

# Methods and Effect Analysis of Whole–Process Blood Quality Control Management in Blood Stations

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**Abstract:** *Objective:* To analyze the methods and effects of quality control management implemented by blood stations in the entire process of blood collection, testing, preparation and transportation. *Methods:* 26 staff members were selected as the analysis objects. According to different management methods, they were divided into two groups. One group was named the regular management group, and the second group was named the quality control management group. The time was selected from February 2025 to June 2025. Each group took 150 blood samples to compare the effects of the two groups. *Results:* The work quality management score of the quality control management group was greater than that of the conventional management group, and the blood sample scrapping rate and error rate were less than that of the conventional management group ( $p < 0.05$ ). *Conclusion:* Quality control management is used in the whole process of blood collection, testing, preparation and transportation in blood stations. It can effectively improve the work quality of staff and reduce the blood sample scrap rate and error rate. It has high application value and is worthy of adoption.

**Keywords:** Blood station; Whole blood process; Quality control management; Effect analysis

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## 1. Introduction

With the rapid development of modern medicine, blood transfusion plays a key role in surgical treatment and disease treatment. Blood safety is an important guarantee for clinical blood transfusion treatment. The work of blood stations covers blood collection, testing, preparation and transportation. Problems in any link may affect blood quality and even threaten patients' lives and health<sup>[1]</sup>. However, due to the multiple complex links and many influencing factors involved, any deviation or error will affect the quality of blood and even induce serious adverse reactions to blood transfusion, causing great pain and potential life threats to patients. Therefore, it is important to control blood quality. In the past, blood stations mostly adopted routine management. Although it could meet basic needs, there were still some shortcomings. It was difficult to fully cooperate with or support the current work of blood stations, and it deserves further improvement. Quality control management has the characteristics of being scientific and effective, achieving strict monitoring and precise management of the entire blood process, promptly discovering and correcting potential quality problems, ensuring blood quality, and reducing blood transfusion risks. In view of this, this study aims to explore the application effect of

quality control management<sup>[2]</sup>. This is explained below.

## 2. Materials and methods

### 2.1. General information

The background time of this research is from February 2025 to June 2025, and the research and analysis subjects are 26 blood station staff. The ratio of men to women is 7:19; the age is 25 to 47 ( $35.35 \pm 2.12$ ) years; the working time is 1 to 10 ( $4.34 \pm 1.21$ ) years.

### 2.2. Inclusion and exclusion criteria

#### 2.2.1. Inclusion criteria

All are blood station staff and have worked for  $\geq 1$  year; have corresponding medical, laboratory or related professional academic backgrounds; all participated voluntarily and signed consent forms; no data was lost; and compliance was good.

#### 2.2.2. Exclusion criteria

Recent serious illness or serious chronic disease; women in special period; recent major life events; unable to participate in the research due to work transfer, long-term vacation, etc.

### 2.3. Method

#### 2.3.1. General management group

Routine management: Follow the blood station workflow and management plan to operate, including blood collection, component preparation, etc. Operate strictly in accordance with the operating specifications. Before taking up their posts, staff must receive systematic pre-job training to improve work content and implementation standards.

#### 2.3.2. Quality control management group

Quality control management

(1) Build a quality management system

Based on relevant regulations and the actual conditions of the blood station, build a management system. Staff members clarify their job responsibilities, formulate operating procedures and quality standards, covering the entire process, and ensure that every link has rules to follow. At the same time, a quality traceability system is established to record the entire preparation process so that the root cause can be traced back in time.

(2) Strengthen personnel training

Develop training plans and organize professional training regularly, with new technologies and quality control points as the main training content. Regularly organize internal training, invite experts to teach, and improve the professional capabilities of staff through diversified methods (theoretical explanations, operational demonstrations, case analyses, etc.). After training, there will be strict assessment, and those who pass will continue to work, while those who fail will undergo retraining and make-up exams until they pass.

(3) Control the quality of raw materials

Establish a strict supplier review system to review the qualifications of raw material suppliers. The quality control department conducts random inspections of each batch of raw materials, including the physical properties of the raw materials. For substandard raw materials, return them immediately and record the supplier's bad behavior.

(4) Strengthen equipment management

Improve equipment files and record in detail the equipment used in the process (centrifuges, low-temperature refrigerators, etc.), including purchase time, usage, etc. Develop an equipment maintenance plan and perform regular cleaning, inspection, maintenance and calibration. Before using the equipment, staff should check the

equipment to ensure that it is operating normally. If there is any abnormality, repair it in time. At the same time, create an emergency plan for equipment failure.

(5) Standardize the management of the preparation process

Strictly follow the operating procedures for blood collection to ensure blood quality. Before blood collection, blood donors should be subject to health examination and identity verification, use standard blood collection consumables, and perform strict aseptic operations. During the separation process, parameters such as centrifugation speed are strictly controlled to ensure the separation effect. During the preparation process, strict visual inspection was carried out and the operation conditions were recorded.

(6) Strict quality inspection management

Improve the quality inspection system and strictly inspect all links, such as initial inspection after blood collection and finished product inspection after ingredient preparation. Use the most advanced testing equipment and methods to ensure the accuracy and reliability of results. At the same time, inter-room quality evaluation activities are regularly carried out to compare and analyze test results to promote the improvement of test quality.

(7) Optimize storage and transportation management

Strictly manage the storage and transportation process of blood to ensure blood quality. Maintain the temperature of the low-temperature refrigerator within the specified range and install a temperature monitoring system to monitor temperature changes in real time. When transporting blood, use transport equipment (refrigerators, etc.) that meets the requirements and maintain a stable transport temperature. At the same time, the transportation process is recorded for traceability and inquiry.

## 2.4. Observation indicators

### 2.4.1. Work quality management score

Including blood source control, collection management, etc., there are 7 dimensions in total, with a 100-point system. Higher scores are better, and are scored by the Blood Station Quality Management Committee.

### 2.4.2. Blood sample scrapping situation

Anti-HIV positive, NAT positive, HBsAg positive, syphilis antibody positive, anti-HCV positive, and other factors, the total incidence rate is the sum of six items.

### 2.4.3. Error situations

Including operating errors, recording errors, detection errors, etc., the total incidence rate is the sum of the three items.

## 2.5. Statistical processing

SPSS25.0 software was used for data analysis. Measurement data are described as mean  $\pm$  standard deviation ( $\bar{x} \pm s$ ) and tested by  $t$ ; count data are described as percentage (%) and tested by  $\chi^2$ . Comparison parameter = 0.05,  $p < 0.05$ , indicating that there is a difference in the data.

## 3. Results

### 3.1. Comparison of work quality management scores between the two groups

Quality control management group > routine management group ( $p < 0.05$ ), see **Table 1**.

**Table 1.** Comparison of work quality management scores between the two groups ( $\bar{x} \pm s$ )

Group	n	Blood source control (points)	Collection management (points)	Preparation control (points)	Quality Inspection Management (points)	Blood transport (points)	Reserve management (points)	Usage management (points)
General management group	26	89.34 ± 5.45	86.65 ± 5.49	89.45 ± 5.13	87.34 ± 5.08	89.46 ± 5.49	87.89 ± 5.43	88.47 ± 5.19
Quality Control Management group	26	95.45 ± 2.48	93.46 ± 2.51	91.46 ± 2.57	93.45 ± 2.34	92.89 ± 2.57	94.35 ± 2.59	95.56 ± 2.47
<i>t</i> value	-	5.203	5.752	1.786	5.570	2.885	5.475	6.290
<i>p</i> value	-	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05

### 3.2. Comparison of discarded blood samples between the two groups

The rate was 13.33% (20/150) in the conventional management group and 3.33% (5/150) in the quality control management group. The latter < the former ( $p < 0.05$ ), **Table 2**.

**Table 2.** Comparison of scrapped blood samples between the two groups [n(%)]

Group	Number of copies	Anti-HIV positive	NAT positive	HBsAg positive	Syphilis antibody positive	Anti-HCV positive	Other factor	Total
General management group	150	3 (2.00)	5 (3.33)	3 (2.00)	4 (2.67)	4 (2.67)	2 (1.33)	20 (13.33)
Quality control Management group	150	3 (2.00)	0 (0.00)	0 (0.00)	2 (1.33)	0 (0.00)	0 (0.00)	5 (3.33)
$\chi^2$ value	-	-	-	-	-	-	-	9.818
<i>p</i> value	-	-	-	-	-	-	-	0.002

### 3.3. Comparison of error situations between the two groups

The rate in the conventional management group was 10.00% (15/150), and that in the quality control management group was 2.67% (4/150). The latter < the former ( $p < 0.05$ ), **Table 3**.

**Table 3.** Comparison of error conditions between two groups [n(%)]

Group	Number of copies	Operation error	Log errors	Detection error	Total
General management group	150	6 (4.00)	3 (2.00)	6 (4.00)	15 (10.00)
Quality control management group	150	1 (0.67)	1 (0.67)	2 (1.33)	4 (2.67)
$\chi^2$ value	-	-	-	-	6.799
<i>p</i> value	-	-	-	-	0.009

## 4. Discussion

In recent years, with the improvement of the medical system, all clinical blood transfusion treatment technologies have also been continuously improved. As an important clinical treatment measure, blood transfusion therapy can provide targeted support for patients, which is of great significance in improving efficacy and ensuring patient safety. Blood

preparation is a key prerequisite for blood transfusion therapy, and its quality directly affects the success or failure of treatment<sup>[3]</sup>. As the core hub of blood supply, blood stations must attach great importance to blood preparation. In order to ensure blood quality and meet the demand for safe blood use, strict and comprehensive quality control management must be carried out. Although routine management has achieved certain results, there are still deficiencies, such as failure to fully consider potential influencing factors, which has led to certain loopholes in quality control and affected the quality of blood preparation. Therefore, attention should be paid from multiple aspects and angles to promote the improvement of work quality<sup>[4]</sup>. Quality control management is a new type of management. Through effective and scientific management measures, the preparation process is strictly monitored and managed. Potential quality problems are discovered and corrected in a timely manner to ensure quality, effectively reduce the risk of blood transfusion, and promote the improvement of the therapeutic effect and safety of blood transfusion for patients. It can be seen that the implementation of quality control management not only effectively improves the quality of blood station work, but also contributes to the sustainable development of blood transfusion therapy<sup>[5]</sup>. In addition, in-depth exploration of quality control management methods and effects can promote the scientific and standardized development of blood station management.

This study showed that the work quality management score of the quality control management group was greater than that of the conventional management group, and the blood sample scrapping rate and error rate were less than that of the conventional management group ( $p < 0.05$ ), which shows that quality control management can help improve the work quality of blood stations. After analysis, quality control management was carried out from multiple aspects to ensure the comprehensiveness and scientificity of the research. Among them

- (1) Strengthen personnel training and organize regular and systematic training based on the situation of the blood station to help improve the work ability of the staff. By adopting diversified training, it is easier for staff to understand and master it, and they can perform operations in each link more accurately and standardizedly. At the same time, the assessment mechanism is improved to ensure the effectiveness of training, promote staff learning enthusiasm and work attitude, and effectively ensure the quality of blood preparation.
- (2) Controlling the quality of raw materials is the basis for ensuring the quality of preparation. Improve the supplier audit and raw material sampling mechanism to eliminate raw materials with substandard quality from the source, thereby effectively reducing the blood scrap rate. At the same time, it also avoids the occurrence of errors in later preparation and detection, thus reducing the blood scrap rate and error rate<sup>[6]</sup>.
- (3) Strengthening equipment management is also an important step in improving preparation quality. By establishing equipment files and formulating equipment maintenance plans, potential equipment problems can be discovered and solved in time to ensure normal operation of the equipment. At the same time, establishing an emergency plan for equipment failure will help improve staff's response capabilities and ensure the continuity and quality of blood preparation.
- (4) Standardize preparation process management: When collecting blood samples, strictly follow the operating specifications. Strict health examination and identity verification are required before blood collection, and strict aseptic operation is required to ensure the quality of blood collection<sup>[7]</sup>. When performing operations such as separation, strict control of relevant parameters and strict visual inspection can ensure purity and safety. Standardized operations and detailed records not only facilitate quality traceability, but also contribute to continuous quality improvement in the later period, thereby improving overall quality.
- (5) Strict quality inspection management, improve the quality inspection system, comprehensively cover initial inspection and finished product inspection, and cooperate with advanced inspection equipment and technology to detect potential problems in a timely manner and ensure the accuracy and reliability of test results. At the same time, inter-room quality evaluation activities are regularly organized to significantly improve the blood station's testing level and help improve testing accuracy and reliability. In addition, strict quality testing is implemented to promptly intercept unqualified blood samples, ensuring the quality and safety of clinical blood transfusions and reducing the occurrence of blood scrapping and resource waste.

(6) Optimize storage and transportation management, use the temperature monitoring system, utilize its real-time monitoring and alarm functions, and cooperate with strict requirements for transportation equipment, so the quality of blood samples can be guaranteed to be stable after leaving the blood station. The transportation process should be recorded in detail for traceability and inquiry<sup>[8]</sup>. Once a problem occurs, the cause can be quickly found and remedial measures can be implemented, effectively reducing the occurrence of blood deterioration and scrapping, and significantly improving the utilization rate of blood resources. Compared with traditional routine management, quality control management is systematic and multi-dimensional. It comprehensively covers the entire process of blood collection, testing, preparation and transportation. Therefore, clinical guidance is extremely valuable and can effectively improve the quality of staff's work and reduce blood sample rejection and error rates<sup>[9]</sup>. However, this study still has shortcomings. The samples are only from blood stations, and the sample size is small, prone to regional and sample differences. The universality of the research results needs to be further verified. In subsequent studies, multi-center studies can be carried out by expanding the sample scope, including data from blood stations of different sizes, and further improving the generalizability and reliability of the research conclusions. At the same time, this study was relatively short and only focused on the short-term impact of quality control management. Future research can carry out long-term follow-up research to deeply explore the long-term role of quality control management<sup>[10]</sup>.

In summary, quality control management is used in the entire blood process of blood stations. Through a series of measures, it effectively improves the work quality and management level of staff, reduces the scrap rate and error rate of blood samples, thereby effectively improving blood quality and ensuring the safety of clinical blood transfusions. It has high application value and is worthy of adoption. At the same time, the implementation of quality control management also provides practical basis and reference direction for the whole-process quality control management of blood.

## About the author

Zhang Yueqi (year of birth: 1981–), female, Han, from Liyang, Jiangsu, has a bachelor's degree, and her research direction is blood transfusion technology.

## Disclosure statement

The author declares no conflict of interest.

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