

Factors Influencing the Management and Distribution of Blood Units in Hospital Settings: A Mixed-Methods Study in Greek Public Hospitals

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Citation: Tzenalis Anastasios (2026). Factors Influencing the Management and Distribution of Blood Units in Hospital Settings: A Mixed-Methods Study in Greek Public Hospitals, *J International Journal of Public Health Research and Epidemiology*; 2 (3) 14, DOI: [10.5281/zenodo.21547999](https://doi.org/10.5281/zenodo.21547999)

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Abstract:

Background: The safe management and distribution of blood products represent critical components of transfusion medicine and patient safety. Errors occurring during the transfusion process may lead to severe adverse events and compromise the quality of healthcare services. Understanding the factors that influence blood management procedures is essential for improving transfusion safety and reducing preventable errors in hospital settings.

Aim: The aim of this study was to investigate the factors affecting the proper management and distribution of blood units from hospital blood banks to clinical departments and to explore the role of organizational conditions and professional training in the occurrence of transfusion-related errors.

Methods: A mixed-method study design was applied. The quantitative phase consisted of cross-sectional surveys conducted among healthcare professionals working in six public hospitals in Greece, including blood bank personnel and clinical staff. Data were collected using structured electronic questionnaires. In addition, the Delphi technique was employed to obtain expert consensus on key factors influencing blood management procedures. Statistical analysis was performed using descriptive statistics and non-parametric tests.

Results: A total of 536 healthcare professionals participated in the study. The findings indicated a relatively low frequency of returned or unsuitable blood units in the participating hospitals. However, several organizational and human factors were identified as important contributors to transfusion-related errors, including work-related stress, excessive workload, staff shortages and ineffective communication between clinical departments and blood bank services. In addition, professional training and continuous education were strongly associated with reduced occurrence of errors and improved transfusion safety.

Conclusion: The findings highlight the importance of structured procedures, effective communication and continuous professional education in ensuring safe blood management practices. Strengthening organizational support and implementing targeted training programs may significantly contribute to reducing transfusion-related errors and improving patient safety in hospital transfusion services.

Key words: transfusion; blood management; transfusion errors; patient safety; nursing practice

Introduction:

Blood transfusion is a fundamental component of modern healthcare and plays a crucial role in the treatment of numerous clinical conditions such as anemia, trauma and acute blood loss. The availability of safe blood and blood components is therefore essential for effective patient care.[1]

Modern transfusion practice relies mainly on the use of specific blood components such as red blood cells, plasma and platelets rather than whole blood, allowing more targeted therapeutic interventions. [2]

The development of transfusion medicine has been closely associated with major scientific discoveries. The identification of the ABO blood group system by Karl Landsteiner in 1901 established the foundation for compatibility testing and significantly improved transfusion safety.[3]

Despite these advances, the transfusion process remains complex and involves multiple stages including patient identification, sample collection, laboratory testing, storage and administration of blood products. Errors may occur at any stage of this process and may lead to serious complications.[4]

Studies have shown that a large proportion of transfusion-related adverse events are associated with human errors, particularly during patient identification and bedside verification procedures. [5,6]

For this reason, improving the management and distribution of blood units from hospital blood banks to clinical departments is essential for enhancing patient safety and optimizing the efficiency of transfusion services. [7]

Aim of the Study

The aim of this study was to investigate the factors affecting the proper management and distribution of blood units from hospital blood banks to clinical departments, and to develop a framework for improving the effectiveness and efficiency of blood management procedures in hospital settings.

More specifically, the study sought to:

- examine the current practices related to the management and distribution of blood units in hospital transfusion services
- identify the most frequent errors or failures occurring during the blood distribution process
- explore the organizational, human and technical factors that may influence the occurrence of such errors
- assess the role of professional training and education in reducing transfusion-related errors.

Research Questions

Based on the objectives of the study, the following research questions were formulated:

- What are the most common errors occurring during the management and distribution of blood units in hospitals?
- Which organizational, human and technical factors influence the occurrence of these errors?
- To what extent does communication between clinical departments and blood bank services affect the safety of blood management procedures?
- What is the role of professional education and training in reducing errors related to blood management and distribution?

Hypotheses

The study also examined the following research hypotheses:

- Sociodemographic characteristics of healthcare professionals influence their perceptions regarding the frequency of errors in blood management and distribution.
- Training and professional education are associated with reduced occurrence of errors in blood management processes.
- Organizational and communication factors within hospitals influence the efficiency and safety of blood distribution procedures.

Ethical Considerations

The study was conducted in accordance with ethical research principles. Participation was voluntary and anonymous, and no personal or sensitive data were collected. Ethical approval for the study was obtained from the scientific committees of the participating hospitals, including the University General Hospital of Patras, the General Hospital of Athens “Evangelismos”, the General Hospital of Attica KAT, the University Hospital of Thessaloniki AHEPA, and the General Hospital of Kalamata.

Methods

Study Design

This study employed a mixed-method research design consisting of two sequential phases. The first phase involved quantitative cross-sectional surveys aimed at investigating the perceptions of healthcare professionals regarding errors in blood management and distribution processes. The second phase employed the Delphi technique in order to achieve expert consensus regarding the interpretation of the findings and the development of improvement strategies. [8,9]

Study Setting and Participants

The study was conducted in six public hospitals in Greece: the General Hospital of Athens “Evangelismos”, the General Hospital of Attica KAT, the University Hospital of Thessaloniki AHEPA, the University Hospital of Patras, the General Hospital of Patras and the General Hospital of Kalamata.

Two study populations were included:

- Healthcare professionals working in hospital blood banks, including hematologists, physicians, blood bank nurses and medical laboratory technologists.
- Healthcare professionals working in clinical departments such as internal medicine, surgery, anesthesiology departments and intensive care units, excluding blood bank staff.

A total of 536 healthcare professionals participated in the study. Specifically, 97 participants were blood bank personnel and 439 were healthcare professionals working in clinical departments.

Sampling Method

A non-probability sampling approach was applied using purposive sampling combined with the snowball technique.^{10,11} Department directors served as gatekeepers and facilitated the recruitment of participants. Invitations to participate in the study were distributed electronically via email.

Data Collection

Data were collected between November 2023 and February 2024 using structured electronic questionnaires developed through the Google Forms platform. Participation was voluntary and anonymous.

Two questionnaires were developed:

- one addressed to blood bank personnel
- one addressed to healthcare professionals working in hospital clinical departments.

Both questionnaires included demographic variables as well as questions assessing the frequency of errors, causes of errors, communication between departments, blood management procedures and training experiences. Responses related to errors and causal factors were measured using Likert-type scales.

Validity and Reliability

The questionnaires were developed based on existing literature regarding blood management and transfusion errors.^{12,13} Content validity was assessed through pilot testing conducted with ten healthcare professionals.

Internal consistency reliability was evaluated using Cronbach’s alpha coefficient.¹⁴ The results demonstrated high internal consistency for both questionnaires ($\alpha = 0.908$ and $\alpha = 0.949$ respectively).

Delphi Phase

The second phase of the study applied the Delphi method to obtain expert consensus regarding the interpretation of the quantitative findings and the development of improvement strategies for blood management processes.^{15,16}

A panel of healthcare experts participated in this phase, including eight experts from the University Hospital of Patras and the General Hospital of Patras and fifteen experts from the University Hospital of Patras.

Statistical Analysis

Data were analyzed using the Statistical Package for Social Sciences (SPSS) version 22. Tests for normality included the Kolmogorov–Smirnov test¹⁷ and the Shapiro–Wilk test.¹⁸ Since the variables did not follow a normal distribution, non-parametric statistical methods were applied.¹⁹

Descriptive statistics included frequencies, percentages, means and standard deviations. Inferential analysis was conducted using the Mann–Whitney U test²⁰ and the Kruskal–Wallis test.²¹ Correlations between variables were examined using Spearman’s rank correlation coefficient.²² The level of statistical significance was set at $p < 0.05$.

For the Delphi phase, agreement among experts was assessed using Kendall’s coefficient of concordance (Kendall’s W).^{23,24}

Results

The study sample consisted of 97 healthcare professionals working in blood bank departments of public hospitals in Greece. The majority of participants were women (79.4%), while most participants were aged over 40 years. Blood bank nurses represented the largest professional group in the sample (58.8%). Additional demographic characteristics of the participants are presented in Table 1.

Variable	n	%
Gender		
Male	20	20.6
Female	77	79.4
Age		
20–29 years	4	4.1
30–39 years	16	16.5
40–49 years	30	30.9
>50 years	47	48.5
Profession		
Hematologist	14	14.4
Clinical physician	13	13.4
Blood bank nurse	57	58.8
Laboratory technologist	13	13.4
Years of service		
0–5 years	13	13.4
6–15 years	23	23.7
≥16 years	61	62.9

Table 1: Sociodemographic characteristics of the participants (N=97)

Regarding the management of blood units, participants reported that returned blood units from clinical departments were identified either “almost never” (40.2%) or “sometimes” (40.2%). Similarly, expired blood units were reported as occurring “almost never” by 54.6% of respondents, while problematic blood units that did not meet transfusion standards were also reported as occurring mostly rarely. The detailed distribution of responses is presented in Table 2.

Variable	Never (%)	Almost never (%)	Sometimes (%)	Often (%)	Very often (%)
Returned blood units from clinical departments	2.1	40.2	40.2	12.4	5.2
Expired blood units in blood bank	15.5	54.6	25.8	3.1	1.0
Problematic blood units unsuitable for transfusion	5.2	51.5	39.2	2.1	2.1

Table 2: Frequency of returned, expired or problematic blood units

Participants were also asked to report the frequency of different types of errors occurring during the blood management and distribution process. The overall mean score of the responses was 2.16 (SD = 0.60), indicating relatively low but present occurrence of errors in clinical practice. The most frequently reported errors included failure to provide the laboratory with adequate patient clinical information (mean = 3.03), errors in patient demographic data entry (mean = 2.76), failure to record blood requests from clinical departments (mean = 2.53), and delayed delivery of blood units for transfusion (mean = 2.44). These results are summarized in Table 3.

Error	Mean	SD
Failure to provide laboratory with patient clinical information	3.03	1.09
Errors in patient demographic data entry	2.76	1.08
Failure to record blood request from clinical department	2.53	1.09
Delayed delivery of blood unit for transfusion	2.44	1.11

Table 3 : Most frequent errors in blood management procedures

Participants were further asked to indicate the factors that may contribute to the occurrence of errors in blood management and distribution processes. The overall mean score for these responses was 3.93 (SD = 0.82). The highest scoring factors included work-related stress (mean = 4.30), fatigue of healthcare personnel (mean = 4.28), excessive workload (mean = 4.28), distraction due to multiple simultaneous tasks (mean = 4.22), staff shortages (mean = 4.11), and poor communication between hospital departments (mean = 4.05). These findings are presented in Table 4.

Cause	Mean	SD
Work-related stress	4.30	0.91
Fatigue of healthcare personnel	4.28	0.93
High workload	4.28	0.89
Distraction due to multiple simultaneous tasks	4.22	0.95
Staff shortage	4.11	0.98
Poor communication between departments	4.05	0.95

Table 4: Main causes of errors in blood management

In terms of professional education and training, the majority of respondents reported that they had participated in educational programs related to blood management procedures. Specifically, 85.6% of participants reported having attended such training, while 97.9% expressed interest in further professional education on blood management practices. These results are presented in Table 5.

Variable	Yes (%)	No (%)
Participation in blood management training programs	85.6	14.4
Adequate knowledge regarding blood management procedures	85.6	14.4
Interest in further education and training	97.9	2.1

Table 5: Education and training of healthcare professionals

Discussion:

The present study aimed to investigate the factors affecting the proper management and distribution of blood units from hospital blood banks to clinical departments in Greek public hospitals. The findings provide important insights into the perceptions and experiences of healthcare professionals regarding transfusion-related procedures and potential sources of error.

One of the key findings of the study was the low frequency of returned, expired or unsuitable blood units in the participating hospitals. This result suggests that internal quality assurance procedures related to blood product management appear to function effectively in the examined institutions. The implementation of standardized procedures and continuous staff training may contribute significantly to minimizing errors and ensuring safe transfusion practices.

These findings are consistent with previous studies reporting high levels of compliance with quality standards in hospital transfusion services. For example, a prospective study conducted at the Blood Transfusion Center of Mansoura University Hospital in Egypt reported that more than 90% of blood products complied with national and international quality standards (NBTS, AABB, Council of Europe).²⁵ Similar findings were reported in a regional blood center in northern Pakistan, where internal quality control procedures ensured high compliance rates for different blood components, including red blood cells, plasma and platelets.^[26]

Another important finding concerns the procedures used for verifying and documenting blood group compatibility prior to blood distribution. The results indicate that the verification of the patient's blood group through additional sampling and the proper documentation of blood group information in blood bank records are considered essential safety procedures by healthcare professionals. These findings are in line with previous studies demonstrating that double verification of blood group identity is a critical component of transfusion safety. ^[25-27]

The study also revealed a high level of compliance with transfusion protocols among healthcare professionals working in the participating hospitals. Adherence to standardized protocols plays a crucial role in ensuring patient safety and preventing transfusion-related complications, including infections transmitted through blood products such as HIV, hepatitis B and hepatitis C. ^[28]

International evidence supports the importance of strict adherence to transfusion guidelines. Previous studies have demonstrated that institutions with well-established protocols and regularly trained staff show significantly lower error rates in blood management procedures.²⁵⁻²⁷ In contrast, studies conducted in healthcare systems with limited resources report lower compliance with transfusion protocols, mainly due to staff shortages and insufficient training opportunities. ^[29-31]

Another important finding concerns the role of communication between clinical departments and blood bank services. Participants emphasized that effective communication between healthcare professionals significantly reduces the likelihood of errors during blood management procedures. Similar findings have been reported in previous research highlighting that communication failures between clinical departments and transfusion services are among the most common causes of delayed or inappropriate transfusions. ^[32,33]

In addition, the study identified several organizational and human factors contributing to transfusion-related errors. Healthcare professionals reported that work-related stress, fatigue, excessive workload, multitasking and staff shortages represent the most important risk factors. These findings are consistent with previous studies indicating that human factors and organizational conditions significantly influence the occurrence of transfusion-related errors. [34-37]

Several studies have also shown that errors in sample labeling, patient identification and documentation represent some of the most frequent causes of potentially incompatible transfusions. [38-42] Maskens et al reported that incorrect sample labeling remains one of the most common transfusion errors. Similarly, Ansari and Szallasi⁴⁰ identified wrong blood in tube (WBIT) errors as a major cause of transfusion incidents. Other studies have highlighted the importance of accurate documentation and data entry during blood sample collection and transfusion procedures.

Another significant finding of the study concerns the role of professional training and continuing education in reducing transfusion-related errors. Both blood bank personnel and other healthcare professionals recognized the importance of education in improving transfusion safety. Previous research has demonstrated that insufficient knowledge regarding blood management procedures, sample labeling and transfusion verification processes increases the risk of preventable errors. [43-45]

The findings also suggest that healthcare professionals who have received structured training in blood management procedures report fewer errors in clinical practice. These results support previous research indicating that continuous education programs and regular training sessions significantly improve transfusion safety and reduce the risk of medical errors.

Overall, the findings of this study highlight the importance of structured procedures, effective communication, adequate staffing and continuous professional education in ensuring the safe management and distribution of blood products in hospital settings. Strengthening these factors may contribute significantly to improving transfusion safety and reducing preventable errors in clinical practice.

Conclusion:

The present study investigated the factors influencing the management and distribution of blood units from hospital blood banks to clinical departments in Greek public hospitals. The findings highlight the importance of structured procedures, effective communication and adequate training of healthcare professionals in ensuring the safety and efficiency of transfusion practices.

The results indicate that the frequency of unsuitable or returned blood units in the participating hospitals is relatively low, suggesting that quality control procedures and transfusion protocols are generally well implemented. At the same time, the study identified several organizational and human factors that may contribute to errors in blood management, including work-related stress, staff shortages, excessive workload and insufficient communication between clinical departments and blood bank services. These factors have been widely reported in previous research as key contributors to transfusion-related errors. [34-36]

Another important finding concerns the role of professional education and continuous training. Healthcare professionals who had received training in blood management procedures reported fewer errors and demonstrated greater awareness of transfusion safety practices. These findings underline the critical importance of ongoing education programs and standardized training protocols in improving transfusion safety and reducing preventable errors. [43-45]

Overall, improving organizational conditions, strengthening interdisciplinary communication and implementing systematic educational programs may significantly enhance the safety and effectiveness of blood management processes in hospital settings. Future research should focus on developing and evaluating targeted interventions aimed at improving transfusion safety and optimizing blood management systems in healthcare organization

Conflict of Interest:

The authors declare that they have no conflicts of interest.

Funding:

No financial support was received for this study.

Ethics Approval:

Ethical approval for this study was obtained from the scientific committees of the participating hospitals, including the University General Hospital of Patras, the General Hospital of Athens “Evangelismos”, the General Hospital of Attica KAT, the University Hospital of Thessaloniki AHEPA, and the General Hospital of Kalamata.

Acknowledgements:

The authors would like to thank all healthcare professionals who participated in this study.

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