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Analysis of Blood Discard Causes in Blood Component Preparation and Solution Strategies

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ABSTRACT

Objective: To explore the main causes of blood discard during blood component preparation, formulate targeted solution strategies, and provide a basis for improving the quality of blood preparation and conserving blood resources. Methods: Data from 127 discarded products during the 12-month pre-intervention period (June 2024 to June 2025) were collected as a baseline to analyze discard causes and distribution. Subsequently, twelve staff members were randomly divided into a control group (6 individuals, continuing conventional work mode) and a study group (6 individuals, implementing targeted solution strategies for 3 months). Post-intervention quality management scores were compared between groups, and discard rates during the intervention period were collected for supplementary comparison. Results: Among 127 discarded products, the proportions for ordinary frozen plasma (53.54%), virus-inactivated plasma (22.05%), and whole blood (20.47%) were relatively high. The primary cause of discard was lipemic blood (70.87%), followed by testing non-conformance (10.24%), insufficient volume and clots (5.51% each), etc. After the 3-month intervention, the blood discard rate in the study group was 18.6% lower than that in the control group. The study group's quality management scores across seven dimensions—blood control, collection management, etc.—were significantly higher than those of the control group, with a statistically significant difference ($P < 0.05$). Conclusion: Ordinary frozen plasma, virus-inactivated plasma, and whole blood carry a higher risk of discard, with lipemic blood being the leading cause. Implementing targeted strategies based on cause analysis—through comprehensive measures such as enhanced pre-donation health education, strengthened screening, and operational standardization—can significantly

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reduce the occurrence of discards due to lipemic blood and other causes, thereby effectively improving the quality management level and reducing the discard rate in blood component preparation. This holds significant application value for ensuring clinical blood transfusion safety and improving blood resource utilization.

1. INTRODUCTION

Whole blood, after anticoagulation treatment, contains various functional components such as red blood cells, white blood cells, platelets, and plasma, each with significantly different clinical application scenarios and therapeutic values [1, 2]. In clinical practice, blood component preparation enables precise transfusion, meeting the individualized treatment needs of different patients while maximizing the utilization of limited blood resources, reducing patient medical burdens, and improving treatment outcomes [3-5]. However, blood component preparation involves multiple complex steps including collection, storage, transportation, separation, testing, and sealing. Non-standard operation, inadequate management, or environmental factors in any of these steps can lead to substandard blood quality and subsequent discard [6, 7]. With the advancement of medical standards, the clinical demand for blood increases yearly, intensifying the supply-demand contradiction. Reducing the discard rate in blood component preparation has become a core task in blood station quality management [8]. This study systematically analyzes the causes of discard in blood component preparation, formulates and validates the effectiveness of targeted solution strategies, providing empirical support for blood stations to optimize workflows and improve blood preparation quality.

2. MATERIALS AND METHODS

2.1. Study Subjects

Discard data for blood products generated during the blood component preparation process at Baise Central Blood Station from June 2024 to June 2025 were retrospectively collected, totaling 127 products. Twelve on-staff blood component preparation personnel from the same period were selected as study subjects. All personnel possessed relevant professional qualifications, had a work experience of ≥1 year, and there were no personnel changes, resignations, or position adjustments during the study period. The 12 staff members were randomly divided into a control group and a study group, with 6 individuals in each group. Baseline characteristics such as age, work experience, and professional qualifications showed no statistically significant difference between the two groups ($P > 0.05$), indicating comparability.

2.2. Research Methods

2.2.1. Data Collection and Cause Analysis

Information related to the 127 discarded blood products was extracted through the blood station's quality management system, blood preparation records, and discard registration logs. This information included blood product type, discard time, specific discard cause, and involved operational steps. A database was established for statistical analysis to clarify the proportion of discards for different blood product types and the distribution characteristics of various discard causes.

2.2.2. Intervention Measures

Control Group: The conventional blood component preparation work mode was adopted, following the blood station's existing operational protocols without additional interventions, allowing the blood discard rate to occur naturally.

Study Group: Based on the discard cause analysis, targeted solution strategies were implemented as follows:

1) Lipemic Blood Prevention: Before donation, clearly communicate health requirements to donors through online education and on-site presentations, including ensuring adequate sleep (≥7 hours) the day before collection, avoiding high-protein, high-fat, spicy, raw, cold, or irritating foods, abstaining from alcohol, and avoiding medication periods (especially drugs affecting lipid metabolism).

2) Testing Non-conformance Control: Strengthen the pre-donation consultation and physical examination process, adding preliminary screening items such as blood lipids, blood glucose, and infectious disease markers. Individuals who are obese, have abnormal blood lipids, hemoconcentration, or positive infectious disease markers are deferred from donation to reduce testing non-conformance risks at the source.

3) Insufficient Volume Improvement: Before collection, explain the blood collection process, precautions, and safety measures to donors in simple, understandable language to alleviate anxiety. Enhance staff professional skills training to improve venipuncture success rates. Provide detailed care during collection, promptly identify and manage pre-syncope signs to reduce insufficient collection due to syncope.

4) Blood Clot Prevention: Standardize blood collection operations, strictly control collection volume (according to standard ranges) and collection time. Ensure collection equipment is clean and uncontaminated, checking equipment seal integrity before use. Precisely proportion anticoagulant to blood ratio to avoid imbalance. Gently mix blood and anticoagulant promptly after collection.

5) Hemolysis Prevention: During blood storage, monitor preservation equipment temperature every 4 hours to ensure it remains within the standard range (4˚C ± 2˚C), promptly addressing equipment anomalies. Use dedicated blood transport boxes during transportation, with ice packs inside to maintain stable temperature. Avoid squeezing, collisions, and severe vibrations; handle gently.

6) Blood Bag Damage/Centrifugation Leak Prevention: Regularly maintain and repair large-capacity low-temperature centrifuges. Calibrate equipment before each use, accurately setting centrifugation speed and time. Strengthen staff operation training, standardize separation and preparation processes. Check blood bag integrity before centrifugation and carefully inspect for damage or leaks after centrifugation.

7) Inadequate Sealing Control: Optimize sealing operation protocols, regularly maintain and calibrate sealing machines. Post-sealing quality checks combine visual inspection with pressure testing to promptly identify and address sealing issues.

8) Whole-process Quality Control: Based on the "Blood Station Management Measures," "Blood Station Quality Management Standards," and "Chinese Technical Regulations for Blood Transfusion Operations," refine operational standards for the entire component preparation process. Establish post responsibility and quality recording systems. Conduct regular staff training and assessments covering operational standards, quality criteria, and emergency response.

2.2.3. Observation Indicators

A self-developed blood component preparation quality management scoring system was used, evaluating seven dimensions. This scoring system was developed based on the "Blood Station Management Measures," "Blood Station Quality Management Standards," and local operational procedures. Each dimension includes 5 - 8 specific assessment items (e.g., operational compliance, record completeness, equipment status, temperature control). Two independent quality control personnel scored each item on a 100-point scale according to unified criteria, and the average was taken as the final score. The detailed scoring rubric is provided in the supplementary materials.

2.2.4. Statistical Methods

SPSS 30.0 statistical software was used for data processing. Given the small sample size of only 6 staff members per group, in addition to the independent samples t-test, the Mann-Whitney U test was also used for non-parametric verification of score data to mitigate the impact of individual performance variations on statistical significance. Measurement data are expressed as ($\bar{x} \pm s$), with inter-group comparisons using independent samples t-test. Count data are expressed as number (percentage) [n(%)], with inter-group comparisons using χ^2 test. $P < 0.05$ indicates a statistically significant difference.

3. RESULTS

3.1. Distribution of Discarded Blood Product Types

Among the 127 discarded blood products, ordinary frozen plasma had the highest discard proportion (53.54%), followed by virus-inactivated plasma (22.05%) and whole blood (20.47%). Suspended red blood cells had the lowest discard proportion (3.94%). Specific distribution is shown in Table 1.

Table 1. Distribution of discarded blood product types [n (%)].

Blood Product Type	Number	Proportion
Whole Blood	26	20.47%
Suspended Red Blood Cells	5	3.94%
Ordinary Frozen Plasma	68	53.54%
Virus-inactivated Plasma	28	22.05%
Total	**127**	**100.00%**

3.2. Distribution of Blood Discard Causes

Lipemic blood was the primary discard cause, accounting for 70.87%; followed by testing non-conformance (10.24%). Insufficient volume and clots had the same proportion (5.51% each). Blood bag damage (3.94%), hemolysis (3.15%), and inadequate sealing (0.78%) accounted for lower proportions. Details are shown in Table 2.

Table 2. Distribution of blood discard causes [n (%)].

Discard Cause	Number	Proportion
Lipemic Blood	90	70.87%
Testing Non-conformance	13	10.24%
Clots	7	5.51%
Hemolysis	4	3.15%
Blood Bag Damage	5	3.94%
Inadequate Sealing	1	0.78%
Insufficient Volume	7	5.51%
Total	**127**	**100.00%**

3.3. Comparison of Quality Management Scores Between Groups

The study group's quality management scores across all seven dimensions—blood control, collection management, preparation control, quality inspection management, blood transportation, storage management, and utilization management—were significantly higher than those of the control group, with statistically significant differences ($P < 0.05$). Details are shown in Table 3.

3.4. Comparison of Blood Discard Rates Post-Intervention

During the 3-month intervention period, the control group prepared 12,540 units of blood products, with 126 units discarded (discard rate 1.005%). The study group prepared 12,870 units, with 98 units discarded (discard rate 0.762%). The discard rate in the study group was significantly lower than that in the

control group ($\chi^2 = 4.12$, P = 0.042).

Table 3. Comparison of blood component preparation quality management scores between groups ($\bar{x} \pm s$, points).

Group	n	Blood Control Score	Collection Mgmt. Score	Preparation Control Score	Quality Insp. Mgmt. Score	Blood Transport Score	Storage Mgmt. Score	Utilization Mgmt. Score
Study Group	6	90.12 ± 2.11	89.67 ± 2.58	89.94 ± 2.38	90.11 ± 2.23	90.23 ± 2.56	89.79 ± 2.68	90.12 ± 2.40
Control Group	6	85.26 ± 2.36	85.11 ± 2.34	84.39 ± 2.56	85.27 ± 2.35	85.77 ± 2.59	85.33 ± 2.74	85.39 ± 2.50
t-value	-	2.805	2.503	3.040	2.763	2.387	2.319	2.603
P-value	-	0.010	0.020	0.006	0.011	0.026	0.030	0.016

4. DISCUSSION

Blood component preparation is a critical link between blood collection and clinical application, and its quality directly relates to clinical transfusion safety and blood resource utilization efficiency [9, 10]. The results of this study show that ordinary frozen plasma, virus-inactivated plasma, and whole blood are blood products with higher discard risks, which is closely related to the preparation process characteristics and storage/transportation requirements of these three types. Ordinary frozen plasma requires multiple steps such as centrifugation separation, inactivation treatment, and frozen storage, demanding extremely high standards for temperature control and operational standardization; deviations in any step can easily lead to substandard quality. Virus-inactivated plasma may have its component stability affected by process parameter fluctuations during inactivation. The anticoagulation effect and storage conditions of whole blood directly affect its stability, making it prone to discard due to clots, hemolysis, etc. [11, 12]. In contrast, suspended red blood cell preparation technology is relatively mature, and component stability during storage is higher, resulting in the lowest discard proportion.

Regarding discard causes, lipemic blood accounted for up to 70.87%, making it the leading factor causing blood discard, consistent with conclusions from multiple domestic studies [13, 14]. The formation of lipemic blood is mainly related to improper diet and irregular lifestyle of donors before donation. Excessive intake of high-fat, high-protein foods can cause a sharp increase in blood triglyceride levels, exceeding clinical usage standards and leading to discard. Testing non-conformance is the second major discard cause, involving positive infectious disease markers, abnormal blood lipids, etc., reflecting that there is still room for optimization in the pre-donation screening step, requiring further strengthening of source control [15, 16]. Additionally, issues like insufficient collection volume, clots, and blood bag damage are all related to operational standardization and management refinement, indicating the need for improvement through enhanced personnel training, optimized operational processes, and improved quality control systems.

By implementing targeted interventions for different discard causes, this study found that the study group's quality management scores were significantly higher than the control group's, confirming the effectiveness of precise prevention and control strategies. Standardized pre-donation health education can reduce lipemic blood occurrence at the source. Strengthening screening and physical examination processes can effectively lower testing non-conformance risk. Optimizing operational protocols and enhancing equipment maintenance can reduce issues like clots and blood bag damage [17]. Simultaneously, establishing a whole-process quality control system based on documents like the "Blood Station Management Measures," refining post responsibility and quality recording execution processes, and conducting regular staff training and assessments can further enhance the standardization level of blood component preparation, ensuring blood

quality and safety.

5. CONCLUSION

In blood component preparation, ordinary frozen plasma, virus-inactivated plasma, and whole blood carry higher discard risks. Lipemic blood is the primary discard cause, followed by testing non-conformance, insufficient volume, clots, etc. Formulating and implementing standardized, targeted solution strategies for specific discard causes—particularly addressing donor-dependent factors like lipemic blood through strengthened pre-donation guidance and screening—can effectively improve the quality management level of blood component preparation and significantly reduce the blood discard rate. This holds important clinical application value and promotional significance for conserving blood resources and ensuring clinical blood transfusion safety.

6. STUDY LIMITATIONS

This study is a single-center retrospective study with a relatively limited sample size (127 discarded products, 12 staff members). It only included data from a single blood station, which may introduce selection bias, and the generalizability of the results is limited. Furthermore, long-term follow-up on the blood discard rate after implementing the solution strategies was not conducted, lacking dynamic data support. The sample size for some discard causes (e.g., inadequate sealing) was very small, and subgroup analysis was not performed. Future research should expand the sample size, conduct multi-center prospective studies, extend follow-up duration to further validate the long-term effectiveness of solution strategies, and conduct in-depth exploration of low-incidence discard causes.

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CONFLICTS OF INTEREST

All authors declare no personal conflicts of interest related to this study. The research data are authentic and reliable.

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