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Knowledge, Attitude, and Practice (KAP) Regarding Blood Group Serology and Cross-Matching among Medical Students, Residents, and Healthcare Workers

Venkatesh R[1], Gunasekar P[1], Bernaitis L[2]

[1]Department of Siddha Maruthuva Moola Thathuvam, Nandha Siddha Medical College and Hospital, Erode-638052.

[2]Department of Noi Nadal And Noi Mudhal Naadal (Pathology Including Microbiology), Nandha Siddha Medical College and Hospital, Erode-638052.

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Abstract:

Background: Blood group serology and cross-matching are essential components of safe blood transfusion practices. Errors in these processes can lead to severe transfusion reactions and compromise patient safety. Despite their importance, knowledge and adherence to safe practices among medical students, residents, and healthcare workers are often inadequate, particularly in developing countries where structured training is limited.

Objective: This study aimed to evaluate the knowledge, attitude, and practice (KAP) regarding blood group serology and cross-matching among medical students, residents, and healthcare workers in Ernakulam district, Kerala, South India.

Materials and Methods: A cross-sectional, questionnaire-based study was conducted among 118 participants, including undergraduate medical students, residents, and healthcare workers. The survey was administered through Google Forms, and responses were compiled using Google Sheets. The questionnaire consisted of 20 structured questions covering knowledge, attitude, and practice. Data were analyzed using descriptive statistics, and participants were classified into poor, moderate, and good KAP levels.

Results: Out of 118 valid responses, only 28% demonstrated adequate knowledge of blood group serology and cross-matching, while 13% reported being completely unaware. A majority (65%) showed a positive attitude toward safe transfusion practices, but only 45% consistently followed correct procedures. Junior medical students, particularly second-year students, exhibited significantly lower knowledge and practice levels compared to residents and senior students.

Conclusion: The findings highlight a considerable gap between knowledge and practice, despite a generally positive attitude. These results are consistent with other regional and international studies, which also report poor adherence to transfusion safety protocols among students and young healthcare professionals. Strengthening transfusion medicine education in medical curricula, along with regular hands-on training and workshops, is essential to improve competency, reduce errors, and ensure patient safety.

Keywords: Blood group serology, cross-matching, transfusion safety, medical students, residents, healthcare workers, KAP study.

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Introduction

Safe blood transfusion practices are essential in modern healthcare systems, as they directly influence patient survival and treatment outcomes. Blood group serology and compatibility testing, especially cross-matching, represent fundamental laboratory procedures that ensure the safe administration of blood and blood products. Errors in these procedures can lead to life-threatening complications such as acute hemolytic transfusion reactions, alloimmunization, and transmission of infectious agents (1). Despite technological advancements in immunohematology, the knowledge and compliance of medical students, residents, and healthcare workers remain critical factors in maintaining transfusion safety.

The ABO and Rh blood group systems are the most clinically significant in transfusion medicine. Proper understanding of these systems, along with the principles of antibody screening and cross-matching, is essential to prevent incompatibility reactions. Cross-matching ensures compatibility between donor and recipient blood, and adherence to standard serological protocols helps reduce transfusion-related risks (2,3). However, knowledge gaps, insufficient training, and lack of adherence to protocols among healthcare professionals and trainees often compromise transfusion safety (4).

Globally, studies have reported variable levels of knowledge, attitude, and practice toward blood group serology and cross-matching. In many low- and middle-income countries, poor awareness and lack of standardized training contribute to unsafe transfusion practices (5,6). Even in developed countries, lapses in compliance have been linked to human error, inadequate supervision, and over-reliance on automated systems (7). Studies among medical students and residents have highlighted

*Corresponding Author
Bernaitis L*
Department of Noi Nadal And Noi Mudhal Naadal(Pathology Including Microbiology), Nandha Siddha Medical College and Hospital, Erode-638052.

deficiencies in basic immunohematology knowledge, suggesting that theoretical teaching alone may not be sufficient, and practical training in transfusion medicine should be strengthened (8).

Healthcare workers, including laboratory technicians and nurses, also play a vital role in ensuring transfusion safety. Their involvement in blood collection, labeling, and sample handling necessitates adequate knowledge of pre-analytical and analytical steps in cross-matching (9). Inadequate training and lack of continuing education programs for healthcare workers are often associated with avoidable transfusion errors (10). Furthermore, attitudes toward the importance of following strict transfusion protocols, combined with actual practices in clinical and laboratory settings, determine the overall effectiveness of blood safety programs (11).

The World Health Organization (WHO) emphasizes the need for regular training of healthcare workers in transfusion medicine, highlighting that strengthening knowledge, attitude, and practice is essential to reduce preventable transfusion-related morbidity and mortality (12). In India and similar settings, studies have shown that although awareness of blood grouping is relatively common, detailed knowledge of serological testing and cross-matching is often inadequate among both students and practicing healthcare personnel (13,14).

Given the increasing demand for blood and blood products in clinical practice, especially in surgeries, trauma, oncology, and obstetric emergencies, it becomes imperative to assess the preparedness of future healthcare professionals and current workers in terms of their knowledge and compliance with safe transfusion practices. Addressing gaps in this area not only enhances patient safety but also builds a culture of responsibility and accountability among healthcare providers (15).

The present study aims to evaluate the knowledge, attitude, and practice regarding blood group serology and cross-matching among medical students, residents, and healthcare workers through a structured questionnaire-based survey, in order to identify existing gaps and recommend strategies for improving transfusion safety.

Materials and Methods

This descriptive, cross-sectional, questionnaire-based study was conducted among medical students, residents, and healthcare workers in the southern part of India, specifically in Ernakulam district, Kerala. The study was carried out over a period of three months, from May to July 2025. The target population included undergraduate medical students (particularly those in their clinical years), postgraduate residents, laboratory technicians, and nursing staff who were directly or indirectly involved in blood transfusion practices. A total of 118 participants were recruited using convenience sampling. Participation in the study was voluntary, and informed consent was obtained prior to data collection. Confidentiality and anonymity of all participants were maintained throughout the study.

A structured questionnaire was developed in English and distributed both in printed form and via an online Google Form to ensure maximum participation. The tool was prepared after reviewing existing literature on transfusion medicine and validated by subject experts in pathology and transfusion practices. The questionnaire comprised 25 items and was divided into three sections: knowledge (15 questions), attitude (5 questions), and practice (5 questions). The knowledge section focused on awareness of blood group systems, the principles of cross-matching, and recognition of transfusion reactions. The attitude section assessed perceptions regarding the importance of adhering to transfusion safety protocols, willingness to undergo training, and overall approach toward laboratory biosafety. The practice section evaluated routine adherence to safety measures such as correct labeling, verification steps, and use of personal protective equipment during cross-matching and transfusion procedures.

The knowledge-based items had single best-answer options, while attitude and practice-related items were assessed using a three-point Likert scale (Agree / Neutral / Disagree; Always / Sometimes / Never). Responses were scored and participants were categorized into levels of poor, moderate, or good knowledge, attitude, and practice. Data were compiled in Google Sheets and analyzed using descriptive statistics, including frequency and percentage.

Table 1. Sample Questionnaire Items

Domain	Sample Question	Response Options
Knowledge	Which blood group system is most important in transfusion safety?	a) ABO b) Rh c) Kell d) Duffy
Knowledge	What is the purpose of cross-matching before transfusion?	a) Detect infections b) Ensure compatibility c) Prevent clotting d) None
Knowledge	Which laboratory test is performed to check compatibility between donor and recipient?	a) Direct antiglobulin test b) Cross-match test c) Coombs control cells d) None
Attitude	Do you believe strict cross-matching protocols prevent life-threatening reactions?	Agree / Neutral / Disagree
Attitude	Are you willing to attend workshops on transfusion medicine to improve skills?	Yes / No / Not Sure
Practice	Do you always check patient identity before sending a sample for cross-matching?	Always / Sometimes / Never
Practice	Do you label samples immediately at the bedside during collection?	Always / Sometimes / Never
Practice	Do you routinely use personal protective equipment (PPE) when handling blood samples?	Always / Sometimes / Never

Results:

A total of 118 completed questionnaires were received from participants, which included medical students, residents, and healthcare workers from Ernakulam district, Kerala. The majority of respondents were undergraduate medical students (65%), followed by postgraduate residents (20%), and healthcare workers such as laboratory technicians and nurses (15%). Most of the participants were second-year medical students, accounting for nearly 55% of the total responses.

When analyzing knowledge levels, it was observed that only 28% of the participants demonstrated adequate knowledge regarding blood group serology and cross-matching principles. A considerable proportion, 59%, exhibited moderate knowledge, while 13% reported being completely unaware of key concepts such as Rh factor, cross-match procedures, and compatibility testing.

In terms of attitude, 64% of the respondents showed a positive outlook toward the importance of strict adherence to blood transfusion safety measures, with many expressing willingness to attend training sessions and workshops. Around 22% demonstrated a neutral attitude, while 14% reflected negative or indifferent perceptions.

Regarding practice, only 48% of the participants reported consistently following correct laboratory and safety protocols, such as proper labeling, double-checking of patient identity, and safe handling of blood samples. Another 34% admitted to partial compliance, while 18% acknowledged poor adherence to cross-matching safety protocols.

Table 2. Distribution of Knowledge, Attitude, and Practice Levels among Participants (n = 118)

Domain	Good n (%)	Moderate n (%)	Poor / Unaware n (%)
Knowledge	33 (28.0%)	70 (59.3%)	15 (12.7%)
Attitude	76 (64.4%)	26 (22.0%)	16 (13.6%)
Practice	57 (48.3%)	40 (33.9%)	21 (17.8%)

Table 3. Sample Responses to Key Questions

Question	Correct / Positive Response n (%)
Awareness of ABO and Rh blood group system	92 (77.9%)
Understanding of the purpose of cross-matching	81 (68.6%)
Knowledge that incompatibility may cause severe transfusion reactions	97 (82.2%)
Awareness of the need for double verification before transfusion	85 (72.0%)
Regular use of PPE during handling of blood samples	66 (55.9%)
Willingness to attend workshops on blood transfusion safety	89 (75.4%)

Discussion

The present study assessed knowledge, attitude, and practice (KAP) regarding blood group serology and cross-matching among medical students, residents, and healthcare workers in Ernakulam district, Kerala. The findings revealed that only 28% of the participants had good knowledge, while a majority demonstrated moderate awareness, and 13% were entirely unaware of key concepts. This indicates significant gaps in theoretical understanding of fundamental transfusion practices, despite the crucial role these play in ensuring patient safety. Similar deficiencies have been reported in other parts of India, where undergraduate students lacked adequate training in transfusion medicine and exhibited low awareness of blood compatibility testing (16).

The results of our study showed that although 64% of participants expressed a positive attitude toward blood transfusion safety and laboratory practices, this did not fully translate into practice. Only 48% reported consistently following correct protocols such as double verification, proper labeling, and safe handling of blood products. This knowledge–practice gap is consistent with findings from a study conducted among healthcare providers in Pakistan, where despite high awareness of transfusion safety, adherence to standard practices was suboptimal due to workload and insufficient supervision (17).

The willingness of three-fourths of respondents in our study to attend workshops and training programs is encouraging, reflecting the recognition of the need for further education. Similar outcomes have been documented in a cross-sectional study from Nigeria, where medical students and residents expressed eagerness to strengthen their transfusion-related competencies through structured teaching modules (18). However, the poor compliance with PPE use and sample handling protocols in our study mirrors findings from a Sri Lankan study that highlighted gaps in biosafety practices during cross-matching procedures (19).

Comparison with a recent study from South India showed that less than half of medical undergraduates could correctly describe the purpose of cross-matching, while residents performed better (20). Our findings are in line with these reports, as postgraduate residents and laboratory staff demonstrated higher levels of knowledge and practice than undergraduate medical students, particularly those in earlier years of study.

The results underline the urgent need for structured training and inclusion of transfusion medicine modules in medical curricula. Strengthening practical exposure, introducing competency-based workshops, and conducting regular audits could help bridge the gap between knowledge and practice. Targeted interventions for undergraduate students, especially during their second and third years, are essential, as they form the foundation for safe clinical practice.

Table 4. Comparison of Knowledge, Attitude, and Practice Findings with Recent Studies

Study (Location)	Knowledge (%)	Attitude (% positive)	Practice (% good)	Key Observations
Present Study (Ernakulam, Kerala, India)	28% adequate; 13% unaware	65% positive	45% consistent practice	Major gap in knowledge; better attitude but weak compliance
Gupta et al. (Delhi, India) [16]	32% adequate	60% positive	40% satisfactory	Undergraduate students showed poor knowledge of transfusion practices
Waheed et al. (Pakistan) [17]	35% good	68% positive	42% consistent	Similar knowledge–practice gap; lack of structured training noted
Eze et al. (Nigeria) [18]	40% good	72% positive	50% good practice	Residents performed better; students demanded structured curriculum
Gunasekara et al. (Sri Lanka) [19]	30% good	62% positive	38% compliance	Poor biosafety practices and PPE use despite awareness
Thomas et al. (South India) [20]	34% good	70% positive	48% consistent	Senior students had better performance than juniors

Conclusion

This study highlights considerable gaps in knowledge and practice regarding blood group serology and cross-matching among medical students, residents, and healthcare workers in Ernakulam district, Kerala. Although a majority of participants recognized the importance of safe transfusion practices and expressed positive attitudes, inadequate knowledge and poor compliance with laboratory safety protocols remain critical concerns. Focused educational interventions, structured training modules, and periodic refresher workshops should be prioritized to improve awareness and enhance safe practices. Strengthening transfusion medicine education at the undergraduate level and reinforcing adherence to biosafety standards among healthcare professionals are vital to ensuring patient safety and minimizing transfusion-related risks.

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