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COMPARATIVE STUDY ON THE EFFECTIVENESS OF HEMOGLIDE TECHNOLOGY VS CONVENTIONAL SMEAR PREPARATION IN PERIPHERAL BLOOD FILM QUALITY AT POINT OF CARE

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INTRODUCTION:

Peripheral blood smear analysis has long been regarded as an essential component of hematological diagnostics, playing a critical role in identifying and monitoring a diverse range of blood disorders. These disorders range from anemia and infections to more severe conditions like leukemia and other hematologic malignancies. Accurate interpretation of blood smears relies heavily on the quality and consistency of the smear preparation process, which has historically been manual, labor-intensive, and prone to variability. Despite the pivotal role of peripheral blood smears in diagnostics, traditional preparation methods often face challenges. Creating a blood smear manually involves a technician spreading a droplet of blood across a slide to form a thin film, a process that requires precision and skill to ensure optimal results. This process, while seemingly straightforward, is subject to significant variability based on the technique and expertise of the operator. Such inconsistencies can lead to sub optimal smear quality, potentially compromising diagnostic accuracy. Studies have shown that poorly prepared smears may obscure critical morphological details, leading to diagnostic errors and delays in clinical decision-making.[1,2]

The introduction of automation and innovative technologies in laboratory settings aims to address these challenges. Hemoglide is a novel blood smear and transport technology designed to improve both the efficiency and consistency of smear preparation, offering a practical solution to longstanding challenges in this critical diagnostic process. This semi-automated device is designed to standardize the smear preparation process, ensuring uniformity and reducing operator-dependent variability. By integrating automated controls for sample distribution and slide movement, Hemoglide aims to streamline laboratory workflows and improve diagnostic turnaround times. The quality of a peripheral blood smear directly influences the accuracy of hematological diagnoses. Uniform and artifact-free smears allow for clear visualization of cellular morphology, enabling pathologists to identify subtle changes indicative of various conditions. Manual smear preparation often results in uneven sample distribution, inadequate staining, or the presence of artifacts, all of which can obscure key diagnostic features. Research suggests that adopting automated approaches for smear preparation could potentially enhance diagnostic accuracy and contribute to better patient outcomes.[3,4] In clinical laboratories, time and resources are critical constraints. Manual smear preparation is a repetitive and time-consuming task that diverts skilled personnel from more complex and demanding responsibilities.

We developed the “Hemoglide” device which is a semi-automated device designed to improve the accuracy and efficiency of peripheral blood smear preparation. Traditional manual smear techniques are often inconsistent due to differences in operator skill, leading to variability in smear quality. The Hemoglide addresses these challenges by incorporating a controlled spreading mechanism that ensures uniform blood distribution, minimizing human error.Hemoglide addresses this issue by automating key steps in the smear preparation process, thereby reducing the time required for each slide and increasing overall laboratory throughput. This efficiency gain is particularly valuable in high-volume settings, where rapid diagnostic turnaround is essential.[5,6] Human error is an inherent risk in manual laboratory processes. Factors such as fatigue, inexperience, or inconsistent technique can contribute to errors in smear preparation, potentially leading to misdiagnoses. Automation minimizes these risks by standardizing the process, ensuring consistent results regardless of operator skill or workload. By

reducing reliance on manual intervention, Hemoglide enhances the reliability and reproducibility of smear preparations.[7,8]

In resource-limited settings, access to skilled laboratory technicians and advanced diagnostic tools is often restricted. This limitation can result in sub optimal diagnostic practices, delaying or compromising patient care. Hemoglide's user-friendly design and semi-automated functionality make it an ideal solution for such environments, enabling healthcare providers to deliver high-quality diagnostics even in under-served areas. By making reliable smear preparation technology more accessible, Hemoglide could play a significant role in enhancing healthcare outcomes, especially in low-resource settings.[9] Peripheral blood smear analysis remains a vital component of hematological diagnostics, despite advancements in automated blood analyzers. While these analyzers provide valuable quantitative data, they cannot replace the detailed morphological assessment offered by blood smears. For conditions like malaria, sickle cell anemia, and certain leukaemias, microscopic examination of blood smears remains indispensable.[10] Hemoglide's ability to produce high-quality smears consistently aligns with the growing demand for accurate and efficient diagnostic practices in modern healthcare.

Furthermore, the device's compatibility with existing staining protocols and microscopes ensures seamless integration into current laboratory workflows. This adaptability enhances its utility across diverse clinical settings, from high-volume tertiary care centers to small community laboratories. The development and implementation of Hemoglide exemplify the importance of continuous innovation in medical diagnostics. By addressing longstanding challenges in smear preparation, this research contributes to the broader field of laboratory technology and paves the way for future advancements. The insights gained from this study could inform the design of other semi-automated or fully automated diagnostic tools, fostering a culture of innovation within the medical community. Additionally, the device's potential to improve diagnostic accuracy and efficiency has far-reaching implications for patient care and clinical outcomes. The aim of the study is to compare the accuracy of peripheral blood smear preparation between Hemoglide and conventional slide preparation and to compare the parameters like quality of smear (uniformity, distribution, absence of artifacts), staining quality, cell morphology clarity, smear preparation time and diagnostic turnaround time between Hemoglide and conventional slide preparation. Also, we evaluated the effectiveness of Hemoglide as a tranport device.

MATERIALS AND METHODS:

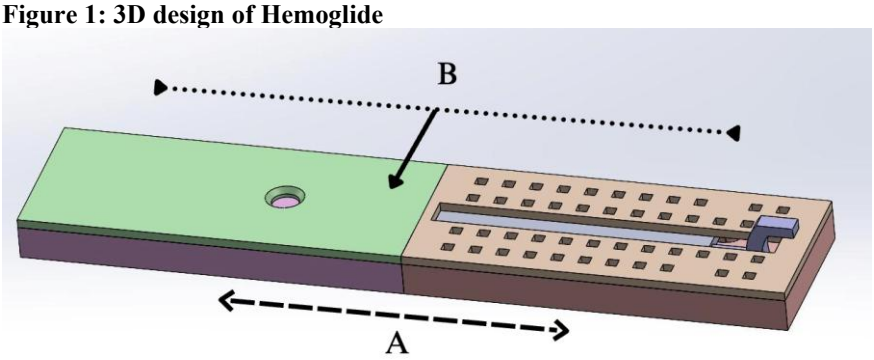
PRODUCT DEVELOPMENT:

The Hemoglide was developed through a three-stage iterative process using Fused Deposition Modeling (FDM) 3D printing. This approach allowed for rapid prototyping, design refinements, and functional testing to optimize the device. The Hemoglide was 3D printed using Acrylonitrile Butadiene Styrene Plus (ABS+), a durable and lightweight thermoplastic with several advantages:

- High durability to withstand repeated use.
- Chemical resistance, allowing it to be cleaned with common laboratory disinfectants.
- Lightweight and strong, making it easy to handle without compromising robustness.
- Minimal warping during the 3D printing process, ensuring better precision and structural integrity.

The Hemoglide consists of two primary components as shown in Figure 1:

Figure 1: 3D design of Hemoglide



A= Lower Unit; B= Upper Unit

1. Upper unit:

- Slides smoothly over the lower unit, ensuring controlled motion during smearing.

- Houses a spreader blade that ensures the even distribution of blood across the slide.
- Includes side covers that overlap the lower unit, helping to reduce contamination risks and improve handling safety

2. Lower unit:

- Functions as the base platform where glass slides are placed.
- Contains precisely aligned slots to hold disposable glass slides securely, preventing movement.
- Ensures reproducibility by maintaining a consistent slide position during smear preparation.

Control mechanism:

- The upper unit's movement is synchronized with the lower unit using a regulated system, ensuring even smearing.
- The spreader blade operates at a controlled speed, preventing uneven distribution and minimizing artifacts.
- The calibrated movement reduces reliance on the operator's dexterity, making the process more consistent and reproducible.

The Hemoglide was developed through a three-stage iterative process using Fused Deposition Modeling (FDM) 3D printing. This approach allowed for rapid prototyping, design refinements, and functional testing to optimize the device.

STUDY METHODOLOGY:

This experimental study was conducted over a period of one year, from April 2024 to April 2025, in the Department of Pathology at Saveetha Medical College and Hospital, Chennai. The study involved whole blood samples collected from patients of all age groups and genders who were being evaluated for anemia, infections, leukemia, or other hematological conditions. Following approval from the Institutional Ethics Committee (Ref No: 086/09/2024/IEC/SMCH), samples were obtained using standard venipuncture techniques, labeled systematically, and documented for traceability. A total of 3000 blood samples collected in EDTA tubes were included using a convenience sampling method.

Samples eligible for inclusion were those collected in EDTA anticoagulant tubes from patients with relevant clinical indications. Hemolyzed, clotted samples and those collected in incorrect anticoagulants were excluded. The study compared two methods of peripheral blood smear preparation—one using the Hemoglide device and the other by conventional manual technique. The Hemoglide device comprises a lower platform for slide placement and an upper movable unit with a spreader blade. It is equipped with a speed control system to ensure uniform smear quality. For slide preparation using Hemoglide, a drop of blood was placed on a slide fixed onto the lower unit, and the upper unit with the spreader blade was used to make the smear under controlled speed. In the conventional method, slides were prepared manually using standard techniques with a spreader slide.

All smears were stained using standard protocols and were assessed microscopically. The evaluation focused on four parameters: smear quality, staining quality, cell morphology clarity, and preparation time. Smear quality was assessed based on the uniformity of cell distribution and absence of artifacts such as clumping or streaking. Staining quality was evaluated for clarity, consistency, and absence of over- or under-staining. Clarity of cellular morphology was determined by the ease of identifying and differentiating red blood cells, white blood cells, and platelets. Each parameter was graded on a five-point scale ranging from poor (1) to excellent (5). The time taken for smear preparation—from sample

application to smear readiness—was recorded in seconds. Additionally, diagnostic turnaround time, defined as the time from sample collection to final report, was documented in minutes for both methods. Statistical analysis was performed using SPSS software version 26 or higher. Descriptive statistics was used to summarize smear scores, preparation and turnaround times. Continuous variables were expressed as mean, standard deviation, and range; categorical variables will be reported as frequencies and percentages. Paired t-tests or Wilcoxon signed-rank tests were used for comparing preparation and turnaround times, depending on data distribution. Independent t-tests to assess differences in smear quality, staining, and morphology clarity scores between the two methods. Subgroup analyses based on age, gender, and clinical diagnosis was conducted using Chi-square tests for categorical data and one-way ANOVA or Kruskal-Wallis tests for continuous variables. Inter-rater agreement for smear evaluations was analyzed using Cohen's Kappa coefficient. A p-value of less than 0.05 will be considered statistically significant.

RESULTS:

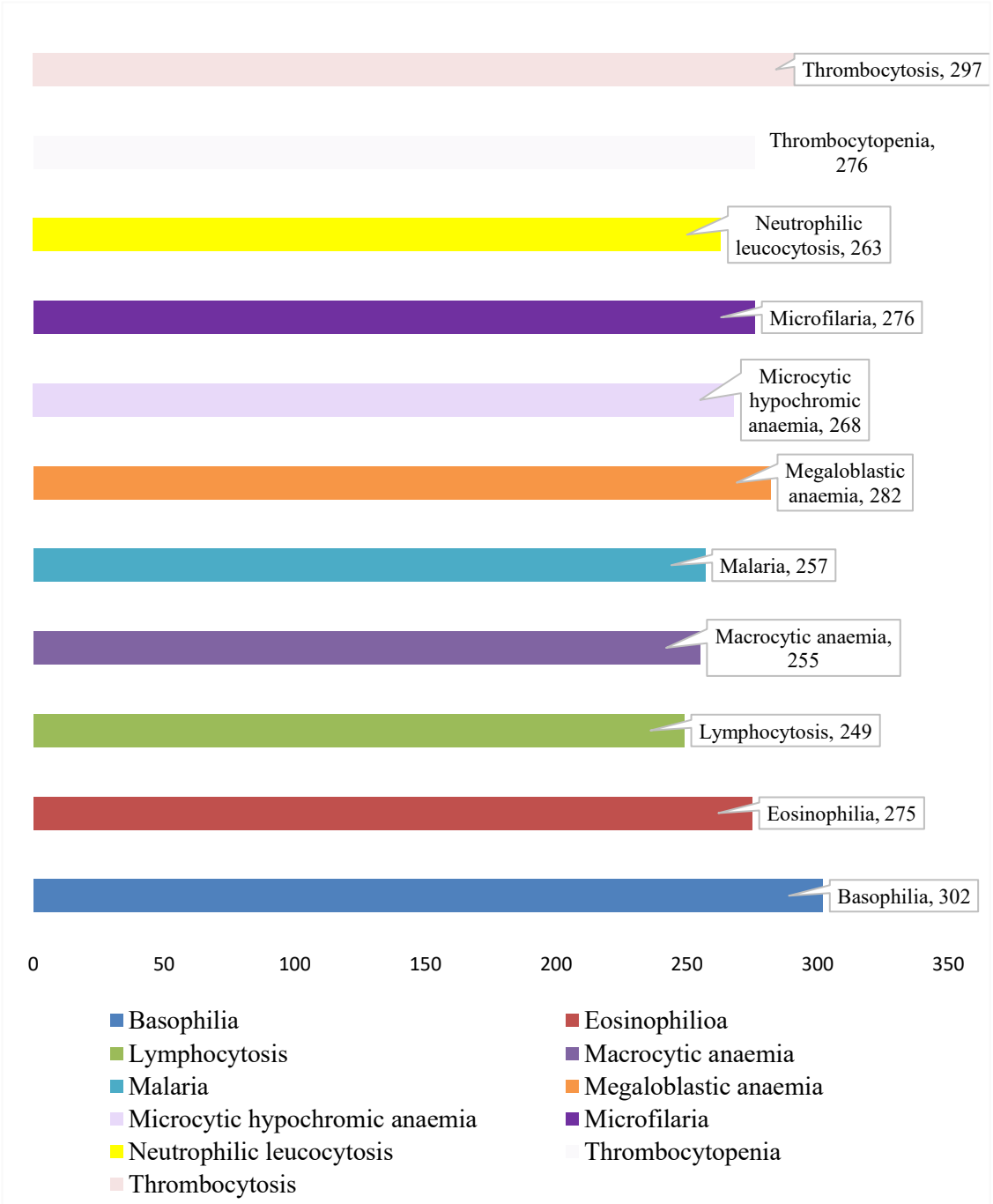
This experimental study analyzed a total of 3000 EDTA-anticoagulated blood samples collected over a one-year period from patients with diverse hematological conditions. The study compared two methods of peripheral blood smear preparation- Hemoglide, a semi-automated device, and the conventional manual technique- based on smear quality, staining quality, morphological clarity, preparation time, and diagnostic turnaround time.

The age of the study population ranged from 1 to 90 years. The majority of participants were in the 21–40-year age group, accounting for 23.6% of the total, followed by those aged 41–60 years (21.8%) and 61–80 years (20.7%). The lowest proportion was observed among individuals above 81 years of age (9.9%). The gender distribution was nearly equal, with 50.7% male and 49.3% female participants. (Table 1) The most frequently encountered clinical condition among the study samples was basophilia (10.1%), followed closely by thrombocytosis (9.9%) and megaloblastic anemia (9.4%). Other conditions such as microfilaria, eosinophilia, and malaria showed similar proportions of approximately 9%, indicating a wide spectrum of hematological diagnoses represented in the sample set as shown in Figure 2.

Table 1: Demographic and clinical characteristics of the study population

Characteristic	Category	Frequency (n)	Proportion (%)
Age Group (years)	1–10	365	12.2
	11–20	355	11.8
	21–40	709	23.6
	41–60	655	21.8
	61–80	620	20.7
	>81	296	9.9
Gender	Male	1521	50.7
	Female	1479	49.3
Clinical Diagnosis	Basophilia	302	10.1
	Thrombocytosis	297	9.9
	Megaloblastic anemia	282	9.4
	Microfilaria	276	9.2
	Eosinophilia	275	9.2
	Thrombocytopenia	276	9.2
	Microcytic Hypochromic Anemia	268	8.9
	Neutrophilic Leukocytosis	263	8.8
	Malaria	257	8.6
	Macrocytic Anemia	255	8.5
	Lymphocytosis	249	8.3

Figure 2: Distribution of Clinical Diagnosis among the study population:



Assessment of smear quality revealed a marked difference between the two methods. Hemoglide produced a significantly higher proportion of excellent smears (48.5%) and very good smears (48.8%), with no slides falling into the poor or fair categories. In contrast, the manual method yielded only 2.1% excellent and 47.3% very good smears, with an additional 2.1% rated as fair. These differences were statistically significant ($p < 0.001$, Fisher's exact test). The mean smear quality score for Hemoglide was 4.46 ± 0.551, significantly higher than the manual method score of 3.49 ± 0.579 ($p < 0.001$, independent t-test). A similar trend was observed with staining quality. Hemoglide achieved excellent staining in 51.7% of smears and very good staining in 45.9%, with only 0.1% classified as fair and none as poor. In contrast, the manual method showed excellent staining in just 1.8% of smears, very good in 49.7%, and fair in 2.2%. The differences between methods were statistically significant ($p = 0.002$, Fisher's exact test). The mean staining quality score was significantly higher for Hemoglide (4.49 ± 0.550) compared to the manual method (3.51 ± 0.574), with $p < 0.001$. (Table 2) Evaluation of cell morphology clarity also favored the Hemoglide method. A majority (51.7%) of Hemoglide-prepared smears demonstrated

excellent morphological clarity, with an additional 45.9% rated as very good. Only 0.1% were rated as fair, and none as poor. In comparison, only 1.8% of manual smears were rated excellent, and 49.7% very good, while 2.2% were classified as fair. These differences were statistically significant ($p < 0.001$, Fisher's exact test). The mean morphology clarity score for Hemoglide was 4.48 ± 0.537, compared to 3.49 ± 0.596 for the manual method ($p < 0.00001$), reflecting a high degree of statistical significance.

The mean preparation time using Hemoglide was 30.13 ± 3.151 seconds, significantly lower than the manual method's average of 45.08 ± 3.161 seconds ($p < 0.00001$). Box plot analysis indicated a narrower interquartile range for Hemoglide (27–33 seconds) compared to the manual method (42–48 seconds), confirming its superior time efficiency. (Table 2) Interestingly, the mean diagnostic turnaround time was slightly higher for Hemoglide (60.06 ± 3.149 minutes) than for the manual method (59.89 ± 3.121 minutes). Although the difference was minimal, it was statistically significant ($p = 0.045$). However, the box plots demonstrated substantial overlap in the interquartile and total range distributions, suggesting that this difference may have limited clinical impact.

Table 2: Comparison of hemoglide and manual methods across key parameters

Parameter	Metric	Hemoglide	Manual Method	P-value
Smear Quality	Mean score ± SD	4.46 ± 0.551	3.49 ± 0.579	< 0.001
	Excellent grade (%)	48.5	2.1	< 0.001
Staining Quality	Mean score ± SD	4.49 ± 0.550	3.51 ± 0.574	< 0.001
	Excellent grade (%)	51.7	1.8	0.002
Morphology Clarity	Mean score ± SD	4.48 ± 0.537	3.49 ± 0.596	< 0.001
	Excellent grade (%)	51.7	1.8	< 0.001
Preparation Time	Mean time (seconds) ± SD	30.13 ± 3.151	45.08 ± 3.161	< 0.001
Turnaround Time	Mean time (minutes) ± SD	60.06 ± 3.149	59.89 ± 3.121	0.045

DISCUSSION:

The study presents a comparative evaluation of Hemoglide, a semi-automated blood smear preparation technology, against conventional manual slide preparation methods. The primary objective was to assess Hemoglide's efficacy in enhancing the quality and efficiency of peripheral blood smear preparation. This was achieved through specific objectives, including a comparative analysis of accuracy, detailed assessment of smear quality parameters (uniformity, staining, and morphology), smear preparation time, and diagnostic turnaround time.

The demographic characteristics of the study population were broad, with participant ages ranging from 1 to 90 years. The age distribution revealed the 21–40-year age group as the most prevalent, followed by the 41–60 and 61–80-year groups, mirroring the heterogeneity of patient populations encountered in routine clinical practice. Gender distribution was nearly equal, mitigating potential gender-based biases in the results. The spectrum of clinical diagnoses among study participants was diverse, encompassing a range of hematological conditions, with basophilia, thrombocytosis, and megaloblastic anemia being the most frequent. This heterogeneity in clinical presentations strengthens the applicability of the study findings across various hematological investigations.

Previous studies have highlighted the benefits of automated and semi-automated blood smear preparation systems. For instance, an evaluation of the Technicon Autoslide demonstrated that the instrument prepares high-quality wedge blood smears with uniform distribution of leukocytes, excellent red blood cell and platelet morphology, and adequate staining of normal types of leukocytes. However, the fixation-staining characteristics did not enable reliable identification of some immature cell types. [10] Similarly, an evaluation of the CellaVision DM96 automated image analysis system found that the accuracy of the DM96 was 89.2% when compared to manual differentials. The precision of the instrument was similar to that of the 100-cell manual differential, and the DM96 was faster than the manual method, even after reclassification by a laboratory scientist of any cells wrongly categorized by the instrument.[11] Furthermore, a study comparing five methods of blood smear preparation, including mechanical devices, found that the mechanical wedge device was most similar to both reference methods, suggesting that automated systems can produce high-quality smears with uniform cell distribution, which is crucial for accurate morphological assessment. [12]

In the context of this study, the comprehensive demographic representation and the diversity of clinical conditions among participants underscore the potential of Hemoglide to improve peripheral blood smear preparation across a wide range of patient populations and hematological disorders.

Peripheral blood smear quality plays a critical role in hematological diagnostics, as accurate cell identification, differential leukocyte counts, and morphological assessments depend on well-prepared smears. Ensuring smear consistency and quality is essential for the accurate diagnosis and monitoring of hematological disorders. In this study, smear quality was assessed using a standardized scoring system

that evaluated parameters such as uniformity of cell distribution, evenness of spreading, and the presence of artifacts. The findings demonstrated that Hemoglide significantly outperformed the conventional manual method in producing high-quality smears. Hemoglide-prepared slides were rated "Excellent" in 48.5% of cases and "Very Good" in 48.8%. The defining characteristics of "Excellent" smears included uniform cell distribution and a lack of irregularities. In contrast, only 2.1% of manually prepared smears were classified as "Excellent," with the majority (48.4%) receiving a "Good" rating. Furthermore, the manual method produced 2.1% of smears classified as "Fair," exhibiting moderate unevenness and streaking, whereas Hemoglide did not produce any smears rated "Fair" or "Poor." A quantitative analysis reinforced these observations. The mean smear quality score for Hemoglide was 4.46 ± 0.551, compared to 3.49 ± 0.579 for the manual method, a statistically significant difference ($p < 0.001$). This suggests that Hemoglide reduces variability and enhances the reproducibility of smear preparation.

These findings align with previous research emphasizing the importance of standardization and automation in laboratory medicine. [13] Manual smear preparation is subject to variability in technique, including differences in pressure and speed, which can lead to inconsistent results. Semi automated systems like Hemoglide reduce these inconsistencies, improving overall smear quality. Studies have reported that automated analyzers enhance the detection of morphological abnormalities and improve laboratory efficiency by reducing the need for manual review. [14] Similarly, research has demonstrated that automated smear preparation results in more uniform blood film morphology, leading to improved diagnostic accuracy. [15]

Staining quality is a crucial factor in blood smear analysis, as it enhances the visibility of cellular components, aiding in their identification under light microscopy. Proper staining ensures clear differentiation of cells, allowing for accurate morphological assessment and disease diagnosis. Variability in staining can lead to diagnostic errors, making it essential to achieve consistent and optimal coloration across all smears. In this study, staining quality was evaluated based on parameters such as clarity of stained components, the absence of over-staining or under-staining, and uniformity across the smear. The results showed that Hemoglide-prepared smears had superior staining quality compared to those prepared manually. Among Hemoglide-prepared slides, 51.7% were rated as "Excellent," indicating optimal and uniform coloration with clear visualization of cellular details. In contrast, only 1.8% of manually prepared smears were classified as "Excellent." The mean staining quality score for Hemoglide was 4.49 ± 0.550, significantly higher than the 3.51 ± 0.574 observed for the manual method ($p = 0.002$).

The improved staining quality seen with Hemoglide can be attributed to the uniformity of its smears. A well-prepared smear allows for even penetration and binding of dyes, leading to more consistent staining. [16] This uniformity is critical for differentiating cell types and identifying subtle morphological abnormalities, reducing the risk of diagnostic errors[1]. Studies have highlighted that automated staining techniques produce more standardized and reproducible results compared to manual methods, ensuring reliable and high-quality smears. [17,18]

Morphology clarity is important in hematology, as it ensures accurate identification and differentiation of cellular components. The ability to clearly visualize cell structures is essential for diagnosing various hematological disorders, including malignancies where subtle morphological changes hold diagnostic significance. In this study, morphology clarity was assessed based on how well cellular features could be distinguished without distortion or overlap. Hemoglide-prepared smears showed a marked improvement in clarity compared to the manual method. A significant proportion (51.7%) of Hemoglide-prepared slides were rated as "Excellent," indicating sharp cellular differentiation, clear nuclear and cytoplasmic details, and minimal artifacts. In contrast, only 1.8% of manually prepared slides achieved an "Excellent" rating. The mean morphology clarity score for Hemoglide was 4.48 ± 0.537, significantly higher than the 3.49 ± 0.596 observed for the manual method ($p = 0.00001$).

The enhanced morphological clarity observed with Hemoglide is closely linked to its improved smear and staining quality. Uniform smears facilitate even dye penetration, preventing artifacts that may obscure cellular details. This is particularly relevant in the diagnosis of hematological malignancies, where precise morphological assessment is critical for accurate classification and treatment planning. [19] Studies have shown that automated smear preparation methods improve cellular presentation, reducing variability and enhancing diagnostic accuracy. [20,21]

Preparation time is a key factor in laboratory efficiency, influencing workflow, sample throughput, and diagnostic turnaround time. Faster smear preparation allows laboratories to process a higher number of samples while maintaining quality, which is particularly important in high-volume clinical settings. In this study, the smear preparation time was compared between Hemoglide and the conventional manual method. The results showed a significant reduction in preparation time with Hemoglide. The mean preparation time for Hemoglide was 30.13 ± 3.151 seconds, whereas the manual method required 45.08

± 3.161 seconds. This difference was statistically significant ($p = 0.00001$), highlighting the efficiency of Hemoglide in smear preparation.

The reduced preparation time with Hemoglide presents a significant advantage in busy laboratories where rapid processing is crucial. Shorter preparation times help optimize workflow, reduce technician workload, and improve overall laboratory efficiency. [22] Previous studies have shown that automated slide preparation methods enhance laboratory productivity while ensuring consistency and reliability in blood smear quality. [23] The integration of automated smear preparation tools has been reported to decrease manual labor, reduce turnaround times, and improve reproducibility, making them highly beneficial for modern clinical laboratories. [24]

Turnaround time, defined as the interval from sample collection to result reporting, is a critical performance metric in clinical laboratories. Timely diagnosis and treatment decisions rely on minimizing this interval, making it an essential aspect of laboratory efficiency. This study assessed the diagnostic turnaround time for both Hemoglide and the conventional manual method. Contrary to expectations that Hemoglide would reduce turnaround time, the results indicated a slightly longer turnaround time with the device. (Hemoglide: 60.06 ± 3.149 minutes and Manual Method: 59.89 ± 3.121 minutes). Although this difference was statistically significant ($p < 0.05$), the magnitude of the difference (approximately 0.17 minutes) is unlikely to have clinical relevance. Turnaround time in a clinical laboratory is influenced by multiple factors beyond smear preparation alone. These include sample collection and transport, processing delays, staining and drying times, microscopic examination, and result reporting. [25] While Hemoglide optimized smear preparation, other workflow components may have contributed to the slight increase in turnaround time. Variations in sample handling, device operation time, or workflow integration challenges may have played a role. [26] Studies have shown that automation can streamline laboratory processes, but its impact on turnaround time is dependent on the overall workflow efficiency. [27] Some automated systems require additional handling steps, which may offset gains from faster preparation. [28] Additionally, laboratory settings differ in sample volume, staffing, and protocol adherence, all of which influence overall turnaround time. [29]

Further refinements in the design and workflow integration of the Hemoglide device may help address the slight increase in turnaround time observed in this study. Optimizing the device's operational efficiency, particularly in sample loading and processing, could contribute to a more seamless incorporation into routine laboratory practice. Future research should also focus on assessing Hemoglide's impact on specific stages of the diagnostic process, such as microscopic examination, to determine whether it facilitates faster and more reliable cell identification and differential leukocyte counting.

Beyond improving smear preparation, Hemoglide also has potential as a transport medium for peripheral blood smears, particularly in settings where slides need to be transferred between collection sites and laboratories. Proper smear transport is essential to maintain slide integrity, prevent contamination, and ensure accurate diagnostic evaluation. [30] Manual smears are often exposed to environmental factors such as dust, moisture, and temperature fluctuations, which can affect stain quality and cell morphology. [31] Additionally, improperly handled slides risk breakage or damage during transport, leading to sample loss and the need for repeat testing. [32] Hemoglide's design offers a secure enclosure, minimizing these risks by protecting slides from physical and environmental hazards. Standardized smear transport using Hemoglide could also improve consistency in diagnostic quality. Since smears are prepared in a controlled manner within the device, variability due to different manual techniques is reduced, ensuring reliable results even after transport. Further research should assess Hemoglide's effectiveness in preserving smear quality under varying transport conditions and its feasibility in resource-limited settings where centralized laboratories handle samples from multiple remote collection points.

This study has certain limitations that should be taken into account. As a single-center study, its findings may not be directly applicable to other institutions with differing patient demographics, laboratory workflows, and staffing structures. Conducting multi-center studies across a variety of clinical settings would provide a broader perspective on Hemoglide's performance and enhance the generalization of these results. Additionally, while this study focused on key parameters related to smear quality and efficiency, other important factors influencing the adoption of Hemoglide in clinical laboratories were not extensively analyzed. These include a detailed cost-benefit analysis, user-friendliness, training requirements for laboratory personnel and long-term reliability Future investigations should explore these aspects to provide a more comprehensive evaluation of Hemoglide's potential impact on routine hematological diagnostics.

CONCLUSION:

This study highlights the advantages of Hemoglide, a semi-automated blood smear preparation device, in improving smear quality, staining consistency, and morphological clarity compared to conventional manual methods. The results show that Hemoglide produces more uniform and high-quality smears while reducing preparation time, addressing common challenges in manual slide preparation. Although the turnaround time was slightly longer, the difference was minimal and unlikely to impact clinical decision making. The potential for Hemoglide to function as a transport medium further enhances its applicability, particularly in settings where smear integrity during transfer is crucial. Despite these benefits, factors such as workflow integration, cost-effectiveness, and broader validation across different laboratory settings require further investigation. Future studies should explore its role in improving overall diagnostic efficiency, particularly in high volume and resource limited laboratories. With its ability to enhance standardization and reduce variability, Hemoglide represents a valuable advancement in peripheral blood smear preparation, supporting more accurate and reliable hematological diagnoses.

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