Received: 29 January 2021 | Revised: 10 June 2021 | Accepted: 12 June 2021

DOI: 10.1111/trf.16588

TRANSFUSION PRACTICE

TRANSFUSION

Emergency departments are higher-risk locations for wrong blood in tube errors

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Abstract

Background: Wrong blood in tube (WBIT) errors can lead to ABO mistransfusions. It is unknown if WBIT errors are more likely in specific healthcare locations or if specific collection practices influence the commission of WBIT errors.

Study Design and Methods: Data on pretransfusion samples from calendar year 2019 were collected retrospectively by 39 transfusion services in nine countries. We compared the proportion of WBIT errors made in emergency departments (EDs), inpatient wards, and outpatient clinics.

Results: In total, 143 WBIT errors were detected among 1,394,862 samples for an unadjusted aggregate WBIT proportion of 1.03/10,000 samples. Using a pooled random effects model, the WBIT proportion was estimated to be significantly higher in EDs (1.23/10,000 samples, 95% CI 0.62–2.43) than inpatient wards (0.71/10,000, 95% CI 0.44–1.14; $p < .001$) or outpatient clinics (0.24/10,000, 95% CI 0.08–0.65; $p < .001$) and significantly higher in inpatient wards than outpatient clinics ($p = .043$). The use of electronic positive patient identification (ePPID) systems was associated with a significantly lower WBIT proportion in the ED (odds ratio, OR: 0.32, 95% CI: 0.11–0.96, $p = .041$), but not in inpatient wards (OR: 0.45, 95% CI: 0.20–1.01, $p = .054$) or outpatient clinics (OR: 1.95, 95% CI: 0.39–9.74, $p = .415$).

Discussion: Normalized for the number of samples drawn per location, the WBIT proportion in EDs was 1.7 times higher than inpatient wards and 5.1 times higher than outpatient clinics. EDs represent higher-risk clinical locations for WBIT errors, and electronic positive patient identification (ePPID) may provide a greater impact on safety in EDs relative to other clinical areas.

Abbreviations: BEST, Biomedical Excellence for Safer Transfusion; CI, confidence interval; ED, emergency department; EPPID, electronic positive patient identification; FDA, Food and Drug Administration; NMA, network meta-analysis; OR, odds ratio; UK, United Kingdom; US, United States; WBIT, wrong blood in tube.

List of the WBIT Study Investigators is given in the Appendix.

KEYWORDS
blood transfusion, patient safety, pretransfusion testing, specimen collection

1 | BACKGROUND

Wrong Blood in Tube (WBIT) errors are an important cause of ABO-mismatched transfusions.[1] WBIT errors occur (1) when a sample for pretransfusion testing is obtained from the intended patient and labeled with another patient's identifiers or (2) when a sample is obtained from the wrong patient and labeled with the intended patient's identifiers. WBIT errors are detected during pretransfusion testing when the patient's ABO/Rh type does not match the patient's historic results on file.[1] However, not all WBIT events are identified via laboratory testing. Some errors are recognized and reported by clinical areas[2] while other errors are prevented from reaching testing due to labeling errors that result in specimen rejection.[3] In addition, WBIT errors may be missed if the sample coincidentally matches the patient historic type on file (i.e. "silent" WBIT errors).[4] Recent WBIT error estimates range from 4.3 to 5.8 per 10,000 samples.[5,6] The 2018 Serious Hazards of Transfusion report described 792 WBIT errors, 37% of which could have resulted in ABO-incompatible transfusion.[7] When not detected, WBIT errors have led to transfusion fatalities, with the most recent case reported to the United States (US) Food and Drug Administration (FDA) in fiscal year 2016.[8]

In an effort to reduce the risk for ABO-incompatible transfusions through identification of WBIT errors, AABB introduced a revised Standard in 2016 requiring a second determination of the patient ABO group using a second separately drawn sample (i.e. "check sample") for patients without a historic type on file.[9] Prior to this revision, it had been acceptable to retest the same sample, presumably to identify errors in laboratory testing. This option is now only allowable when the patient identification is verified using an electronic positive patient identification (ePPID) system or other system validated to improve safety. A similar requirement was adopted by the College of American Pathologists in 2019.[10]

Data supporting this practice change were recently published in a study examining transfusion fatalities due to ABO incompatibility reported to the FDA from 2000 to 2019.[11] Of the 80 reported fatalities, 21 (26%) were attributed to WBIT errors. The majority of errors (17/21) occurred between 2000 and 2009 with only 4 reported between 2010 and 2019 (exact years of events not provided). The authors report that all 21 cases occurred in facilities without policies requiring blood type verification against a historic type or "check sample" at the time of transfusion. Some reported that this requirement was present in other clinical areas at the time but not in the area where the mistransfusion event occurred. Among the 19 cases that provided information about corrective action following the mistransfusion event, 16/19 implemented a requirement to confirm ABO group through comparison with historical type or a "check sample."

The impact of ePPID on WBIT errors was examined in a multi-institutional Biomedical Excellence for Safer Transfusion (BEST) Collaborative study published in 2019.[12] This study demonstrated that using ePPID at the time of pretransfusion sample collection was associated with significantly fewer WBIT errors compared with using manual patient identification. This study also observed that WBIT errors when using manual patient identification most frequently occurred in inpatient wards (56%) and the emergency department (ED; 19%). Nurses were identified as the providers who most frequently made WBIT errors when using manual patient identification (60% of cases). However, a deeper understanding of factors that increase the risk for a WBIT was limited by the inability to obtain relevant denominators for comparisons (e.g., the total number of samples drawn in different hospital locations or the total number of samples collected by specific categories of hospital staff). Thus, factors that may influence the proportion of WBIT samples in different hospital locations were not assessed. For example, the use of dedicated sample collection staff (i.e. phlebotomists) for some or all sample collections has been proposed to reduce the proportion of samples with WBIT errors.[5] Conversely, the practice of routinely collecting a standard set of samples from all patients upon admission to the ED (i.e. a "rainbow tube" policy) may lead to an increased proportion of samples with WBIT errors as the sample labels for these tubes may not print until the actual labs are ordered, potentially leaving unlabeled tubes in the interim.[13] The observation that ePPID reduces error is supported by a recently published multicenter study from the United Kingdom (UK), which showed that ePPID use was associated with fewer wrong components transfused.[14]

This study was intended to directly address the limitations of the 2019 BEST study with the goal of improving our understanding of WBIT risk factors and identifying opportunities to improve transfusion safety. This study was designed to determine whether WBIT errors are more likely to occur in specific hospital locations (EDs v. inpatient wards v. outpatient clinics). In addition, we explored factors that may affect the proportion of samples with WBIT errors between the same locations at different hospitals, such as use of ePPID,

collection of rainbow tubes in EDs, and use of phlebotomy staff for collection of some or all samples in each location.

2 | METHODS

2.1 | Study design and data collection

This was a retrospective, cross-sectional, descriptive study. Participating hospital transfusion service laboratories were asked to provide the total number of pretransfusion blood samples accepted for ABO typing/antibody identification testing and the number of WBIT errors identified during the 1-year period from January 1, 2019 through December 31, 2019. WBIT errors were defined strictly as cases where a sample had been accepted and tested in the transfusion service laboratory and found not to match a patient's historic ABO type or the ABO type determined using a "check sample." In addition, sites were required to provide the hospital location for all sample collections and WBIT errors. Hospital locations were categorized as: (1) EDs, (2) inpatient wards, (3) outpatient clinics, (4) operating rooms, (5) intensive care units, or (6) labor and delivery wards. Samples accepted for testing included all blood samples accepted for pretransfusion testing for allogeneic transfusion from pediatric and adult inpatients and outpatients, including "check samples" if required at the participating institution. Samples accepted for testing excluded any samples rejected according to local sample labeling requirements or for other reasons (e.g. wrong order, duplicate order, wrong tube, hemolyzed, etc.), or because the samples were accepted for nontransfusion purposes (e.g. antenatal testing). For this study, ED included all areas associated with emergency medical care including clinical observation units associated with the ED where patients may be held after evaluation and prior to discharge or admission to the hospital. Inpatient wards included all nonintensive care inpatient locations including preoperative and postanesthesia care units. Outpatient clinics included all infusion clinics and outpatient procedure areas.

Hospitals were invited to participate from the BEST Collaborative members and contacts. All sites that participated and provided data were included in our study.

2.2 | Statistical analysis

The frequency measure utilized for this study was the WBIT error proportion, i.e. the proportion of all accepted samples during the 1-year study period that had a WBIT error. This was calculated as:

$$\text{Unadjusted WBIT error proportion} = \frac{\text{Number of WBITs}}{\text{Total number of accepted samples}}.$$

Silent WBIT errors, where the typing results match coincidentally, were not accounted for in the unadjusted WBIT error proportion due to expected variability in ABO group and Rh type population frequencies between participating sites. WBIT errors identified prior to testing, either through self-reporting from the clinical area or through sample rejection due to labeling errors or other causes, were also not accounted for in the unadjusted WBIT error proportion. Odds ratios, where calculated should not be interpreted as risks.

Random effects meta-analysis of single proportions was performed to calculate site-specific, location-specific, and overall WBIT error proportions using the metaprop function of the meta package.[15]

Potential confounders were selected a priori and retained in the models regardless of their influence on the effect estimate. A random effects model was applied to allow inference beyond the included studies to the entire population of interest. Due to the rarity of WBIT events, site-specific WBIT error proportions and their associated 95% exact binomial confidence intervals (CIs), as well as the pooled WBIT error proportions, were estimated using a random-intercept logistic regression model, which accommodates sparse data without requiring a continuity correction factor.[16] Network meta-analysis (NMA) for binary data - a statistical technique that allows comparison of multiple arms in the same meta-analysis simultaneously and accounts for multiple comparisons - was used to compare the random effects WBIT estimates among the three hospital locations with the most WBIT errors (ED, inpatient wards and outpatient clinics) using the netmeta package.[17,18] Inconsistency in the network was not a consideration because a single multi-arm study design was utilized, whereby each site had three arms (one for each setting), therefore providing direct evidence for all pairwise comparisons.[19] Finally, mixed effects meta-regression was performed to adjust for the effects of (1) using ePPID, (2) using phlebotomists to collect some or all samples, and (3) collecting rainbow tubes (ED only) on the location-specific WBIT error proportions. All analyses were performed using open-source statistical software (Microsoft R Open version 3.5.3, Microsoft Corporation, WA, US).[20]

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

TABLE 1 Overall WBIT error proportions by site

Site	Country	Samples tested[a] (n)	Total WBITs[a] (n)	WBITs/10,000 samples[a] (unadjusted)
1[b]	UK	7690	5	6.50
2	US	31,747	14	4.41
3	CZECH REP	4931	2	4.06
4	US	12,300	4	3.25
5	UK	14,024	4	2.85
6	CANADA	18,467	5	2.71
7	US	34,457	8	2.32
8	US	22,129	5	2.26
9	UK	32,620	7	2.15
10	DENMARK	38,000	8	2.11
11	US	81,307	17	2.09
12	CANADA	54,920	9	1.64
13	AUSTRALIA	22,954	3	1.31
14	IRELAND	24,381	3	1.23
15	UK	42,023	5	1.19
16	IRELAND	17,085	2	1.17
17	US	34,403	4	1.16
18	UK	17,809	2	1.12
19	CANADA	47,583	5	1.05
20	US	38,061	3	0.79
21	UK	42,611	3	0.70
22	UK	15,209	1	0.66
23	CANADA	31,992	2	0.63
24	US	109,215	6	0.55
25	UK	66,267	3	0.45
26	US	91,979	4	0.43
27	US	129,763	5	0.39
28	US	52,127	2	0.38
29	US	36,446	1	0.27
30	US	38,220	1	0.26
31	US	31,005	0	0
32	ISRAEL	21,281	0	0
33	US	8287	0	0
34	US	44,742	0	0
35	IRELAND	12,958	0	0
36[b]	UK	3791	0	0
37[b]	US	7573	0	0
38	BRAZIL	11,349	0	0
39	US	43,156	0	0
Total:		1,394,862	143	1.03

Abbreviations: WBIT, wrong blood in tube error.

[a]Includes all hospital locations, including operating room, intensive care units and labor and delivery.

[b]Excluded from location specific analyses due to lack of an Emergency Department at the facility (1) or inability to provide location specific data (36, 37).

TABLE 2 Location-specific WBIT error proportions

	EDs	Inpatient wards	Outpatient clinics
Samples tested, n	193,781	475,549	425,136
WBITs identified, n	36	39	19
WBITs/10,000 samples (unadjusted)	1.86	0.81	0.45
Pooled random effects model WBIT estimate/10,000 samples (95% CI)	1.23[a,b] (0.62–2.43)	0.71[c] (0.44–1.14)	0.24 (0.08–0.65)

Abbreviations: EDs, Emergency Departments; WBIT, Wrong Blood in Tube error.
[a]*p*-value for ED v. inpatient wards (pooled random effects model): <.001.
[b]*p*-value for ED v. outpatient clinics (pooled random effects model): <.001.
[c]*p*-value for inpatient wards v. outpatient clinics (pooled random effects model): .043.

TABLE 3 Electronic positive patient identification use and WBIT errors by location

	EDs using ePPID (n = 16)	EDs not using ePPID (n = 20)	Inpatient wards using ePPID (n = 18)	Inpatient wards not using ePPID (n = 18)	Outpatient clinics using ePPID (n = 16)	Outpatient clinics NOT using ePPID (n = 20)
Samples tested, n	93,351	100,430	282,303	196,246	184,433	240,709
WBITs identified, n	9	27	16	23	9	10
WBITs/10,000 samples (unadjusted)	0.96	2.69	0.57	1.17	0.49	0.42
Pooled random effects model WBIT estimate/10,000 samples (95% CI)	0.66[a] (0.18–2.42)	2.08 (1.04–4.18)	0.42[b] (0.17–0.99)	1.17 (0.78–1.76)	0.30[c] (0.07–1.31)	0.19 (0.05–0.78)

Abbreviations: EDs, Emergency Departments; ePPID, electronic positive patient identification; WBIT, Wrong Blood in Tube error.
[a]*p*-value for ED + ePPID v. ED − ePPID (mixed effects model): .041.
[b]*p*-value for inpatient wards +ePPID v. inpatient wards −ePPID (mixed effects model): .054.
[c]*p*-value for outpatient clinics +ePPID v. outpatient clinics −ePPID (mixed effects model): .420.

human subjects. All site investigators obtained any necessary ethics approvals at their respective institutions.

3 | RESULTS

Study data were submitted from 39 sites in the following countries: US (18), UK (9), Canada (4), Ireland (3), Australia, Brazil, Czech Republic, Denmark, and Israel (1 each). Collectively, these sites tested a total of 1,394,862 pretransfusion samples during calendar year 2019 and identified 143 WBIT errors for an overall unadjusted WBIT error proportion of 1.03 per 10,000 samples tested (range 0.00–6.50, 9 sites reported no WBIT errors) (Table 1). Three sites (1 US, 2 UK) were excluded from further analysis due to the inability to provide location-specific sample data (n = 2) or lack of an ED at the facility (n = 1).

The total number of WBIT errors and samples tested for each hospital location and information about the use of ePPID, use of phlebotomists for some or all sample collection, and collection of rainbow tubes (ED only) are provided for each site as supplementary material (Tables S1–S3). During the study period, one or more WBIT errors were made in 15 of 36 EDs (42%), 20 of 36 inpatient wards (56%), and 12 of 36 outpatient clinics (33%).

Using a random effects model, we estimated the WBIT error proportion to be approximately 1.7 times higher in the ED than in the inpatient wards (1.23 v. 0.71 WBITs per 10,000 samples; odds ratio-(OR) 2.42, $p < .001$ in NMA model) and 5.1 times higher in the ED than in the outpatient clinics (1.23 v. 0.24 WBITs per 10,000 samples; OR 3.90, $p < .001$ in NMA model) (Table 2). The WBIT error proportion in the inpatient wards was approximately 3.1 times higher compared to the outpatient clinics (0.71 v. 0.24 WBITs per 10,000 samples, OR 1.61, $p = .043$ in NMA model).

TABLE 4 Use of phlebotomists for sample collection and WBIT errors by location

	EDs using phlebotomists (n = 5)	EDs not using phlebotomists (n = 31)	Inpatient wards using phlebotomists (n = 26)	Inpatient wards NOT using phlebotomists (n = 10)	Outpatient clinics using phlebotomists (n = 26)	Outpatient clinics NOT using phlebotomists (n = 10)
Samples tested, n	28,438	165,343	390,915	87,634	319,295	105,841
WBITs identified, n	2	34	34	5	15	4
WBITs/10,000 samples (unadjusted)	0.70	2.06	0.87	0.57	0.47	0.38
Pooled random effects model WBIT estimate/10,000 samples (95% CI)	0.70[a] (0.18–2.81)	1.14 (0.69–2.85)	0.71[b] (0.44–1.14)	0.49 (0.12–2.11)	0.26[c] (0.08–0.78)	0.18 (0.01–2.42)

Abbreviations: EDs, Emergency Departments; WBIT, Wrong Blood in Tube error.
[a]*p*-value for ED + phlebotomists v. ED − phlebotomists (mixed effects model): .29.
[b]*p*-value for inpatient wards +phlebotomists v. inpatient wards − phlebotomists (mixed effects model): .39.
[c]*p*-value for outpatient clinics + phlebotomists v. outpatient clinics − phlebotomists (mixed effects model): .57.

There was substantial practice variation in ePPID implementation, with 17 sites not using ePPID in any of the 3 locations, 2 sites using ePPID in the inpatient wards and outpatient clinics only, 1 in the inpatient wards only, 1 in the ED only, 1 in the ED and inpatient wards only, and 14 using ePPID in all three locations.

EDs that used ePPID were less likely to commit WBIT errors compared with EDs that did not use ePPID in the bivariate analysis (random effects proportions: 0.66 v. 2.08 WBITs per 10,000 samples, $p = .100$) and in the unadjusted meta-regression model (unadjusted OR: 0.28, 95% CI: 0.09–0.84, $p = .023$), and this effect was significant after controlling for the effects of phlebotomists collecting some or all specimens and rainbow tube collections on the WBIT error proportion in the meta-regression model (adjusted OR: 0.32, 95% CI: 0.11–0.96, $p = .041$) (Table 3).

In the inpatient wards, although ePPID was associated with approximately 2.8 times fewer WBIT errors in the bivariate analysis (0.42 v. 1.17 WBITs per 10,000 samples, $p = .010$), this effect was not significant in either the unadjusted meta-regression model (unadjusted OR: 0.45, 95% CI: 0.20–1.02, $p = .057$) or after controlling for the effect of phlebotomists collecting some or all specimens in the meta-regression model (adjusted OR: 0.45, 95% CI: 0.20–1.01, $p = .054$).

In the outpatient clinics, there was not a significant difference in WBIT errors when comparing sites that used versus those that did not use ePPID in the bivariate analysis (0.30 v. 0.19 WBITs per 10,000 samples, $p = .69$), in the unadjusted meta-regression model (unadjusted OR: 1.79, 95% CI: 0.38–8.56, $p = .464$) or after controlling for the effect of phlebotomists collecting some or all specimens in the meta-regression model (adjusted OR: 1.95, 95% CI: 0.39–9.74, $p = .415$).

TABLE 5 Collection of rainbow tubes and WBIT errors in the emergency department

	EDs collecting rainbow tubes (n = 14)	EDs not collecting rainbow tubes (n = 22)
Samples tested, n	84,966	108,815
WBITs identified, n	20	16
WBITs/10,000 samples (unadjusted)	2.35	1.47
Pooled random effects model WBIT estimate/10,000 samples (95% CI)	1.96[a] (0.91–4.23)	0.76 (0.23–2.48)

EDs, Emergency Departments; WBIT, Wrong Blood in Tube error.
[a]*p*-value for ED + rainbow tubes v. ED − rainbow tubes (mixed effects model): .59.

Only five EDs (14%) utilized phlebotomists to collect some or all samples as compared to 26 inpatient wards (72%) and 26 outpatient clinics (72%). Using phlebotomists in the ED, inpatient wards, or outpatient clinics was not associated with significant differences in WBIT error proportions after controlling for the effects of ePPID and rainbow tube collections in the meta-regression model (Table 4). A minority of ED locations in this study collected rainbow tubes (n = 14, 39%). Rainbow tube

collections in the ED were not associated with significant differences in WBIT error proportions after controlling for the effects of ePPID and phlebotomists collecting some or all specimens in the meta-regression model (Table 5).

4 | DISCUSSION

In this study, we analyzed WBIT errors made during the collection of approximately 1.4 million pretransfusion samples across 39 hospitals. Sites varied considerably in the proportion of samples representing WBIT errors. After normalizing for the total number of samples collected in the three distinct clinical locations with the highest WBIT error proportions (ED, inpatient wards, or outpatient clinics), we confirmed that WBIT error proportions differ based on hospital location. We observed that among these three locations, the ED is the highest-risk area for WBIT errors to occur, followed by inpatient wards, with outpatient clinics having the lowest proportion of WBIT errors. Although we did not study why WBIT errors are more likely in the ED, we speculate that contributing factors may include the nature of the ED work environment with staff tending to multiple patients at one time, rapid patient turnover, staggered staffing shifts leading to multiple sign outs and overall stressful working conditions.[21] This study did not compare risk for WBIT errors in other hospital locations such as the operating room, intensive care unit, or labor and delivery due to lower expected error proportions in these locations. We also did not compare factors that would potentially be associated with errors in these locations (such as use of ePPID or phlebotomists for sample collection) in these areas, again due to lower expected error proportions.

A previous BEST Collaborative study demonstrated a reduced rate of WBIT errors associated with using ePPID.[12] In the present study, we observed a significantly reduced WBIT error proportion associated with using ePPID in the ED. Although use of ePPID was associated with a lower WBIT error proportion in the inpatient wards in the bivariate analysis, this effect was not significant in the meta-regression models, potentially due to the lower WBIT error proportion in the inpatient setting compared with the ED and, therefore, lower precision around the estimated odds ratio for the inpatient setting. Overall, while using ePPID would appear to have the greatest potential benefit in the ED environment, its impact in other hospital settings requires further study.

We found that the use of phlebotomy staff to collect some or all samples was not associated with a significantly reduced WBIT error proportion in the ED, inpatient wards, or outpatient clinics. It was not possible in this study, however, to compare WBIT error proportions among different categories of sample collection staff (phlebotomists, nurses, physicians, etc.) as we did not have access to the category of staff responsible for drawing all samples. Finally, while the inherent risks associated with rainbow tube collections may be mitigated by use of ePPID and/or utilizing phlebotomists to collect some or all samples as suggested by the meta-regression analysis in this study, there remains broad consensus against rainbow tube collections in the ED due to the potential for WBIT errors. In fact, this practice was implicated in one recent high-profile fatality in the US that resulted from a WBIT error.[22]

There are limitations to this study. First, the data collection was retrospective and potentially subject to confounding. Not all WBIT errors identified at participating hospitals may have been reported as such. Further, we only defined WBIT errors as those in which a sample had been accepted and tested in the transfusion service laboratory and found not to match a patient's historic ABO type or type determined with "check sample". Therefore, we likely underestimated overall but not relative WBIT error proportions as we did not account for silent WBIT errors where the typing results match coincidentally or for WBIT errors identified prior to testing either through self-reporting from the clinical area or through sample rejection due to labeling errors or other causes.

In addition, we did not collect hospital demographic data such as the number of beds, surgical volumes, deliveries, emergency department visits or other factors that may better describe each practice setting (academic or nonacademic, urban, suburban or rural, different patient populations, etc.). Therefore, we could not assess the influence of these variables on WBIT errors. There are multiple other potential sources of variation among participating sites that were not directly assessed by this study, including differences in institutional procedures and policies surrounding specimen collection and labeling, training for specimen collection staff, and error reporting and investigation practices. Finally, other factors that could influence specimen collection practices such as types of electronic medical records and/or laboratory information systems in use and participation in national hemovigilance programs and other patient safety initiatives were not evaluated.

Sites self-reported sample collection practices surrounding use of ePPID, use of phlebotomy staff for some or all sample collections, and collection of rainbow tubes in the ED as dichotomous variables (i.e. YES/NO). We were not able to measure actual differences in the total number of samples collected by phlebotomy staff as compared to nursing or other staff. We did not account for different types of ePPID systems in use, or the proportion

of type and screen samples from the ED collected via a rainbow tube as opposed to an order-based draw.

Although we solicited participation from a wide variety of hospitals, the data were contributed primarily by larger facilities, with 30 sites (77%) testing more than 15,000 type and screen samples in 2019. Although we solicited international participation, 35 sites (90%) were from English speaking countries, primarily in Europe and North America. Therefore, these results may not be representative for other practice settings. Future prospective studies may be necessary to address these limitations and further refine our understanding of WBIT errors.

In conclusion, this study demonstrated that the ED clinical setting has a higher risk for WBIT errors when compared to inpatient wards and outpatient clinics. Use of ePPID systems in the ED is associated with reduced risk, and centers planning to implement ePPID should prioritize the ED for early adoption.

CONFLICT OF INTEREST

The authors have disclosed no conflicts of interest.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.

How to cite this article: Dunbar NM, Delaney M, Murphy MF, Pagano MB, Saifee NH, Seheult J, et al. Emergency departments are higher-risk locations for wrong blood in tube errors. Transfusion. 2021;61:2601–10. https://doi.org/10.1111/trf.16588

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