GlucoMen®LX PLUS system: investigation of accuracy variation with haematocrit level

Authors:	F. Berti, C. Scuffi (Scientific & Technology Affairs)
Date:	16/10/2012
Type:	Confidential

1. Aim

GlucoMen LX Plus is intended to be used in capillary blood samples with an haematocrit range between 25% and 60%, as reported in sensor strips insert sheet as well as in meter user manual. The aim of this study was to clarify system accuracy variation with haematocrit (HCT%) levels, including two "out of range" situations: HCT% lower than 25% and higher than 60%. On this purpose, five different levels of haematocrit were investigated: three within the declared range, one lower than 25% and one higher than 60%.

2. Procedure

2.1 Materials

- 10 GlucoMen LX Plus meters
- 100 GlucoMen LX sensor strips (Lot 3211325249)
- Reference Glucose measuring system: YSI 2300 STAT PLUS (method: GOD).
- Haematocrit measuring system: NUVE Bench-Top Centrifuge NF048
- Partial Oxygen Pressure (pO_2) measuring system: IRMA TruPoint (ITC)

2.2 Preparation of blood samples

Venous blood samples withdrawn from healthy subjects were employed to perform this test. Blood samples were firstly analysed with YSI, then manipulated to add or deplete glucose in order to obtain two different (plasma referred) concentrations:

- **Level A** (low)= 2.8-3.9 mmol/L
- **Level B** (high)= 15.0-16.1 mmol/L

No manipulation was required to obtain Level A, as blood samples were naturally within the range. Level B was obtained by spiking the sample with a standard solution of glucose (1389 mmol/L in physiological buffer).

Five levels of haematocrit (Hct%) were investigated, according to the following distribution:

Level	Target HCT%	Achieved HCT% for Level A	Achieved HCT% for Level B
1	< 25%	15%	15%
2	30%	30%	28%
3	44%	49%	44%
4	58%	61%	60%
5	>60%	80%	65%

For preparing samples at haematocrit level higher than the initial one, blood sample was centrifuged and a calculated volume of supernatant plasma was removed, thus increasing the HCT% value. On the other hand, samples with reduce HCT% were obtained by adding a suitable amount of collected plasma.
After each adjustment, haematocrit level was checked performing a further measurement of HCT%.

N.B. In order to obtain results comparable with capillary blood tests, Partial Oxygen Pressure (pO_2) was maintained between 70 mmHg and 90 mmHg (tonometry). When samples consist of venous blood, the initial pO_2 is lower. Therefore, pO_2 needs to be increased by allowing sample oxygenation (i.e. keeping a blood aliquot in a vial with wide head space) until the target range is reached. In case of excessive blood oxygenation (pO_2 >90 mmHg), pO_2 can be reduced by adding a suitable volume of initial (non-oxygenated) venous blood.

2.3. Test with meters

For both Glucose concentrations (A and B), each HCT% level was tested by performing 10 measurements (1 measurement x meter). Thus, a total of 100 measurements was performed (2 glucose level x 5 HCT% levels x 10 meters).
Before starting the measurement series, each sample was analysed with YSI in order to obtain the reference glucose concentration.

2.4 Data evaluation

Accuracy variation with haematocrit level was evaluated referring to ISO/DIS 15197 (2011 version), considering the number of values comprised in the ± 0.83 mmol/L range for Level A (< 5.55 mmol/L) and in the ± 15% range for Level B (> 5.55 mmol/L).

3. Results

Table 1 shows a summary of data obtained from these experiments and displayed in Figure 1 and 2 as Bias (or Bias%) vs haematocrit plot.

Table 1.

HCT % level	Glucose Level A			Glucose Level B		
	Plasma reference – YSI *(mmol/L)*	**Average meter reading** (mmol/L)	**SD** (meter reading)	***Plasma reference – YSI*** *(mmol/L)*	**Average meter reading** (mmol/L)	**SD** (meter reading)
1	*3.1*	3.3	0.1	*15.6*	16.4	0.5
2	*2.9*	3.3	0.1	*15.6*	16.2	0.3
3	*3.9*	4.1	0.2	*15.6*	15.7	0.4
4	*3.4*	3.9	0.2	*15.3*	15.8	0.8
5	*3.6*	E4	-	*15.2*	16.3	0.5
	Measures compliant with ISO/DIS 15197			*Measures compliant with ISO/DIS 15197*		
	40/40 (100%)			50/50 (100%)		

For glucose Level A (low), results within the ± 0.83 mmol/L range were obtained for all the investigated haematocrit levels (Figure 1), with only exception of the highest one (HCT% = 80%). In this case, all of the 10 meters tested gave the error message "E4" *as a result.

GlucoMen LX Plus meter is able to estimate the actual haematocrit level through an inter-electrode impedance measurement and corrects the glucose signal accordingly (haematocrit compensation). When measuring a sample with HCT% = 80%, E4 error was due to meter detection of a haematocrit level dramatically exceeding the allowed operating range.

For glucose Level B (high), results within the ± 15% range were obtained for all the investigated haematocrit levels (Figure 2).

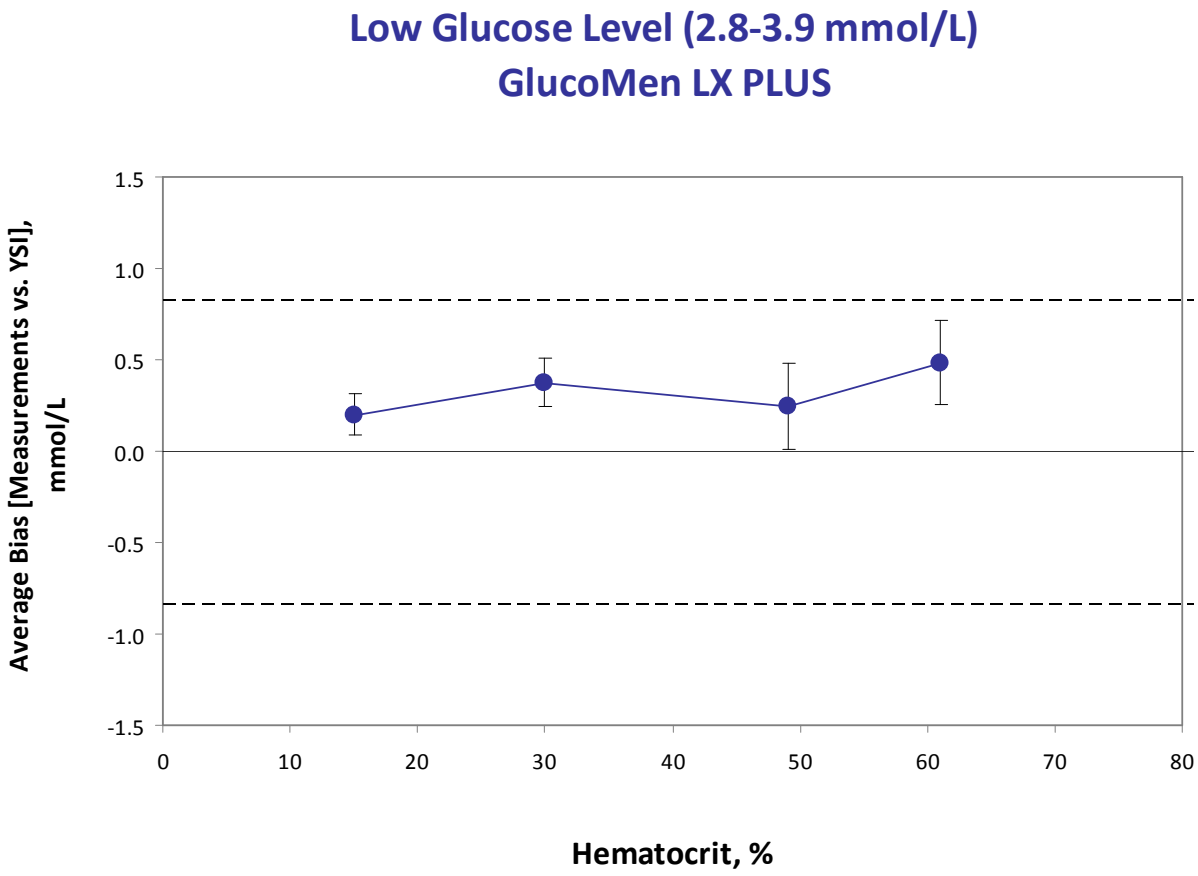

Figure 1. Average Bias variation vs Haematocrit level for Low Glucose Level (Level A = 2.8-3.9 mmol/L)

* According to meter user manual, E-4 error message means "Blood Sample Error" and can be attributed to incorrect application of blood sample (or control solution) onto the sensor, damaged sensor, incorrect blood sample quantity or sampling technique, or, finally, to *haematocrit out of the allowed range for glucose measurement.*

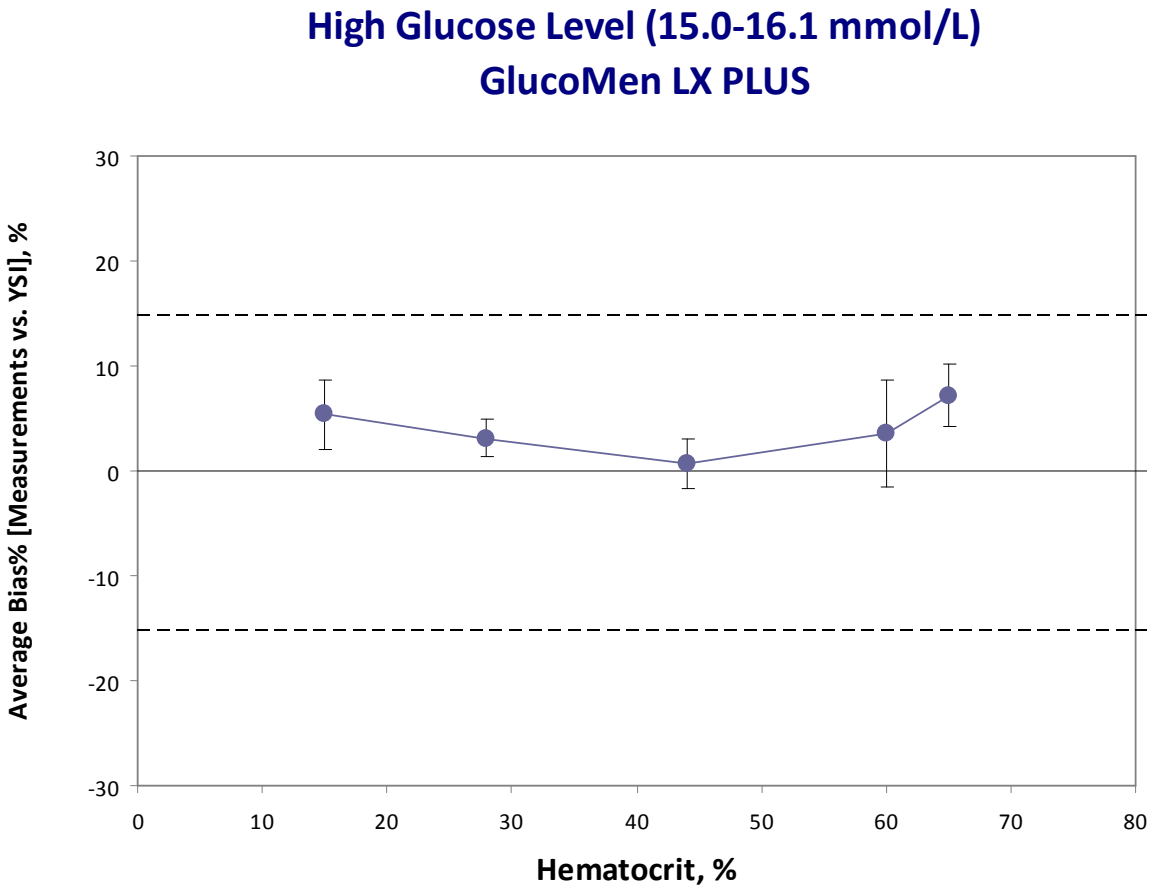

Figure 2. Average Bias% variation vs Haematocrit level for High Glucose Level (Level B = 15.0-16.1 mmol/L)

4. Conclusion

Laboratory tests were specifically designed to evaluate GlucoMen LX Plus system performance at different haematocrit levels, three included in the declared operating range (25%-60%) and two "out of range" (<25%, >60%). Data obtained in these particular experiments by testing two different glucose concentration (Level A= 2.8-3.9 mmol/L, Level B= 15.0-16.1 mmol/L) resulted compliant with ISO/DIS 15197 (2011 version) accuracy requirements, even for "extreme" HCT% levels such as 15% and 65%.