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The Application Effect of Comprehensive and Refined Management in Quality Management of Unpaid Blood Donation at Blood Stations

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Abstract: Objective: To analyze the application effect of comprehensive and refined management in the quality management of unpaid blood donation at blood stations. Methods: A total of 330 unpaid blood donors at our blood station from July 2024 to July 2025 were selected and randomly divided into two groups, with 165 donors in each group. The control group received conventional management, while the observation group received comprehensive and refined management in addition. The success rate of one-time puncture, the occurrence of adverse events after blood collection, the blood discard rate, and the quality of the blood collection and supply environment were compared between the two groups. Results: The success rates of one-time puncture in the observation group and the control group were 98.19% and 93.33%, respectively, and the incidence rates of adverse events after blood collection were 5.45% and 18.79%, respectively ($P<0.05$). In terms of blood discard, the incidence rates of confidential blood discard, non-standard blood, clotted blood, abnormal plasma color, and abnormal testing process in the observation group were 1.21%, which was lower than the 6.67% in the control group ($P<0.05$). The quality pass rates of the observation group in terms of the air in the blood collection and supply environment, the surface of environmental objects, the skin of donors' arms, the hygienic hands of blood collection nurses, blood storage refrigerators, and blood specimen transport boxes were all higher than those of the control group ($P<0.05$). Conclusion: Implementing comprehensive and refined management in the management of unpaid blood donation at blood stations can improve the success rate of blood collection operations, reduce adverse events and blood discard, and improve the quality of the blood collection and supply environment, thereby comprehensively enhancing the quality management level of unpaid blood donation.

Keywords: Blood station; Unpaid blood donation; Quality management; Comprehensive and refined management; Blood discard rate

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1. Introduction

Blood stations, as public welfare health institutions responsible for recruiting voluntary blood donors, collecting and preparing blood, storing it, and supplying it for clinical use, have their management levels that not only affect

donors' willingness to participate and the prevention of adverse reactions during blood donation but also relate to the quality and safety of blood products. They are a crucial link in ensuring the safe clinical use of blood [1]. During the process of blood collection and supply, if staff members do not operate in accordance with standards, such as incomplete disinfection, improper puncture, or incorrect labeling, the risk of errors increases easily, affecting blood quality [2]. Therefore, strengthening quality management in blood stations is of great significance. Comprehensive and refined management, as a management model centered on systematic thinking and refined operations, optimizes the entire process of blood collection, including pre-, during-, and post-collection stages, as well as personnel operations. This approach can improve the quality and efficiency of blood collection, reduce adverse reactions in donors, and promote the safe and efficient utilization of blood resources [3]. Studies have indicated that applying comprehensive and refined management to blood donation services in blood stations can optimize nursing quality, reduce adverse reactions in donors and cases of blood wastage, and enhance donor satisfaction [4]. Therefore, this study will compare the differences between comprehensive and refined management and conventional management in terms of the success rate of single puncture, the incidence of adverse events after blood collection, the blood wastage rate, and the qualification rate of the blood collection and supply environment, exploring its application effects in the quality management of voluntary blood donation in blood stations.

2. Materials and Methods

2.1. General Information

After approval by the Medical Ethics Committee, 330 volunteers who donated blood voluntarily at our blood station from July 2024 to July 2025 were included. There were no statistically significant differences in general information between the two groups ($P > 0.05$), as shown in **Table 1**.

Table 1. General Information [($\bar{x} \pm s$), Cases (n)]

Group	n	Gender (M/F)	Age (years)	BMI (kg/m²)	Education Level		
					Junior High or Below	High School/ Vocational	College or Above
Observation Group	165	93/72	35.59 ± 6.20	24.85 ± 1.47	32 (19.39)	67 (40.61)	66 (40.00)
Control Group	165	101/64	34.82 ± 5.09	24.56 ± 1.82	40 (24.24)	54 (32.73)	71 (43.03)
t/χ^2		0.801	1.265	1.592		2.468	
P-value		0.371	0.207	0.112		0.291	

2.2. Inclusion and Exclusion Criteria

Inclusion Criteria: (1) All participants meet the requirements specified in the "Health Examination Requirements for Blood Donors" [5]; (2) Male participants weigh ≥50 kg and female participants weigh ≥45 kg; (3) Participants have no history of severe systemic diseases such as heart, liver, or kidney diseases, as well as no history of infectious diseases; (4) All blood donors have signed an informed consent form.

Exclusion Criteria: (1) Individuals with a fear of needles, blood, or severe psychological phobias; (2) Individuals who do not meet blood donation criteria due to anemia, hypertension, diabetes, or other conditions prior to donation; (3) Individuals who experience acute adverse reactions or interrupted blood collection during the donation process; (4) Individuals under the age of 18.

2.3. Methods

The control group received routine management: (1) Information registration was conducted first, followed by health consultations, physical examinations, and preliminary blood screening. The blood collection process and precautions were explained, and participants were guided in preparing mentally and physically, with emphasis on the importance of cooperation during the procedure. (2) During blood collection, strict adherence to standardized puncture and disinfection procedures was maintained. Personal protective equipment was worn, disposable supplies were used in accordance with regulations, and relevant equipment and contact surfaces were disinfected after blood collection, with proper hand hygiene practices observed. (3) After blood collection, participants were assisted in applying pressure with a bandage to stop bleeding. They were instructed to remove the bandage themselves after 30 minutes and to keep the wound dressing in place for 4 hours. They were informed of possible adverse reactions and were asked to remain under observation for 30 minutes. If no abnormalities were observed, they could leave on their own. (4) Collected blood samples were packaged, labeled, stored, and registered according to standard requirements. The blood collection room was statically disinfected using ultraviolet lamps for 1 hour every morning and evening.

The observation group was supplemented with comprehensive and refined management: (1) A comprehensive and refined management team for the blood station was established, consisting of management staff, blood collection personnel, and quality control specialists. It was divided into five subgroups responsible for blood collection, preparation, storage, transportation, and infection prevention and control, with each subgroup collaborating in their respective areas. Weekly quality meetings were held to analyze problems and formulate corrective measures. Statistical assessments were conducted on blood collection volume, discard rates, and adverse events, fostering a mechanism for continuous improvement. Additionally, the "Blood Station Quality Management Manual" was compiled, detailing operational standards and a reward-and-punishment system. (2) Two centralized training sessions and skill assessments were organized monthly, covering blood collection procedures, aseptic techniques, error prevention, emergency response, and humanistic communication. These sessions combined theoretical learning, scenario-based drills, and practical assessments. Rewards were given to top performers, while those who did not meet the standards were required to undergo retraining until they passed. (3) The blood station adhered to a "people-oriented" service philosophy, with staff patiently receiving blood donors, explaining procedures and precautions, and alleviating their anxiety. Before blood collection, educational brochures were distributed, and knowledge videos were played. During blood collection, staff closely monitored donors' expressions and provided timely communication and reassurance. After blood collection, videos on post-donation care were played, guiding donors on diet and rest. Donors were observed for 15 minutes to ensure no abnormalities before leaving the station. (4) Strict adherence to aseptic techniques and verification procedures was enforced, following the principle of "one needle, one tube, and one towel per person." Before blood collection, information, blood type, and volume were verified. After blood collection, the blood was immediately mixed with anticoagulant, and label verification was completed. Two dedicated personnel inspected blood collection equipment, consumables, and blood storage containers daily. (5) The blood collection and supply environment underwent daily scheduled disinfection, utilizing ozone machines, negative ion generators, and chlorine-based disinfectants to maintain clean air and surfaces. Quality supervisors were assigned in each department to cooperate with the quality control department for inspections. Key areas were subject to video surveillance and regular sampling inspections. Strict adherence to hand hygiene, waste classification, and protective measures was enforced. (6) Blood preparation was handled by dedicated personnel responsible for component separation, quality inspection, and data recording, maintaining aseptic conditions throughout the process. In the storage and transportation phase, temperature visualization monitoring was implemented, with blood storage

refrigerators maintained at 2-6°C, equipped with temperature recording and alarm systems, as well as independent power supplies. Blood distribution followed the "first-in, first-out" principle, with regular inventory checks to control discard rates. During transportation, the cold chain status was verified.

2.4. Observation Indicators

(1) Record the success rate of a single puncture and the occurrence of adverse events (local skin redness and swelling, subcutaneous congestion, infection, nausea, fainting, and pallor) in the two groups of voluntary blood donors.

(2) Blood discard situations include confidential blood discard, non-standard volume blood, clotted blood, abnormal plasma color, and abnormal testing process.

(3) Quality testing of the blood collection and supply environment includes collecting air samples from the center and four corners of the blood collection room (approximately 1 m from the wall and at a height of 0.8-1.5 m), as well as samples from environmental object surfaces, the hands of blood collection nurses, the skin of donors' arms, blood storage refrigerators, and the surfaces of blood transportation boxes. These samples are cultured at 37°C for 48 hours before colony counting. The criteria for evaluation are as follows: air ≤ 4 CFU/(5 min·plate), blood storage equipment ≤ 8 CFU/(10 min·plate), disinfectant in use ≤ 10 CFU/mL, object surfaces and hands of blood collection nurses ≤ 10 CFU/cm², and the irradiation intensity of ultraviolet lamps ≥ 70 μW/cm².

2.5. Statistical Analysis

Statistical analysis was performed using SPSS 25.0 software. Count data were expressed as n (%) and the chi-square test was performed. Measurement data were expressed as ($\bar{x}$±s), and the t-test was performed. A P-value < 0.05 was considered statistically significant.

3. Results

3.1. Success Rate of a Single Puncture and Incidence of Adverse Events After Blood Collection

The success rate of a single puncture in the observation group was higher than that in the control group, and the incidence of adverse events after blood collection was lower than that in the control group (P < 0.05). See **Table 2**.

Table 2. Success Rate of a Single Puncture and Incidence of Adverse Events After Blood Collection [Cases (%)]

Group	n	First-Attempt Success Rate [n(%)]	Post-Blood Draw Adverse Events [n(%)]						Total Adverse Event Rate [n(%)]
			Local Skin Redness	Subcutaneous Bruising	Infection	Nausea	Fainting	Pale Complexion	
Observation Group	165	162 (98.19)	2 (1.21)	1 (0.61)	0 (0.00)	2 (1.21)	1 (0.61)	3 (1.82)	9 (5.45)
Control Group	165	154 (93.33)	6 (3.64)	3 (1.82)	2 (1.21)	5 (3.03)	2 (1.21)	13 (7.88)	31 (18.79)
χ^2-value		4.774							13.769
P-value		0.029							<0.001

3.2. Blood discard rate

Compared with the control group, the observation group had a lower blood discard rate ($P < 0.05$). See **Table 3**.

Table 3. Blood discard rate [Case (Percentage)]

Group	n	Confidential Discard	Non-Standard Volume	Clotted Blood	Abnormal Plasma Color	Testing Process Abnormality	Total Discard Rate
Observation Group	165	0 (0.00)	1 (0.61)	0 (0.00)	0 (0.00)	1 (0.61)	2 (1.21)
Control Group	165	1 (0.61)	2 (1.21)	1 (0.61)	1 (0.61)	6 (3.64)	11 (6.67)
χ^2-value							6.486
P-value							0.011

3.3. Quality of blood collection and supply environment

The quality of the blood collection and supply environment in the observation group was superior to that in the control group ($P < 0.05$). See **Table 4**.

Table 4. Quality of blood collection and supply environment [Case (Percentage)]

Group	n	Air Quality in Blood Collection/Supply Environment	Environmental Surface	Donor's Arm Skin	Healthcare Worker's Hand Hygiene	Blood Storage Refrigerator	Blood Specimen Transport Container
Observation Group	165	161 (97.58)	159 (96.36)	163 (98.79)	165 (100.00)	160 (96.97)	160 (96.97)
Control Group	165	152 (91.12)	150 (90.91)	156 (94.55)	158 (95.76)	151 (91.52)	148 (89.70)
χ^2-value		5.024	4.119	4.608	7.152	7.366	7.013
P-value		0.025	0.043	0.032	0.007	0.007	0.008

4. Discussion

The demand for clinical blood use continues to grow, with an average annual increase of 10% to 15%. This necessitates blood stations to optimize their blood management processes to ensure the safety of clinical blood use and reduce the occurrence of blood discards [6]. As the primary source of clinical blood products, blood stations are responsible for managing key processes such as blood collection, testing, preparation, storage, and distribution. The quality of their operations directly impacts the safety and efficiency of clinical blood transfusions. The successive issuance of documents such as the "Measures for the Administration of Blood Stations," "Quality Management Standards for Blood Stations," and "Quality Management Standards for Blood Station Laboratories" by the state since 2006 has facilitated the standardization and institutionalization of blood management processes. However, studies have shown that from 2015 to 2019, the main non-compliant aspects in blood station quality management were concentrated in quality control, blood collection and acceptance, as well as storage and transportation, with proportions of 31.68%, 27.06%, and 2.97%, respectively [7]. Research by Zhu Xiaoqin [8] also pointed out that issues in record management, blood donation services, and blood testing were prominent, requiring strengthened supervision and continuous improvement. Therefore, this study will introduce comprehensive and refined

management to systematically, standardly, and traceably manage the entire process of blood collection and supply.

This study indicates that the observation group had a higher success rate of single puncture and lower rates of adverse events after blood collection and blood discard compared to the control group ($P < 0.05$). The study by Cao Hualin [9] and others also pointed out that the introduction of comprehensive nursing management into the quality management of voluntary blood donation at blood stations can improve the success rate of one-time puncture and reduce the risk of adverse events after blood collection. This is because comprehensive and meticulous management establishes a management team, enabling clear division of labor and a quality tracking mechanism in the blood collection process. The normalization of skill training and assessment helps strengthen the standardization of operations, which is reflected in more precise key steps such as puncture site selection, needle insertion angle, and needle fixation. Strict implementation of the verification system before operation, including information verification and equipment inspection, avoids puncture failures caused by information omission or equipment abnormalities. The seamless connection of multi-link management makes the operation process more stable, thereby enhancing the success rate of one-time puncture. The decrease in the incidence of adverse events after blood collection is mainly attributed to the knowledge education and psychological counseling provided to blood donors before blood collection, which reduces their anxiety levels. After blood collection, on-site observation and dietary guidance ensure safety during the short-term recovery period and reduce the occurrence of delayed reactions. Meanwhile, the implementation of aseptic operation procedures reduces the risks of skin redness, bleeding, and infection. The meticulous execution of hand hygiene management, consumable replacement, and surface disinfection further reduces local reactions after puncture. The decrease in blood discard rate indicates stricter quality control in the collection, testing, storage, and distribution processes, as well as more standardized sample preservation and information management. This is manifested in the timely mixing of anticoagulants and accurate label verification during the collection process; the implementation of temperature monitoring and alarm systems during storage and transportation to prevent temperature fluctuations from affecting blood components; equipment inspections and independent power supplies to ensure continuous cold chain operation; and adherence to the “first-in, first-out” principle during distribution to reduce discards. Regular environmental disinfection, combined with quality control inspections and video monitoring, effectively maintains air and surface cleanliness, ensuring a stable environment for blood preparation and preservation [10]. The quality of the blood collection and supply environment in the observation group was superior to that in the control group ($P<0.05$), suggesting that comprehensive and meticulous management can enhance the environmental hygiene level and quality compliance rate throughout the entire blood collection and supply process.

In summary, comprehensive and refined management has established a multi-departmental collaborative management system, strengthened personnel training and skill assessments, rigorously enforced aseptic and verification procedures, standardized cold chain storage and transportation as well as environmental disinfection processes. This has made the blood collection process more standardized, risk prevention and control more rigorous, and the blood collection and supply environment cleaner and more stable. Consequently, it has effectively increased the success rate of one-time punctures, reduced adverse events after blood collection and the rate of blood discard, and improved the pass rates of quality tests for air, surface hygiene, and hand hygiene of operators.

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