvement (QI) initiative conducted to improve the safety of intraoperative blood component transfusions.

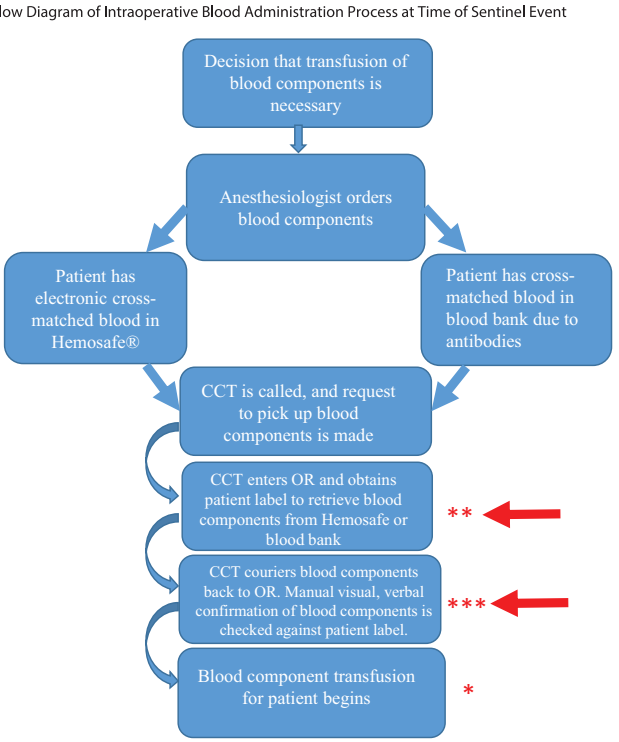

Figure 1: The quality improvement project team examined the current process of intraoperative blood product administration in the operating rooms (ORs) and procedural areas. Transfusion was indicated in the sentinel event because of the large-volume blood loss in an emergency vascular case and hemodynamic instability. The red arrows signify where the safety measure broke down in the sentinel event. Each asterisk (*) represents a degree of patient safety risk involved. Hemosafe® (Haemonetics Corporation, Braintree, Massachusetts) is a blood bank refrigerator used to assign and distribute packed red blood cells. If critical care technologists (CCTs) have more than one procedural area for which they are obtaining blood products, then they write the OR location on the patient label.

METHODS

Setting and Ethics

The Johns Hopkins Hospital (JHH; Baltimore) is a 1,000-bed academic medical center that performs 64,100 operations and procedural interventions each year. Approximately 23,500 units of blood are transfused in the perioperative environment. In July 2016 JHH made the transition to using the Epic (Epic Systems Corporation, Verona, Wisconsin) electronic health record (EHR). The hospital's Institutional Review Board waived a requirement for approval because of the QI initiative's status as quality assurance/quality improvement.

Launching the Initiative

To better understand the sequence of events that led to the wrong-patient blood transfusion sentinel event described, in September 2014 a 17-member QI project team was formed. It consisted of representatives from the Armstrong Institute for Patient Safety and Quality[16] [P.J.P.], the Department of Anesthesiology and Critical Care Medicine [N.B.H., C.G.K., K.S., A.S., T.L.S.], Information Technology (IT), and Transfusion Medicine [J.B]. The Board of Trustees, the Armstrong Institute, and the Clinical Quality Improvement Committee all provided long-term support of this QI health care improvement initiative.

We (the QI project team) examined the current process of blood product administration in the ORs and procedural areas (Figure 1). There was an opportunity for improvement in how anesthesia providers (anesthesiologists, nurse anesthetists, and trainees) check to ensure that blood components coming into the ORs are for the correct patient, particularly when the patient's ID bracelet is frequently inaccessible (Figure 1). The Armstrong Institute, along with hospital and health system risk

Sidebar 1. Initial Steps (14–16 Weeks) for Improving Perioperative Blood Administration After Sentinel Event, September 2013–December 2013

1. Senior Johns Hopkins Hospital leadership and Board of Trustees notified of sentinel event
2. Communication plan—staff meetings, e-mails, and website to communicate urgency of situation
3. Policy on perioperative blood administration revised
4. Staff education through mandatory online module
5. Quality assessment/performance improvement data collection and analysis

Sidebar 2. Four-Phase Conceptual Model to Initiate Bedside Bar Code Transfusion Verification (BBTV) and Intraoperative Dual Electronic Signatures in Epic

Phase 1 **October 2013–November 2013**	Communicate Goals and Measures Across All Levels of the Organization • JHH Board of Trustees • JHH Clinical Quality Improvement Committee • JHH Department of Anesthesiology and Critical Care Medicine and Department of Pathology, Transfusion Medicine Division
Phase 2 **October2014–July 2015**	Creating the Quality Management Infrastructure and Clinical Communities • Multidisciplinary QI project team: CMIO, programmers, anesthesiologists, blood bank leaders, and QI specialists • Weekly meetings for 10 months
Phase 3 **March 2015–June 2016**	Transparently Reporting and Ensuring Accountability for Performance • Bedside bar code transfusion verification (BBTV) is launched at JHH • Fault tree analysis for BBTV prior to launch • Four-component education strategy • Increased safety, efficiency, and satisfaction among anesthesia providers
Phase 4 **July 2016–October 2017**	Developing a Sustainability Process • JHH transitions to Epic EHR • BBTV used in Epic, but electronic signatures are not available in intraoperative module • Pilot of novel dual electronic signatures is successful and expanded May 2017 • Transparent reporting at each level of JHH to ensure accountability and sustainability of the novel process

JHH, Johns Hopkins Hospital; QI, quality improvement; CMIO, chief medical information officer; EHR, electronic health record.

management, conducted a root cause analysis of the event and recommended a series of short- and long-term steps to improve the safety of blood product administration in the OR (Sidebar 1). Because of the seriousness of the potential risk to patients, the steps that required immediate action were fully implemented within eight weeks (communication to JHH leadership and board of trustees, e-mails to staff, and revision of blood administration policy). Because the anesthesia information management system (AIMS) used at that time was not programmed for bedside bar code verification technology, implementation of this tool became one of our long-term goals. On the basis of evidence in the literature, we projected that implementation of a bedside bar code transfusion verification (BBTV) system would enhance the safety of perioperative blood product administration in our institution.

Implementation

We implemented the QI process in four phases, as summarized in Sidebar 2.

Phase 1: Communicate Goals and Measures Across All Levels of the Organization (October 2013–November 2013). In Phase 1, we communicated our goals to the JHH Board of Trustees, Clinical Quality Improvement Committee, and Centers for Medicare & Medicaid Services (CMS). JHH then notified CMS, along with The Joint Commission, after the sentinel event occurred. JHH also communicated our goals and metrics to CMS in the plan of action after it was issued a citation. Prior to the sentinel event, the circulating OR nurse would greet each patient outside of the OR and, immediately before entrance, use two identifiers from the patient ID bracelet to confirm correct patient identity. Soon after the event, it was recognized that the anesthesia team (anesthesiologist, nurse anesthetist, resident, or fellow) also needed to participate in the patient ID process to ensure that the correct patient chart was accessed in the AIMS. The policy on intraoperative blood component transfusion was revised during this time to indicate that blood units would be checked against the patient chart in the AIMS because it is difficult to access the patient's ID bracelet during surgery.

Phase 2: Creating the Quality Management Infrastructure and Clinical Communities (October 2014–July 2015). In Phase 2, we created the quality management infrastructure by convening the QI project team, as previously described. The team met weekly dur-

ing a 10-month period to initiate intraoperative BBTV of blood components. IT experts within JHH partnered with the external AIMS vendor (MetaVision [iMDsoft Ltd., Wakefield, Massachusetts]) to create a 2D bar code system that could confirm and document a match between the patient ID bracelet and correct blood component before transfusion. The medical director of the Transfusion Medicine Division, The Johns Hopkins Medical Institutions (Baltimore)—as well as the division's manager, quality assurance specialist, and safety officer—ensured that all processes and identifiers conformed to AABB (formerly the American Association of Blood Banks) standards and regulations. In addition, Transfusion Medicine Division staff created test bar codes to determine if a patient and blood product mismatch would be reliably captured during simulation of patient care. Equipment engineers assisted with the purchase of bar code scanners for each OR and helped to establish the optimal mounting location in the anesthesia work area to enhance user convenience and minimize intrusiveness.

We used bar code technology to confirm a match between identifiers present on the patient ID bracelet and the AIMS chart visible on the anesthesia workstation computer. This step allowed transfer of the "source of truth" of patient identifiers from the patient ID bracelet to the AIMS. As mentioned previously, the initial electronic confirmation of patient identity was vital to the process because anesthesia providers frequently do not have access to the patient armband during surgical procedures.

Phase 3: Transparently Reporting and Ensuring Accountability for Performance (March 2015–June 2016). During Phase 1, education had been provided to all anesthesia staff members and OR nursing staff regarding the new patient ID process, known as the "anesthesia time-out." Compliance with this anesthesia time-out was audited by real-time observers. Initial feedback from the auditors showed that adoption of the new process was not as robust as expected. Mean compliance from January 2014 until February 2015 was 96.2%, short of our goal of 100% for six consecutive months, given its importance. Specifically, participation and engagement of team members during the patient ID process was variable.

Members of the safety and quality leadership team within the Department of Anesthesiology and Critical Care Medicine [N.B.H., B.H.M., K.S., T.L.S.] met with perioperative nursing leadership in an effort to better understand nursing perspectives on the patient ID process. Previously, the nursing staff stated that they felt forced to comply with a new time-out procedure for patient ID—and most of them did not know that it was precipitated by the sentinel event. A reeducation initiative began that included the story of the patient transfused with the wrong blood. Called STOP ID (Safety Time Out for Patient Identification), the initiative was intended to signify that far from a specific team's owning the safety process, the entire perioperative team was committed to advocating for patient safety by correctly identifying the patient and ensuring a match with the patient's chart open in the AIMS. Visual prompts and reminders in the form of large and laminated STOP ID posters were displayed in the OR, and team members were encouraged to speak up if failure occurred.

In Phase 3, now that the infrastructure for bedside bar coding of blood components was in place, the Armstrong Institute provided a team leader to use a fault tree analysis tool to expose failure modes (Figure 1). A Lean Sigma Master Black Belt met with the QI project team, which created the BBTV work product, to analyze each of the failure modes and determine if existing safety checks had the capacity to reliably mitigate those errors deemed most likely to occur.

Before implementation, we conducted a pilot for 12 weeks in the two surgical service lines with the highest intraoperative blood product utilization: cardiac surgery and liver transplantation. The new BBTV work flow was met with positive feedback by those participating in the pilot, and the system did not miss any patient/blood component mismatches. Therefore, we proceeded to the educational phase of process improvement, which entailed the following four components:

1. A departmental meeting demonstrating the new process
2. OR simulation education directed at nurse anesthetists and attending physicians
3. Simulation training for all residents during protected didactic time
4. Development of an e-learning module that consisted of the new work flow, which was followed by a postlecture assessment.

Attendance at the departmental meeting was mandatory; those unable to attend performed simulation and completed the online learning module. In addition, we created a Fast Facts sheet, "Intraprocedure Dual Blood Sign-off," to help clinical and ancillary OR staff successfully complete the necessary steps (Appendix 1, available in online article).

For 14 months—from April 2015 through June 2016, we used BBTV with our MetaVision AIMS, finding successful implementation of the patient ID process. However, because we were still using paper blood requisition as the method of measurement of two-person verification of blood component intraoperative transfusions, we did not meet the goal of > 96% compliance with dual-signature verification. In July 2016 the entire JHH switched to Epic EHR. Because of concerns surrounding the potential risk posed by new process implementation, manual documentation on paper was continued during this time.

Phase 4: Developing a Sustainability Process (July 2016–October 2017). In Phase 4, key performance indicators were reported monthly at each level of the

health system—the JHH Clinical Quality Improvement Committee, the JHH Board of Trustees, and the Department of Anesthesiology and Critical Care Medicine's Quality, Safety, and Service meeting. We achieved 100% compliance with patient ID on entry to the OR and adherence to policy and procedures during real-time observations of intraoperative blood product administration within a two-year period— from July 2014 through June 2016. However, compliance with dual-signature verification continued to be lower than our goal of > 96%. At this time, we had been auditing two metrics: (1) proportion of blood component paper requisitions available and (2) percentage of blood transfused that had dual verification. Because the main problem was locating all the paper requisitions, we were hopeful that the BBTV solution would ensure that we met our goal.

In the initial two-year period, we used manual random sample audits of blood component transfusions to examine the accuracy of documentation. From July 2016 through October 2017, we were then able to use population-level audits from automated Epic reports to examine documentation.

When Epic AIMS was implemented in July 2016, compliance with completion of all required elements of performance measured during retrospective chart review dropped from 97% to 26%, which we attributed to a failure to produce documentation in the Epic AIMS of dual-signature verification before transfusion. The existing process within Epic blood component administration for the floor and ICU settings required reverification of ID and match for each individual unit. However, staff found that process onerous and even unsafe intraoperatively in the context of unstable or massively transfused patients. Therefore, Epic programmers created a novel dual verification process for intraoperative settings in which multiple units of the same type of blood component could be scanned without repeated reentry of user name and password. The streamlined process takes only six clicks in Epic and two bar code scans of the donor ID number and product code on the blood component unit. This new process was met with greater frontline provider satisfaction because of the improved efficiency, as the prior process involved signing each blood component paper requisition. The process now involved another safety check—two-person verification with BBTV—as soon as all blood components came into the OR. Allocated blood in Epic is documented as given to the patient by selecting the unit that we have scanned and are now transfusing. The blood component units that are scanned into Epic but not transfused are cleared out of the record after the anesthesia stop time.

One possible limitation to this new streamlined process is that the provider would have to stop and perform the dual electronic signatures at any time the type of blood component being scanned was changed, thereby reducing efficiency, particularly in a massive transfusion scenario (>10 units of RBCs). However, during the pilot period, we successfully used this new process to perform >100-unit blood component transfusions for two patients, without any adverse effects on safety or timeliness.

We conducted another pilot of the newly enhanced work flow in the cardiac surgery and liver transplantation ORs—this time for four months (November 2016–February 2017). Audit results of the pilot revealed 100% adherence with electronic dual verification among providers using the new work flow—during a time when several massive transfusion cases involved >100 units of blood product. The primary dissatisfier for providers was the requirement to provide two electronic signatures for each type of blood component. They preferred that the requirement of two signatures cover all blood components.

Measures

To study the impact of our interventions, we performed population-based auditing for percent compliance. Success was defined as 100% compliance for six consecutive months. QI auditors and the assistant administrator for the Department of Anesthesiology and Critical Care Medicine [K.S., A.S.] conducted intraoperative auditing from January 1, 2014, through March 31, 2015, to measure success with the first part of the plan—direct observation of verbal verification and blood product administration. Intraoperative auditing was also conducted to determine if STOP ID was performed for every patient upon entrance to the OR.

RESULTS

Audits

March 2014–June 2016. Our audits of two metrics—proportion of blood component paper requisitions available and percentage of blood components transfused with dual verification—from March 2014 to June 2016, demonstrated 87% and 92% compliance, respectively (Figure 2). As seen in Figure 2, we had more difficulty with accounting for all paper requisitions after March 2015 (starting in quarter 4, fiscal year 2015), mostly because of the launch of BBTV at that time. BBTV with MetaVision allowed us to document the two verifiers electronically and thus, providers may have not ensured that all paper requisitions were placed in the patient's chart. These results demonstrated that we would continue to fall short in meeting our goal with a paper process. Full compliance with the STOP ID performance was achieved on January 30, 2016.

May 2017–October 2017. After implementing Epic electronic dual verification, we improved to > 96% compliance with obtaining three metrics on documentation of patient ID (two electronic signatures, start and stop times of transfusion, and blood volume transfused) during this period (from quarter 4, fiscal year 2017, to quarter 2, fiscal year 2018). Figure 3 illustrates the significant decrease

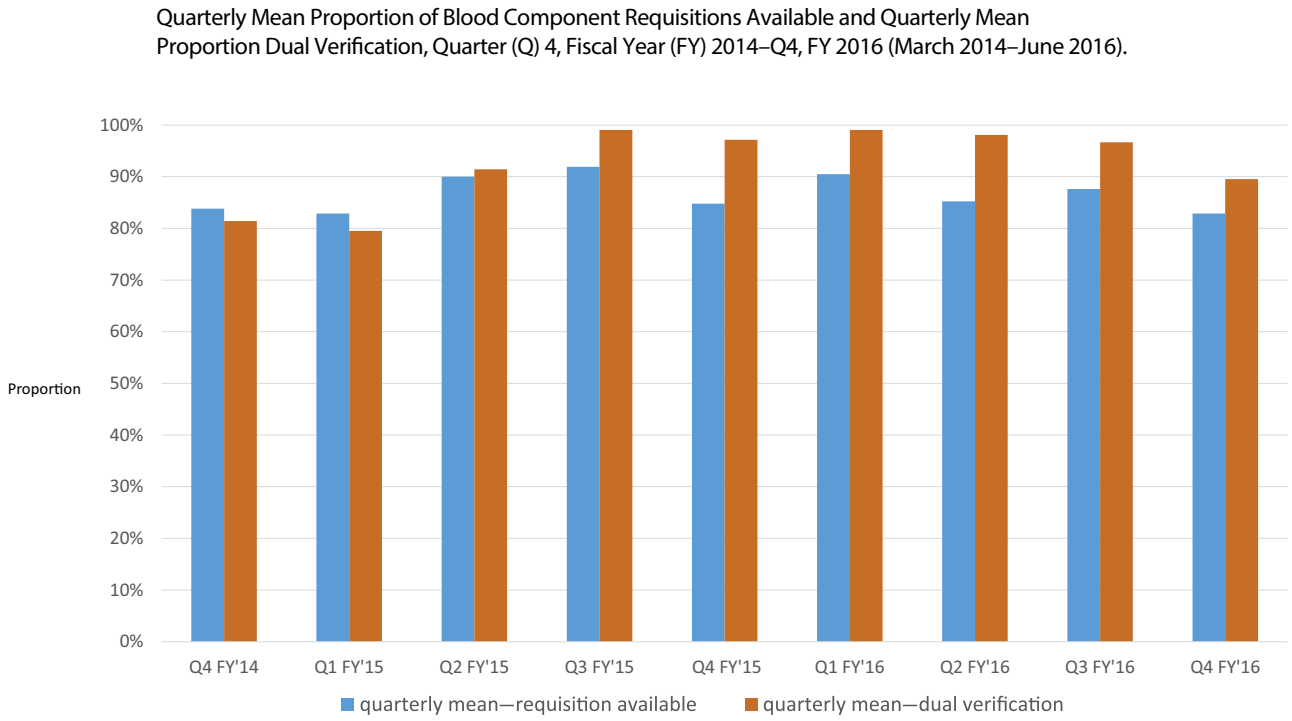

Figure 2: The quarterly mean of paper blood component requisitions available and the quarterly mean proportion of dual verification are shown for blood component requisitions before the hospital transitioned to Epic in July 2016. These audits of two metrics—proportion of blood component paper requisitions available and percentage of blood components transfused with dual verification—from March 2014 to June 2016, demonstrated 87% and 92% compliance, respectively.

(from 97% to 21%) in concert with the Epic go-live in July 2016. The decrease was due to the QI project team's poor understanding of the intraoperative module within Epic. The field for dual verification was not a hard stop, and most users were unaware of it or did not complete it because it was not required when documenting blood transfusions intraoperatively. Dual signature documentation improved by a 16% increase (86% to 100%) after the Epic dual verification work flow was modified (Figure 3) and was sustained for eight months (July 2017–February 2018).

Provider Feedback and Response

Variation in the data was explored qualitatively through direct provider feedback and response. A senior member of the Epic team also analyzed variation objectively by reviewing provider documentation. Variation caused by provider knowledge deficits decreased over time with reeducation, as seen in Figure 3, which also illustrates the decrease in variation after quarter 3 of fiscal year 2015 and then an increase again with the transition to Epic.

DISCUSSION

In this article, we describe how JHH sustained a goal of performing safer and more reliable blood product transfusions intraoperatively. The operative arena, in which the complex multistep process of getting the right blood component to the right patient often has to be done urgently, given hemodynamic instability, is unique. Dual-signature documentation of transfused blood components increased by 16%—from 86% to 100%. Improved documentation likely reflects increased safety by ensuring that all checks have been completed in the process. The first phase demonstrated that we needed to rebrand the "anesthesia time-out"' to STOP ID in order to obtain buy-in from all stakeholders to ensure a way to transfer the "source of truth" of who the patient is to the EHR at a time when that patient's ID armband cannot be accessed. In the final phases (Phases 3 and 4), the pilots demonstrated that we could be successful with BBTV and with dual-signature documentation, even in instances of emergent massively transfused patients in which the complex process of transfusion may be more prone to error. BBTV ensures that the blood component assigned to the patient matches the patient access in the Epic AIMS.

Turner et al. also reported an improvement in performing the steps of blood administration after bar code scanning was initiated at their large academic medical center's hematology unit.[6] As opposed to the hematology unit, which Turner et al. had chosen because of the large number of transfusions in a nonurgent setting, our study entailed one of the most urgent settings for transfusions to occur—ORs. Misidentification of the patient during the transfusion process has been considered the single most important factor in wrong-patient blood component error.[7,8,11,17] Establishing the AIMS as the "source of truth" after bar code scanning of the patient's wristband on the pa-

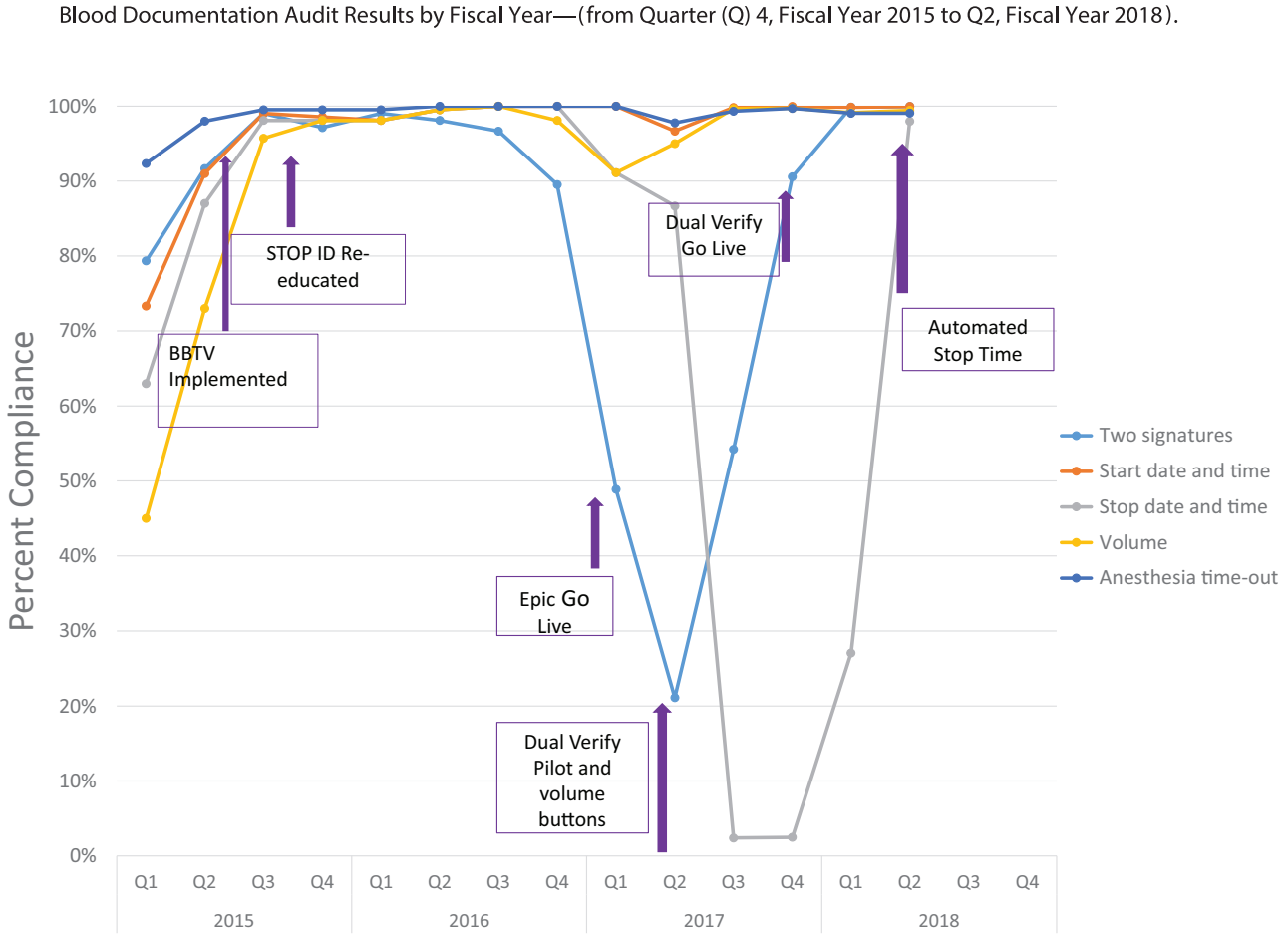

Figure 3: Percentage compliance shown is the quarterly mean percentage compliance in sample-level and population-level auditing of intraoperative blood product transfusion. Anesthesia time-out started in December 2013 but was rebranded to STOP ID in August 2015. Sample-level auditing on paper blood component requisitions began in March 2014 and transitioned to Epic electronic population-level auditing in July 2016. The significant decrease (from 97% to 21%) in concert with the Epic go-live in July 2016 is shown. Dual-signature documentation improved by a 16% increase (86% to 100%) after the Epic dual verification work flow was modified in May 2017 and has been sustained until February 2018. BBTV, bedside barcode transfusion verification.

tient's arrival to the OR was a key cornerstone of the new work flow that we have described.

Our experience with this QI initiative suggests that (1) BBTV is a safe, effective way to ensure that the correct patient is receiving the correct blood product; (2) the novel approach of enacting electronic dual signatures during intraoperative blood product administration is possible in a high-paced environment;, and (3) continual auditing and transparency of reporting are vital for obtaining success.

This QI initiative also suggests three recommendations for other health care organizations considering adapting our interventions to medical units, ICUs, and other hospital areas where blood transfusions take place. First, attempting to achieve success by using a paper process auditing metric will likely be inadequate. Blood component paper requisitions get misplaced in the chaotic OR environment, and only electronic documentation yields accurate audits. Second, it is necessary for the team to understand a new EHR system, as much as possible, so that it can predict where failures will occur. Because we lacked understanding of the new Epic intraoperative blood administration module, we failed to recognize that the field for entering the second verifier's name was not covered by the required training, was not intuitive, and was not a hard stop. We continued to keep the paper downtime process while we transitioned to Epic to prevent any safety failures. Third, ensuring engagement with the frontline providers by conducting a pilot program was crucial for our ability to subjectively evaluate a novel intraoperative process. By interviewing frontline providers, we could learn about process noncompliance, failure modes, and provider satisfaction. Ultimately, we had high frontline provider satisfaction because of the efficiency of combining the dual electronic signatures with a bedside bar coding transfusion verification approach.

A robust, multidisciplinary educational effort surrounding STOP ID successfully enhanced the engagement of the entire OR team and has proven sustainable. Even though

our version of MetaVision was unable to require scanning of the patient's ID bracelet before proceeding with the OR process by creating a hard stop, we were able to incorporate this function and used it after we transitioned to Epic. This step in the work flow, we believe, made the intervention stronger and more sustainable.

The QI project's costs included purchase and installation of bar code scanners for approximately 50 ORs (excluding ambulatory and an eye center, in which blood components are not routinely given) and perioperative services, as well as multidepartmental staff education. These same bar code scanners may be used for intraoperative medication scanning and therefore may currently serve a secondary benefit. In examining the opportunity cost, including the legal costs associated with a major transfusion incident,[17] the benefit of having a safer system for intraoperative blood transfusion greatly outweighed the costs of the QI project team time, equipment, and staff education. As Chan et al. stated, if one considers the legal costs associated with a major transfusion incident, the benefit significantly outweighs the cost.[17]

Limitations

The limitations of this study include the lack of complete capture of data for all near-miss events after BBTV was initiated in the OR. We expected to see an increase in near-miss episodes, as other institutions conducting bar coding of blood components have reported[9,15] because the bar coding system would have been able to capture these episodes and we would not have had to rely on voluntary reports. Another limitation of our study was that we did not undertake a prospective process to address inappropriate transfusions, which was outside the scope of our initiative. Still, the reduction of inappropriate transfusions is a vital part of the oversight of blood utilization and transfusion practice and represents an opportunity to decrease costs and risks for patients.[18]

CONCLUSION

In the fast-paced perioperative environment, most hospitals still rely on a paper process to demonstrate two-person verification of the blood component. An approach combining dual electronic signatures and bedside bar coding transfusion verification led to improved safety of the complex process of blood transfusion. In a one-year period, compliance with obtaining three metrics on documentation of patient identification (two electronic signatures, start and stop times of transfusion, and blood volume transfused) improved to > 96%.

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Conflicts of Interest. All authors report no conflicts of interest.

SUPPLEMENTARY MATERIALS

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jcjq.2018.08.010.

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