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

F. Thomas, M. Signal, C Pretty, J.G. Chase, G.M. Shaw

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 Optimum Xceed, Roche Accu-chek Inform II, Nova Statstrip) in the ICU setting.

METHODS

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
- Price Range (USD): $45 – $51 USD
- White to Plasma Blood Glucose Conversion: Assumes a constant adjustment factor of 1.15 validated for a hematocrit range of 20-70%
- Intended Use: Diabetic management
- Number of Paired BGA Measurements: 764

Nova Statstrip GLU
- Price Range (USD): $50 – $60 USD
- White to Plasma Blood Glucose Conversion: Measures hematocrit and adjusts accordingly validated for a hematocrit range of 20-45%
- Intended Use: Point of care testing in the hospital environment
- Number of Paired BGA Measurements: 442

Roche Accu-chek Inform II
- Price Range (USD): $300 – $320 USD
- White to Plasma Blood Glucose Conversion: Measures hematocrit and adjusts accordingly validated for a hematocrit range of 10-80%
- Intended Use: Point of care testing in the hospital environment
- Number of Paired BGA Measurements: 481

RESULTS

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

<table>
<thead>
<tr>
<th></th>
<th>Abbott Optimum Xceed</th>
<th>Nova Statstrip GLU</th>
<th>Roche Accu-chek Inform II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Bias (mmol/L)</td>
<td>0.4</td>
<td>0.1</td>
<td>-0.1</td>
</tr>
<tr>
<td>Mean Precision (mmol/L)</td>
<td>0.6</td>
<td>0.5</td>
<td>0.3</td>
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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.

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. While the IQR of the Abbott meter appear independent of glucose level the 90%-range deviates.

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.