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BACTERIAL CONTAMINATION IN STORED BLOOD PRODUCTS AT HEMATOLOGY LAB OF HAYATABAD MEDICAL COMPLEX PESHAWAR

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Abstract

Background: *The problem of bacteria contamination of stored blood products is a possible cause of transfusion-related infections even in the era of development of storage and screening methods. The differences in the level of contamination between different locations indicate the impact of environmental factors, storage and aseptic handling.*

Objective: *To determine the frequency and pattern of bacterial contamination in stored blood products at the Hematology Laboratory of Hayatabad Medical Complex (HMC), Peshawar.*

Methodology: *This study was cross-sectional, conducted from 9th November 2024 to 10th May 2025 and involved 184 stored blood products (whole blood, packed red cells and platelet concentrates). The samples were cultured in nutrient broth and subcultured on Blood and MacConkey agar at 37 ^{0}C during 24-48 hours. The SPSS-25 was used to analyze data, and Chi-square test applied at p 0.05 was considered a statistically significant value.*

Results: *The contaminated blood products frequency was 12(6.4%) among which 172 (93.6%) were sterile and is frequent in whole blood (10.0%), followed by packed red cells (4.9%) and platelet concentrates (4.8%) (p = 0.22). statistically significant association was not observed with donor blood group (p = 0.96), however, samples stored >14 days demonstrate significantly higher contamination (16.7%) compared to those stored ≤14 days (3.5%) (p = 0.031). Mean storage temperature was also significantly higher in contaminated units (5.91 ± 1.35°C vs. 3.77 ± 0.97°C; p < 0.001). Coagulase-negative* Staphylococcus *was the most common isolate (33.3%).*

Conclusion: *A low but clinically significant contamination rate was observed. Regular sterility monitoring, optimal temperature maintenance, and strict aseptic techniques are essential to ensure transfusion safety.*

INTRODUCTION

Blood and blood products are routinely used in the therapeutic medicine for management of a variety of conditions ranging from as benign as anemia and dengue to as lethal as life threatening hematological malignancy [1,2]. Owing to the widespread availability of the advanced refrigeration methods, preservative solutions, anticoagulants, modern design blood bags and testing facility for screening the blood and its products for virulent agents, the availability of blood products have seen a robust increment [3]. Although, with the availability of next generation screening tests, the chances of transmission of bacterial contaminants through the transfusion of stored blood have reduced dramatically in Pakistan as well as on the global

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scale, yet there is always a chance of such incident to occur [4,5].

In this instance, a study reported that the frequency of bacterial contamination of stored blood products was 20% [6]. In this study it was also reported that 10% of the samples showed the growth of Staphylococcus aureus while 10% showed the growth of Staphylococcus epidermidis [6]. In another study, it was reported that the frequency of bacterial contamination of stored blood products was 9.2% with most common bacteria isolated being coagulase negative Staphylococcus (27.7%) followed by Bacillus spp. (22.2%), Staphylococcus aureus (16.6%), Pseudomonas aeruginosa (16.6%), Streptococcus pneumonia (11.1%) and Escherichia coli (5.5%) [7]. In one study it was reported that the highest frequency of bacterial contamination was seen in stored whole blood (5.6%) followed by platelet concentrates (3.9%) and packed red cells (4.3%) [8].

Aforementioned studies show that a wide variation exists regarding the frequency of bacterial contamination of stored blood products in different geographical regions of the world likely due to differences in the storage capabilities and standards across different regions of the world. Additionally, no local data is available in this regard. Therefore, present study is being conducted with the aim to determine the frequency of bacterial contamination of stored blood products at hematology lab of HMC, Peshawar. Results of present study will help assessing and auditing the storage standards and practices at this institution and will help in making necessary improvements in this regard.

METHODOLOGY

The study design was cross sectional, conducted at the Hematology department, Hayatabad Medical Complex, Peshawar from *9th November 2024 to 10th May 2025*, considering 184 blood sample products (whole blood, platelet concentrates and packed red cells) obtain for transfusion donation and stored in the hematology lab of HMC, calculated through sample size WHO formula, keeping the confidence interval of 95%, marghin of error 2.8% and anticipated frequency of bacterial contamination of platelet concentrates as 3.9% [8]. Blood samples obtained from febrile patients for culture and sensitivity testing was excluded from the study. Bacterial contamination was defined as the growth of microorganisms from a 5 mL sample of stored blood product cultured in nutrient broth at 37°C for 24 hours, followed by subculturing on Blood agar and MacConkey agar plates and incubation at 37°C for 24–48 hours. The bacteria isolated included *Coagulase-negative Staphylococcus*, *Bacillus* spp., *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Streptococcus pneumoniae*, and *Escherichia coli*.

Ethical approval was obtained from HMC research committee under Approval No. 2238; dated: 31.10.2024. Complete information about blood product including whole blood, platelet concentrates, red cell concentrate, duration of storage, temperature of storage and donor blood group was documented. A 5ml of blood sample was collected from tubing of each blood component. The sampling was performed under a laminar air flow following all aseptic precautions, the tubing of blood component unit bag was first stripped using a stripper and the tubing was disinfected using methylated spirit followed by collection of 5ml blood component sample by puncturing of the blood bag tubing with a sterile needle and syringe. The 5ml sample so collected was then dispensed in nutrient liquid broth media for assessing presence of bacterial contamination. This was followed by subcultures in Blood agar and MacConkey agar culture plates and growth was evaluated after incubation at 37°C for 24-48hours. Bacteria being isolated on the culture was documented. In case of bacterial contamination, stored blood product was discarded and wasted as per hospital infectious material wasting protocols. All the data was collected through a predesigned proforma.

SPSS-25 was used for analysis purpose. The numeric variables (duration and temperature of storage) was presented as mean ± SD or median (IQR) after checking data normality by Shapiro-Wilk test while frequency and percentages was used for categorical variables (blood product, donor blood group, presence of bacterial contamination and bacteria isolated). Bacterial contamination was stratified by blood product, duration of storage and donor blood group to deal with effect modifiers. Post- stratification Chi-square test was used keeping p-value≤ 0.05 as statistically significant.

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RESULTS

Among the 184 stored blood product samples, the majority were packed red cell concentrates 82 (44.6%), followed by whole blood 60(32.6%) and platelet concentrates 42 (22.8%). The mean duration of storage was 13.33 ± 4.21 days, and the mean storage temperature was 4.54 ± 1.63°C. Overall, 12 samples (6.4%) showed bacterial contamination, while 172 (93.6%) were free of contamination (Table 1).

Contamination was more frequent in whole blood 6 (10.0%), compared to packed red cell concentrates 4 (4.9%) and platelet concentrates 2 (4.8%), though this difference was not statistically significant (p = 0.22). Similarly, contamination rates did not vary significantly among donor blood groups (A: 3 (6.5%), B: 3 (6.0%), O: 4 (6.6%), AB: 2 (7.4%); p = 0.96) (Table 2). Blood products stored for more than 14 days exhibited a higher contamination rate 7 (16.7%) than those stored for ≤14 days 5 (3.5%). This difference was statistically significant (p = 0.031), with an odds ratio of 4.06 (95% CI: 1.17–14.05), indicating that samples stored beyond 14 days were over four times more likely to become contaminated (Table 3). The most commonly isolated organisms were coagulase-negative Staphylococcus 4 (33.3%). Table 4

Contaminated samples had significantly longer storage durations (15.9 ± 5.9 vs. 11.7 ± 4.9 days; p = 0.004) and higher storage temperatures (5.91 ± 1.35°C vs. 3.77 ± 0.97°C; p < 0.001). Table 5

Table 1: Stored blood products characteristics (n = 184)

Type of blood product (n, %)	Whole blood	60 (32.6%)
	Packed red cell concentrate	82 (44.6%)
	Platelet concentrate	42 (22.8%)
Duration of storage (days)- Mean ± SD		13.33 ± 4.21
Storage temperature (°C)- Mean ± SD		4.54 ± 1.63
Donor blood group (n, %)	A	46 (25.0%)
	B	50 (27.2%)
	O	61 (33.2%)
	AB	27 (14.6%)
Contaminated Status (n, %)	Contaminated	12 (6.4%)
	Not contaminated	172 (93.6%)

Table 2: Bacterial contamination by blood product type and group

		Contaminated	Not Contaminated	P value
Blood product	Whole blood	6 (10.0%)	54 (90.0%)	0.22
	Packed red cell concentrate	4 (4.9%)	78 (95.1%)	
	Platelet concentrate	2 (4.8%)	40 (95.2%)	
Donor blood group	A	3 (6.5%)	43 (93.5%)	0.96
	B	3 (6.0%)	47 (94.0%)	
	O	4 (6.6%)	57 (93.4%)	
	AB	2 (7.4%)	25 (92.6%)	

Table 3: Bacterial contamination by storage duration

Storage duration	Contaminated	Not contaminated	P value	Odd Ratio
≤ 14 days	5 (3.5%)	137 (96.5%)	0.031	4.06 (1.17–14.05)
> 14 days	7 (16.7%)	35 (83.3%)		

Table 4: Distribution of bacterial isolates in contaminated samples (n=25)

Organism isolated	contaminated (n, %)
Coagulase-negative Staphylococcus	4 (33.3%)
Bacillus spp.	2 (16.7%)
Staphylococcus aureus	2 (16.7%)

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Pseudomonas aeruginosa	2 (16.7%)
Streptococcus pneumonia	1 (8.3%)
Escherichia coli	1 (8.3%)

Table 5: Comparison of contamination status

Variable	Contaminated	Not contaminated	P value
Duration of storage (days)- Mean ± SD	15.90 ± 5.9	11.65 ± 4.9	0.004
Storage temperature (°C)- Mean ± SD	5.91 ± 1.35	3.77 ± 0.97	< 0.001

DISCUSSION

The findings of this study demonstrated a relatively low contamination rate of 6.4%, compared to earlier literature reported a 14.2% [9] contamination rate in platelet concentrates, while a study conducted in 2022 highlighted bacterial contamination as a persistent challenge in Pakistani blood banks [10]. On the contrary, other researches conducted internationally were lower, with rates ranging between 0.44% and 3% [11,12]. This difference is probably caused by differences in donor screening, environmental factors, storage facilities, and aseptic manipulation practices in different institutions and geographical locations.

Whole blood appeared to be the most contaminated product, and platelet concentrates and packed red cell were the following. The trend is consistent with the literature that has found a greater contamination rate in whole blood (18.75) than in other parts [13]. Whole blood is more prone to bacteria increase since it is not undergone through much processing and any contamination caused during collection may continue to exist during storage. In contrast, packed red cells and platelets showed lower contamination frequencies. The RBCs are maintained at 4°C which prevents most mesophilic implying that most bacteria are represented by mesophilic types [14]. Though, even cold-stored products have to be carefully temperature controlled, e.g., psychrotrophic bacteria, like *Pseudomonas fluorescens*, can still survive or grow slowly at these temperatures. Platelet concentrates, which are kept at 220 C are said to be susceptible to the growth of bacteria because most skin flora have good conditions of storage. Contamination of platelets was reported to be between 0.44% and 3% [11,12], whereas the Irish Blood Transfusion Service data reported rates of 0.125 to 0.191% [15].

There was also a considerable level of relation between length of storage (> 14 days) and bacterial contamination, proving that the risk of contamination increases with the length of storage. This observation is consistent with the literature that psychrotrophic bacteria could attain measurable levels within the second week of storage even in 4 o C [14]. On the same note, another study also noted that it is important to restrict storage time of platelet concentrates to 6 days at 22 ^{0}C in order to enhance bacterial growth. [11].

Temperature fluctuations during storage were also found to be critical. The contaminated units in the current study exhibited higher mean storage temperatures compared to uncontaminated ones, reinforcing evidence from El-Desoukey et al, that a small variation in the suggested temperature may result in hemolysis and further the development of bacteria [16]. In locations with limited resources such as Pakistan, where power supply may not be very predictable, cold-chain transport device battery-based has been suggested as a viable solution in ensuring that the temperature remains stable [17]. The current results point out the significance of a tight control of temperature, constant checking, and frequent changes of blood stocks to avoid contamination. Coagulase-negative Staphylococcus (33.3) was the most prevalent bacteria isolate in this study, then there was Bacillus spp., Staphylococcus aureus, Pseudomonas aeruginosa, Streptococcus pneumoniae and Escherichia coli. Such distribution is similar to the world statistics of the majority of contaminants being skin commensals or environmental organisms that are introduced in the collection or handling [18]. Coagulase-negative Staphylococcus and Bacillus species are predominant implying either contamination by skin flora or airborne spores,

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potentially during venipuncture or component preparation.

Similar tendencies were identified by Aidoo (2024), who discovered that a maximum of 32% of donor blood units in Ghana had carried skin commensals [18]. The appearance of Staphylococcus aureus and Pseudomonas aeruginosa is an alarming issue, as these bacteria are capable of provoking lethal sepsis of transfusion, when not revealed. The results highlight the importance of aseptic precautions including chlorhexidine-alcohol in the preparation of venipuncture sites and the use of sterile blood transfer equipment. As shown by Doi et al. (2024), these interventions decreased the contamination rates by two percent to one percent when incorporated in a combined infection-controlling strategy [19].

In this experiment, the donor blood group had no relationship with bacterial contamination as earlier established literature has described [18]. This proves that the risk of contamination is mostly connected with environmental, procedural and storage conditions rather than the peculiarities of the donors themselves. Thus, the conventional infection prevention protocols are supposed to be used in all donor samples equally. Even a small proportion of contaminated blood products can have serious clinical consequences. Transfusion-transmitted bacterial infections (TTBIs) may range from mild febrile reactions to fatal septicemia. Mehdaoui et al, found that platelet concentrates even containing only 0.44% contamination rate were related to severe transfusion reactions such as septic shock. Additionally, the transfusions of blood with skin commensals, which is sometimes clinically inconsequential, can cause the consumption of unnecessary antibiotics and extended hospital stay [20]. Therefore, the principle of zero tolerance towards contamination is still among the foundations of transfusion safety.

LIMITATIONS AND FUTURE IMPLICATION

The study limitation includes its single centre setup which does not reflect the practices on wide ranges. No molecular identification of bacteria was carried out, which restricted accuracy to species. However, the research gives an important baseline information on the rate of bacterial contamination in stored bloods in Peshawar and can be used as a reference point in future surveillance and quality improvement efforts. Recommended are multicentre studies in the future.

CONCLUSION

This study found a 6.4% rate of bacterial contamination in stored blood products at Hayatabad Medical Complex, Peshawar. The frequency of contamination of whole blood was relatively higher in comparison with packed red cells and platelet concentrates, which means that additional efforts to monitor and handle whole blood should be made during the collection and storage processes. The most frequent isolates, such as Coagulase-negative Staphylococcus, Bacillus spp., and Staphylococcus aureus indicate that contamination is caused by the skin flora and the environment to a great extent. The compliance with aseptic methods, the constant observation of storage conditions, and enhanced quality control measures are necessary to increase the safety of blood transfusions even more.

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