Clinical performance of Medonic™ M32 3-part hematology analyzer compared with a 5-part reference instrument

Medonic M32 automated hematology analyzer is routinely used in laboratory diagnostics for determination of patients' blood status. This work demonstrates the performance of Medonic M32 3-part hematology analyzer in comparison with a more technically advanced 5-part reference analyzer in complete blood count (CBC) analyses of patient samples taken from the normal routine screening. The results show that the analyzers are in good agreement, indicating the suitability for use of Medonic M32 in general health screenings.

Medonic M32B | Medonic M32M | Medonic M32C | Medonic M32S

Figure 1. Medonic M32 automated 3-part hematology analyzer is available in four versions. While both M32B and M32M support open tube aspiration, M32M features an integrated mixer. M32C and M32S support closed-tube sampling to minimize the risks associated with contaminated blood. In addition, M32S is equipped with an Auto Loader for up to 2 × 20 samples - just load and walk away.

Introduction

A CBC is highly useful in general screenings as a tool to aid in diagnosis and monitoring of disease conditions. Automated instruments for this type of analyses were developed as early as in the 1950s. The Medonic systems were introduced by Ingemar Berndtsson and Bram Bottema, founders of Medonic AB in 1982 (now part of Boule Diagnostics) and both with a long history and experience in hematology, clinical chemistry, and blood-banking engineering.

Before, blood cell counts were performed manually by microscopy. Although manual examination of blood smears is still used as a control method for verification of results from abnormal samples, the automated hematology analyzers have largely replaced the manual method for determination of hematology parameters in the routine use.

The Medonic M32 system is an automated hematology analyzer for in vitro diagnostic use under laboratory conditions (Figure 1). The analyzer is intended for determination of hemoglobin (HGB) concentration, for counting of red blood cells (RBC) and platelets (PLT) as well as for counting and differentiation of white blood cells (WBC) into three subpopulations, namely lymphocytes (LYM), mid-sized white cells (MID, mainly monocytes), and granulocytes (GRAN, mainly neutrophils, eosinophils and basophils). The measurement principles of the Medonic M32 are based on impedance for cell counts and spectrophotometry for HGB.

Although such a 3-part hematology analyzer provides enough information for the smaller local hospital laboratory, trends show an increased interest in 5-part instruments, typically used in larger central hospital and hematology laboratories, also for use in small physician office laboratories (POL).

While a 5-part analyzer offers improved WBC assessment, differentiating them into neutrophils (NEU), lymphocytes (LYM), monocytes (MONO), eosinophils (EOS), and basophils (BASO), a 3-part instrument can offer great cost benefits to general screenings of patients' blood status (1).

The objective of this study was to evaluate the performance of Medonic M32 3-part hematology analyzer against a 5-part reference instrument.

Materials and methods

Medonic M32 3-part hematology analyzer and associated reagents, calibrator, and control material were used as test system. As reference system, the Sysmex™ XN-5000 5-part hematology analyzer and associated reagents, calibrator, and control material (Sysmex Corp.) were used. Three levels of control blood were analyzed daily before and after sample runs.

Fresh normal and abnormal human whole blood samples (n = 353), collected for routine analyses, were analyzed in duplicate on the test analyzer and in single assays on the reference analyzer. Samples included in the study were primarily selected to support the main test parameters RCB, HGB, PLT and WBC. The analyzers were co-calibrated prior to the statistical analyses.

The strength of the relationship between the cell count in the test and the reference systems was measured using Pearson correlation coefficient (r). Passing-Bablok regression analysis and Bland-Altman difference plots for estimation of agreement and possible systematic bias between the test and the reference systems were performed on matched samples.

For comparison with the Medonic M323-part system, results from the Sysmex 5-part differential were combined into GRAN, MID and LYM as given in Table 1.

The evaluation was performed in collaboration with a Swedish hospital in accordance with the standard SS-EN 13612 for compliance with the demands in the European IVD directive (98/79/EC).

Table 1. Correlation of parameters between 3-part and 5-part differential

Medonic M32	Sysmex XE-5000
GRAN	Neutrophils + eosinophils + basophils (+ bands if present)
MID	Monocytes
LYM	Lymphocytes

Results

Correlation results, with specification limits for the correlation coefficient (r) and bias between test and reference systems, are given in Table 2. No bias is given for parameters without full clinical significance. As shown, all parameters passed the correlation and bias requirements, except for the mean cell volume (MCV), for which the correlation coefficient was just below the acceptance criterion.

Correlation plots are shown in Figure 2. The plot for RBC shows two outliers. The same two samples did not show a corresponding deviation for PLT or WBC, that is, the outliers were not caused by dilution errors. The duplicate runs did show the same deviation. Thus, the probability is high that these samples represented fragile RBCs and that lysis occurred before the samples was assayed on the test instrument.

The MCV plot shows a cluster of eight samples as outliers. The diluents contain substances that make the cells spherical before analysis, and clinical conditions with high bilirubin can induce differences in membrane plasticity and swelling. Thus, MCV might be recorded differently in the two systems. When correlation results for MCV were recalculated with the eight MCV outliers removed because of the possible interference, the results were within the specification limits (Figure 3), and the results for MCV were considered approved.

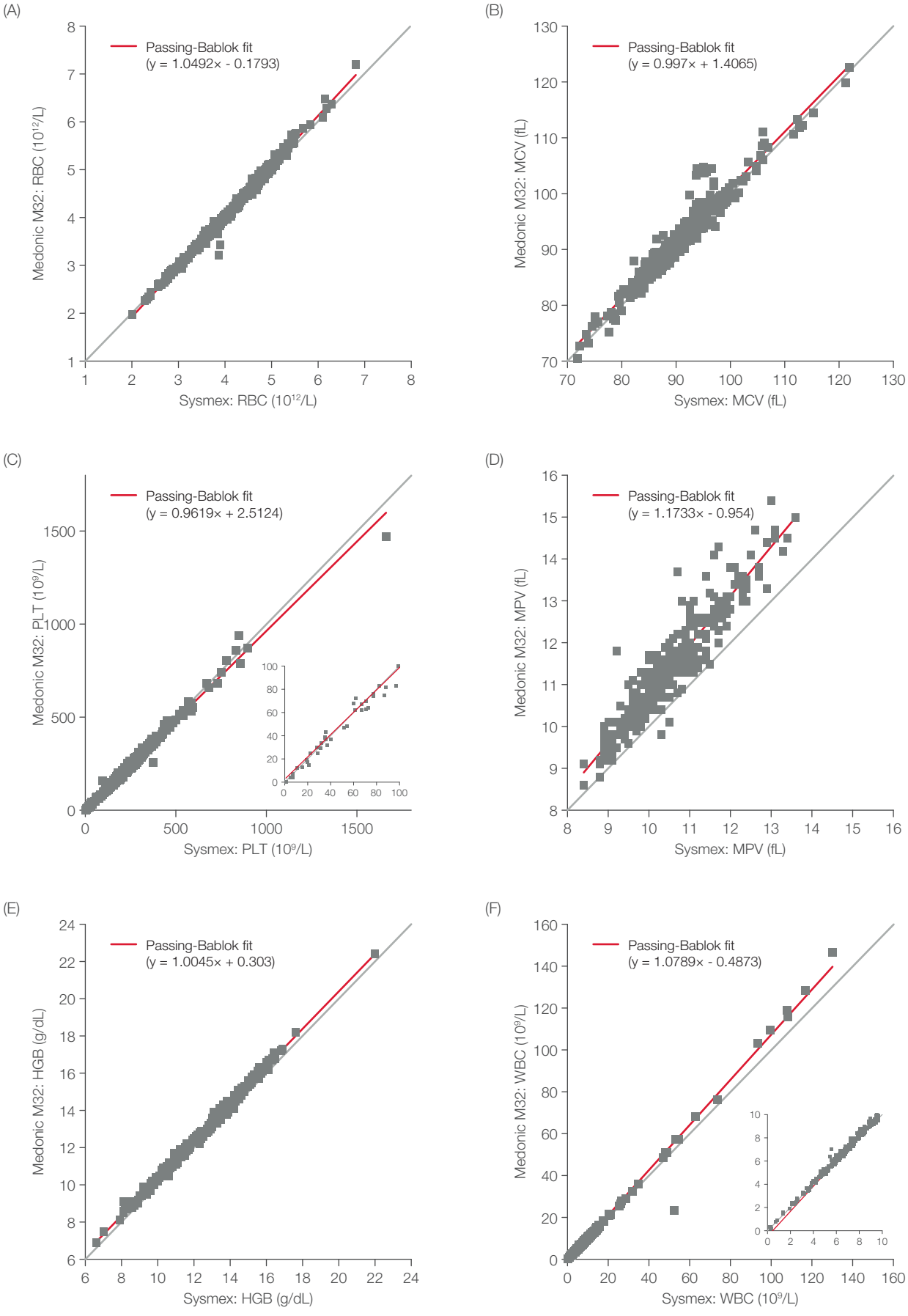
The mean platelet volume (MPV) plot shows a general deviation from direct linearity, which can be due to differences between the systems in how this parameter is calculated. In addition, a more technically advanced system uses a laminar flow through the aperture causing less distortion of cell signals. These differences are well known and accepted within the community of laboratory professionals.

There were no observations of deviating samples in the plots for PLT, PCT, HGB and WBC, except for one outlier in the plot for WBC, which also influenced the differential plots. The sample did not show the same deviation for HGB, that is, the outlier was not caused by a dilution error. The duplicate runs did show the same deviation and both instruments gave a left shift flagging (test instrument gave DE-flag, i.e., left hand shift or interference from debris, whereas reference instrument gave a left shift flag and indication of granulocytosis with blast cells), indicating a severe pathological state. For PLT and WBC, the correlation was also good in the lower range (see inserts in Figures 2C and 2F).

Table 2. Correlation results of Medonic M32 versus Sysmex XN-5000

Result/specification	RBC	MCV	PLT	MPV	HGB	WBC	LYM	MID	GRAN
r	1.00	0.97	0.99	0.94	1.00	0.99	0.99	0.89	0.98
r, specification	≥ 0.98	≥ 0.98	≥ 0.95	≥ 0.90	≥ 0.98	≥ 0.97	≥ 0.90	N/A	≥ 0.90
Bias (%)	0.47	1.23	- 3.88	7.70	1.69	2.53	- 9.00	- 16.30	12.57
Bias, specification (%)	± 2.5	± 2.5	± 7.0	± 10	± 2.5	± 3.0	N/A	N/A	N/A

N/A= not applicable


(A)
Passing-Bablok fit
(y = 1.0492× - 0.1793)
Medonic M32: RBC (10¹²/L)
Sysmex: RBC (10¹²/L)
(B)
Passing-Bablok fit
(y = 0.997× + 1.4065)
Medonic M32: MCV (fL)
Sysmex: MCV (fL)
(C)
Passing-Bablok fit
(y = 0.9619× + 2.5124)
Medonic M32: PLT (10⁹/L)
Sysmex: PLT (10⁹/L)
(D)
Passing-Bablok fit
(y = 1.1733× - 0.954)
Medonic M32: MPV (fL)
Sysmex: MPV (fL)
(E)
Passing-Bablok fit
(y = 1.0045× + 0.303)
Medonic M32: HGB (g/dL)
Sysmex: HGB (g/dL)
(F)
Passing-Bablok fit
(y = 1.0789× - 0.4873)
Medonic M32: WBC (10⁹/L)
Sysmex: WBC (10⁹/L)

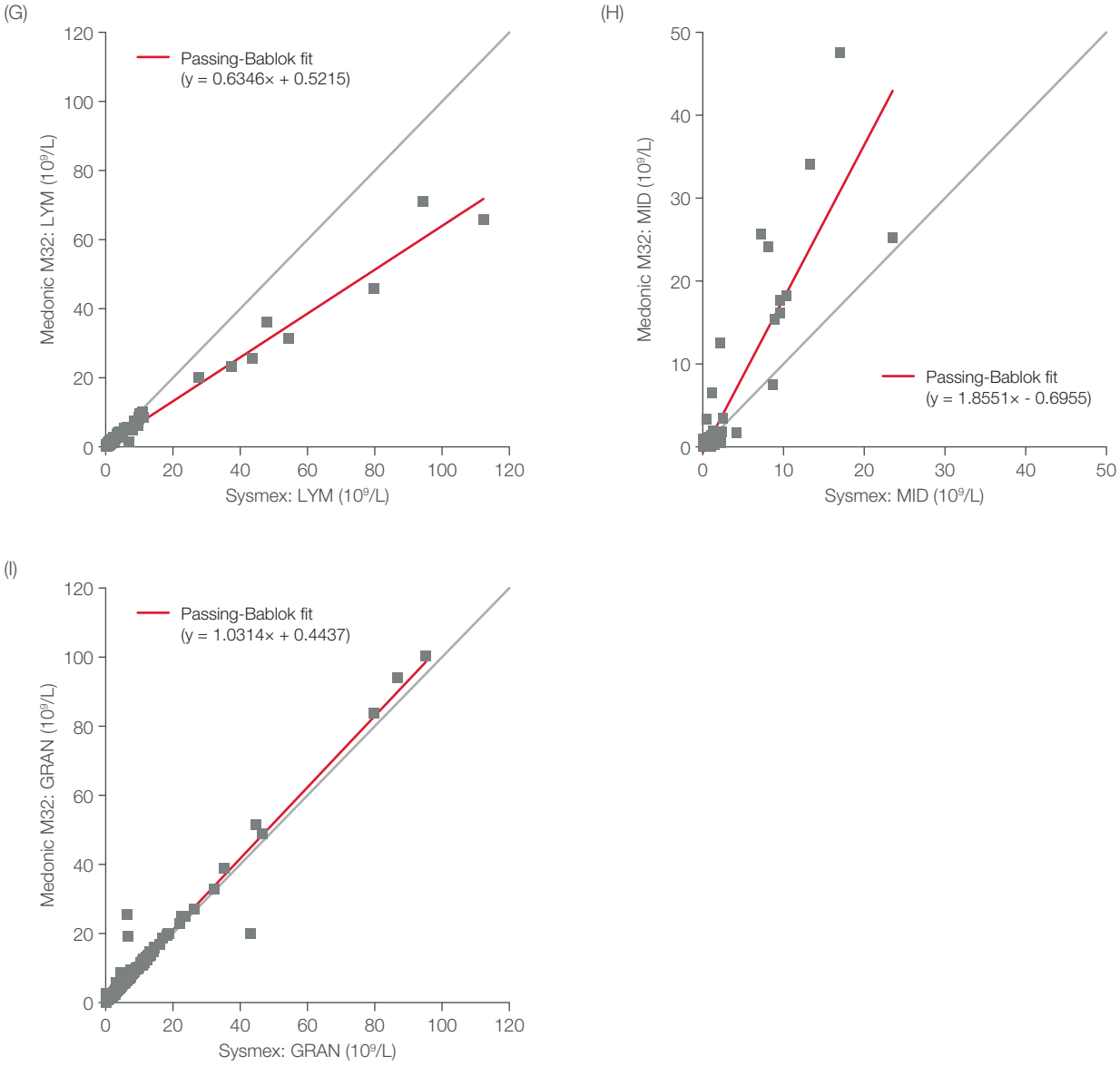
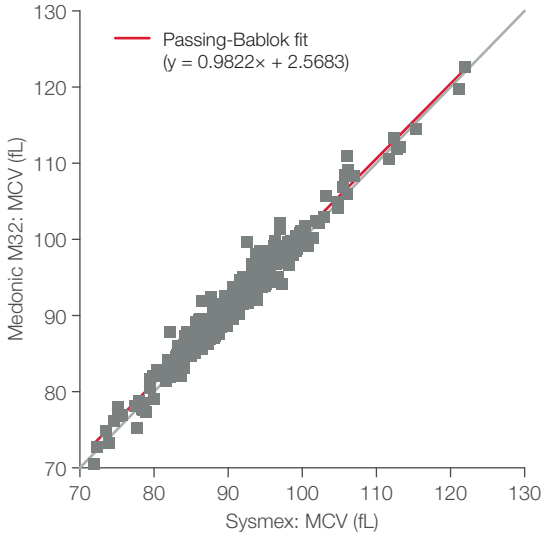


Figure 2. Correlation plots for (A) RBC, (B) MCV, (C) PLT, (D) MPV, (E) HGB, (F) WBC, (G) LYM, (H) MID (I) GRAN. In the regression plots, the gray line corresponds to identity (x = y) and the red line corresponds to best fit.

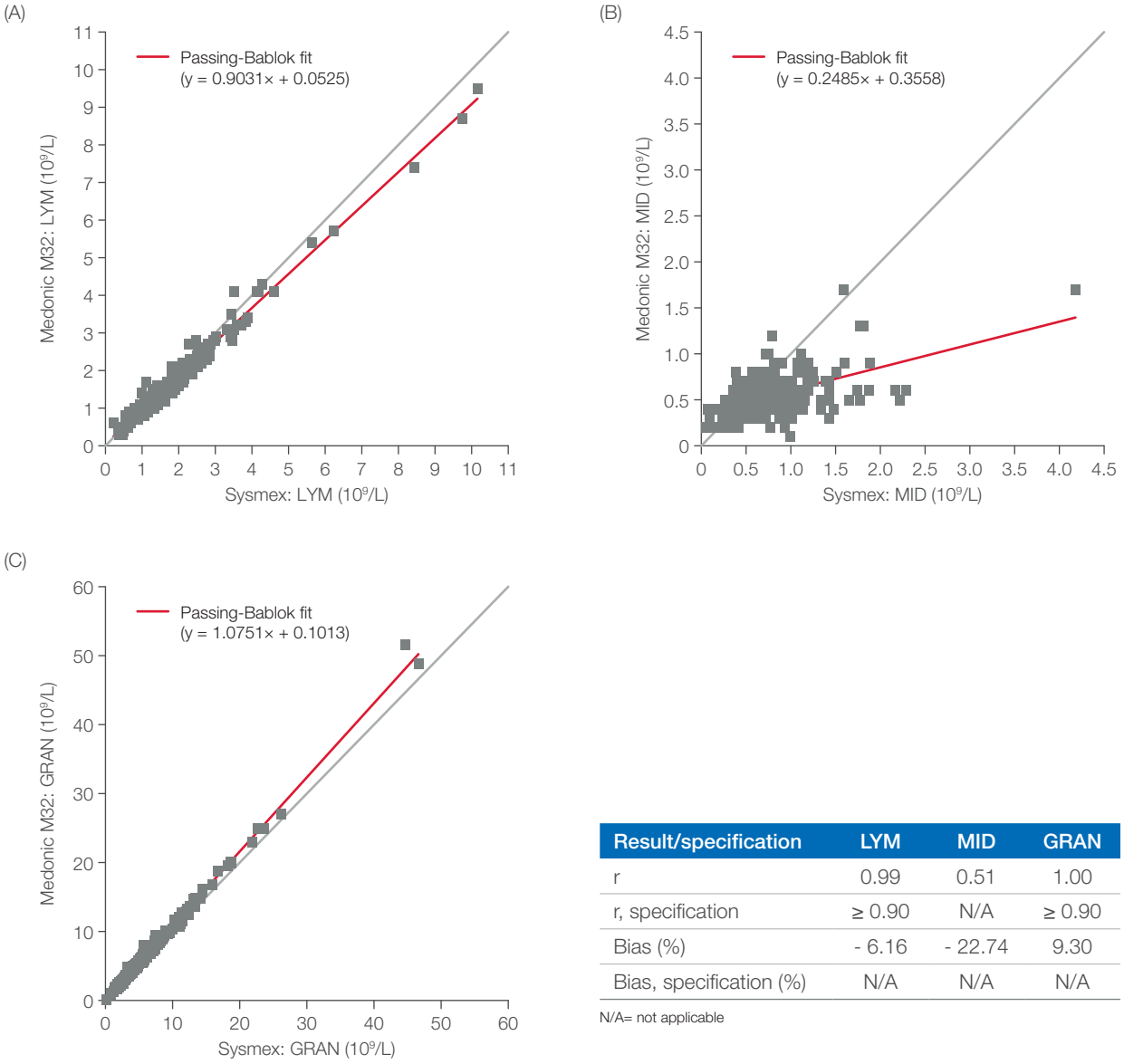


Result/specification	MCV
r	0.98
r, specification	≥ 0.98
Bias (%)	1.04
Bias, specification (%)	± 2.5

Figure 3. MCV correlation plot after removal of outlier. In the regression plot, the gray line corresponds to identity (x = y) and the red line corresponds to best fit.

Medonic M32 operates with a floating discriminator for the WBC differential, with a fallback to a firm discriminator when the algorithm for the floating discriminator cannot find an optimal fit. In such an event, the instrument gives a flagging that the sample should be analyzed by manual microscopy as a reference method. For non-flagged samples, the results were all within specification, even though granulocyte values for the reference system were calculated by summarizing the neutrophil, eosinophil and basophil values (Figure 4).

The MID cell correlation was not direct and showed substantial scatter especially within the normal range. In 3-part instruments, MID cells constitute a mix of cells, with the majority of cells being monocytes. Hence, the correlations of MID cells to monocytes are known to be inferior to the other parameters. Additionally, monocytes are present at substantially lower levels in comparison to lymphocytes and granulocytes. As previously shown, it can be difficult for the analyzer to differentiate the subpopulations at high WBC counts, and removal of such samples could improve correlation of the systems (2).



Result/specification	LYM	MID	GRAN
r	0.99	0.51	1.00
r, specification	≥ 0.90	N/A	≥ 0.90
Bias (%)	- 6.16	- 22.74	9.30
Bias, specification (%)	N/A	N/A	N/A

N/A= not applicable

Figure 4. Correlation plots for (A) LYM, (B) MID (C) GRAN for unflagged samples. In the regression plots, the gray line corresponds to identity (x = y) and the red line corresponds to best fit.

Conclusion

This study points to some of the differences between a more technically advanced 5-part analyzer, intended for use in a larger central hospital laboratory, and a less advanced 3-part analyzer, intended for use in general health screenings at smaller local hospital laboratories. Although some samples included in this study were from patients with pathological states that often are not applicable to the placement of a 3-part hematology analyzer, these samples provide the analytical parameter range necessary for the evaluation.

The results from this study demonstrate that the performance of Medonic M32hematology analyzer is in good agreement with that of the reference analyzer. Although manual microscopic examination of blood smears is recommended as complementary method for confirming analytical data, the results indicate the suitability of Medonic M32for use in routine hematology analysis.

Disclaimer

The results and conclusions presented in this study are valid for this specific study only. Other study conditions and assumptions could have significant impact on the outcome.

References

1. Whitepaper: Hematology analyzers: 3-part or 5-part, that is the question. Boule Diagnostics, WP31183, Edition 1 (2019).
2. Application note: Clinical performance of Medonic M51 5-part hematology analyzer. Boule Diagnostics, ANM31190, Edition 1 (2019).

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