Background  Blood for point-of-care analysis of glucose levels is often obtained from different sources (fingerstick, arterial or central venous catheter).

Objectives  To examine agreement between point-of-care and laboratory glucose values and to determine effects of hematocrit, serum carbon dioxide, and mean arterial pressure on the accuracy of point-of-care values.

Methods  Point-of-care values were compared with laboratory values. In 49 critically ill patients, blood was obtained first from a catheter for laboratory testing and then from the catheter and via fingerstick for point-of-care testing. Bias, precision, and root-mean-square differences were calculated to quantify differences in values between the 2 methods. A t-test was used to determine differences in values between each point-of-care blood source and the laboratory value. Multiple regression analysis was used to determine if serum level of carbon dioxide, hematocrit, and/or mean arterial pressure significantly contributed to the difference in bias and precision for the point-of-care blood sources.

Results  Mean laboratory glucose level was 135 (SEM 5.3, range 58-265) mg/dL. In point-of-care testing, bias ± precision and root-mean-square differences were 2.1 ± 12.3 and 12.35, respectively, for fingerstick blood and 0.6 ± 10.6 and 10.46 for catheter blood. Values for point-of-care and laboratory tests did not differ significantly. For catheter samples, hematocrit and serum carbon dioxide levels contributed significantly to the difference between point-of-care and laboratory glucose values (P < .001).

Conclusions  Glucose values for point-of-care samples did not differ significantly from laboratory values. For catheter samples, hematocrit and serum carbon dioxide levels accounted for the difference between point-of-care and laboratory glucose values. (American Journal of Critical Care. 2007;16:336-347)
Abnormal blood glucose levels are common in critically ill patients and increase the risk for complications such as infection, metabolic problems, and/or cerebral damage.¹⁻⁵ Frequent monitoring of blood glucose levels and aggressive management of hyperglycemia can decrease these complications and mortality.³⁻⁶⁻¹³ Although laboratory analysis is the most accurate method for evaluating glucose levels, because of cost and time delays, bedside point-of-care (POC) testing is often used to determine glucose levels when frequent monitoring of glucose is important. Although POC glucose meters were designed to be used with capillary blood obtained from a fingerstick, clinicians often obtain blood for POC testing from arterial or central venous pressure (CVP) catheters.

Several investigators¹⁴⁻²³ have evaluated the accuracy of fingerstick POC glucose testing compared with that of laboratory glucose analysis, but clinical studies²⁴⁻²⁷ on the accuracy of using blood from arterial or CVP catheters for POC glucose determination are limited. None of these studies¹⁴⁻²³ included evaluations of the impact of biochemical derangements, such as altered pH, on the accuracy of glucose meters when blood from arterial or CVP catheters was used, and the impact of abnormal hematocrit values²⁵ or poor tissue perfusion²⁷ was evaluated in only a single study. In earlier studies¹⁴,¹⁵,²³,²⁶⁻³⁵ with capillary blood, these conditions interfered with the accuracy of POC glucose values.

The purpose of this study was to compare POC glucose meter values of both capillary (fingerstick) and arterial or CVP blood samples with laboratory glucose values in critically ill patients. In addition, we examined whether hematocrit, serum level of carbon dioxide, and mean arterial pressure (MAP) affected the bias of the different sources of blood, because other investigators¹⁴,¹⁵,²³,²⁶⁻²⁸,³¹⁻³⁶ either found or hypothesized that these physiological variables affected or would affect the accuracy of measurements obtained with glucose meters.

Materials and Methods

This study was conducted in a 394-bed community-based hospital in the southeastern region of the United States. Approval was obtained from the institution’s investigational review board before any data were collected.

Study Design

A method-comparison study design was used to compare glucose values obtained with a POC device and a clinical laboratory analysis method. The dependent variables were the differences between glucose values obtained with the POC testing device (fingerstick and arterial or CVP catheter specimens) and the values obtained with the clinical laboratory method.

Sample

A convenience sample of critically ill patients had POC testing done once at the same time a blood sample was collected for glucose determination via the laboratory method. Inclusion criteria included the presence of a CVP or an arterial catheter. Sample size was determined a priori by power analysis (power = 80%, α = .05, effect size = 0.73 for t-test and 0.25 for multiple regression analysis).³⁶ Determinations of effect size were based on the national standard for minimal acceptable accuracy for glucose POC devices of 20% or less variation from laboratory values for glucose concentrations of 75 mg/dL or greater³⁷ (to convert glucose values to millimoles per liter, multiply by 0.05551).

Procedure

In a standard procedure, blood was obtained from the CVP or arterial catheter and placed in a separator vacuum test tube for laboratory glucose testing. The minimum amount of catheter blood discarded before laboratory glucose sampling was 5
mL, a volume that is at least 5 times the catheter dead space. Blood for laboratory testing was analyzed by using standard procedures. Laboratory glucose was determined by using the adapted hexokinase-glucose-6-phosphate method (Dimension Clinical Chemistry System, model RxL, Dade Behring Inc, Deerfield, Illinois). Manufacturer’s specifications indicate less than 5% mean for the coefficient of variation for this model of glucose analyzer.38 Mean time from blood sampling to laboratory analysis is 45 minutes in our hospital.

After the CVP or arterial catheter blood was obtained for laboratory testing of glucose, an additional 0.1 mL of blood was obtained from the catheter for glucose measurement with the POC glucose oxidase photometry device (SureStep Pro Hospital Meter and SureStep Pro Hospital Products Test Strips, Johnson & Johnson, Milpitas, California). As specified in the manufacturer’s directions, glucose testing was performed by placing a drop of blood on the reagent strip and then placing the strip into the glucose meter for reading. Capillary blood was then immediately obtained by lancing a fingertip to produce a drop of blood, which was then tested for glucose with the POC testing device (fingerstick POC testing) via the same procedure as that used for catheter blood. All POC testing was done immediately after blood was obtained from the catheter or via fingerstick. The same investigator (C.D.) obtained and analyzed all the POC samples.

Hematocrit, serum carbon dioxide, and MAP values at the time of therapeutic glucose determination were hand logged onto a data sheet for each patient. Hematocrit and serum carbon dioxide levels were analyzed by the hospital clinical laboratory with a Beckman Coulter LH 750 hematology analyzer (Beckman Coulter Inc, Brea, California) and a Dimension RxL Max w/ HM and RMS chemistry analyzer (Dade Behring Inc, Deerfield, Illinois), respectively, according to the manufacturers’ guidelines. MAP was measured directly via a radial artery catheter connected to a pressure transducer (MX9501T TranStar Patient Mount Monitoring Kit, Medex, Dublin, Ohio) and a bedside pressure monitor (Solar 8000, model 415982-005, GE Marquette Medical Systems, Milwaukee, Wisconsin).

Quality control of the glucose meters was done daily according to manufacturer’s directions and included testing both high- and low-quality control reagents.38 Care was taken to ensure that POC test strips were from the same lot number and had not expired. Before data collection, the investigator (C.D.) who would be performing the POC sampling and analysis was trained in the proper use of the POC glucose meter.38

Data Analysis

Data were summarized by using descriptive statistics. Difference scores between both POC glucose values (fingerstick and arterial or CVP) and laboratory glucose values also were calculated for each patient. Mean difference scores, or device bias, and limits of agreement between the POC test values (fingerstick and arterial or CVP) and the laboratory glucose values were calculated by using the Bland-Altman method.37-41 Also, t tests were used to determine if differences between the laboratory glucose value and each of the POC (fingerstick and arterial or CVP) glucose values were significant. Multiple regression analysis was used to determine if hematocrit, serum carbon dioxide, and/or MAP accounted for the difference scores between the laboratory value and the POC glucose values. The level of significance for all statistical tests was set at $P < .05$, with a Bonferroni correction for the multiple $t$ tests.

Results

A total of 49 patients were evaluated. Demographic data for the sample are presented in Table 1. Mean age was 66.8 (SEM 2.2) years. Of the 49 patients, 13 had diabetes and 3 had steroid-induced hyperglycemia. Blood for laboratory testing was obtained from an arterial catheter in 42 patients and from a CVP catheter in 7. The ranges and mean values of hematocrit, serum carbon dioxide, and MAP are summarized in Table 2.

Laboratory glucose values ranged from 58 to 265 mg/dL; fingerstick and catheter POC glucose values ranged from 52 to 281 mg/dL and from 61 to 263 mg/dL, respectively (Table 3). Glucose values were normally distributed. Bias (difference) and precision (limits of agreement) were 2.1 and 12.3, with root-mean-square differences (RMSDs) of 12.35 for the fingerstick POC and laboratory glucose values and 0.6 and 10.6, with RMSD of 10.46 for the catheter POC and laboratory glucose values (Table 3, Figure 1). Results of the $t$ tests indicated no significant differences between the laboratory glucose value and the POC glucose values (fingerstick POC: $t_{48} = 1.21, P = .23$; catheter POC: $t_{48} = -0.40, P = .69$).

Multiple regression analysis indicated that hematocrit and serum carbon dioxide levels were
significant contributors to difference scores between the laboratory and the catheter POC methods ($F_{3,45} = 8.17, P < .001$; Table 4). MAP did not significantly account for the difference scores. No significant contributors were found for difference scores between the laboratory and fingerstick POC analysis methods ($F_{3,45} = 2.56, P = .07$).

Because the number of samples obtained via the CVP catheters was so small, the 7 POC blood samples obtained via a CVP catheter were removed from the study. The bias and precision (differences and limits of agreement; Table 3, Figure 2) and results of multiple regression analysis (Table 4) for the arterial POC and laboratory glucose values ($n = 42$) were similar to those for the entire sample ($N = 49$), with the exception of serum carbon dioxide. Multiple regression analysis for the fingerstick POC method indicated that serum carbon dioxide level was a significant contributor to the difference scores between the laboratory and arterial POC analysis methods ($P = .04$; Figure 3).

**Discussion**

Blood obtained from arterial and CVP catheters had slightly smaller bias and precision values than did blood from a fingerstick sample. The differences between laboratory and POC glucose values, however, were not statistically significant. In addition, hematocrit and serum carbon dioxide levels significantly accounted for the differences between the laboratory and POC testing values.

Although obtaining blood for POC glucose testing from arterial or venous catheters instead of using the fingerstick method is common in critical care units, this practice has been examined in only a few published studies. Only 2 of these studies had sufficient detail and clarity for adequate interpretation of the results. Small sample size, evaluation of devices no longer used in clinical practice, and

**Table 1**

Sample characteristics for 49 critically ill patients

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reason for admission to intensive care unit, No. of patients</td>
<td>22</td>
</tr>
<tr>
<td>Respiratory failure/distress</td>
<td>12</td>
</tr>
<tr>
<td>Postoperative care</td>
<td>4</td>
</tr>
<tr>
<td>Sepsis</td>
<td>3</td>
</tr>
<tr>
<td>Cardiac dysrhythmias</td>
<td>2</td>
</tr>
<tr>
<td>Renal failure</td>
<td>6</td>
</tr>
<tr>
<td>Age range, mean (SEM), y</td>
<td>23-96, 66.8 (2.2)</td>
</tr>
<tr>
<td>Men, No. of patients</td>
<td>25</td>
</tr>
</tbody>
</table>

**Table 2**

Values for selected physiological variables for 49 critically ill patients

<table>
<thead>
<tr>
<th>Variable</th>
<th>Range</th>
<th>Mean</th>
<th>SEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hematocrit, %</td>
<td>20-53</td>
<td>31.7</td>
<td>0.8</td>
</tr>
<tr>
<td>Serum level of carbon dioxide, mmol/L</td>
<td>12.5-45.7</td>
<td>27.8</td>
<td>1.1</td>
</tr>
<tr>
<td>Mean arterial pressure, mm Hg</td>
<td>56-130</td>
<td>81.9</td>
<td>2.3</td>
</tr>
</tbody>
</table>

**Table 3**

Glucose values, bias, precision, and root-mean-square of the difference scores for 49 critically ill patients

<table>
<thead>
<tr>
<th>Blood source/method of analysis</th>
<th>Range</th>
<th>Mean</th>
<th>SEM</th>
<th>Bias (difference)</th>
<th>Precision (limits of agreement)</th>
<th>Root-mean-square</th>
</tr>
</thead>
<tbody>
<tr>
<td>All patients ($n = 49$)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Catheter/laboratory</td>
<td>58-265</td>
<td>135.0</td>
<td>5.3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fingerstick/POC</td>
<td>52-281</td>
<td>137.1</td>
<td>5.4</td>
<td>2.1</td>
<td>12.3</td>
<td>12.35</td>
</tr>
<tr>
<td>Arterial or CVP catheter/POC</td>
<td>61-263</td>
<td>135.6</td>
<td>4.9</td>
<td>0.6</td>
<td>10.6</td>
<td>10.46</td>
</tr>
<tr>
<td>Patients with arterial catheters ($n = 42$)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Catheter/laboratory</td>
<td>58-265</td>
<td>137.1</td>
<td>5.9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fingerstick/POC</td>
<td>52-281</td>
<td>138.2</td>
<td>6.2</td>
<td>1.0</td>
<td>12.3</td>
<td>12.23</td>
</tr>
<tr>
<td>Catheter/POC</td>
<td>61-263</td>
<td>137.1</td>
<td>5.5</td>
<td>-0.1</td>
<td>11.0</td>
<td>10.91</td>
</tr>
</tbody>
</table>

Abbreviations: CVP, central venous pressure; POC, point of care.

aDifference scores = POC glucose value - laboratory glucose value.

bTo convert glucose values to millimoles per liter, multiply by 0.05551.
Figure 1 Bland-Altman graphs depicting the differences between the laboratory glucose value and the point-of-care (POC) glucose values determined with blood from a fingerstick (A) or an arterial or a central venous pressure (CVP) catheter (B) for 49 patients.

To convert glucose values to millimoles per liter, multiply by 0.05551.
inappropriate statistical analysis limit the generalizability of the studies to clinical practice.

In a study of 50 postoperative cardiac surgical patients, Maser et al. found a significant difference between the mean glucose values obtained with an arterial POC device (Accu-Check II, Boehringer-Mannheim) and the arterial sample analyzed by using the laboratory method: 249 (SD 12) mg/dL and 219 (SD 12) mg/dL, respectively. Mean POC values with fingerstick samples, 210 (SD 12) mg/dL, were lower than the laboratory mean value. Maser et al hypothesized that the large differences between the various methods for glucose analysis might have been related to low body temperature and the effect on the enzymatic reactions on the test strips rather than to the source of the blood for analysis or to systematic error.

In the study by Maser et al., all POC testing was performed by the same investigator to minimize user error. A major limitation of the study, which makes interpretation of the data difficult, is that difference scores between the POC value and the laboratory reference value were not computed and graphed according to the Bland-Altman method. Experts in technology assessment consider the Bland-Altman method the best way to examine the level of agreement between 2 medical devices. Correlational methods are inappropriate for analysis in these types of studies because, with those methods, the degree of relationship rather than the difference between 2 variables is examined.

Unlike Maser et al., Ray et al. found no difference between arterial glucose values obtained with a POC device (One Touch Profile, Lifescan, Johnson & Johnson) and values obtained with the laboratory reference standard. In that study, blood was obtained from 10 critically ill patients in a total of 105 sampling periods. The results of our study were similar to those of Ray et al, but we used a different POC device (SureStep Pro, Lifescan, Johnson & Johnson).

Hematocrit has long been known to affect the accuracy of POC glucose analysis. Despite manufacturers’ operating instructions for POC devices that suggest limiting use of the devices to clinical situations in which hematocrit levels are within a specific range of values, typically 25% to 55% or 60%, POC devices often are used clinically without regard for hematocrit level. Similar to our finding, the results of several studies of different

<table>
<thead>
<tr>
<th>Independent variable</th>
<th>Coefficient</th>
<th>SE</th>
<th>P</th>
<th>R²</th>
<th>Adjusted R²</th>
<th>Degrees of freedom</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependent variable: fingerstick POC difference scores for all patients (N = 49)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Serum carbon dioxide</td>
<td>-0.409</td>
<td>0.235</td>
<td>.09</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Hematocrit</td>
<td>-0.523</td>
<td>0.310</td>
<td>.10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>MAP</td>
<td>0.085</td>
<td>0.107</td>
<td>.43</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dependent variable: arterial or CVP catheter POC difference scores for all patients (N = 49)</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Serum carbon dioxide</td>
<td>-0.532</td>
<td>0.175</td>
<td>.004</td>
<td></td>
<td></td>
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<tr>
<td>Hematocrit</td>
<td>-0.703</td>
<td>0.231</td>
<td>.004</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>MAP</td>
<td>0.023</td>
<td>0.080</td>
<td>.77</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Dependent variable: fingerstick POC difference scores for patients with arterial catheters (n = 42)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Serum carbon dioxide</td>
<td>-0.546</td>
<td>0.263</td>
<td>.04</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Hematocrit</td>
<td>-0.411</td>
<td>0.348</td>
<td>.24</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAP</td>
<td>0.099</td>
<td>0.117</td>
<td>.40</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dependent variable: arterial catheter POC difference scores for patients with arterial catheters (n = 42)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Serum carbon dioxide</td>
<td>-0.674</td>
<td>0.202</td>
<td>.002</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Hematocrit</td>
<td>-0.665</td>
<td>0.266</td>
<td>.02</td>
<td></td>
<td></td>
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<tr>
<td>MAP</td>
<td>0.054</td>
<td>0.089</td>
<td>.55</td>
<td></td>
<td></td>
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</tbody>
</table>

Abbreviations: CVP, central venous pressure; MAP, mean arterial pressure; POC, point of care.
POC method is used, whereas hematocrit values higher than normal (>45%) result in underestimates of laboratory values. Although the mechanism for glucose meters have indicated that lower than normal hematocrit values (<30% to <35%) result in overestimates of laboratory glucose levels when the POC method is used, whereas hematocrit values higher than normal (>45%) result in underestimates of laboratory values. Although the mechanism for

Figure 2  Bland-Altman graphs depicting the differences between laboratory glucose value and the point-of-care (POC) glucose value obtained with blood from a fingerstick (A) or an arterial catheter (B) for 42 patients.
To convert glucose values to millimoles per liter, multiply by 0.05551.
Figure 3 Scattergrams of point-of-care (POC) and laboratory glucose differences for significant multiple regression variables, hematocrit and serum carbon dioxide level, in 42 patients with POC testing of arterial blood. A, hematocrit and arterial POC; B, serum carbon dioxide and arterial POC; C, serum carbon dioxide and fingerstick POC.

To convert glucose values to millimoles per liter, multiply by 0.05551.
When point-of-care measures are used, a low hematocrit level may result in overestimates of blood glucose.

Any single point-of-care glucose value for titration of insulin should be used cautiously.

these differences is not known, various hypotheses have been proposed to explain the impact of abnormal hematocrit levels on POC testing: altered viscosity of the blood, prevention of plasma from reaching the reaction surface of the test strip, change in diffusion kinetics, and/or increased packed red cell volume and displacement of plasma volume leading to insufficient plasma volume for accurate testing.\(^{15}\)

In earlier studies\(^{14,15,25,28,29,31-33}\) on the effect of hematocrit on POC testing, the investigators used fingerstick (capillary) blood and found a negative bias of glucose values with increasing levels of hematocrit. We did not find that hematocrit significantly explained the difference between fingerstick POC glucose values and laboratory values. This difference in findings may be due to differences in device performance, because the POC devices in the earlier studies differed from the POC device we used. Another possible explanation is that hematocrit ranges in our study were more homogeneous than were the ranges in the other studies. Although hematocrit values ranged from 20% to 53% in our study, mean hematocrit was 32% with a small SEM (0.8%). Few of our subjects had hematocrit values outside the manufacturers’ recommended range for optimal device functioning (25%-60%).

Another reason for the different results might be the changes made in POC devices used today to improve the accuracy of measurement of capillary blood glucose levels in patients with abnormal hematocrit levels. This last reason also would explain why hematocrit levels significantly accounted for differences between POC glucose values obtained with CVP or arterial blood and the laboratory value in our study but not for the differences between POC values with capillary (fingerstick) blood and the laboratory value. Any improvements in device performance made to correct the effect of hematocrit on glucose determinations when the POC device is used with capillary samples could then cause an overcorrection if the source of blood used for POC testing is not capillary blood.

In addition to the adverse effect of hematocrit levels on the accuracy of POC glucose values, several other factors can interfere with the accuracy of different models of POC glucose meters\(^{44}: \) creatinine levels,\(^{45,46}\) bilirubin levels,\(^{30}\) high arterial oxygen levels,\(^{15,46}\) shock states,\(^{23,34,35,47}\) and altered pH.\(^{31,34}\) On the basis of anecdotal experience with discrepancies between POC and laboratory glucose values in individual patients with shock states, we decided to evaluate MAP and serum carbon dioxide level, because arterial pH values are not routinely available in our patients. Serum carbon dioxide levels vary in relationship to alterations in blood pH, so we hypothesized that serum carbon dioxide would be associated with differences between POC and laboratory glucose. In all but one of the multiple regression analyses we performed (fingerstick POC glucose values minus laboratory glucose values), serum carbon dioxide significantly accounted for the POC and laboratory difference scores. This finding is similar to, and consistent with, findings in previous studies\(^{11,34}\) on the effect of pH on the accuracy of POC glucose values, because serum levels of carbon dioxide depend on serum pH.

Unlike the findings in previous studies\(^{23,34,35,47}\) of shocklike states, MAP did not significantly explain the difference scores between POC and laboratory glucose values in our study. Because most of our subjects had MAP greater than 60 mm Hg, and thus did not have shocklike states, our findings are not surprising. Future studies should be done in patients with shock to determine if MAP is a significant contributor to POC accuracy.

Clinical Implications

The lack of differences between glucose values obtained via a laboratory analysis and values obtained with the POC device, whether capillary or catheter blood was used, supports the common practice in critical care units of using catheter rather than fingerstick blood for POC testing. With the advent of aggressive glucose management protocols to decrease infection risks in critically ill patients,\(^{16-18}\) blood samples are needed frequently, and use of catheter blood avoids painful needlesticks to obtain capillary blood.

One limitation of our findings is that all of the POC tests were done by the same investigator. This practice, although ideal for research control, is not typical of the way POC testing is usually done. Significant user error can be introduced with multiple users and can make the difference between POC and laboratory values in actual practice situations more pronounced than the differences in our study. Having multiple care providers do the POC testing in a replication of our study would be prudent to determine the impact of the number of testers on the accuracy of POC glucose values. In the other study\(^{23}\) that showed no difference between POC and laboratory glucose values, a single provider also did all the POC tests.
Because of the range of difference scores and the width of the 95% CIs (the ±2 SD lines) of the Bland-Altman graphs (Figures 1 and 2) in our study, we recommend caution in using any individual POC glucose value as a basis for adjusting insulin doses when tight glucose management protocols are being used. Many of the patients in our study had glucose differences of at least 10 mg/dl between the POC and laboratory methods, which may be a large enough difference from the true glucose value to change management decisions when treatment protocols call for narrow ranges for glucose levels.

As shown in other studies, abnormal hematocrit levels may influence the accuracy of a POC device. In patients with abnormally low hematocrit levels, periodically validating the POC test result by comparing it with a laboratory glucose level would be a prudent approach to avoid situations in which the POC value is an overestimation of the true glucose value.

Conclusions

Our findings validated the practice in critical care units of obtaining blood for POC testing from arterial or venous catheters rather than from a fingerstick source. The bias and precision of glucose POC testing with a fingerstick sample was slightly higher than the bias and precision with samples obtained from an arterial or a CVP catheter, but the differences were not statistically significant. In addition, for hematocrit and serum carbon dioxide levels below normal ranges, POC values with arterial blood tended to be overestimates of laboratory glucose values. In individual situations, for patients with abnormal hematocrit or carbon dioxide levels, care should be taken to verify the accuracy of POC glucose testing by comparing the POC value with the laboratory value of a sample obtained at the same time as the POC sample. Further study is needed to determine if patients with abnormally low MAP have greater discrepancies between POC and laboratory glucose values.

ACKNOWLEDGMENTS

Special thanks to Marianne Chulay, RN, DNSc, FAAN, for assistance with study design, data analysis, and manuscript preparation.

FINANCIAL DISCLOSURES

None reported.
1. Bedside point-of-care testing was designed to be used with which of the following?
   a. Arterial sampled blood
   b. Central venous sampled blood
   c. Fingerstick capillary blood
   d. Any serum blood sample

2. Of the research studies conducted on point-of-care glucose testing compared with laboratory analysis, how many have examined the impact of biochemical derangement such as altered pH on the accuracy of test results?
   a. None
   b. One
   c. Two
   d. Three or more

3. Of the research studies conducted on point-of-care glucose testing compared with laboratory analysis, how many have examined the impact of abnormal hematocrit values?
   a. None
   b. One
   c. Two
   d. Three or more

4. What was the minimum amount of catheter blood that was discarded in this study before laboratory glucose sampling?
   a. A volume at least 2 times the catheter dead space
   b. A volume at least 3 times the catheter dead space
   c. A volume at least 4 times the catheter dead space
   d. A volume at least 5 times the catheter dead space

5. Which of the following factors has been found to contribute significantly to difference scores between laboratory and point-of-care glucose testing methods?
   a. Anemia
   b. Hematocrit
   c. Mean arterial pressure
   d. Anion gap

6. Which of the following factors has not been found to contribute significantly to difference scores between laboratory and point-of-care glucose testing methods?
   a. pH
   b. Hematocrit
   c. Mean arterial pressure
   d. All of the above

7. Which of the following factors has been demonstrated to contribute to significant differences between laboratory and arterial point-of-care analysis methods?
   a. Hemoglobin
   b. Serum carbon dioxide level
   c. Mean arterial pressure
   d. pH

8. Manufacturers’ operating instructions for point-of-care devices usually suggest limiting use of the devices for a hematocrit value in which of the following ranges?
   a. 15% to 40%
   b. 20% to 50%
   c. 25% to 60%
   d. 30% to 65%

9. A lower-than-normal hematocrit value (<30% to <35%) will result in which of the following effects on laboratory glucose levels when point-of-care testing is used?
   a. Overestimate
   b. Underestimate
   c. No effect
   d. None of the above

10. A higher-than-normal hematocrit value (>45%) will result in which of the following effects on laboratory glucose levels when point-of-care testing is used?
    a. Overestimate
    b. Underestimate
    c. No effect
    d. None of the above
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Teresita Lacara, Caroline Domagtoy, Donna Licklter, Kathy Quattrocchi, Lydia Snipes, Joanne Kuszaj and MaryClare Prasnikar

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