Accuracy and Precision of Three Common Glucose Meters in the Intensive Care Unit

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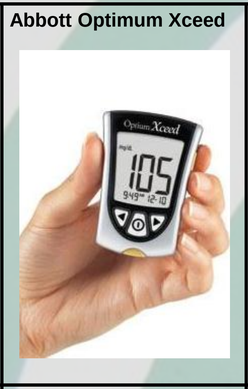
INTRODUCTION

Hand-held glucometers have become standard in most Intensive Care Units (ICU) for monitoring patients with stress-induced hyperglycaemia. Inaccuracies in these devices can lead to reduced glycaemic control performance. This research quantifies and compares the performance of three glucometers (Abbott Optium Xceed, Roche Accu-chek Inform II, Nova Statstrip) in the ICU setting.

METHODS

Glucometer Data

Blood samples from 13 critically ill patients were analysed for blood glucose (BG) concentration using a blood-gas analyser (BGA, Radiometer ABL90 Flex). Aliquots from each sample were also distributed across up to 5 glucometers of each model:

	Abbott Optimum Xceed	Nova Statstrip GLU	Roche Accu-chek Inform II
			
Price Range (USD)	$45 -- 85 USD	$530 – 825 USD	$300 – 820 USD
Whole to Plasma Blood Glucose Conversion	Assumes a constant adjustment factor of 1.12 (validated for a hematocrit range of 20-70%)	Measures haematocrit and adjust accordingly (validated for a hematocrit range of 20-65%)	Measures haematocrit and adjust accordingly (validated for a hematocrit range of 10-65%)
Intended Use	Diabetes management	Point of care testing in the hospital environment	Point of care testing in the hospital environment
Manufacture Error Data (CV%)	3.3	2.9	3.3
Number of Paired BGA Measurements	724	432	481

Analysis of Performance

Bias and precision were used to describe the device performance. Bias was determined by the median of the 5 glucometer reading minus the corresponding BGA. Precision was characterised by the difference between the maximum and minimum glucometer values for a given BGA measurement.

Also Kernel density models were created to examine glucometer performance of each device-type based on this paired BG-glucometer data.

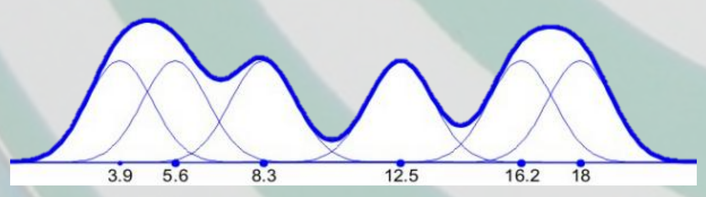


Figure 1: Demonstrates a one-dimensional kernel density estimation . The kernel density estimate ρ(x) is the large blue line; the kernel functions which add up to ρ(x) are the small blue lines.

RESULTS

Table 1: Mean Precision and Bias for each of the glucometers trialled

	Abbott Optimum Xceed	Nova Statstrip GLU	Roche Accu-chek Inform II
Mean Bias (mmol/L)	0.4	0.1	-0.1
Mean Precision (mmol/L)	0.6	0.5	0.3

76% of data were concentrated in the 5-8mmol/L range. In this range, glucometer error was independent of glucose level for the Nova and Roche devices. The while the IQR of the Abbott meter appear independent of glucose level the 90%-range deviates.

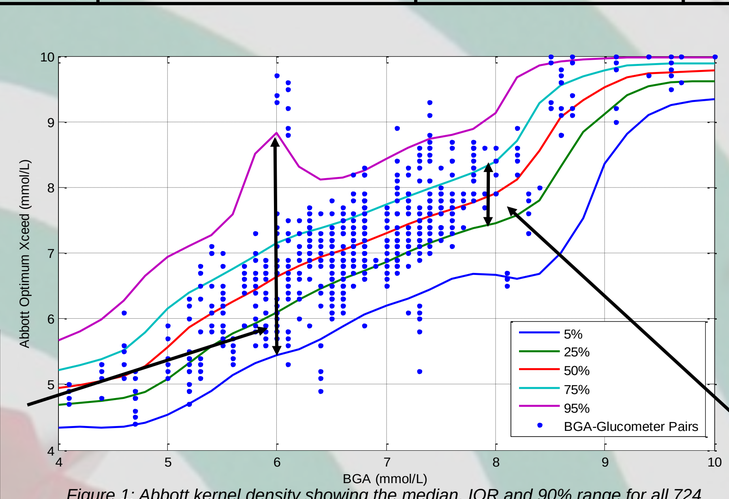


Figure 1: Abbott kernel density showing the median, IQR and 90% range for all 724 Abbott-BGA paired measurements

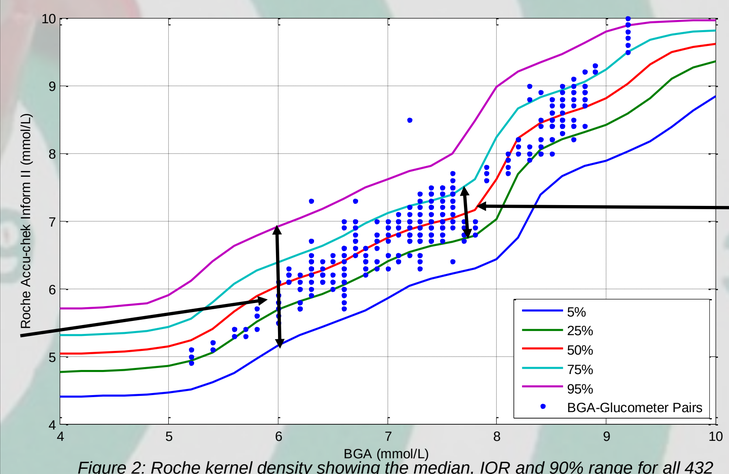


Figure 2: Roche kernel density showing the median, IQR and 90% range for all 432 Roche-BGA paired measurements

All devices can report within ±0.5 mmol/L across the IQR

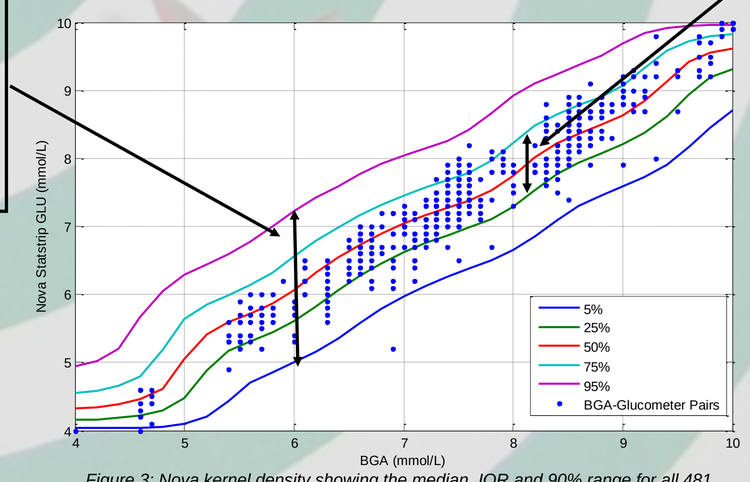


Figure 3: Nova kernel density showing the median, IQR and 90% range for all 481 Nova-BGA paired measurements

CONCLUSION

While all devices can report within ±0.5 mmol/L across the IQR when the bounds are increased to 90%-range the Abbott's performance varies with BG with greater inaccuracies. The Nova and the Roche glucometer adjust for hematocrit when calculating plasma glucose concentration. The lack of patient-specific haematocrit adjustment may account for this reduced performance at increased bounds. Both the Nova and Roche are designed for point of care testing in the hospital environment. Their negative bias means they will under estimate BG level, increasing patient safety. In contrast, the Abbott, an inexpensive device designed for diabetes management, can overestimate BG. This over estimation may not be significant for many cases of diabetes management. However, in an ICU setting, with very variable patients, underestimation is preferred as it would result in lower insulin doses and increased safety.

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