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BRIEF REPORT

TRANSFUSION

Factors associated with wrong blood in tube errors: An international case series – The BEST collaborative study

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Abstract

Background: A wrong blood in tube (WBIT) error signifies a blood sample that does not match the patient identified on the sample label. WBIT errors can result in ABO mistransfusions.

Study design and methods: In this international, multicenter, descriptive study, healthcare facilities provided detailed information on WBIT errors occurring from 1/1/2019 to 12/31/2020. Factors contributing to WBIT errors were classified as protocol violations, knowledge gaps, and slips/lapses.

Results: 331 WBIT errors were compiled from 36 centers in 11 countries. WBIT errors were most frequently detected through pretransfusion sample testing (191, 58%), with 38 (20%) detected by a second ("check") sample. WBIT errors were divided almost evenly between intended patient drawn/wrong label applied (166, 50%) and wrong patient drawn/intended label applied (158, 48%). Information on contributing factors was available for 260 WBIT errors; most involved a combination of protocol violations and slips/lapses (139, 53%). The most frequent contributing factor was another patient's sample labels or tubes being available during phlebotomy (61%). Protocol violations were more likely to result in wrong patient being drawn ($p = .0007$). In 43 WBIT errors, electronic positive patient identification (ePPID) was not used when available or was used incorrectly.

Conclusions: Protocol violations and slips/lapses frequently contribute to WBIT errors. Sample collection processes should be designed to minimize error opportunities; staff should be educated on why protocol compliance is critical for patient safety. Using ePPID does not eliminate all WBIT errors. Institutions using ePPID may elect to require check sample verification as an added safety measure.

KEYWORDS

blood transfusion, patient safety, pretransfusion testing, specimen collection

Abbreviations: ePPID, electronic positive patient identification; UK, United Kingdom; US, United States; WBIT, wrong blood in tube.

Members of WBIT Study Investigators are shown in Appendix.

1 | BACKGROUND

Wrong blood in tube (WBIT) errors are errors in patient sample collection that result in the blood in the tube not being from the person identified on the sample label.[1] These errors can be classified as: (1) intended patient drawn/wrong label applied; and (2) wrong patient drawn/intended label applied. The relative frequency of each error type is unknown.

WBIT errors are detected during pre-transfusion testing when results do not match historic results or those from a second, separately drawn check sample. WBIT errors may also be identified by clinical areas and during sample accessioning.[2, 3] Current WBIT frequency estimates range from 4.3 to 5.8 per 10,000 samples.[4, 5]

Undetected WBIT errors can result in ABO-mismatched transfusions, which can be fatal if ABO-incompatible.[6] In some situations, the blood type of the sample is coincidentally compatible with the patient ("silent WBIT error").[7] The 2018 Serious Hazards of Transfusion report described 792 WBIT errors, 37% of which could have resulted in an ABO-incompatible transfusion.[8]

WBIT errors involve a variety of contributing factors and may occur during all steps of the sample acquisition process. Errors at the time of patient admission include inadvertently registering the wrong patient, or a patient intentionally providing false identification.[9] At the time of sample collection, WBIT errors may be caused by failing to identify the patient, labeling samples away from the bedside, and incorrect or missing wristband information.[1] Risk is compounded by human factors including time pressures, competing tasks, stress, interruptions, and fatigue.[10] A taxonomy developed to understand errors in industrial situations can be applied to WBIT errors (Figure 1).[11, 12] In this schema, mistakes result from noncompliance errors (protocol violations) and/or cognitive errors attributed to either thinking (knowledge gaps) or execution (slips/lapses) (Figure 1).

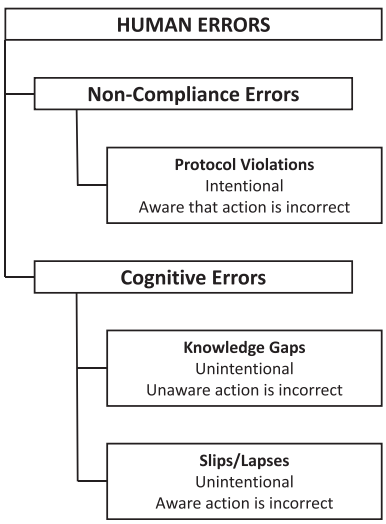

FIGURE 1 A skill-rule-knowledge model of human error

One intervention to reduce risk for WBIT errors is the use of electronic positive patient identification (ePPID) systems.[13] Use of ePPID has been associated with a decreased risk for WBIT errors.[14–16] Current guidelines in both the United States (US) and United Kingdom (UK) require blood group confirmation via a check sample in patients without a historic type on file, unless ePPID systems are in use.[17–19]

A study examining sample collection errors in 23 participating sites in Canada showed a significant decrease in WBIT rates between 2006 and 2015 (12 to 5.8 per 10,000).[5] Only one site used an ePPID system and 6 sites reported check sample requirements. Sites with check sample requirements had lower WBIT rates compared to sites without check sample requirements (0.4 vs 1 per 10,000 samples, $p < .0001$). In the US, there has also been a decrease in ABO incompatible red cell transfusions reported to the Food and Drug Administration in the past decade, possibly due to increased adoption of check sample requirements and/or implementation of ePPID systems.[20]

This study was designed to prospectively collect WBIT error case reports to describe essential features. Understanding these errors may identify additional opportunities for practice improvement.

2 | METHODS

2.1 | Study design and data collection

This was an international, multicenter, descriptive study. Participating sites included Biomedical Excellence for Safer Transfusion (BEST) Collaborative members and contacts.

Investigators prospectively completed standardized case report forms for all WBIT errors identified in calendar year 2020. Investigators could also submit retrospective WBIT error reports from calendar year 2019 if they had the necessary information. The case report form collected information on error type, location, staff involved, and method of detection (Table 1).

The case report form allowed investigators to submit a free text narrative describing how the WBIT error occurred. The first 25 narratives were used to develop a checklist of contributing factors for subsequent case reports. Additional contributing factors were identified during data analysis by a manual review of all narratives. Contributing factors were classified using a simplified version of Rasmussen's skill-rule-knowledge model of human error (Figure 1).[11]

TABLE 1 Characteristics of wrong blood in tube (WBIT) errors

	WBIT errors $n = 331$
WBIT error type, n (%)	
Intended patient drawn/wrong patient label applied	166 (50)
Wrong patient drawn/intended patient label applied	158 (48)
Unknown	7 (2)
WBIT error location, n (%)	
Inpatient ward	59 (18)
Labor and delivery	43 (13)
Emergency department	42 (13)
Intensive care unit	36 (11)
Outpatient clinic	24 (7)
Operating room	19 (6)
Unknown	108 (33)
Staff involved in WBIT sample collection, n (%)	
Nurse	258 (78)
Phlebotomist	27 (8)
Physician	20 (6)
Other*	17 (5)
Unknown	9 (3)
Method of WBIT error detection, n (%)	
Sample testing	191 (58)
Comparison with historic ABO/Rh type	*152 (80)*
Comparison with ABO/Rh type of "check sample"	*31 (16)*
Comparison with antibody screen results of "check sample"	*7 (4)*
Comparison with historic antibody screen results	*1 (<1)*
Sample review	82 (25)
Paperwork/sample/label discrepancy	*71 (87)*
Unexpected sample received	*11 (13)*
Notification from clinical area	40 (12)
Other	2 (<1)
Unknown	16 (5)

*Other includes midwife ($n = 4$), student (4), patient† (2), technician (2), health care assistant (2), nurse anesthetist, (1) and unknown (2).
†One center allows patients to collect their own samples from central lines in an outpatient clinic. They reported 2 WBIT errors.

2.2 | Data analysis

The error type, location, staff involved, and method of error detection were tabulated for each WBIT error. Contributing factors were also enumerated to determine the frequency each factor was observed, recognizing that each case could have multiple contributing factors. Categorical data were analyzed using a 2×2 contingency table with Fisher's exact test to determine the statistical significance of differences observed using a two-tailed p value, where appropriate (GraphPad Software, San Diego, CA).

2.3 | Ethics

The Committee for the Protection of Human Subjects at Dartmouth-Hitchcock Medical Center reviewed this study protocol and deemed that it was not research involving human subjects.

3 | RESULTS

A total of 331 detailed reports of WBIT errors were obtained from 36 centers in 11 countries (Australia (1), Brazil (1), Canada (4) Czech Republic (1), Denmark (1), France (1), Germany (1), Ireland (2), Israel (1), UK (6), and US (17)). All errors were "near miss" events, meaning none resulted in mistransfusion. The majority ($n = 272$, 82%) were collected prospectively during the calendar year 2020. The remainder (59, 18%) occurred in 2019 with case report forms completed retrospectively. Thirty-five hospitals submitted an average of six WBIT error reports (range 1–19). One national blood transfusion service provided 119 case reports from 30 hospitals throughout France (range 1–28 WBIT error reports per hospital), collected through mandatory reporting to the national hemovigilance system.

WBIT error types were split almost evenly between intended patient drawn/wrong label applied and the wrong patient drawn/intended label applied. WBIT errors occurred in all areas of the hospital, involved all types of staff, and were detected through a variety of methods. The majority (191, 58%) were identified during laboratory testing. A subset of these (38, 20% of WBIT errors identified through testing, 11% of all WBIT errors) was detected via comparison with results from a check sample (Table 1).

In 260 WBIT errors, sufficient information was available to classify contributing factors. These WBIT errors were classified as protocol violations, knowledge gaps, and slips/lapses (Table 2). Most WBIT errors (66%) had more than one contributing factor (mean 2.3, range 1–6). Protocol violations were common and most frequently involved failure to identify the patient at the time of sample collection (139, 53%) or failure to label the sample at the bedside (72, 28%). Slips/lapses were also common

TABLE 2 Classification of factors contributing to wrong blood in tube (WBIT) errors

	WBIT errors $n = 260$
Noncompliance errors- protocol violations	
Patient identification not confirmed	139 (53)
Sample not labeled at bedside	72 (28)
ePPID not used or used incorrectly	43 (17)
Patient identification/bracelet/barcode used not attached to patient	19 (7)
Patient provided false identification at time of registration	4 (2)
Second sample drawn at same time as first sample	2 (1)
Cognitive errors- knowledge gaps	
Issues related to training/education/competence*	9 (3)
Cognitive errors- slips/lapses	
Another patient's labels or tubes available at time of sample draw†	159 (61)
Multiple patients on same floor requiring sample collection at the same time	65 (25)
Multiple staff involved in sample collection/labelling	37 (14)
Collection staff interrupted during sample collection process	17 (7)
Patients with similar names	14 (5)
Wrong patient chart accessed	10 (4)
Patient identification incorrect at time of registration (i.e., wrong patient registered)	8 (3)
Wrong patient identifier attached to patient (i.e., wrong wristband)	5 (2)

Note: Multiple factors could be selected for each error.
Abbreviation: ePPID, electronic positive patient identification.
*includes 2 instances of patient drawing own samples.
†includes 32 mom/baby or twin/triplet errors.

and most frequently involved access to another patient's tubes or labels at the time of sample draw (159, 61%) and multiple patients on the sample floor requiring sample collection at the same time (65, 25%). Knowledge gaps related to training, education, or competence were rare (9, 3%).

Electronic positive patient identification (ePPID) systems were associated with 43 WBIT errors (17% of classifiable errors). These included incorrect use of the system (scanning wristbands or barcodes unattached to the patient or drawing samples separately from scanning patient information) and choosing not to use the system when available. These WBIT errors were all classified as protocol violations. In addition, there were 7 errors that involved ePPID system limitations, including the software failing to clear patient information from the mobile device when the sample collection process was aborted, failure to print duplicate labels for both the tube and the requisition, and inability of scanner to read the patient bar code resulting in need to hand label the specimen. In all of these cases, other contributing factors were present.

Labor and Delivery was the location for 43 WBIT errors, 32 of which (74%) involved slips/lapses related to access to another patient's labels or tubes at the time of sample draw. These included mother/baby errors, such as cord blood samples labeled with mother identifiers or maternal fetal cell screen samples labeled with baby identifiers, and twin or triplet mix-ups.

Of the 260 WBIT errors with contributing factors identified, most involved a combination of protocol violations and slips/lapses (139, 53%), followed by slips/lapses only (64, 25%) and protocol violations only (53, 20%). WBIT errors that included protocol violations were more likely to result in wrong patient drawn; 89/103 (86%) wrong patient drawn errors included protocol violations compared to 105/155 (68%) intended patient drawn errors ($p = .007$). Although nurses were the staff most frequently associated with WBIT errors, these were more likely to be attributed to slips/lapses only (58/199, 29%) when compared to errors involving other collection staff (4/56, 7%; $p = .0004$).

4 | DISCUSSION

This study provides detailed information describing circumstances associated with WBIT errors and identifies contributing factors using a schema applied to human errors in industrial settings.[11] Most WBIT errors involved multiple contributing factors. Errors related to knowledge gaps (i.e., training and education) were rare and errors due to protocol violations were common. This suggests that staff generally understand sample collection protocols but may not appreciate why failure to follow the protocol might result in patient harm. In protocol violations, the individual intentionally deviates from the sample collection protocol, generally not with the intent to harm the patient but rather to expedite care (i.e., well-meaning but misguided actions).

The high frequency of slips/lapses may indicate a need for interventions to reduce factors that lead to these errors including access to multiple patient labels and the ability to open multiple patient charts at the same time. Errors in patient registration, including patients intentionally providing false identification for medical care, increase the risk for WBIT errors, and strategies to improve proper patient identification, including the incorporation of photos in the medical record, may reduce risk.[21]

This study highlights the fact that the adoption of ePPID systems does not eliminate WBIT errors. Protocol violations including improper use of ePPID or failure to use ePPID when available were reported. This study also illustrates the value of check sample requirements, which led to the detection of 11% of WBIT errors. Although not currently required by regulations and/or professional standards in the US and the UK, check sample verification for patients without a historic type on file may still be valuable to protect patients from ABO mistransfusions where ePPID systems are in use.

The strengths of this study include the large number of cases and participating sites from a diverse group of countries. This study also has several important limitations. WBIT error reporting was voluntary and may have been incomplete. Retrospective reporting by some centers may have added potential bias. Case investigations varied from site to site and data necessary to assign contributing factors were missing for 21% of WBIT error reports. Assigning contributing factors that led to WBIT errors was subjective, and in some cases, insufficient information was available. Finally, this study is essentially a large case series; therefore, an analysis of the proportions of different attributes of WBIT errors compared to the total number of samples collected was not possible.

In spite of these limitations, this large international case series adds new information to our understanding of WBIT errors. Recognition of factors that contribute to WBIT errors may help select appropriate risk mitigation strategies to decrease error rates and improve patient safety. Based on this project, we developed a WBIT error investigation form that can be adopted by transfusion services to investigate and classify WBIT errors when they are detected to facilitate identifying appropriate interventions to reduce risk (Data S1).

CONFLICT OF INTEREST

The authors have disclosed no conflicts of interest.

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher's website.

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