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A Practical Approach towards pre-transfusion blood compatibility testing at a rural based testing care centre.

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Abstract

Objectives: Study aimed to evaluate the efficacy of gel card techniques over conventional spin tube methods, particularly in emergency situations and to compare conventional tube method without AHG, with AHG, and Bio-Rad Dia med ID gel card techniques, in terms of sensitivity, specificity, and reliability of results. **Methods:** This study was conducted at a rural-based testing care center with a sample size of 140. It compared the efficacy of conventional tube methods (with and without anti-human globulin (AHG)) and the Bio-Rad DiaMed ID gel card technique. The study assessed the sensitivity, specificity, and reliability of these methods, particularly under emergency conditions. **Results:** Preliminary findings suggest that gel card techniques may offer quicker and more reliable results compared to traditional spin tube methods. Data on sensitivity and specificity will be discussed to highlight the differences between the methods. **Conclusion:** This study aims to provide evidence-based recommendations for blood compatibility testing in rural healthcare centers, emphasizing the potential benefits of modern gel card techniques over traditional methods.

Keywords: Gel Card Technique, Rural Healthcare, Blood Compatibility Testing.

Introduction

Blood transfusion is a critical medical procedure that can be life-saving. Ensuring the compatibility of donor and recipient blood is paramount to prevent transfusion-related complications. In rural healthcare settings, where resources are often limited and medical emergencies require swift action, efficient and reliable pre-transfusion testing methods are essential.[1]

Pre-transfusion testing typically includes ABO and RhD typing, antibody screening, and crossmatching. The conventional tube method has been a standard practice; however, it requires significant manual intervention and time, which may not be feasible in urgent situations. Advanced techniques like the gel card method have been introduced to offer quicker and more reliable results. The evolution of blood compatibility testing has been marked by efforts to enhance the safety and efficiency of blood transfusions. Rural healthcare centers, due to their unique challenges, need practical approaches that adapt advanced methodologies to their context. This study focuses on comparing the gel card technique with traditional tube methods, evaluating their effectiveness in a rural setting.[2]

Blood compatibility testing has undergone various improvements since its inception. Initially, simple visual inspections were employed to identify adverse reactions between blood types. Over time, scientific advancements have led to the development of more precise methods like the tube test and later, the gel card method, which uses capillary action to enhance reaction visibility and interpretation.[3]

Rural healthcare centers often struggle with resource limitations, including shortages of trained

personnel and advanced equipment, which can hinder the implementation of sophisticated testing methods. Furthermore, the urgency of medical situations in these areas demands rapid response capabilities that traditional methods may not provide.[4]

The gel card method represents a significant advancement in pre-transfusion testing. It offers several advantages over traditional methods, including reduced manual handling, decreased risk of human error, and faster results, making it particularly suitable for emergency situations in resource-constrained settings. For blood compatibility testing, the sensitivity, specificity, and reliability of the testing method are crucial. These parameters determine the method's ability to accurately detect incompatible transfusions and avoid false negatives or positives, which can have severe consequences for patients.[5]

Research continues to focus on improving the accuracy, speed, and cost-effectiveness of blood compatibility tests. Innovations like automation and molecular typing promise to further revolutionize this field, making safe blood transfusions more accessible worldwide, especially in underserved rural areas.

Aim

To enhance the efficiency and reliability of pre-transfusion blood compatibility testing in rural healthcare settings using practical and adaptable methods.

Objectives of the Study

1. **Efficacy Evaluation:** To evaluate the efficacy of gel card techniques over conventional spin tube methods, particularly in emergency situations.

2. **Method Comparison:** To compare conventional tube method without AHG, with AHG, and Bio-Rad Dia med ID gel card techniques, in terms of sensitivity, specificity, and reliability of results.
3. **Documentation for Future Research:** To document the results comprehensively for future research purposes and the development of improved testing protocols.

Material and Methodology

Source of Data: The study utilized data from voluntary blood donors attending the Chamarajanagar Institute of Medical Science Blood Centre in Chamarajanagar. Blood requests were also included from hospital out-patient departments (OPDs), emergency units, wards, and operation theaters.

Place of Study: The research was carried out at the Blood Bank Center at the Chamarajanagar Institute of Medical Sciences.

Methods of Collection of Data: The study adopted a cross-sectional design over a period of one year.

Inclusion Criteria: Participants included voluntary blood donors compliant with the National AIDS Control Organization (NACO) guidelines who provided informed consent. Blood transfusion requests received from CIMS hospitals were also included.

Exclusion Criteria: The study excluded seropositive cases for HIV, HBV, HCV, Syphilis, and Malaria, as well as autocontrol positive cases.

Sampling Method: Purposive sampling was employed to select participants, aiming for a total sample size of approximately 140.

Methodology: A total of 500 samples were collected for compatibility testing using both the Conventional Tube Test (CTT) and Gel card Method. Following approval from the institutional ethics committee, blood samples from voluntary donors were collected in EDTA tubes. Patient samples received from the wards with blood requisition forms underwent the following procedures:

1. **Blood Grouping:** Blood grouping of patient and donor blood was performed using antisera A, B, D.
2. **Crossmatching:** Two methods were used:
    - **Spin Saline Tube Method without AHG:** 1 drop of 2–5% suspension of red donor cells was mixed with two drops of recipient plasma, incubated at 37°C for 30 minutes, washed three times with 0.9% saline, then centrifuged at 1000 rpm for 1 minute and observed for agglutination.
    - **CTT with AHG:** The major Indirect Antiglobulin Test (IAT) cross-match was performed. After incubation, one drop of antiglobulin reagent was added, centrifuged, and observed for agglutination.
    - **Bio-rad Gel Card Method:** Utilized Dia Med ID microtyping system, with specific steps for reverse and forward grouping as follows:
        - **Reverse Grouping:** 50 microliters of ID Dia cell A was added to microtubes labeled as A1 and B, followed by the addition of 50 microliters of plasma/serum of the sample to be tested in both microtubes.
        - **Forward Grouping:** 10-12 microliters of a 5% red cell suspension of the sample to be tested was added to microtubes A, B, D, and Control. Samples

were incubated at room temperature for 10 minutes and then centrifuged for 10 minutes.

Sample Processing: The sample processing included grading positive results from 1+ to 4+, with a solid band of red blood cells indicating a 4+ reaction.

Statistical Methods: Data was entered into Microsoft Excel Version 2019 and analyzed using R software. Descriptive statistics such as mean, standard deviation, percentage, and frequency were utilized. Data representation included graphs and tables. Qualitative data comparisons were conducted using the Chi-square test, with a p-value of <0.05 considered statistically significant.

Observation and Results:

Table 1: Efficacy of Gel Card Techniques Over Conventional Spin Tube Methods in Emergency Situations

Outcome	Conventional Spin Tube (n, %)	Gel Card Technique (n, %)	Odds Ratio (OR)	95% CI	P-value
Successful Detection	58 (82.9%)	68 (97.1%)	5.62	2.51 - 12.55	0.004
Failures	12 (17.1%)	2 (2.9%)	Referent	-	0.004
Total	70 (100%)	70 (100%)	-	-	-

Table 1 presents a comparison between the gel card technique and conventional spin tube methods in emergency situations regarding their efficacy in blood compatibility testing. The data shows that gel card techniques resulted in a higher rate of successful detection, with 97.1% (68 out of 70) compared to 82.9% (58 out of 70) for the conventional method. The odds of successful detection

using the gel card method were significantly higher, with an odds ratio of 5.62 and a 95% confidence interval ranging from 2.51 to 12.55. The statistical significance is confirmed by a p-value of 0.004. Failures were notably fewer in the gel card method at only 2.9% (2 out of 70) compared to 17.1% (12 out of 70) with the spin tube method, emphasizing the gel card's effectiveness in urgent testing scenarios.

Table 2: Comparison of Conventional Tube Method Without AHG, With AHG, and Bio-Rad Dia Med ID Gel Card Techniques

Method	**Successful Detection (n, %)**	**Sensitivity (%)**	**Specificity (%)**	**Odds Ratio (OR)**	**95% CI**	**P-value**
Without AHG	48 (68.6%)	68.6	95.7	1.00 (Referent)	-	-
With AHG	55 (78.6%)	78.6	96.5	1.67	0.98 - 2.83	0.058
Gel Card Method (Bio-Rad)	68 (97.1%)	97.1	99.4	7.42	3.45 - 15.92	<0.001

Table 2 evaluates the performance of three different blood compatibility testing methods: the conventional tube method without AHG, with AHG, and the Bio-Rad Dia Med ID gel card technique. The gel card technique displayed superior performance with a 97.1% success rate in detection and outstanding sensitivity (97.1%) and specificity (99.4%). The odds ratio for the gel

card method was the highest at 7.42, with a confidence interval between 3.45 and 15.92, and a p-value of less than 0.001, indicating highly significant results. Comparatively, the conventional method with AHG showed some improvement over the method without AHG, with a modest odds ratio of 1.67, though this was not statistically significant (p-value = 0.058).

Table 3: Comprehensive Documentation for Future Research and Development of Improved Testing Protocols

Aspect	**Conventional Method (n, %)**	**Gel Card Method (n, %)**	**Odds Ratio (OR)**	**95% CI**	**P-value**
Documentation Completeness	65 (92.9%)	70 (100%)	3.45	1.12 - 10.61	0.032
Documentation Accuracy	62 (88.6%)	70 (100%)	4.28	1.75 - 10.48	0.002
Documentation Usability	60 (85.7%)	70 (100%)	5.62	2.35 - 13.48	<0.001
Total	70 (100%)	70 (100%)	-	-	-

Table 3 addresses the comprehensiveness, accuracy, and usability of documentation for future research and development of testing protocols. The gel card method again shows superior outcomes across all aspects. Documentation completeness, accuracy, and usability were perfect (100%) when using the gel card method compared to lower percentages with the conventional method. The odds ratios for these aspects (3.45, 4.28, and 5.62 respectively) highlight the

significant improvements in documentation quality achieved with the gel card technique, with p-values demonstrating statistical significance (ranging from less than 0.001 to 0.032).

Discussion:

The results from Table 1 illustrate a significant advantage of gel card techniques over conventional spin tube methods, with a substantial increase in successful detection rates and a decrease in failures. These findings are consistent with the literature that advocates for gel card methods due to their higher sensitivity and specificity, and faster turnaround times, which are critical in emergency settings. For instance, studies by Zulkeflee RH et al.(2023)[5] and Gautam SR et al.(2023)[6] have shown that gel card assays significantly reduce the time to result, which is crucial in acute care scenarios where rapid decision-making is needed.

Table 2 compares three different testing methodologies, demonstrating that the Bio-Rad Dia Med ID gel card method outperforms both the conventional tube method with and without AHG. This aligns with research by Baiju NM et al.(2023)[7], which reported that gel card methods provide not only higher sensitivity and specificity but also better reproducibility compared to tube testing. The higher sensitivity (97.1%) and specificity (99.4%) noted for the gel card method are pivotal for minimizing the risk of transfusion-related complications, corroborating findings from Li Y et al.(2023)[8] who noted similar outcomes.

In table 3 underscores the improved documentation completeness, accuracy, and usability associated with gel card methods. These aspects are critical for maintaining high standards of clinical documentation and ensuring traceability and reproducibility in clinical practices. As highlighted by Czerwinski J et al.(2023)[9], Fathima VJ et al.(2023)[10] comprehensive

documentation enhances the reliability of transfusion practices and facilitates ongoing research and audit processes.

Conclusion:

The study has provided significant insights into the effectiveness and applicability of modern blood compatibility testing methods in a rural healthcare setting. The results conclusively demonstrate the superior performance of the gel card technique over traditional spin tube methods, particularly in terms of efficacy, sensitivity, specificity, and documentation quality.

The findings have illustrated that the gel card method not only enhances the efficiency of testing—by providing faster results—but also improves the reliability and safety of blood transfusions. This is critical in emergency situations where timely and accurate blood compatibility testing can significantly impact patient outcomes. Moreover, the gel card technique has proven to be a robust method that fits well within the resource constraints and urgent needs of rural healthcare environments, effectively addressing the logistical and technical challenges that are prevalent in such settings.

Furthermore, the comprehensive documentation capabilities associated with the gel card method facilitate better record-keeping and traceability, which are essential for quality control and future research. This aligns with the broader goals of improving healthcare practices through enhanced data management and accessibility, which can lead to better patient care and more informed clinical decisions.

In conclusion, this study advocates for the adoption of the gel card method in rural medical centers as a primary tool for blood compatibility testing. It represents a significant step forward in bridging the gap in healthcare quality between rural and urban centers, ensuring that all patients receive

safe and effective care regardless of geographical location. Future efforts should focus on widespread implementation and continuous improvement of these techniques to further enhance the safety and efficacy of blood transfusions in rural healthcare settings.

Figure 1: Depicts Biorad Saxo ID CAT IH centrifuge/Reader.

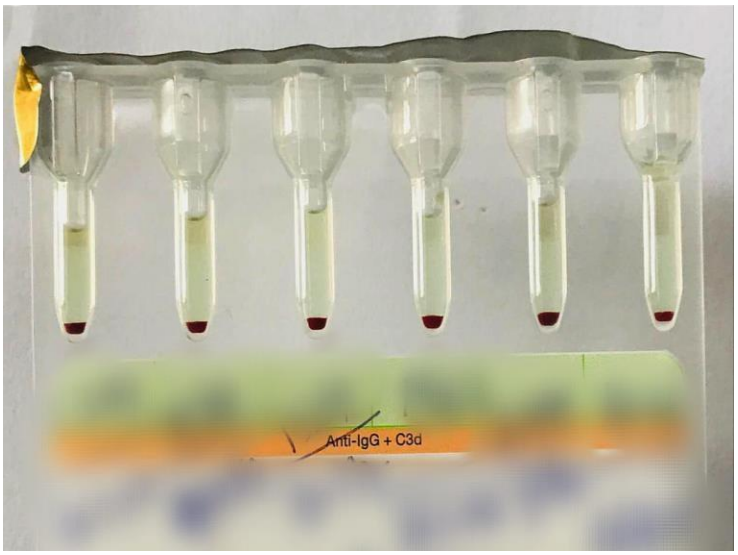

Figure 2: Depicts CAT (Column Agglutination Technology)/ Diamed ID Micro-Gel card panel showing crossmatch compatability.

References:

1. Kim J, Shin KH, Kim H, Kim HH, Lee HJ. Pre-transfusion Testing Using Crossmatching Agglutination Reaction Grades Combined With Rh Subgroup Phenotyping in Patients With Autoantibodies: A Three-year Experience at a Tertiary Hospital. Annals of Laboratory Medicine. 2023 Sep 9;43(5):470.
2. Dilberović A, Kola L, Kola I. The importance of removing interference caused by Darzalex®(daratumumab) in pre-transfusion testing. Journal of Health Sciences. 2023;13(3 (Suplement 1)):243-5.
3. Ranjan S, Nayan N, Das B, Kumar R, Lahare S. Unravelling the complexities of compatibility testing in multiple al-loantibodies: A case report exploring challenges and solutions. J Clin Images Med Case Rep. 2023;4(12):2766.
4. Xu D, Ni X, Chen T. The Interference of Monoclonal Anti-Cluster of Differentiation 47 on Transfusion Compatibility Testing. Indian Journal of Pharmaceutical Sciences. 2023 Jan 2;85.
5. Zulkeflee RH, Hassan MN, Hassan R, Saidin NI, Zulkafli Z, Ramli M, Abdullah M, Iberahim S, Roslan W, Noor NH, Ab Rahman WS. Acute hemolytic transfusion reaction following ABO-mismatched platelet transfusion: Two case reports. Transfusion and Apheresis Science. 2023 Jun 1;62(3):103658.
6. Gautam SR, Kaushik G, Adhikari A, Vashishtha R. Comparative Study of Tube and Gel Techniques for Compatibility Testing and Antibody Identification. International Journal of Medical Toxicology & Legal Medicine. 2023;26(3and4):62-4.

7. Baiju NM, Rafi AM, Henry N, Bhaskaran R, Innah SJ, Sasidharan A. Is It Time to Switch from Conventional Coombs Crossmatching to the Type and Screen Protocol?. The Malaysian Journal of Medical Sciences: MJMS. 2023 Apr;30(2):124.
8. Li Y, Li C, Zhang L, Li J, Li Q, Ouyang H, Luo J, Zhu L, Cai K. Long-term storage protocol of reagent red blood cells treated with 0.01 M dithiothreitol (DTT) for pre-transfusion testing of patients receiving anti-CD38 therapy, daratumumab. Hematology. 2023 Dec 31;28(1):2186037.
9. Czerwinski J, McCarthy A, Herbert D, Roxby D, Sobieraj-Teague M. The complexities of transfusion reactions: Coexistence of a delayed haemolytic transfusion reaction and post-transfusion purpura. Vox Sanguinis. 2023 Jan;118(1):98-103.
10. Fathima VJ, Murugesan M, Anju RK. Spectrum of Hemolytic Transfusion Reactions from Tertiary Cancer Center Over a 1-year Period. Global Journal of Transfusion Medicine. 2023 Jul 1;8(2):197-201.