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Comparative Incidence of Bacterial Contamination in Whole Blood-Derived and Apheresis Platelet Concentrates in a Philippine Blood Service Facility

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Abstract

Background: *Bacterial contamination of platelet concentrates remains a leading cause of transfusion-associated morbidity and mortality due to storage at room temperature, which favors bacterial growth. Despite global awareness of this risk, comparative data in the Philippine setting remain limited.*

Objective: *This study aimed to determine and compare the incidence of bacterial contamination in whole blood-derived and apheresis platelet concentrates obtained from a selected blood service facility in Manila, Philippines.*

Methods: *This descriptive comparative study analyzed 150 platelet concentrate segments, with 75 samples each from whole blood-derived and apheresis-derived platelet units. Samples were aseptically cultured using Brain Heart Infusion (BHI) broth and subcultured on blood agar and MacConkey agar. Bacterial identification was performed using Gram staining and standard biochemical tests, including catalase, coagulase, and novobiocin susceptibility testing. pH levels were measured. Differences in contamination rates were analyzed using Fisher's exact test.*

Results: *Bacterial contamination was detected in 3 out of 75 (4.0%) whole blood-derived platelet concentrates, while no contamination (0/75) was observed in apheresis-derived units. All isolates were identified as Staphylococcus epidermidis. Contaminated samples had pH values above 6.2, indicating no association between pH and bacterial presence. Although contamination was higher in whole blood-derived platelets, the difference was not statistically significant ($p = 0.24$).*

Conclusion: *Whole blood-derived platelet concentrates showed a measurable risk of bacterial contamination compared to apheresis-derived units. These findings highlight the need for strict aseptic techniques and support the consideration of routine bacterial screening to improve transfusion safety in the Philippines.*

Keywords: *Platelet concentrates, bacterial contamination, apheresis, whole blood-derived platelets, Staphylococcus epidermidis, transfusion safety, Philippines.*

INTRODUCTION

Platelet transfusion is an essential component of modern clinical practice, particularly in the management of thrombocytopenia, hematologic malignancies, trauma, and major surgical procedures [7]. Platelets play a critical role in hemostasis by adhering to damaged vascular endothelium, aggregating to form a platelet plug, and supporting coagulation pathways [19]. The relative contribution of bacterial contamination to transfusion-related complications has become more pronounced in many healthcare settings [4, 16, 9]. Despite these important therapeutic functions, platelet transfusions are associated with a higher risk of transfusion-transmitted bacterial infections compared to other blood components, primarily due to their storage at room temperature.

Platelet concentrates are stored at 20–24°C, a condition that promotes bacterial growth and increases the likelihood of contamination [1]. As a result, bacterial contamination has become a leading cause of transfusion-related morbidity and mortality worldwide. With significant improvements in viral screening, the relative contribution of bacterial contamination to transfusion-related complications has become more pronounced in many healthcare settings [4, 16, 9].

The sources of bacterial contamination in platelet concentrates are multifactorial. These include the introduction of microorganisms from donor skin flora during phlebotomy, transient bacteremia in donors, and lapses in aseptic technique during blood collection and processing [20]. Among the most commonly isolated organisms are Gram-positive cocci, particularly coagulase-negative staphylococci

such as Staphylococcus epidermidis, which are part of the normal skin microbiota but may cause opportunistic infections, especially in immunocompromised patients [2].

Platelet concentrates can be prepared using either whole blood-derived methods or apheresis collection techniques [11]. Whole blood-derived platelets are produced by pooling platelet components from multiple donors, whereas apheresis platelets are collected from a single donor using automated cell separators [18, 21]. Previous studies have suggested that these preparation methods may differ in their susceptibility to bacterial contamination. Whole blood-derived platelets may present a higher risk due to increased donor exposure and additional processing steps, whereas apheresis platelets may reduce variability but are not entirely free from contamination risks [9, 10, 14].

In high-income countries, routine bacterial screening of platelet concentrates using culture-based or rapid detection systems has been widely implemented as part of hemovigilance programs, with regulatory agencies such as the U.S. Food and Drug Administration mandating bacterial detection or pathogen reduction strategies to enhance transfusion safety [8, 30] . However, in many low- and middle-income countries, including the Philippines, such screening practices are not consistently mandated, and local data on contamination rates remain limited [13, 9]. Existing studies in the Philippines have reported variable contamination rates and have identified skin commensals as predominant isolates, suggesting potential gaps in aseptic technique and quality control practices in blood service facilities.

Given the clinical importance of transfusion-associated bacterial infections and the limited comparative data available in the local setting, this study aimed to determine and compare the incidence of bacterial contamination in whole blood-derived and apheresis platelet concentrates obtained from a selected blood service facility in Manila, Philippines. Specifically, the study sought to: (1) determine the presence of bacterial contamination in both methods; (2) compare the prevalence of contamination between whole blood-derived and apheresis platelet concentrates; (3) identify the bacterial species isolated from contaminated units; and (4) evaluate the relationship between platelet pH and bacterial contamination.

MATERIALS AND METHODS

Study Design and Setting

This study employed a descriptive comparative design to evaluate the incidence of bacterial contamination in platelet concentrates collected using whole blood-derived and apheresis methods. The study was conducted between January and February 2016 using samples obtained from a selected blood service facility in Manila, Philippines. Laboratory analyses were performed at the Arellano University College of Medical Technology laboratory under controlled conditions.

Sample Size and Study Population

A total of 150 platelet concentrate segments were included in the study. Of these, 75 were derived from whole blood platelet concentrates and 75 from apheresis (single-donor) platelet concentrates. Samples were collected randomly regardless of storage duration, provided they were within the allowable shelf life for platelet storage.

Sample Collection and Handling

Platelet concentrate segments were aseptically obtained from blood bag tubing using a heat-sealing device. Before collection, all materials and surfaces were disinfected with 70% alcohol, and procedures were conducted in a laminar airflow cabinet to minimize environmental contamination. For whole blood-derived platelet concentrates, segments were prepared under sterile conditions within the blood service facility. Apheresis platelet segments were obtained from pre-prepared units. All samples were placed in sterile containers, transported in insulated carriers, and processed immediately upon arrival at the laboratory.

Microbiological Analysis

Each platelet segment was disinfected externally before sampling. The first drop of platelet concentrate was discarded to reduce contamination from the tubing surface. Subsequently, one drop of the sample was inoculated into 4–5 mL of Brain Heart Infusion (BHI) broth as an enrichment medium. Inoculated broths were incubated aerobically at 37°C and observed daily for turbidity for up to 72 hours.

Samples demonstrating turbidity were subcultured onto blood agar plates (BAP) and MacConkey agar (MAC) and incubated at 37°C for 24–48 hours. Colony growth was assessed based on morphology and pigmentation. Bacterial identification was performed using standard microbiological techniques, including Gram staining and biochemical testing.

Bacterial Identification

Gram staining was conducted to determine bacterial morphology and Gram reaction. Colonies showing growth on blood agar were further subjected to catalase and coagulase testing to differentiate Staphylococcus species from Streptococcus species and to distinguish coagulase-positive from coagulase-negative staphylococci. Isolates that were catalase-positive and coagulase-negative were further tested using novobiocin susceptibility testing. A zone of inhibition greater than 16 mm was interpreted as indicative of *Staphylococcus epidermidis*.

For isolates demonstrating growth on MacConkey agar, additional biochemical tests, including Triple Sugar Iron Agar (TSIA), Lysine Iron Agar (LIA), Sulfide Indole Motility (SIM), and Simmons Citrate Agar (SCA), were intended for the identification of Gram-negative organisms. However, no growth was observed on MacConkey agar in this study.

pH Determination

The pH of each platelet concentrate sample was measured using a calibrated pH meter immediately after sample collection. Measurements were recorded to assess whether pH variation was associated with bacterial contamination.

A pH value of ≥6.2 was considered acceptable based on platelet storage standards.

Outcome Measures

The primary outcome measure was the presence or absence of bacterial contamination, defined by visible turbidity in BHI broth and confirmed by growth on subculture media. Secondary outcomes included identification of bacterial species and comparison of contamination rates between whole blood-derived and apheresis platelet concentrates.

Statistical Analysis

Descriptive statistics were used to summarize the data, including frequencies and percentages of contaminated samples. The incidence of bacterial contamination between whole blood-derived and apheresis platelet concentrates was compared using Fisher's exact test due to the small number of positive cases. A p-value of <0.05 was considered statistically significant.

Ethical Considerations

Permission to conduct the study and collect samples was obtained from the head of the participating blood service facility. The study adhered to principles of confidentiality and anonymity, ensuring that no identifying information related to donors or the facility was disclosed. All procedures were conducted in accordance with institutional ethical guidelines for laboratory-based research.

RESULTS

Bacterial Detection in Platelet Concentrates

A total of 150 platelet concentrate samples were analyzed, comprising 75 whole blood-derived and 75 apheresis-derived platelet units. Following incubation in Brain Heart Infusion (BHI) broth, bacterial growth was observed in 3 out of 75 (4.0%) whole blood-derived platelet concentrates, while none (0/75) of the apheresis-derived platelet concentrates demonstrated evidence of bacterial contamination. These findings are consistent with reported contamination rates in platelet units, which range from approximately 1 in 1,000 to 1 in 3,000 units, with variability depending on collection and processing methods [5].

Among the contaminated whole blood-derived platelet samples, two (2/44; 4.5%) were identified in 2-day-old platelet units and one (1/27; 3.7%) in a 3-day-old unit. No bacterial growth was observed in 1-day-old whole blood-derived platelet samples. All apheresis-derived platelet units, regardless of storage duration (1 to 4 days), remained negative for bacterial growth throughout the incubation period. The absence of contamination in apheresis-derived units aligns with studies suggesting lower contamination risk associated with single-donor platelet collection compared to pooled whole blood-derived products [23].

pH Measurement of Platelet Concentrates

The pH values of the three contaminated whole blood-derived platelet samples were within acceptable limits for platelet storage. The recorded pH values were 7.21, 7.30, and 7.39, respectively, all above the minimum acceptable threshold of pH 6.2. No consistent variation in pH was observed between contaminated and non-contaminated samples, indicating no apparent association between pH levels and bacterial contamination. This observation is consistent with previous reports indicating that pH measurement alone has limited sensitivity as a screening tool for bacterial contamination in platelet concentrates [15] .

Subculture and Morphological Characteristics

All three contaminated samples demonstrated growth on blood agar plates (BAP), characterized by white, opaque, non-pigmented colonies. No growth was observed on MacConkey agar (MAC), suggesting the absence of Gram-negative organisms. Gram staining of isolates from the positive cultures revealed Gram-positive cocci arranged in clusters in all three samples. These findings are consistent with commonly reported bacterial contaminants in platelet concentrates, which are predominantly Gram-positive organisms originating from skin flora [24, 25].

Biochemical Identification of Isolates

All isolates obtained from contaminated platelet concentrates were catalase-positive and coagulase-negative. Subsequent novobiocin susceptibility testing demonstrated zones of inhibition measuring 16–20 mm, indicating susceptibility. Based on these findings, all isolates were identified as *Staphylococcus epidermidis*. This organism is among the most frequently reported contaminants in platelet units due to its presence as a commensal organism on human skin and its potential introduction during blood collection [26,27].

Incidence of Bacterial Contamination

The overall incidence of bacterial contamination among all platelet concentrates tested was 2.0% (3/150). When stratified by method of preparation, the incidence was 4.0% (3/75) for whole blood-derived platelet concentrates and 0% (0/75) for apheresis-derived platelet concentrates. The higher contamination rate observed in whole blood-derived platelet concentrates is in agreement with studies reporting increased contamination risk associated with pooled or multi-step processing methods [6]. Comparative analysis using Fisher's exact test showed no statistically significant difference in contamination rates between whole blood-derived and apheresis platelet concentrates ($p = 0.24$).

DISCUSSION

The findings of this study demonstrate a measurable incidence of bacterial contamination in whole blood-derived platelet concentrates, while no contamination was observed in apheresis-derived platelet units. This observation is consistent with existing literature indicating that platelet concentrates are particularly vulnerable to bacterial contamination due to their storage at room temperature, which supports microbial proliferation [17].

The contamination rate of 4.0% observed in whole blood-derived platelet concentrates in this study is higher than rates reported in large-scale surveillance studies, which typically range from approximately 0.03% to 0.3%, depending on detection methods and screening protocols [4,12]. Similar variability in contamination rates has been reported in other low- and middle-income regions, including Latin America, where differences in screening practices and resource availability influence transfusion safety outcomes [9]. This difference may be explained by variations in methodology, including the use of conventional culture-based detection without automated continuous monitoring systems, as well as potential inconsistencies in aseptic technique, donor screening, and laboratory conditions. In resource-limited settings, where routine bacterial screening is not consistently implemented, higher contamination rates may be encountered.

In contrast, no bacterial contamination was detected among apheresis-derived platelet concentrates. This finding aligns with previous studies suggesting that single-donor apheresis platelets may be associated with a lower risk of contamination compared to pooled whole blood-derived products, primarily due to reduced donor exposure and fewer processing steps [22]. However, this result should be interpreted with caution, as the relatively small sample size may limit the ability to detect low-frequency contamination events. Previous research has shown that although apheresis platelets generally exhibit lower contamination rates, they are not entirely free from risk [6].

All bacterial isolates identified in this study were Staphylococcus epidermidis, a coagulase-negative staphylococcus commonly present as part of normal skin flora. This strongly suggests that contamination likely originated from donor skin during venipuncture or from lapses in aseptic technique during blood collection and processing. Similar findings have been widely reported, with coagulase-negative staphylococci representing the most frequently isolated contaminants in platelet units [28, 29]. Although generally considered to have low virulence, this organism can cause clinically significant infections, particularly in immunocompromised patients, emphasizing the importance of strict adherence to aseptic procedures.

No Gram-negative organisms were isolated in this study. Although less frequently encountered, Gram-negative bacteria are clinically significant due to their association with severe and potentially fatal transfusion reactions resulting from endotoxin production [3]. The predominance of Gram-positive organisms observed in this study is consistent with contamination originating from external sources such as skin flora, rather than from donor bacteremia.

The pH values of contaminated platelet units remained within acceptable limits (>6.2), indicating that pH measurement alone may not be a reliable indicator of bacterial contamination. This finding supports previous reports that significant pH changes typically occur only at higher bacterial loads or later stages of storage, thereby limiting its usefulness as an early screening tool [15].

From a statistical perspective, although a higher contamination rate was observed in whole blood-derived platelet concentrates compared to apheresis-derived units, the difference was not statistically significant ($p = 0.24$). This lack of statistical significance may be attributed to the limited sample size and the small number of positive cases. Nevertheless, the observed trend toward higher contamination in whole blood-derived platelet concentrates may still be clinically relevant, particularly in settings where even minimal contamination can pose serious risks to vulnerable patient populations.

From a clinical and public health perspective, these findings highlight the importance of implementing effective strategies to minimize bacterial contamination in platelet products, a concern that remains significant across both developed and developing regions [9]. In high-resource settings, interventions such as routine bacterial screening, pathogen reduction technologies, and improved donor skin disinfection protocols have significantly reduced the incidence of transfusion-transmitted bacterial infections [17]. In the Philippine context, where such measures may not be consistently implemented, strengthening aseptic techniques, enhancing staff training, and reinforcing quality assurance practices in blood service facilities are essential.

Furthermore, the results suggest that apheresis platelet collection may offer advantages in reducing contamination risk. Although financial and logistical constraints may limit widespread adoption, prioritizing apheresis-derived platelet use for high-risk patients, such as those who are immunocompromised, may improve transfusion safety outcomes.

Overall, this study contributes to the limited body of local evidence on bacterial contamination in platelet concentrates and supports global findings regarding the relative safety of apheresis-derived platelets compared to whole blood-derived products. However, further large-scale and multi-center studies incorporating more sensitive detection methods are needed to better characterize contamination risks and inform evidence-based transfusion practices in the Philippines.

CONCLUSION

This study demonstrated that whole blood-derived platelet concentrates are associated with a measurable risk of bacterial contamination, with an incidence rate of 4.0%, whereas no contamination was detected in apheresis-derived platelet units. The exclusive identification of *Staphylococcus epidermidis* among contaminated samples indicates that contamination most likely originated from skin flora introduced during blood collection or handling. The findings further showed that pH measurement was not a reliable indicator of bacterial contamination, as all contaminated units maintained pH levels within acceptable limits.

These results support existing evidence that apheresis-derived platelet concentrates may offer a safer alternative to whole blood-derived platelets in terms of bacterial contamination risk.

However, the absence of contamination in apheresis units in this study should be interpreted with caution due to the limited sample size. The study highlights the ongoing risk of transfusion-associated bacterial contamination and underscores the importance of stringent aseptic techniques and quality control measures in blood collection and processing.

RECOMMENDATIONS

Based on the findings of this study, several measures are recommended to enhance the safety of platelet transfusion practices. Blood service facilities should reinforce strict adherence to aseptic techniques during donor skin preparation, blood collection, and component processing to minimize contamination from skin flora. The implementation of routine bacterial screening for platelet concentrates, particularly for whole blood-derived units, should be considered to allow early detection of contaminated products prior to transfusion. Where resources permit, the adoption of advanced detection systems, such as automated culture-based methods or rapid bacterial detection assays, is encouraged to improve the sensitivity and timeliness of detection. In addition, increasing the use of apheresis platelet collection may be beneficial, especially for high-risk patient populations such as immunocompromised individuals, given its lower observed contamination risk. Continuous training and competency assessment of healthcare personnel involved in blood collection and transfusion should also be strengthened to ensure compliance with best practices. Finally, further large-scale and multi-center studies using more sensitive diagnostic technologies are recommended to better establish the true incidence of bacterial contamination in platelet concentrates and to inform evidence-based transfusion policies in the Philippines.

LIMITATIONS

This study has several limitations that should be considered when interpreting the findings.

First, the sample size was relatively small (n = 150), which may limit the statistical power of the study and affect the generalizability of the results, particularly the absence of bacterial contamination observed in apheresis-derived platelet concentrates.

Second, the study was conducted in a single blood service facility in Manila, which may not be representative of other institutions in the Philippines with different protocols, resources, or levels of compliance with aseptic techniques.

Third, the study relied on conventional culture-based methods for bacterial detection, which, while widely used, may have lower sensitivity compared to automated continuous monitoring systems or molecular diagnostic techniques. As a result, low-level or slow-growing bacterial contamination may not have been detected. Fourth, only aerobic culture conditions were employed, potentially limiting the detection of anaerobic organisms. Additionally, the study focused solely on bacterial contamination and did not assess other potential contaminants or transfusion-transmissible agents.

Finally, potential confounding factors such as donor characteristics, variations in collection techniques, storage duration beyond categorization, and environmental conditions during processing were not fully controlled or analyzed. These factors may influence the risk of bacterial contamination and should be explored in future studies. Despite these limitations, the study provides valuable preliminary data on bacterial contamination in platelet concentrates in the local setting.

Table 1: Distribution of Platelet Samples by Type and Storage Duration

Platelet Type	Storage Duration (Days)	Number of Samples (n)	Contaminated Samples (n)
Whole Blood-Derived	1	4	0
	2	44	2
	3	27	1
Subtotal	—	75	3
Apheresis-Derived	1–4	75	0
Total	—	150	3

Values are presented as frequency (n). Storage duration indicates the number of days from collection to testing. Whole blood-derived platelet concentrates were analyzed by individual storage day, while apheresis-derived platelet concentrates were grouped (1–4 days) due to absence of bacterial contamination.

Table 2: pH Values of Contaminated Platelet Concentrates

Sample ID	Platelet Type	Storage Duration (Days)	pH Value	Contamination Status
WA1	Whole Blood-Derived	3	7.21	Positive
WA13	Whole Blood-Derived	2	7.30	Positive
WA15	Whole Blood-Derived	2	7.39	Positive

Values represent pH measurements of platelet concentrates with confirmed bacterial contamination. Storage duration indicates the number of days from collection to testing. A pH value ≥6.2 is considered acceptable for platelet viability during storage.

Table 3: Microbiological Characteristics of Isolates

Sample ID	Gram Stain Result	Catalase Test	Coagulase Test	Novobiocin Susceptibility	Identified Organism
WA1	Gram-positive cocci in clusters	Positive	Negative	Susceptible (18 mm)	*Staphylococcus epidermidis*
WA13	Gram-positive cocci in clusters	Positive	Negative	Susceptible (20 mm)	*Staphylococcus epidermidis*
WA15	Gram-positive cocci in clusters	Positive	Negative	Susceptible (16 mm)	*Staphylococcus epidermidis*

Gram stain results indicate bacterial morphology and arrangement. Catalase-positive and coagulase-negative reactions suggest coagulase-negative staphylococci. Novobiocin susceptibility testing was performed, where a zone of inhibition ≥16 mm indicates susceptibility, consistent with identification of Staphylococcus epidermidis.

Table 4. Incidence of Bacterial Contamination by Platelet Type

Platelet Type	Total Samples (n)	Contaminated (n)	Incidence (%)	p-value*
Whole Blood-Derived	75	3	4.0%	—
Apheresis-Derived	75	0	0.0%	—
Comparison	—	—	—	0.24

Values are presented as n (%). p-value calculated using Fisher's exact test; p <0.05 considered statistically significant.

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