OPEN ACCESS

Saudi Journal of Medicine

Abbreviated Key Title: Saudi J Med
ISSN 2518-3389 (Print) | ISSN 2518-3397 (Online)
Scholars Middle East Publishers, Dubai, United Arab Emirates
Journal homepage: https://saudijournals.com

Original Research Article

Performance Evaluation of the Sysmex XN50 Slide-Maker-Stainer

Ouijdane Kajjoune[1]*, Anass Sakhi[1], Salma Rouhi[1], Wafae Quiddi[1], Sanae Sayagh[1]

[1]Hematology Laboratory of University Hospital Mohammed VI, Marrakesh, Morocco

DOI: https://doi.org/10.36348/sjm.2025.v10i03.002 | **Received:** 19.01.2025 | **Accepted:** 24.02.2025 | **Published:** 01.03.2025

***Corresponding Author:** Ouijdane Kajjoune
Hematology Laboratory of University Hospital Mohammed VI, Marrakesh, Morocco

Abstract

Automated equipment has many benefits but analytical assessment of instrument is required for laboratory usage. This study evaluates the performance of Sysmex XN-50 slide-maker and stainer compared to manual technique. The primary goal of the study was to evaluate smear's quality. Additionally, carry-over, repeatability, comparability using Passing Bablok Regression for white blood cells then sensitivity and specificity for red blood cells and platelets. Smear's quality was acceptable except for one. There was no carry-over on the Sysmex XN50. Repeatability showed acceptable results. There was good agreement on white blood cells differential count including abnormal cells between blood films by the Sysmex XN50 and manually prepared blood films. Red blood cells and platelets were also comparable, the results were excellent, with sensitivity and specificity being very high. The results obtained in this study show the quality of the Sysmex XN50 device in a laboratory, it offers advantages due to its reliability and speed of preparation of blood smears.

Keywords: Sysmex XN-50, slide-maker-stainer, white blood cells, red blood cells, platelets, blood films.

INTRODUCTION

Without technological advancements, clinical laboratories would not be able to conduct a large number of tests and deliver accurate findings in a timely manner. As a result, speed and quality of information have become crucial factors on laboratory report releases nowadays [1, 2]. Automated blood cell counters have recently experienced significant improvements due to the introduction of new methodological concepts, as well as the progressive evolution of software and cell analysis [3, 4].

Automated equipment has many benefits, including quick results release, high sensitivity, increased accuracy with lower coefficient of variation, improved reproducibility, and increased laboratory testing productivity. However, in order to provide trustworthy and recorded proof that the procedure provides precise patient results, analytical assessment of instruments is required for laboratory usage [5, 6].

Traditional microscopic analysis of blood cells is essential because some cellular alterations can be clinically significant and aid in the patient's diagnosis [7]. Nevertheless, the quality of the blood smear and staining, as well as the observer's experience, influence this morphological and differential analysis [2, 7, 8].

Numerous automated technologies are currently available to improve the quality and accuracy of hematological analysis while reducing this subjectivity. Sysmex XN 3100 is an example that includes automated slide preparation and staining equipment, Sysmex XN-50, which can be used to prepare standard slides with uniform and high-quality blood smears. By enhancing the speed, quality, specificity, and sensitivity of hematological studies and aiding in the early and precise diagnosis of diseases, this system seeks to increase technical efficiency and the consistency of results. Few studies have assessed the effectiveness of automated slide-makers and stainers since their introduction in the late 1970s [9].

The aim of this study is to evaluate automated performance of Sysmex XN-50 slide-maker and stainer compared to manual technique.

MATERIALS AND METHODS

This study was conducted in the hematology laboratory of University Hospital Mohammed VI, MARRAKESH.

Blood samples was obtained by venipuncture in EDTA K3 Carestainer tube with 4ml. Complete blood count (CBC) was performed in this samples using XN-3100 chain analyzer. Smears was performed manually

and in Sysmex XN-50 slide-maker, respecting the recommended time of three hours between sampling and preparation of the smear.

Three procedures are available for staining blood smears with the XN50. The first is May Grunwald Giemsa double staining, which is carried out in two steps: May Grunwald staining first, followed by Giemsa staining. Secondly, there is Wright Giemsa double staining, which is accomplished in two stages: Wright staining and Giemsa staining. The third technique is one-step Wright single staining.

Panoptic May Grunwald Giemsa double staining was used in the both manual and automated methods and with the same reagents. Reading of the slides carried out by objective 10 then 50 at the immersion level with the same microscope.

The data was saved using Microsoft Excel, statistical analysis was performed with the aid of the Statistical Package for Social Sciences (SPSS) IBM version 22.

Smear's quality:

The quality of blood smears prepared by the Sysmex XN slide-maker-stainer was examined macroscopically and microscopically by two operators.

Carry-over:

Samples with a high white blood cell count with many lymphocytes (a case of chronic lymphocytic leukemia) and an extremely low white blood cell count were selected for contamination testing. The high white blood cell count sample was analyzed first, followed by the low white blood cell count sample. This combination was executed two more times. Five fields of view in the work area were randomly selected and evaluated under a microscope at ×50 magnification. In this case, Carry-over was defined if a lymphocytic reaction was found in the work area of the sample with low leukocyte count [10, 11].

Repeatability:

Repeatability was assessed by examination of five samples with normal CBC. Ten consecutive blood films were prepared per sample and two examiners performed differential white blood cell counts of 200 cells on each blood film. The mean, standard deviation (SD) and coefficient of variation (CV) were calculated for the white blood cell differential parameters [11, 12]. Results were defined as acceptable if the calculated standard deviation of the neutrophil population was <6, the lymphocyte population <5 and the monocyte population <3 [10, 11].

Comparability:

Fifty samples with normal and abnormal CBC were included and twenty-five samples was abnormal, as CLSI and International Council for Standardization in Hematology guidelines suggest half or one third of normal samples [5, 6]. Two experienced observers performed 200 white blood cells count on both manually prepared and automated smears. Comparison of results was performed using Passing Bablok regression analysis.

Morphological assessment of red blood cells was performed in terms of size, shape, and Hb stainability based on ICSH recommendations [13]. Comparison of morphological features between manually prepared and automated smears was assessed.

RESULTS

Smear's quality:

Smear examination revealed that all 50 smears were of acceptable quality in terms of length, margins, transition, working zone, distribution, and morphology.

One automated blood smear was found to show preparation abnormalities as staining artifacts (Table 1).

Table 1: Blood film quality assessment

Evaluation	Length	Margins	Transition	Artifacts	Observation area	Distribution	Coloration	Morphology
Total	50	50	50	50	50	50	50	50
acceptable	50	50	50	49	50	50	49	50
unacceptable	0	0	0	1	0	0	1	0
% unacceptable	0%	0%	0%	2%	0%	0%	2%	0%

Carry-over:

There was no carry-over on the Sysmex XN50. No lymphocyte reactions were observed in blood films with low white blood cell counts.

Repeatability:

Repeatability showed acceptable results with standard deviation values ranging from 1.56 to 2.9 for neutrophils, 1.17 to 2.08 for lymphocytes and 0.95 to 2.05 for monocytes (Table 2).

Table 2: Repeatability based on five normal blood samples

Samples	Neutrophils (%) (average ± SD)	Lymphocytes (%) (average ± SD)	Monocytes (%) (average ± SD)
sample 1	79,4 ± 1,88	10,95 ± 1,89	9,65 ± 1,27
sample 2	66,8 ± 2,57	26,75 ± 1,58	5,05 ± 0,95

Samples	Neutrophils (%) (average ± SD)	Lymphocytes (%) (average ± SD)	Monocytes (%) (average ± SD)
sample 3	75,35 ± 1,56	18,25 ± 1,67	6,25 ± 1,08
sample 4	74,1 ± 2,9	14,45 ± 2,08	9,6 ± 2,05
sample 5	81,05 ± 2,46	11,15 ± 1,17	7,4 ± 1,39

Comparability:

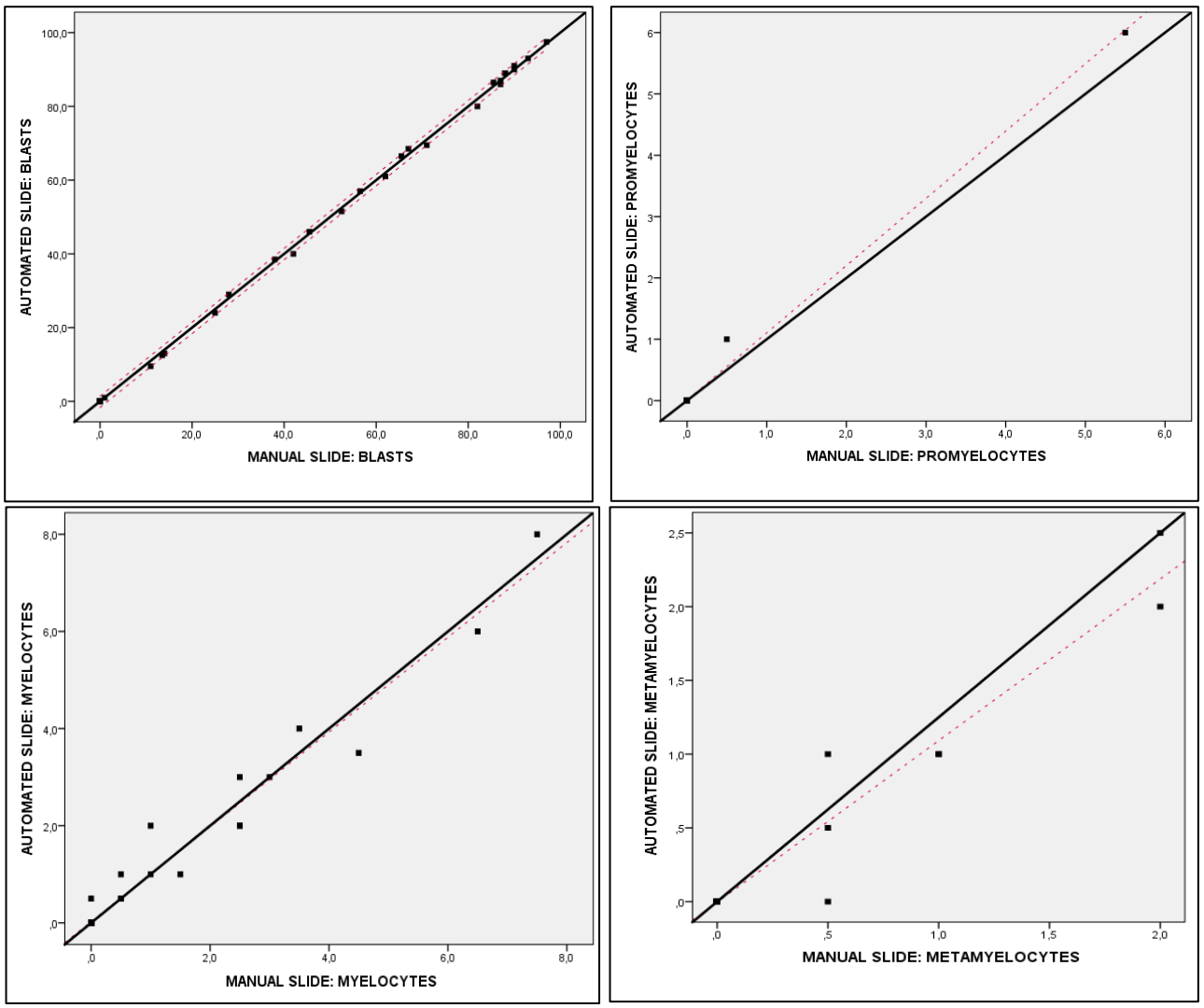
Twenty-five samples was normal and twenty-five was abnormal. Mean age of the selected patients with pathology was 22 (Table 3), with a sex ratio of 0.92. The pathologies included were: 13 cases of acute myeloid leukemia, 11 acute lymphocytic leukemia and 1 chronic myeloid leukemia. There were 19 cases of hyperleukocytosis, 21 cases of bi-cytopenia, 3 cases of isolated cytopenia and 1 case of pancytopenia.

Table 3: Mean and standard deviation of blood count parameters

	Age	WBC (/ul)	platelets (/ul)	RBC (/ul)	hemoglobin (g/dl)	Hematocrit (%)
Mean	22	103040	38720	2648000	8,3	25,5
standard deviation	19	133229	40108	883987	2,5	7,9

A differential count of 400 leukocyte cells for each specimen performed by two examiners revealed remarkable concordance between automated and manual smears (Figure 1).

Scatter plots with regression lines were plotted on a graph of manually prepared smears compared to automated smears by the Sysmex XN50. The regression lines were almost fitted to the identity lines (dashed line), the confidence intervals for the regression lines were in dashed lines. The intercepts and slopes were close to zero and one.



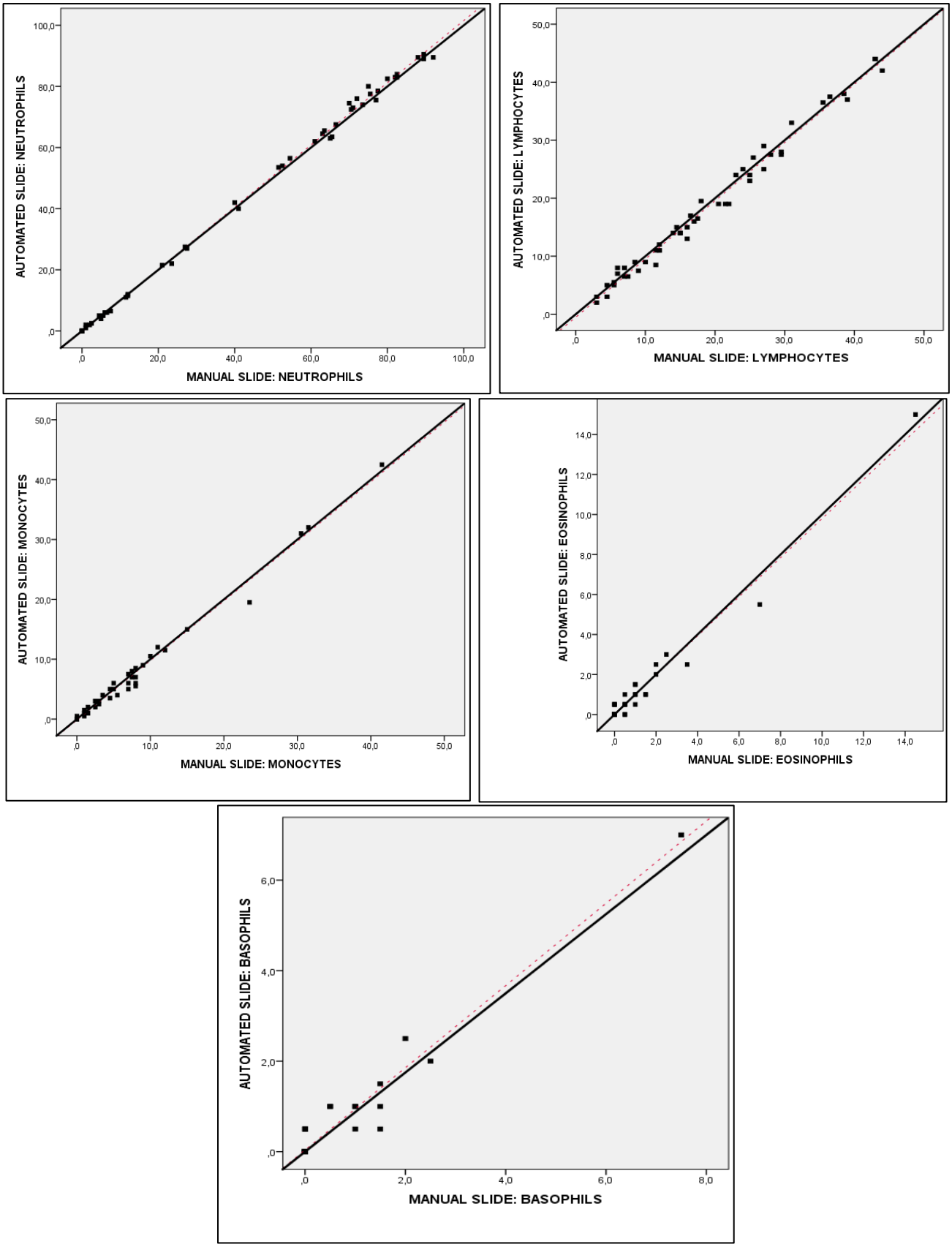


Figure 1: Comparison of WBC differential count results between automated smears and manual smears. (A) Blasts, (B) Promyelocytes, (C) Myelocytes, (D) Metamyelocytes, (E) Neutrophils, (F) Lymphocytes, (G) Monocytes, (H) Eosinophils, (I) Basophils

The size, shape, and Hb stainability of red blood cells were comparable between automated and manual smears in all 50 evaluated normal and abnormal blood samples. The morphological evaluation revealed that the size of the platelets, granularity, and the presence of platelet aggregates were also comparable. This evaluation was conducted by studying sensitivity and specificity, referring to the results of manual smears.

The various morphological abnormalities of red blood cells and platelets found were 14 cases of anisocytosis, 11 cases of poikilocytosis, 14 cases of hypochromia, 5 cases of giant thrombocytes and 24 cases of platelet aggregations.

The results were excellent, with sensitivity and specificity being very high at 100% for all anomalies except for the presence of giant platelets, where the results were 100% and 97% respectively (Table 4).

Table 4: Comparison of red blood cell and platelet abnormalities between automated and manual smears

Anomaly	Sensitivity	Specificity
Anisocytosis	100%	100%
Poikilocytosis	100%	100%
Hypochromia	100%	100%
Giant thrombocyte	100%	97%
Platelet aggregates	100%	100%

DISCUSSION

The blood smear complements the blood count to validate the numerical data and detect morphological abnormalities, the blood smear is an integral part of the blood count and is essential in certain situations, it presents a major examination in the diagnosis of certain pathologies: leukemia by the presence of blasts, thrombotic microangiopathies by the detection of schistocytes or even malaria to determine parasitemia. This major role requires rigor in the production and staining of the slides which should be representative of the blood sample. Automated methods facilitate the task in high-speed laboratories, such as ours, but should be validated to ensure their quality. Also, automated technique adapts the tilt angle between the blade and the coverslip according to the patient's hematocrit.

Before integrating a new instrument into routine laboratory testing, it is essential to evaluate its performance. This step ensures that the equipment operates as intended and delivers reliable results, even if the method or device has been previously tested and validated by the manufacturer [7].

In our study, we evaluated the performance of the automated Sysmex XN50 slide-maker stainer and compared the results between the slides prepared with Sysmex XN50 and manual smears. In our laboratory, the slide-making module and the staining module are integrated into the Sysmex XN3100 analyzer in a single instrument. In order to increase the objectivity of the performance evaluation, we included samples with hyperleukocytosis, bi-cytopenia, pancytopenia, or isolated cytopenia.

The pre-analytical phase is an important step to follow, whatever the technique used, to obtain more reliable results. This involves respecting the time between collection and spreading of the smears, which must not exceed 3 hours.

A single slide was produced for each of the manual and automated preparations, and the same smears were examined by both observers. Consequently, there is a high probability that most of the cells that the observers looked at were identical, reducing inter-observer variability in cell identification [14].

In our study, one automated blood smear was found to show preparation abnormalities as staining artifacts. For this, it is important to ensure rigorous preventive maintenance of the automate with regular cleaning of the coloring tanks to avoid the deposit of staining on the smears which leads to the appearance of staining artifacts. Comparing with the results of the UniCel DxH study, we conclude that our results were very good (Table 5).

Table 5: Comparison of smear quality assessment results between Sysmex XN and UniCel DxH

Evaluation	Length	Margins	Transition	Artifacts	Observation area	Distribution	Coloration	Morphology
% unacceptable UniCel DxH	7,2%	1,2%	0,4%	0%	0,4%	0%	0,4%	0%
% unacceptable Our study	0%	0%	0%	2%	0%	0%	2%	0%

Regarding the carry-over test, there was no contamination on the Sysmex XN50. No lymphocytic reaction was observed in blood smears with low leukocyte count. These results are identical to those reported by Hwan Tae Lee *et al*., in the evaluation study of the SC-120 slide-maker-stainer [10], and to those reported by Brown *et al*., in the evaluation study of UniCel DxH [11].

For repeatability, all the smears showed acceptable standard deviation values. These results are almost similar to those reported by Min-Sun Kwak *et al*., in the evaluation study of Abbott Alinity hs, where the standard deviation values were between 1.7 and 2.9 for neutrophils, 1.4-2.6 for lymphocytes, and 0.6–1.9 for monocytes [9].

In the context of evaluating the performance of automated stainers, Simson *et al*., (2010) were the first to compare the LH755 with manual smear preparation. The differential count was performed manually and was comparable between the two methods [14]. In another study, Brown *et al*., evaluated the ability of the DxH-SMS to reproducibly prepare good quality smears without cross-sample contamination. They also compared the differential leukocyte counts performed on smears prepared by DxH-SMS with those of manually prepared smears, where both were digitized on the DM96. They concluded that there was good agreement between the two methods [11]. Similar results were found in an evaluation study of SC-120, Hwan Tae Lee *et al*., concluded that there was good agreement between SC-120 and manual differentials for white blood cells, including abnormal cells [10]. In another study, Saad Albichr *et al*., evaluated several slide-makers stainers, and they found that Sysmex slide manufacturers seem to be the most consistent in reproducing smears, with good correlation between the results of the two methods was shown [15]. The Alinity hs instrument was also evaluated by Min-Sun Kwak *et al*., in which a differential count of 400 leukocyte cells by two examiners revealed remarkable concordance between Alinity hs and manual smears for the major leukocyte types [9].

Our study aligns with this literature data, revealing a remarkable concordance between automated and manual smears for normal and abnormal samples.

Regarding the evaluation of the size, shape, and Hb stainability of red blood cells as well as the evaluation of the size of platelets, their granularity, and the presence of platelet aggregates, the data were comparable between automated and manual smears in all 50 evaluated normal and abnormal blood samples, the results were excellent. This aligns with the data from the SC-120 evaluation study, where the shape of the red blood cells was comparable between the manually prepared films and the films automated by the SC-120, with high sensitivity (94.1%) and specificity (97.4%) [10]. On the other hand, in the DxH-SMS study, there was a higher prevalence of giant platelets reported on blood smears prepared by the DxH-SMS compared to manual slides [11]. No obvious explanation has been determined for this, but it is possible that the larger observation area produced by the DxH-SMS compared to the manual reference improves the detection of these low-frequency abnormal platelets.

CONCLUSION

Automation has not left hematology laboratories, as automated stainers and slide-makers are used with hematology analyzers to increase productivity.

The results obtained in this study show the quality of the Sysmex XN50 device in a laboratory, it offers advantages due to its reliability and speed of preparation of blood smears. The results are comparable to manual smears for white blood cells, red blood cells as well as platelets.

Although the automated technique for obtaining blood smears simplifies the process, regular and rigorous maintenance is required for the automate used.

REFERENCES

1. Ryan, D. H. (1995). Automated analysis of blood cells. Hematology: basic principles and practice. 2nd ed. New York: Churchill Livingstone, p. 2223-2235.
2. Yu, H., Ok, C. Y., Hesse, A., Nordell, P., Connor, D., Sjostedt, E., ... & Michael Snyder, L. (2012). Evaluation of an automated digital imaging system, Nextslide Digital Review Network, for examination of peripheral blood smears. *Archives of Pathology & Laboratory Medicine*, *136*(6), 660-667. doi:10.5858/arpa.2011-0285-OA
3. Buttarello, M., & Plebani, M. (2008). Automated blood cell counts: state of the art. *American journal of clinical pathology*, *130*(1), 104-116. doi:10.1309/EK3C7CTDKNVPXVTN
4. Barnes, P. W., McFadden, S. L., Machin, S. J., & Simson, E. (2005). The international consensus group for hematology review: suggested criteria for action following automated CBC and WBC differential analysis. *Laboratory hematology: official publication of the International Society for Laboratory Hematology*, *11*(2), 83-90. doi:10.1532/LH96.05019
5. International Council for Standardization in Haematology, Writing Group:, Briggs, C., Culp, N., Davis, B., d'Onofrio, G., Zini, G., ... & International Council for Standardization of Haematology. (2014). ICSH guidelines for the evaluation of blood cell analysers including those used for differential leucocyte and reticulocyte counting. *International journal of laboratory hematology*, *36*(6), 613-627. doi:10.1111/ijlh.12201
6. Koepke, J. A. (2007). CLSI. H20-A2: Reference leukocyte (WBC) differential count (proportional)

and evaluation of instrumental methods. 2nd ed. Wayne, PA: Clinical Laboratory Standards Institute, 2007.

7. Bitencourt, E. D. D. S. D., Voegeli, C. F., Onzi, G. D. S., Boscato, S. C., Ghem, C., & Munhoz, T. (2013). Validation of the Sysmex sp-1000i automated slide preparer-stainer in a clinical laboratory. *Revista brasileira de hematologia e hemoterapia*, *35*(6), 404-408. doi:10.5581/1516-8484.20130121
8. Kratz, A., Bengtsson, H. I., Casey, J. E., Keefe, J. M., Beatrice, G. H., Grzybek, D. Y., ... & Van Cott, E. M. (2005). Performance evaluation of the CellaVision DM96 system: WBC differentials by automated digital image analysis supported by an artificial neural network. *American journal of clinical pathology*, *124*(5), 770-781. doi:10.1309/XMB9-K0J4-1LHL-ATAY
9. Kwak, M. S., Jeong, I. H., Cho, S. S., Woo, K. S., & Han, J. Y. (2022). Performance Evaluation of the Abbott Alinity hs Blood Slide Maker/Stainer. *Annals of Laboratory Medicine*, *42*(4), 482-484. doi:10.3343/alm.2022.42.4.482
10. Lee, H. T., Park, P. W., Seo, Y. H., Kim, K. H., Seo, J. Y., Jeong, J. H., ... & Ahn, J. Y. (2017). Performance evaluation of Mindray CAL 8000 (BC-6800 and SC-120) hematology analyzer and slidemaker/stainer. *Journal of Clinical Laboratory Analysis*, *31*(4), e22065. doi:10.1002/jcla.22065
11. Brown, W., Keeney, M., & Hedley, B. D. (2014). Initial performance evaluation of the UniCel® DxH slide maker/stainer Coulter® cellular analysis system. *International Journal of Laboratory Hematology*, *36*(2), 172-183. doi:10.1111/ijlh.12150
12. CLSI. (2014). Evaluation of Precision Performance of Quantitative Measurement Methods; Approved Standard-Third Edition. Wayne, PA: CLSI; 2014.
13. Palmer, L., Briggs, C., McFadden, S., Zini, G., Burthem, J., Rozenberg, G., ... & Machin, S. J. (2015). ICSH recommendations for the standardization of nomenclature and grading of peripheral blood cell morphological features. *International journal of laboratory hematology*, *37*(3), 287-303. doi:10.1111/ijlh.12327
14. Simson, E., Gascon-Lema, M. G., & Brown, D. L. (2010). Performance of automated slidemakers and stainers in a working laboratory environment–routine operation and quality control. *International journal of laboratory hematology*, *32*(1p1), e64-e76. doi:10.1111/j.1751-553X.2009.01141.x
15. Saad Albichr, I., Sottiaux, J. Y., Hotton, J., De Laveleye, M., Dupret, P., & Detry, G. (2020). Cross-evaluation of five slidemakers and three automated image analysis systems: the pitfalls of automation?. *International Journal of Laboratory Hematology*, *42*(5), 573-580. doi:10.1111/ijlh.13264