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Bacterial Contamination in Stored Blood for Transfusion and Associated Infectious Risks Among Patients with Cancer at Mbarara Regional Referral Hospital, in Uganda

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Background: Patients with cancer often require supportive transfusion therapy. However, this approach is undermined by the risk of bacterial contamination. This study assessed the bacterial contamination rate, identified the bacterial contaminants and their antimicrobial susceptibility patterns; and the associated infectious risk to patients with cancer at Mbarara Regional Referral Hospital, in southwestern Uganda.

Materials and Methods: This prospective cohort study used a pre-transfusion aliquot of donor blood or components for blood culture. Positive cultures were identified and their antibiotic susceptibility testing was performed using the bioMerieux VITEK 2 compact system. Recipients were assessed for bacterial infection at 48 hours post-transfusion. Data were analyzed using R software and presented as proportions.

Results: We evaluated 376 blood units, with 275 (73.1%) of these being red cell concentrates (RCC). The median storage times for RCC and whole blood (WB) were 23 days (IQR, 18–29 days) and 3 days (IQR, 1–5 days) for platelets (PLT), respectively. Four units (3RCC, 1PLT) had bacterial growth, yielding a contamination rate of 1.1% (95% confidence interval, 0.4–1.8%). *Staphylococcus hominis* and *Bacillus subtilis* were isolated from RCC, while *Staphylococcus capitis* was isolated from PLT. The isolates exhibited variable resistance to erythromycin, clindamycin, teicoplanin, vancomycin, tetracycline, nitrofurantoin, rifampicin, and trimethoprim-sulfamethoxazole. There were 211 recipients whose mean age was 34.1 years (standard deviation: 2.84 years). Of these, 62 (29.4%) had received ≥ 3 donor units, and 146 had been on antibiotics. None of the investigated recipients had a positive bacterial blood culture.

Conclusion: The study found a low bacterial contamination rate of stored blood components underscoring the importance of stringent blood collection precautionary measures. The four bacterial isolates were resistant to common antibiotics, which poses a risk of transmission of antibiotic-resistant strains to immunocompromised recipients with cancer. Notably, there was no infectious risk posed post-transfusion presumably due to the concurrent antibiotic therapy.

Keywords: antibiotic susceptibility, bacterial contamination, patients with cancer, blood, transfusion

Background

Blood and blood component transfusions remain pivotal to patients' supportive care.¹ The need for transfusions has led to a rise in global blood collection, which totaled 118.5 million units in 2023.² Indeed, blood and component transfusions are lifesaving, and ensuring transfusion safety remains a global health priority in all settings.² In sub-Saharan Africa (SSA), blood

transfusion needs are rising, and in 2022–2023, the Uganda Blood Transfusion Services (UBTS) collected 313,659 blood units meeting 70% of the country's blood demands.³

Over the past three decades, strategies focused on donor selection and improved testing have been prioritized to avert the risk of transfusion-transmissible infections (TTIs).^{4,5} In Uganda, UBTS has focused on rigorous pre-donation assessment and mandatory and improved testing of all donor units as recommended by the World Health Organization (WHO) for human immunodeficiency virus (HIV), hepatitis B virus (HBV), hepatitis C virus (HCV), and syphilis.⁶ Despite following WHO guidelines, ensuring the safety of donor blood remains a challenge for low- and middle-income countries (LMICs) where the screening protocol is constrained by funding.^{7,8} Beyond the risks posed by TTIs targeted by WHO screening protocols, bacterial contamination of donor units poses a serious transfusion risk.^{9–11} Bacterial contamination refers to the presence of viable bacteria in a blood component whereas transfusion-transmitted bacterial infection refers to infection in the recipient following transfusion of a contaminated component.² Bacterial contamination may result from donor skin flora introduced during venipuncture, transient donor bacteremia, contamination during blood collection or processing, or proliferation of bacteria introduced into the blood component during storage.² The risk of contamination also varied by blood component; platelets are stored at room temperature, which permits bacterial proliferation, whereas red cell concentrates are stored under refrigeration which limits bacterial growth.⁹

Many high-income settings follow protocols to test donor units for contamination, but most LMICs follow WHO protocols which do not include screening for bacterial contamination. However, the risk of bacterial contamination is approximately 2,500 times higher in LMICs than in high-income countries,^{12,13} potentially leading to direct patient harm through lack of screening. This risk is particularly high for patients with cancer, who often require blood and component transfusions as part of their cancer care.¹⁴ In SSA, 6% of all transfusions are indicated for supportive therapy to patients with cancer.¹⁵ Transfusing bacteria-contaminated blood to patients with cancer can be fatal due to the risk of sepsis, which is generally more severe in patients with cancer due to compromised immune systems.⁹ To date, evidence on the rate of bacterial contamination of blood and blood components intended for transfusion to patients with cancer living in SSA remains scarce, particularly in low-resource settings such as Uganda. A better understanding of the risk of bacterial contamination, the bacterial contaminants and their antimicrobial susceptibility patterns in donor blood and blood components is key to informing practice and policy across the continent and for all LMICs. In this study, we assessed the bacterial contamination rate, identified the bacterial contaminants and their antimicrobial susceptibility patterns in stored blood intended for transfusion; and the associated infectious risk to patients with cancer at Mbarara Regional Referral Hospital (MRRH), in southwestern Uganda.

Materials and Methods

Study Design, Site, and Duration

We carried out a prospective cohort study at MRRH blood bank in southwestern Uganda between August and December 2024. This study was part of the ongoing research that enrolled patients with cancer at MRRH; specifically, patients with hematological malignancies were nested within these studies.^{16,17}

MRRH is a tertiary healthcare facility owned by the Uganda's Ministry of Health, situated about 269.7 kilometers from the capital city, Kampala. MRRH has a bed capacity of approximately 600 and serves over 6 million people across 13 districts in southwestern Uganda and neighboring parts of Rwanda, Tanzania, and eastern Democratic Republic of Congo. Blood recipients (patients with cancer) were attending Mbarara Regional Cancer Centre (MRCC) located at MRRH, an auxiliary of the Uganda Cancer Institute. MRCC has served over 6,000 patients since its inception, approximately 40 patients per clinic day. In 2024, the clinic registered more than 1,400 new patients with cancer.

MRRH operates a blood transfusion laboratory that receives blood and components from the Mbarara Regional Blood Bank, a branch of UBTS. The hospital transfusion laboratory prepares and issues approximately 5000–8000 units of blood and components annually, based on clinical transfusion requests.

Study Population, Sample Size Estimation, and Recruitment Criteria

To assess the bacterial contamination rate among donor blood and components, we evaluated such units that were intended for transfusion to patients with cancer being seen at MRCC. The blood units were collected by the UBTS from healthy, anonymous blood donors following the UBTS protocols.¹⁸ Prospective donors were screened for medical conditions as outlined by UBTS guidelines.¹⁸ All included units were used before the expiry date and passed routine pre-transfusion quality checks for visual hemolysis and turbidity. Transfusion units intended for blood recipients of both sexes and all ages were eligible for inclusion. Post-transfusion peripheral venous blood was obtained from recipients 48 hours after transfusion.¹⁹

Our primary endpoint was the proportion of donor units with bacterial contamination, as defined by a culture of a sample of blood/product from that unit. The sample size for the donor units was calculated using Slovin's formula; $n = N/[1 + N(e^2)]$,²⁰ which was selected to estimate a representative sample from the finite population of donor units transfused at MRRH annually (about 5,000 units as N), and a 5% margin of error (e). Using this formula, we calculated that a total of 371 donor units and components would be needed to define the contamination rate. For recipients, a corresponding number was considered.

We utilized a consecutive sampling strategy for both donor units and recipients. Each unit and multiply transfused recipients were sampled once. For this, a recipient of multiple blood or blood component units was sampled during the first transfusion episode, while the additional units were aliquoted and investigated without an extra blood culture from that recipient. For pediatric recipients unable to receive an entire unit, only the first recipient to be transfused underwent a blood culture investigation.

Study Procedures

Each donor unit was visually inspected, the unit was mixed, and the sampling ports were disinfected using a 70% isopropyl alcohol swab and allowed to air-dry. Without opening, disconnecting, or otherwise breaching the primary blood bag system, about 11mL for whole blood and red cell concentrates, or 6mL for the platelet unit was carefully and aseptically transferred through the sealed pre-attached sterile, non-toxic, non-pyrogenic transfer bag tubing (Poly Medicure LTD, India) using a pre-attached sterile needle. The aliquot was labeled as per the primary unit, and then placed in a disinfected clean carrier box and immediately transported to the bacteriology laboratory at room temperature (about 22 to 29°C) for culture. Red blood cell units aliquoted at night when the bacteriology laboratory was inaccessible were kept at 2–8°C, while platelets were kept at room temperature under constant agitation and cultured the following morning. In a biosafety cabinet, the cap from the culture bottle was removed, and the bottle's rubber septum and still-sealed sampling ports of the transfer bag were disinfected with a 70% isopropyl alcohol swab and allowed to air dry. A sterile blood collection needle was connected to a sampling port, and 10mL (for whole blood and red cell concentrates) or 5mL (for platelets) of the aliquot was aseptically transferred into one BD BactecTM Plus Aerobic/F blood culture bottle (Becton Dickinson, USA).

Forty-eight hours after each blood/component unit was transfused, the recipient's venous blood was collected by sterile venipuncture, where the forearm of the recipient was disinfected using a 70% isopropanol swab to obtain about 10mL (for adults) and 5mL (for pediatrics) of venous blood using a syringe. The blood sample was aseptically inoculated into the respective BD BactecTM Plus Aerobic/F blood culture and transported to the bacteriology laboratory. Inoculated blood culture bottles were aerobically incubated in a Bactec FX 200 instrument (BD Diagnostics, USA) at 37°C for up to seven days (for a negative) or until they were flagged positive by the instrument's automated detection system.²¹ Blood cultures flagging positive for growth were mixed by inversion and approximately 2mL of the bottle's contents were drawn up into a sterile syringe. Two drops of the sample were then inoculated onto sterile media plates of blood agar with 5% sheep and MacConkey agar (Becton Dickinson, USA). The plates were aerobically incubated at 37°C and examined for growth at 24 and 48 hours. Any growths were identified using a Gram stain and standard biochemical tests.^{22,23} Final identification and antibiotic susceptibility testing were performed using the bioMérieux VITEK 2 compact system (bioMérieux, Inc).²¹ Blood culture results were classified as: negative (if there was no growth) or positive (if there was growth). Donor unit and recipient cultures were categorized as: "definite contamination" if both cultures were

positive for the same bacterium; “possible contamination” if the recipient culture was either negative or discordant with the donor unit; or “unable to assess” if the recipient was not cultured.²⁴

Quality Control

Donor units that suspiciously appeared visibly contaminated were discarded. Laboratory working surfaces were disinfected regularly using 70% isopropanol, and personnel changed gloves between procedures. Culture media were prepared according to the manufacturer’s instructions. Each batch of blood culture bottles was checked for turbidity prior to use, and all culture media underwent sterility and fertility checks. A sterility check comprised a medium plate or culture bottle without an inoculum, while a fertility check comprised 0.5mL of a 0.5 MacFarland’s standard of *Staphylococcus epidermidis* (ATCC12228) and *Escherichia coli* (ATCC 25922) on a culture media plate or inoculated into a blood culture bottle. After incubation, all quality controls yielded the expected results. MRRH Laboratory participates in an external quality assurance scheme by the Uganda Central Public Health Laboratories and is accredited by the South African National Accreditation System.

Statistical Analysis

Data were entered in Epi InfoTM (Atlanta, Georgia, USA) and analyzed using R version 4.4.2. Continuous variables were summarized using the mean and interquartile range (IQR). Bacterial contamination was reported as a proportion with 95% confidence interval. Antibiotic susceptibility patterns, donor units, and recipient characteristics were tabulated and described using proportions. Given the small number of positive cultures, the analysis was primarily descriptive, and no casual or inferential conclusions were drawn from the contamination events.

Ethical Approval

The study was approved by the Mbarara University of Science and Technology Research and Ethics Committee (MUST-2024-1505) and the Uganda National Council for Science and Technology (HS4551ES). Written informed consent was obtained from adult recipients or their caregivers. Written informed assent was obtained from recipients under 18 years, and written informed consent was obtained from their parents or legal guardians. All donor units were transfused within 4 hours following the breach in the closed system. This study adhered to the Declaration of Helsinki.

Results

Characteristics of the Donor Units Investigated

Of the 1,351 donor units cross-matched during the study period, 394 (29.2%) were for patients with cancer, and the study investigated 376/394 (95.4%) of these units. Eighteen units that were not investigated were cross-matched and issued when aliquoting for the study procedures was not possible. Of the 376 units, 275 (73.1%) were red cell concentrates (RCC), and 194 (51.6%) were of blood group O. Mean storage times were 23 days (IQR, 18–29 days) for RCC and whole blood (WB), and 3 days (IQR, 1–5 days) for platelets (PLT). The characteristics of the donor units investigated are presented in Table 1.

Bacterial Testing of Donor Units and the Antibiotic Susceptibility Patterns of Isolates

Four donor units (3RCC and 1PLT) tested positive, yielding an overall bacterial contamination rate of 1.1% (95% confidence interval [CI], 0.4–1.8%). The contamination rates were 1.1% for RCC and 2.4% for PLT. The bacterial species isolated included *Staphylococcus hominis*, *Staphylococcus capitis*, and *Bacillus subtilis*. These isolates were susceptible to commonly prescribed antibiotics including benzyl-penicillin, oxacillin, moxifloxacin, linezolid, and tigecycline but resistant to erythromycin, clindamycin, vancomycin, tetracycline, nitrofurantoin, rifampicin, and trimethoprim-sulfamethoxazole. On the other hand, one or more isolates were resistant to erythromycin, clindamycin, teicoplanin, vancomycin, tetracycline, nitrofurantoin, rifampicin, and trimethoprim-sulfamethoxazole (Table 2).

Table 1 Characteristics of Blood Donor Units and Components Evaluated

Variable	Number of Units N = 376	Proportion (%)
Blood components		11.2
Platelets	42	
Red cell concentrates	275	73.1
Whole blood	59	15.7
ABO blood type		
A	102	27.1
AB	9	2.4
B	71	18.9
O	194	51.6

Clinical and Transfusion Characteristics of Recipients

The 376 donor units were transfused to 211 patients with cancer. Recipients were mainly outpatients (64.5%), their mean age was 34.1 years (standard deviation: 2.84 years), and 126 were female. Recipient oncologic diagnoses included leukemia, aplastic anemia, lymphoma, and other cancers. Sixty-two (29.4%) recipients had received ≥ 3 units of blood during their current hospitalization. Only 3 (1.4%) of the recipients (two children and one adult) developed fever within 48 hours of transfusion, and thus were suspected to be transfusion-related adverse events. All the three recipients had a negative blood culture. Overall, 168 (79.6%) were receiving chemotherapy, and 146 (69.2%) had previously received antibiotic therapy (Table 3).

Description of Recipients of Contaminated Blood Components

Among the four recipients who received blood components from which bacterial growth was detected, all were receiving antimicrobial therapy at the time of transfusion. One was a pediatric patient receiving chemotherapy and intravenous gentamicin. The second was an adult outpatient receiving oral levofloxacin. The third was an admitted adult patient receiving intravenous piperacillin, gentamicin, and metronidazole. The fourth was an admitted patient receiving intravenous ceftriaxone/sulbactam. All patients had a negative blood culture was negative.

Associated Infectious Risks Among Recipients

Of the 211 recipients, 176 (83.4%) had post-transfusion blood cultures collected. All four recipients who received the donor units with positive blood cultures were among the 176 recipients investigated and none of which turned positive. The remaining 35 (16.6%) recipients did not undergo blood culture collection because 16 declined consent, and 19 were lost to follow-up. Of 19 lost to follow-up, 11 were discharged, and their telephone numbers were unavailable, and 8 died before the next follow-up. The study could not ascertain the cause of their deaths.

Discussion

The study found bacterial contamination in 4/376 donor units, giving a contamination rate of 1.1%, including one isolate of *Staphylococcus hominis*, one isolate of *Staphylococcus capitis*, and two isolates of *Bacillus subtilis*. These were susceptible to common antibiotics used at MRRH. All the 176 recipients' blood cultures were negative.

The 1.1% bacterial contamination rate from this study lies within the 0.3 to 2.1% range reported platelets indicated for transfusion to patients with cancer at the Uganda Cancer Institute.²⁶ However, the contamination rate in our study was lower than what was previously reported from the general blood recipient populations. For instance, it was reported at 9.2–15.3% in Ethiopia;^{27–29} 9.0–32% in Ghana;^{30–32} 8.8% in Nigeria;³³ 3.1% in Zimbabwe;³⁴ and 1.4% in the Democratic Republic of Congo.³⁵ In previous studies at MRRH, bacterial contamination was 3.5%³⁶ and 3%.³⁷ The low bacterial contamination rate reported in this study may presumably be attributed to the improved pretransfusion cautionary practices, including the present use of in-line diversion pouches,³⁸ improved aseptic culture techniques and

Table 2 Bacterial Isolates Recovered from Donor Blood Cultures and their Antibiotic Susceptibility Patterns

Culture Result	Component	Unit Storage Time (Days)/ Time to Detection (hours)	Antibiotic Susceptibility Pattern (S/I/R)															
			BEN-PEN	OXA	GEN	TOB	LFX	MFX	ERY	CLI	LZD	TEIC	VAN	TET	TG	NFT	RIF	TMP-SMZ
<i>Staphylococcus hominis</i>	Red Cell Concentrates	22/17.5	S	S	S	S	S	S	I	S	S	S	I	S	S	S	S	R
<i>Bacillus subtilis</i>	Red Cell Concentrates	5/14.1	S	S	S	S	S	S	I	S	S	R	S	R	S	S	R	R
<i>Staphylococcus capitis</i>	Platelets	2/9.8	S	S	I	I	S	S	R	R	S	R	R	R	S	S	R	R
<i>Bacillus subtilis</i>	Red Cell Concentrates	23/27.2	S	S	S	S	I	S	R	S	S	R	S	R	S	R	R	S

Abbreviations: I, Intermediate; R, Resistant; S, Sensitive; BENPEN, Benzyl-Penicillin; OXA, Oxacillin; GEN, Gentamycin; TOB, Tobramycin; LFX, Levofloxacin; MFX, Moxifloxacin; ERY, Erythromycin; CLI, Clindamycin; LZD, Linezolid; TEIC, Teicoplanin; VAN, Vancomycin; TET, Tetracycline; TG, Tigecycline; NFT, Nitrofurantoin; RIF, Rifampicin; TMP-SMZ, Trimethoprim/Sulfamethoxazole.

Table 3 Clinical and Transfusion Characteristics of Patients with Cancer at MRRH Who Received the Transfused Units Described in Table 1

Characteristics	Number of Recipients N = 211	Percentage
Age, years		
< 18	57	27.0
≥ 18	154	73.0
Sex		
Female	126	59.7
Male	85	40.3
Suspected transfusion adverse events		
Yes (fever [§])	3	1.4
Unknown	208	98.6
Attendance status		
Outpatients	136	64.5
Inpatients	75	35.5
Oncologic diagnosis		
Acute leukemia	13	6.2
Chronic leukemia	28	13.3
Aplastic anemia	16	7.6
Lymphoma	56	26.5
Hemoglobinopathies	17	8.1
Other cancers	81	38.4
Transfusion episodes		
0–3	149	70.6
≥ 3	62	29.4
Received chemotherapy		
Yes	168	79.6
No	41	19.4
Not recorded	2	1.0
History of antibiotic use[†]		
Yes	146	69.2
No	51	24.2
Unknown	14	6.6
Other co-morbidities		
HIV infected	51	24.2
Diabetes	79	37.4
Others (TB, hypertension, sickle cell disease)	34	16.1
None recorded	47	22.3

Notes: [§]Three recipients developed pyrexia defined as an increase in body temperature by $\geq 1^{\circ}\text{C}$ within 48 hours of transfusion.²⁵ [†]History of antibiotic use was self-reported or obtained from the recipient treatment file.

hygiene practices. However, because this study did not directly assess changes in these practices over time, the extent to which they contributed to the lower contamination rate cannot be established. Compared to previous bacterial contamination rates, this finding suggests improvement in the UBTS processes over time; however, differences in study populations, methods and sampling periods should also be considered when making such comparisons.

Bacterial growth was observed in PLT and RCC units as previously reported.^{26,27,35} PLTs are stored at room temperature with continuous agitation in gas-permeable bags, which fosters the growth of bacteria, and they are known to have a relatively

high contamination rate.³⁴ In contrast, the susceptibility of RCC to bacterial contamination is less well-known. However, given that the majority of the components in this study were RCC, this finding may seemingly match the observed bacterial contamination rate. Moreover, two of three RCC units with bacterial growth had a storage duration of ≥ 20 days, which is consistent with previous reports suggesting that prolonged storage may facilitate bacterial proliferation.^{39,40} However, the small number of contaminated units in this study does not allow an association between storage duration and bacterial contamination to be established. Excursions in storage conditions may contribute to this risk, which could potentially be mitigated with shortened storage time.

Among the isolates, *Staphylococcus hominis* and *Staphylococcus capitis* are coagulase-negative-Staphylococci (CoNS) and common skin commensals previously isolated in donor blood.^{41–44} These skin flora may enter a donor unit during phlebotomy and multiply during long storage time to a level sufficient to be detected in routine culture procedures.⁴⁵ In contrast, *Bacillus subtilis* is mainly an environmental contaminant that can adhere to surfaces through spore formation.⁴⁶ Its isolation from donor blood may therefore reflect environmental contamination during blood collection, processing, handling, or storage. However, environmental sampling was not performed in this study; therefore, the precise source of contamination could not be established. However, it has also been reported in donor units³⁵ and infections with *Bacillus subtilis* can cause sepsis and endocarditis in immunocompromised patients.⁴⁷ Prior studies isolated many of these same organisms, in addition to others. In Nigeria and Ethiopia, *Staphylococcus aureus*, CoNS, *Bacillus*, and *Listeria* species were isolated.^{27,33} At the Uganda Cancer Institute, *Streptococcus viridans*, CoNS, and *Bacillus* species were isolated.²⁶ However, prior studies at MRRH isolated *Staphylococcus aureus* and *Streptococcus viridans*;³⁶ *Staphylococcus aureus*, *Micrococcus*, and *Corynebacterium* species.³⁷ Most isolates from these studies are common skin flora, supporting their origin as contaminants at the time of donor unit collection. Although the precise access of the isolated bacteria to donor bags could not be ascertained; they may be due to sub-optimal skin disinfection and inconsistent aseptic techniques. Environmental contamination during processing, handling, or storage may also be possible, particularly for spore-forming organisms such as *Bacillus species*. This finding is similar to the previous reports^{9,27,32,35,48} and could indicate practice gaps that undermine blood safety, including contamination during the phlebotomy process.^{27,49,50} Detection of bacterial growth in prior cultures demonstrates why bacterial testing of blood/component units is recommended. However, testing remains costly and unavailable in LMICs, which rely on the less sensitive process of visually inspecting donor units.⁵¹ The isolation of bacteria from donor units in our study and others from LMICs points to significant safety concerns necessitating urgent attention.

The antimicrobial resistance observed among the isolates is an additional concern for transfusion safety particularly in patients with cancer who may be vulnerable to severe infections and require prompt antimicrobial treatment. The presence of resistant bacterial in blood intended for transfusion raises the potential for transmission of antimicrobial-resistant organisms to recipients if contaminated units are transfused. Although no transfusion-associated bacterial infection was detected in this study, the small number of contaminated units and incomplete recipient follow-up limit the ability to assess the clinical consequences of these resistant isolated. Nevertheless, these findings highlight the importance of strengthening preventive measures during blood collection and handling and of continued surveillance of bacterial contamination in our setting.

Three participants in our study developed post-transfusion pyrexia with negative blood cultures, which suggests that they may have experienced a febrile non-hemolytic transfusion reaction, which has non-bacterial causes.^{52,53} In fact, all transfusion recipients in our study who underwent blood culture had negative cultures. This finding may be attributed to antibiotic therapy in the recipients, as previously reported.²⁶ In this study, 146 (69.2%) of the 211 recipients were receiving concurrent antibiotic treatment which may have reduced the likelihood of detecting bacterial infection following transfusion, particularly among patients with cancer due to compromised immunity, which may afford them some protection against transfusion-related infections. However, because antibiotic use was not controlled for and there was no comparison group of recipients, its contribution to the negative blood cultures cannot be fully established. Furthermore, the BD BactecTM culture media used in this study contain resins that neutralize antibiotics and facilitate the recovery of viable bacteria in patients receiving antibiotics. Therefore, the absence of bacterial growth in the recipients' blood cultures may in part unlikely to be attributed to antibiotic-mediated inhibition of bacterial recovery in the culture system.

Our study results should be interpreted in light of some limitations. The study primarily relied on aerobic culture media (BD Bactec™ Plus Aerobic/F and BD Bactec™ Peds Plus™/F), which are not optimized for the detection of anaerobic bacteria and fungi. Thus, the study may not have captured contamination caused by these organisms. More, patient follow up was incomplete, with 35(16.6%) of participants not undergoing follow-up blood culture collection because 16 declined consent, and 19 were lost to follow-up. This may have limited our ability to fully assess the infectious outcomes. In addition, we investigated a limited number of platelet units because few were readily available at MRRH. Also, when a single donor unit was divided for transfusion to multiple recipients (quadruple packs), only the first recipient transfused from that unit underwent blood culture investigation. Consequently blood stream infection among subsequent recipients receiving aliquots from the same unit could not be systematically assessed. Finally, due to cost constraints, we performed a single blood culture despite the recommendation to perform multiple cultures, and 35 recipients (16.6%) did not undergo blood culture, which could lead to underestimation of the post-transfusion risk. It should also be noted that amongst the four positive cultures, environmental contamination cannot be excluded. In this study, 29 (7.7%) of the donor blood units were aliquoted when it was not possible to access and perform the blood culture immediately; this meant culturing the samples the subsequent morning, and this is associated with bias. There was also potential bias in ascertaining antibiotic use since this was often self-reported and dependent on accurate recall and reporting.

Conclusion

This study found a low bacterial contamination rate underscoring the importance of stringent blood collection precautionary measures. Isolates were resistant to common antibiotics, which poses a risk of transmission of antibiotic-resistant strains to immunocompromised cancer recipients. Of note, no post-transfusion blood cultures from transfusion recipients demonstrated growth, which may be due to concurrent antibiotic therapy. However, incomplete follow-up and the high prevalence of antibiotic use among recipients limit interpretation of this finding and preclude attributing the negative cultures to antibiotic therapy. The isolation of bacterial contaminants in donor blood ready for transfusion highlights the risk of transfusing unsafe blood to recipients. Thus, the study emphasizes the need for best practices during blood collection and processing, as well as strengthening bacteriological surveillance and blood safety checks for donor units. The study findings call for preventive and corrective measures to minimize contamination of donor units. Further research is needed to identify the source(s) of bacterial contamination in donor units to evaluate practical, affordable, and rapid approaches for detecting contaminated blood components in resource limited settings.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors declare no conflict of interest in this work.

References

1. Yilmaz S, Bölükbaş F, Sezer Z, et al. A study to reveal the rationales of overnight transfusion in a training and research hospital. *Med J Armed Forces India*. 2025;81(2):212–218. doi:10.1016/j.mjafi.2024.08.014
2. World Health Organization. Blood safety and availability. 2023. Available from: <https://www.who.int/news-room/fact-sheets/detail/blood-safety-and-availability>. Accessed September 7, 2026.
3. Available from: www.redcrossug.org/health-and-social-services/blood-donor-recruitment/. Accessed January 15, 2025.
4. Busch MP, Bloch EM, Kleinman S. Prevention of transfusion-transmitted infections. *Blood J Am Soc Hematol*. 2019;133(17):1854–1864.
5. Goel R, Tobian AAR, Shaz BH. Noninfectious transfusion-associated adverse events and their mitigation strategies. *Blood J Am Soc Hematol*. 2019;133(17):1831–1839.
6. Uganda Blood Transfusion Services. UBTS-QA. Available from: https://www.ubts.go.ug/quality_assurance.html. Accessed September 7, 2026.
7. Puerto-Meredith S, Singogo E, Chagomerana M, et al. Systematic review of prevalence and risk factors of transfusion-transmissible infections among blood donors, and blood safety improvements in Southern Africa. *Transfus Med*. 2023;33(5):355–371. doi:10.1111/tme.12988
8. Kanagasabai U, Selenic D, Chevalier MS, et al. Evaluation of the WHO global database on blood safety. *Vox Sang*. 2021;116(2):197–206. doi:10.1111/vox.13001
9. Jacobs MR, Zhou B, Tayal A, Maitta RW. Bacterial contamination of platelet products. *Microorganisms*. 2024;12(2):258. doi:10.3390/microorganisms12020258
10. Narayan S, Poles D, Bellamy M, Spinks C, Mistry H, Carter-Graham S. on behalf of the Serious Hazards of Transfusion (SHOT) steering group. The 2021 annual SHOT report. 2022.
11. Centre for Disease Control and Prevention. Clinical guidance for bacterial contamination and blood safety. Atlanta (GA). 2024. Available from: <https://www.cdc.gov/blood-safety/hcp/clinical-guidance/index.html>. Accessed September 7, 2026.
12. Bloch EM, Vermeulen M, Murphy E. Blood transfusion safety in Africa: a literature review of infectious disease and organizational challenges. *Transfus Med Rev*. 2012;26(2):164–180. doi:10.1016/j.tmr.2011.07.006
13. Kyeyune-Byabazaire D, Hume HA. Towards a safe and sufficient blood supply in Sub-Saharan Africa. *ISBT Sci Ser*. 2019;14(1):104–113. doi:10.1111/vox.12468
14. Gale M, Dhawan V, Pastores SM. *Patients with Malignancy. Hematologic Challenges in the Critically Ill*. Springer. 2018;215–236.
15. Dhabangi A, Dziki WH, Idro R, et al. Blood use in sub-Saharan Africa: a systematic review of current data. *Transfusion*. 2019;59(7):2446–2454. doi:10.1111/trf.15280
16. Taremwā IM, Niyonzima N, Ashaba S, et al. Red blood cell alloantibodies in transfused patients with haematological malignancies at Mbarara Regional Referral Hospital and the Uganda Cancer Institute: prevalence, specificities and associated factors. *Vox Sang*. 2026;121(5):614–624. doi:10.1111/vox.70198
17. Taremwā IM, Niyonzima N, Ashaba S, et al. The incidence of hemolytic and serologic transfusion reactions among patients with hematological malignancies at Mbarara Regional Referral Hospital and the Uganda Cancer Institute, in Uganda. *J Blood Med*. 2026;17:589504. doi:10.2147/JBM.S589504
18. 2024. Available from: www.ubts.go.ug/. Accessed December 3, 2024.
19. Transfusion Transmitted Infection Section, Blood Safety Surveillance and Healthcare Acquired Infections Division, Public Health Agency of Canada. Guidelines for investigation of suspected transfusion transmitted bacterial contamination. *Can Commun Dis Rep*. 2008;34(Suppl 1):1–8.
20. Slovin E. Slovin's formula for sampling technique. 1960.
21. bioMérieux SA. VITEK[®] 2 Compact automated identification and susceptibility testing system. Marcy-l'Etoile, France: bioMérieux; Available from: <https://www.biomerieux.com>. Accessed September 7, 2026.
22. Delost MD. *Introduction to Diagnostic Microbiology for the Laboratory Sciences*. Jones Bartlett Learning; 2020:600.
23. Franco-Duarte R, Černáková L, Kadam S, et al. Advances in chemical and biological methods to identify microorganisms—from past to present. *Microorganisms*. 2019;7(5):130. doi:10.3390/microorganisms7050130
24. Martin IW, Cohn CS, Delaney M, et al. Limitations of current practices in detection of bacterially contaminated blood products associated with suspected septic transfusion reactions. *Transfusion*. 2021;61:2414–2420. doi:10.1111/trf.16545
25. Centers for Disease Control and Prevention (CDC). *National Healthcare Safety Network (NHSN) Biovigilance Component: Hemovigilance Module Surveillance Protocol. Version 2.0*. Atlanta (GA): Division of Healthcare Quality Promotion, National Centre for Emerging and Zoonotic Diseases; 2018:1.
26. Hume HA, Ddunga H, Angom R, et al. Platelet transfusion therapy in sub-Saharan Africa: bacterial contamination, recipient characteristics, and acute transfusion reactions. *Transfusion*. 2016;56:1951–1959. doi:10.1111/trf.13594
27. Agzie M, Niguse S, Tsegay E, Kahsay G, Mahmud MA. Bacterial contaminants of stored blood and blood components ready for transfusion at blood banks in Mekelle, Northern Ethiopia. *BMC Res Notes*. 2019;12(1):169. doi:10.1186/s13104-019-4217-0
28. Wondimu H, Addis Z, Moges F, Shiferaw Y. Bacteriological safety of blood collected for transfusion at university of gondar hospital blood bank, Northwest Ethiopia. *Int Sch Res Notices*. 2013;2013:308204

29. Esmael A, Dagnew Z, Degu G. Bacterial contamination of stored blood ready for transfusion at a referral hospital in Ethiopia. *J Clin Res Bioeth.* 2014;5(2):176.
30. Opoku-Okrah C, Feglo P, Amidu N, Dakorah MP. Bacterial contamination of donor blood at the Tamale teaching Hospital, Ghana. *Afr Health Sci.* 2009;9(1):13–18.
31. Adjei AA, Kuma GK, Tettey Y, et al. Bacterial contamination of blood and blood components in three major blood transfusion centers, Accra, Ghana. *Jpn J Infect Dis.* 2009;62(4):265–269. doi:10.7883/yoken.JJID.2009.265
32. Aidoo NB, Ramirez-Arcos S, Gillard L, Azumah DE, Adatsi A. Preliminary determination of bacterial contamination of whole blood units in a Ghanaian blood bank: providing evidence to improve transfusion safety. *Vox Sang.* 2025;120(5):503–508. doi:10.1111/vox.13806
33. Bolarinwa RA, Aboderin OA, Odetoyin BW, Adegunloye AB. Bacterial contamination of blood and blood components in a tertiary hospital setting in Nigeria. *Int J Infect Control.* 2011;7(1):1–6.
34. Makuni N, Simango C, Mavengwa RT. Prevalence of bacterial contamination in blood and blood products at the national blood service Zimbabwe. *J Infect Develop Countries.* 2015;9(4):421–424. doi:10.3855/jidc.5428
35. Heroes AS, Ndalingos N, Kalema J, et al. Bacterial contamination of blood products for transfusion in the Democratic Republic of the Congo: temperature monitoring, qualitative and semi-quantitative culture. *Blood Transfusion.* 2020;18(5):348–358. doi:10.2450/2020.0108-20
36. Aloysius GB, Joel B, Apece R II, Byarugaba F. Bacterial contamination of blood and blood products at Mbarara Regional blood bank in rural South Western Uganda. *Adv Infect Dis.* 2013;3(3):205–209. doi:10.4236/aid.2013.33030
37. Rukundo HAM, Taremwa IM, Muwanguzi E, Ndyomubantu M, Byarugaba F, Natukunda B. Assessment of the quality of stored blood for transfusion at Mbarara Regional Referral Hospital, Southwestern Uganda. *J Blood Med.* 2019;10:161–169. doi:10.2147/JBM.S205708
38. Satake M, Mitani T, Oikawa S, et al. Frequency of bacterial contamination of platelet concentrates before and after introduction of diversion method in Japan. *Transfusion.* 2009;49(10):2152–2157. doi:10.1111/j.1537-2995.2009.02243.x
39. Lee CK. Bacterial contamination of blood products. *ISBT Sci Ser.* 2011;6(1):427–431. doi:10.1111/j.1751-2824.2011.01527.x
40. Martínez F, Tarrand J, Lichtiger B. Impact on patient outcome following transfusion of bacterially contaminated platelets: the M.D. Anderson cancer center experience. *Am J Clin Pathol.* 2010;134(2):207–212. doi:10.1309/AJCPS9YV7YTOMRRH
41. Gautam VG, Nandini Sethuraman NS, Ramanpreet Kaur RK, Suchet Sachdev SS, Neelam Marwaha NM, Pallab Ray PR. Changing epidemiology of coagulase-negative staphylococci in normal flora of skin. *Indian J Med Microbiol.* 2017;35(2):277–278.
42. Szczuka E, Krzyńska S, Bogucka N, Kaznowski A. Multifactorial mechanisms of the pathogenesis of methicillin-resistant *Staphylococcus hominis* isolated from bloodstream infections. *Antonie van Leeuwenhoek.* 2018;111(7):1259–1265. doi:10.1007/s10482-017-1007-3
43. Natsis NE, Cohen PR. Coagulase-negative Staphylococcus skin and soft tissue infections. *Am J Clin Dermatol.* 2018;19(5):671–677. doi:10.1007/s40257-018-0362-9
44. Crepin DM, Chavignon M, Verhoeven PO, Laurent F, Josse J, Butin M. *Staphylococcus capitis*: insights into epidemiology, virulence, and antimicrobial resistance of a clinically relevant bacterial species. *Clin Microbiol Rev.* 2024;37(1):e00118–23. doi:10.1128/cmr.00118-23
45. Cameron DR, Jiang JH, Hassan KA, et al. Insights on virulence from the complete genome of *Staphylococcus capitis*. *Front Microbiol.* 2015;6:980. doi:10.3389/fmicb.2015.00980
46. Koca Ö. Microbiological characteristics of Bacillus subtilis species and their relationship with hospital infections. In: *Bacterial, Viral, Fungal and Parasitic Coinfections*. IntechOpen; 2024.
47. d'Azevedo PA, Trancesi R, Sales T, Monteiro J, Gales AC, Pignatari AC. Outbreak of *Staphylococcus hominis* subsp. novobiosepticus bloodstream infections in Sao Paulo city. *Brazil J Med Microbiol.* 2008;57(2):256–257. doi:10.1099/jmm.0.47345-0
48. Sugai Y, Sugai K, Fuse A. Current status of bacterial contamination of autologous blood for transfusion. *Transfus Apheresis Sci.* 2021;24(3):255–259. doi:10.1016/S1473-0502(01)00067-2
49. Ahmad Y, Heroes A, Hume HA, et al. Bacterial contamination of blood products in Africa. *Transfusion.* 2021;61(3):767–780. doi:10.1111/trf.16262
50. Jindal S, Agarwal S. Is your blood bag safe for transfusion? Bacterial screening of donor blood and its components: an essential infection control tool for safe transfusion practice. *J Patient Safety Infect Control.* 2024;11(2):23–29. doi:10.4103/jpsic.jpsic_6_24
51. Janatpour KA, Paglieroni TG, Crocker VL, DuBois DJ, Holland PV. Visual assessment of hemolysis in red blood cell units and segments can be deceptive. *Transfusion.* 2004;44(7):984–989. doi:10.1111/j.1537-2995.2004.03315.x
52. Savage WJ. Transfusion reactions. *Hematol/Oncol Clin.* 2016;30(3):619–634. doi:10.1016/j.hoc.2016.01.012
53. El-Radhi AS. Fever in non-infectious diseases. In: *Clinical Manual of Fever in Children*. Cham: Springer International Publishing; 2018:141–177.