A veterinary-calibrated point-of-care glucometer accurately measures blood glucose concentration in dogs and cats

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OBJECTIVE
To determine the clinical and analytical accuracy of a new veterinary-calibrated portable blood glucose monitor (PBGM) compared to a reference laboratory analyzer.

ANIMALS
Client-owned dogs (n = 77) and cats (n = 64).

METHODS
Peripheral and paired capillary whole-blood glucose concentrations measured via PBGM were compared to plasma glucose concentrations measured via a Cobas c501 reference analyzer (Roche). Analytical accuracy was evaluated with the Spearman rank correlation coefficient, Bland-Altman difference plot analysis, and Deming regression. Clinical accuracy was evaluated with Parkes error grid analysis. Paired peripheral and capillary blood samples were compared with the Wilcoxon matched-pairs signed-rank test.

RESULTS
There was a high correlation between PBGM and reference analyzer readings in dogs and cats. Human quality assurance standards (International Organization for Standardization 15197:2013 guidelines) for analytical accuracy were met for 95% of feline peripheral blood samples and 89% of canine samples. Similar veterinary standards (American Society of Veterinary Clinical Pathology guidelines) were met for 89% of canine and 92% of feline peripheral blood glucose measurements. Error grid analysis showed that all peripheral canine and 97% of feline measurements were clinically accurate (zone A). Any altered clinical decision for the remaining feline measurements was expected to minimally impact outcome (zone B). No significant difference was found between peripheral and capillary blood glucose measurements in either species.

CLINICAL RELEVANCE
The PBGM produced clinically accurate results and is suitable for use in veterinary and home settings to measure blood glucose.

Keywords: portable blood glucose monitor, glucometer, dogs, cats, clinical accuracy

Portable blood glucose monitors (PBGM) are widely used in veterinary medicine in the hospital setting for point-of-care blood glucose measurement to screen for hypoglycemia or hyperglycemia associated with disease1,2 and to assess glycemic control in diabetic patients.3 PBGMs are also used to measure capillary blood glucose in the home setting to assess the management of diabetic dogs and cats.3

Various PBGMs designed for both veterinary4–6 and human7–9 use are commercially available and have been evaluated for use in dogs and cats. The International Organization for Standardization (ISO) has published criteria to evaluate the analytical and clinical accuracy of PBGMs in people,10 and various veterinary studies6,9,11 have used these guidelines to assess the use of PBGMs in dogs and cats. The American Society for Veterinary Clinical Pathology...
Portable blood glucose monitor

A single PETRACKR PBGM (Universal Biosensors) was used to measure blood glucose in whole blood. The PETRACKR PBGM uses electrochemical technology that combines an enzymatic recognition element and an amperometric analytical method to report a plasma equivalent glucose concentration. Species differences in PCV and glucose distribution between red blood cell cytosol and plasma are factors that could impact the accuracy of a PBGM’s calculation of plasma-equivalent glucose.\textsuperscript{13} The PETRACKR’s amperometric method is tolerant to the difference in blood between cats and dogs, so the user is not required to enter this information. Immediately following sample collection, a test strip was inserted into the PBGM, and approximately 0.7 μL whole blood was placed on the test strip. Duplicate samples were tested on a single PBGM, with the first sample to evaluate accuracy as compared to a reference laboratory and a second sample to evaluate precision of the PBGM. If a reading was too low or too high to give a numerical value, the sample was omitted from analysis.

Reference analyzer

Following the measurement of glucose in whole blood with the PBGM, a portion of the remaining blood was placed into lithium heparin tubes and centrifuged within 5 minutes at 674 X g, and plasma was separated into plastic tubes. The plasma was analyzed by the reference laboratory using the Cobas c501 Biochemistry Analyzer (Roche). The Cobas c501 analyzer was calibrated weekly with daily quality control testing against 2 commercially manufactured standards.

Anaerobic glycolysis

Peripheral whole-blood samples from 10 dogs and 5 cats were incubated at room temperature for 4 to 36 hours to allow for anaerobic glycolysis to increase the number of hypoglycemic to low/normal samples. Following incubation, blood glucose was measured with the PBGM and reference analyzer as described above.

Statistical analyses

Statistical analysis was performed with Prism (version 9.5; GraphPad Software). The correlation between blood glucose measurements between the PBGM and reference analyzer was determined by calculating the Spearman correlation coefficient (\(r\)) and was interpreted as: 0 to 0.29, little to no correlation; 0.30 to 0.49, low correlation; 0.50 to 0.69, moderate correlation; 0.7 to 0.89, high correlation; and 0.90 to 1.00, very high correlation.\textsuperscript{6,15} Deming
regression analysis was performed to determine whether there were constant and proportional differences between the reference method and the glucometer. The 95% CIs for the slope and constant parameters, coefficient, and corresponding P value were calculated. Bland-Altman difference plots were constructed in which the differences between the results of the glucometer and reference method were plotted against the average value obtained for the 2 tests. Error grid analysis was conducted with Excel for Mac (version 16.77.1; Microsoft Corp). Precision was assessed by calculating the mean, standard deviation, and coefficient of variation. Data for paired peripheral and capillary blood were assessed for normality with the Shapiro-Wilk test. P values were < .05, indicating the data were not normally distributed. Therefore, the paired peripheral and capillary blood samples were compared with the Wilcoxon matched-pairs signed-rank test. The influence of PCV on the difference between in-blood glucose measurements by the PBGM minus the reference analyzer was assessed by calculating the Spearman rank correlation coefficient. The difference in blood glucose measurement by the PBGM and reference analyzer was compared between anemic (PCV < 41% in dogs, < 31% in cats) and dogs and cats with normal PCVs (41% to 59% in dogs, 31% to 48% cats) with the Mann-Whitney U test. A P value of < .05 established significance.

**Results**

**Blood samples**

Peripheral blood samples were obtained from 77 dogs and 64 cats. In approximately 20% (16% to 19%) of these patients (12 dogs, 12 cats), a lancet was used to contemporaneously obtain a capillary sample from the ear. Breeds of dogs included Labrador Retriever (7), Golden Retriever (4), Beagle (3), Standard Poodle (3), German Shepard (3), Pit Bull/American Staffordshire Terrier (3), Shetland Sheepdog (2), Irish Setter (2), Miniature Schnauzer (2), Rottweiler (2), Newfoundland (2), English Setter (1), Pug (1), Cavalier King Charles Spaniel (1), Jack Russell Terrier (1), Dachshund (1), Old English Sheepdog (1), Saint Bernard (1), Chow Chow (1), Bernese Mountain Dog (1), German Pincher (1), Cocker Spaniel (1), Whippet (1), Silky Terrier (1), Pomeranian (1), French Bulldog (1), Siberian Husky (1), Treeing Walker Coonhound (1), Doberman Pincher (1), Yorkshire Terrier (1), Shih Tzu (1), Rat Terrier (1), and mixed-breed dogs (23) of different sex (29 spayed females, 5 intact females, 39 castrated males, and 4 intact males), weight (median, 25 kg; range 0.93 to 77), and age (median, 7 years; range, 0.4 to 18). Data from 1 dog (peripheral and capillary) were omitted as the blood glucose was too high to read on the glucometer (> 600 mg/dL; reference analyzer measured 687 mg/dL). Breeds of cats included Domestic Shorthair (47), Domestic Medium Hair (6), Domestic Longhair (3), Exotic Shorthair (2), Maine Coon (2), Siamese (2), Birman (1), and Persian (1) of different sex (23 spayed females, 2 intact females, 28 castrated males, and 1 intact male), weight (median, 4.76 kg; range, 1.98 to 8.4), and age (median, 12 years; range, 1 to 18). Data from 1 cat were omitted because the blood to be submitted to the reference laboratory sat longer than 5 minutes before the plasma was separated. Ultimately, samples from the 76 dogs and 63 cats included had blood glucose measured by the reference analyzer ranging from 34 to 466 mg/dL (median, 103 mg/dL) and 27 to 286 mg/dL (median, 102 mg/dL), respectively (Table 1; Supplementary Tables S1 and S2).

**Analytical accuracy**

The Spearman correlation coefficients were calculated to determine the correlation between blood glucose concentrations measured by the PBGM and reference analyzer. Overall, there was a very high correlation between the PBGM in both dogs (P = 0.9467; 95% CI, 0.9158 to 0.9664; P < .0001) and cats (P = 0.9595; 95% CI, 0.9328 to 0.9758; P < .0001). The first ISO criterion of the updated guidelines (ISO 15197:2013) to assess the accuracy of PBGMs specifies that 95% of the blood glucose concentrations by the PBGM should be within 15% (blood glucose ≤ 100 mg/dL) or 15 mg/dL (blood glucose ≥ 100 mg/dL) of that determined by the gold standard reference analyzer in people. We found that 89% of canine and 95% of feline peripheral blood samples measured by the PBGM were within 15% (blood glucose ≥ 100 mg/dL) or 15 mg/dL (blood glucose < 100 mg/dL) of that determined by the gold standard reference analyzer. Historically, very few PBGMs developed for use in people or veterinary patients meet these analytical accuracy requirements when evaluated for use in veterinary patients.

**Table 1**—Distribution of blood glucose concentrations in dogs and cats.

<table>
<thead>
<tr>
<th>Blood glucose (mg/dL)</th>
<th>Canine peripheral [capillary] (n)</th>
<th>Canine peripheral (% of total)</th>
<th>Feline peripheral [capillary] (n)</th>
<th>Feline peripheral (% of total)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 50</td>
<td>4</td>
<td>5</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>≥ 50 to &lt; 80</td>
<td>9</td>
<td>12</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>≥ 80 to &lt; 120</td>
<td>42 (6)</td>
<td>55</td>
<td>25 (6)</td>
<td>40</td>
</tr>
<tr>
<td>≥ 120 to &lt; 200</td>
<td>8 (1)</td>
<td>11</td>
<td>25 (4)</td>
<td>40</td>
</tr>
<tr>
<td>≥ 200 to &lt; 300</td>
<td>3 (2)</td>
<td>4</td>
<td>5 (2)</td>
<td>8</td>
</tr>
<tr>
<td>≥ 300 to &lt; 400</td>
<td>7 (1)</td>
<td>9</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>≥ 400</td>
<td>3 (1)</td>
<td>4</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Peripheral samples from 10 dogs and 5 cats incubated at room temperature, resulting in blood glucose concentrations ranging from 38 to 75 mg/dL in dogs and 27 to 81 mg/dL in cats.
ASVCP guidelines for quality assurance for PBGM use in veterinary medicine specify that the allowable total error (TEa) between PBGM and the reference analyzer should be within 10% for hypoglycemic samples and within 20% for euglycemic and hyperglycemic samples. In dogs, we found TEa ≤ 10% in 3 of 9 (33%) hypoglycemic samples and 65 of 67 (97%) euglycemic and hyperglycemic samples. In cats, we found TEa ≤ 10% in 3 of 5 (60%) hypoglycemic samples and 61 of 63 (97%) euglycemic and hyperglycemic samples. Overall, we found that 89% of canine and 92% of feline peripheral blood glucose measurements met the TEa requirements as per ASVCP. To increase the number of samples in the hypoglycemic range, we incubated whole-blood samples at room temperature to allow glucose to be depleted by anaerobic glycolysis. Such incubation allows for increased proteolysis, which can impact the ability of a PBGM to effectively measure glucose concentration and may, in part, explain why the TEa’s were higher in the hypoglycemic samples. Although ISO15197 guidelines allow for such artificial depletion of glucose, they recommend directly comparing fresh sample types or proving commutability if different sample types are used.

Deming regression analysis was used to assess the correlation between blood glucose measured by the reference analyzer and PBGM and to reveal whether there were constant and proportional differences between the reference method and the glucometer. With the Deming regression analysis, if the 95% CI for the y-intercept include 0, no constant difference between the 2 analytical methods exists. No proportional difference exists if the 95% CI for the slope includes 1. For canine peripheral blood samples, the slope was 1.175 (95% CI, 1.144 to 1.205), suggesting that a proportional difference exists, and the y-intercept was −16.72 (95% CI, −20.51 to −12.94), suggesting that a constant difference exists (Figure 1). For feline peripheral blood samples, the slope was 1.063 (95% CI, 0.9444 to 1.182), indicating no proportional difference, and the y-intercept was −11.83 (95% CI, −26.08 to 2.143), indicating no constant difference (Figure 1). For both feline and canine peripheral blood samples, the F test had a P value of < .0001, indicating that the measurements of the PBGM were a good predictor of the reference analyzer measurements.

Limits of agreement (Bland-Altman) plots showed that canine blood glucose measured by the PBGM had a mean bias of 7.9 mg/dL greater than that measured by the reference analyzer. The 95% limits of agreement were −48 and 32 mg/dL, with visual inspection of the plot showing that as the blood glucose increased, the difference increased (Figure 2). Feline blood glucose measured by the PBGM had a fixed bias of 3.32 mg/dL less than that measured by the reference analyzer. The 95% limits of agreement were −20.32 and 26.95 mg/dL, with no obvious trend in magnitude with increasing blood glucose (Figure 2). As the 95% CI for the limits of agreement include 0, there is no statistically significant difference between the PBGM and the reference analyzer.

Figure 1—Deming regression analysis of the peripheral blood glucose measurements by the portable blood glucose monitor (PBGM) and reference analyzer in dogs and cats. Blood glucose measurements from the PETRACKR PBGM are noted on the y-axis, and measurements by the Cobas c501 reference analyzer (Roche) are indicated on the x-axis in dogs (A) and cats (B). The black line represents Deming regression fit, and the red dotted lines indicate allowable difference (blood glucose ± 15 mg/dL < 100 mg/dL and ± 15% ≥ 100 mg/dL).

Clinical accuracy

Error grid analysis was performed to assess clinical accuracy. All canine peripheral blood samples (Figure 3) and 97% of feline blood samples (Figure 3) fell within zone A, indicating that they are clinically accurate measurements with no effect on clinical action. The remaining 3% of peripheral feline blood samples were located in zone B, indicating altered clinical action expected to have little or no effect on clinical outcome.
Precision
Peripheral blood was measured in duplicate to assess the precision of the PBGM. In dogs, the intra-assay coefficient of variation across the entire glycemic range was 3.1% (SD, 2.7 mg/dL) and, similarly, was 2.8% in cats (SD, 2.8 mg/dL). When the hypoglycemic, euglycemic, and hyperglycemic ranges are evaluated independently, the intra-assay coefficient of variation was 3.5% (SD, 5.3 mg/dL), 3.0% (SD, 1.6 mg/dL), and 3.0% (SD, 2.8 mg/dL), respectively, in dogs and 4.5% (SD, 4.7 mg/dL), 2.5% (SD, 2.6 mg/dL), and 2.8% (SD, 2.5 mg/dL) in cats.

Peripheral versus capillary blood glucose
Paired peripheral and capillary blood samples were compared with the Wilcoxon matched-pairs signed-rank test. No significant difference was found between peripheral and capillary blood glucose measurements in either dogs ($P = .3633$) or cats ($P = .4775$). Peripheral and capillary blood samples differed by a median of 6.6% (range, 2.5% to 25.2%) in dogs and 5.3% (range, 1.5% to 19.2%) in cats. Capillary blood glucose measured by the PBGM was within ± 15 mg/dL (when blood glucose concentration is < 100 mg/dL) or 15% (when blood glucose concentration is ≥ 100 mg/dL) of the reference analyzer in 8 of 11 dogs and 11 of 12 cats. Venous blood glucose concentrations from the same patients met analytical accuracy requirements in 11 of 11 dogs and 12 of 12 cats. The capillary blood measurements from the 3 dogs that did not meet analytical

Figure 2—Bland-Altman plots of the difference between peripheral blood glucose concentrations using the reference analyzer and portable blood glucose monitor (PBGM) in dogs and cats. The difference between blood glucose measurements by the Cobas c501 reference analyzer and PETRACKR PBGM (y-axis) is plotted against the mean for both methods (x-axis) in dogs (A) and cats (B). The mean difference was marked with a black dashed line, with 95% confidence intervals as black dotted lines above and below. The solid red lines indicate allowable difference (blood glucose ± 15 mg/dL < 100 mg/dL and ± 15% ≥ 100 mg/dL).

Figure 3—Parkes error grid analysis for canine and feline peripheral blood glucose concentrations comparing measurements by the portable blood glucose monitor (PBGM) and reference analyzer. Blood glucose concentration measurements by the Cobas c501 reference analyzer are noted on the x-axis and PETRACKR PBGM on the y-axis in dogs (A) and cats (B). Zones A through E represent different clinical consequences of blood glucose measurement as follows: A, clinically accurate measurements with no effect on clinical action; B, altered clinical action but little or no effect on clinical outcome; C, altered clinical action likely to affect clinical outcome; D, altered clinical action that could have significant clinical risk; and E, altered clinical action that could have dangerous consequences. Figure created in part with BioRender.com.
accuracy standards included 2 fasted euglycemic dogs and 1 unfasted profoundly hyperglycemic dog (blood glucose 98 mg/dL, 95 mg/dL, and 398 mg/dL, respectively, as measured by the reference analyzer). The measurement from the 1 cat that did not meet analytical accuracy standards was an unfasted diabetic that was hyperglycemic (blood glucose 98 mg/dL, 95 mg/dL, and 398 mg/dL, respectively, as measured by the reference analyzer). Error grid analysis showed that capillary samples measured by the PBGM in 10 of 11 dogs and 12 of 12 cats were in zone A (Supplementary Figure S1A). The outstanding canine capillary sample was in zone B (Supplementary Figure S1B).

Effect of PCV on the association between blood glucose measured by the PBGM and reference analyzer

PCVs ranged from 27% to 59% (median, 46%) in dogs and 21% to 55% in cats (median, 37%). The interference of PCV on the agreement between peripheral blood glucose measurement by the PBGM and reference analyzer was measured by the Spearman rank correlation coefficient (Figure 4). Low correlation was observed between PCV and PBGM values minus reference analyzer blood glucose measurements in both dogs ($\rho = 0.4065$; 95% CI, 0.1993 to 0.5789; $P = .0003$) and cats ($\rho = -0.3402$; 95% CI, -0.5475 to -0.09354; $P = .006$). The difference in blood glucose measurement by the PBGM and reference analyzer was compared between anemic (13 dogs: median PCV, 35%; range, 27% to 40%; 10 cats: median PCV, 29%; range, 21% to 40%) and dogs and cats with normal PCVs (62 dogs: median, 48%; range, 41% to 57%; 52 cats: median, 36%; range, 31% to 48%). One cat and 1 dog were excluded as they each had mild erythrocytosis. There was a greater difference in blood glucose measurement by the PBGM and reference analyzer in mildly anemic dogs (median, 17 mg/dL) compared to dogs with normal PCVs (median, 6.0 mg/dL; $P = .0196$). There was no difference in blood glucose measurement by the PBGM and reference analyzer in anemic cats compared to those with PCVs within the normal reference range ($P = .6467$).

Discussion

The accuracy of the PETRAKR PBGM was measured with peripheral blood samples from 76 dogs and 63 cats, spanning the hypoglycemic to hyperglycemic range. We found that the PBGM produces clinically accurate results in dogs and cats and meets ISO 15197:2013 guidelines for analytical accuracy in cats. Analytical accuracy was evaluated using both the ISO 15197:2013 guidelines used to evaluate PBGMs for people and ASVCP guidelines for quality assurance for PBGM use in veterinary medicine. Although the ISO 15197:2013 guidelines were developed specifically for use to validate PBGMs in people, these guidelines have been used in whole or in part to assess the accuracy of PBGMs in veterinary patients. These guidelines specify that 95% of peripheral blood samples measured by the PBGM should be within 15% (blood glucose $\geq 100$ mg/dL) or 15 mg/dL (blood glucose < 100 mg/dL), measured by the gold standard reference analyzer. This was achieved in cats (95% of samples met the requirements) but not dogs (89%). Recently, another veterinary-calibrated PBGM, the AlphaTrak 3 (Zoetis Services LLC), was also shown to meet ISO 15197:2013 guidelines for analytical accuracy. In dogs, 33 of 33 (100%) hypoglycemic and euglycemic samples < 100 mg/dL were within 15 mg/dL of the reference analyzer; 7 of 8 (88%) euglycemic samples > 100 mg/dL, 20 of 23 (87%) mildly hyperglycemic (< 250 mg/dL), and 10 of 12 (83%) profoundly hyperglycemic (> 250 mg/dL) were within 15% of the reference analyzer. Therefore, samples > 100 mg/dL that exceeded a 15% difference with the reference analyzer were spread across the euglycemic and hyperglycemic range.

ASVCP guidelines for quality assurance for PBGM use in veterinary medicine are more stringent in the hypoglycemic range but more relaxed in the euglycemic and hyperglycemic ranges. The TEa between the PBGM and reference analyzer was within the recommended 10% for hypoglycemic samples in 3 of 9 (33%) dogs and 3 of 5 (60%) cats and within the recommended 20% for euglycemic and hyperglycemic samples in 65 of 67 (97%) dogs and 55 of 58 (95%) cats. In comparison, a similar study evaluating a different PBGM found that 83% of 128 canine samples...
and 68% of 37 feline samples were within ASVCP’s TEa guidelines. In dogs, the PBGM consistently overestimated blood glucose measurements compared to the reference analyzer. The Bland-Altman plot with limits of agreement analysis revealed a mean bias of 7.9 mg/dL that increased with degree of hyperglycemia. The 95% agreement lines showed that a given blood glucose value measured by the PBGM could differ by −48 to +32 mg/dL from the reference analyzer, with smaller differences observed in hypoglycemic samples and the largest differences observed in severely hyperglycemic samples. In contrast, in cats the PBGM underestimated blood glucose measurements compared to the reference analyzer. The Bland-Altman plot with limits of agreement analysis revealed a fixed bias of 3.3 mg/dL with 95% limits of agreement lines, indicating that a given blood glucose value could differ by −20.32 and 26.95 mg/dL between the PBGM and reference analyzer. Regression analysis demonstrated similar results and revealed a proportional and constant difference between the PBGM and reference analyzer in dogs but not cats.

The clinical accuracy of the PBGM was evaluated with error grid analysis. The Parkes error grid defines 5 risk zones: A, clinically accurate measurements with no effect on clinical action; B, altered clinical action but little or no effect on clinical outcome; C, altered clinical action likely to affect clinical outcome; D, altered clinical action that could have significant clinical risk; and E, altered clinical action that could have dangerous consequences. Error grid analysis helps characterize data points that exceed requirements for analytical accuracy: a ± 15-mg/dL (when blood glucose concentration is < 100 mg/dL) or 15% (when blood glucose concentration is ≥ 100 mg/dL) difference between the PBGM and reference analyzer. It is generally acceptable that a clinically accurate PBGM should show at least 95% of data points in zone A of the Parkes grid. If a PBGM meets the first ISO15197:2013 criterion for accuracy, it will also meet this second criterion based on error grid analysis. However, it would be necessary for clinicians to know whether even a small percentage of measurements fell in zones where altered clinical actions were likely to affect clinical outcomes and how severe the expected consequences may be. Error grid analysis can also show that even when a PBGM does not meet the analytical accuracy standards, it still provides clinically accurate measurements. In this study, the PBGM met the ISO15197:2013 standards for analytical accuracy in cat peripheral blood samples with 61 of 63 (97%) measurements within zone A. The remaining 2 of 63 (3%) samples fell within zone B. The 2 samples in zone B were euglycemic, and no preanalytical cause for the discrepancy between the PBGM and reference analyzer could be identified. Though the PBGM did not meet analytical accuracy in peripheral blood samples from dogs, all blood glucose measurements fell with zone A, indicating that it provides clinically accurate measurements in dogs. Historically, few PBGMs developed for use in people or veterinary patients meet the analytical accuracy requirements, supporting their use in veterinary patients.

In the clinical setting, PBGMs are used to measure venous blood glucose. However, many people with diabetic dogs and cats will use PBGMs to measure capillary blood glucose concentrations. In a fasting state, capillary blood glucose is typically 2 to 5 mg/dL higher than venous blood due to the depletion of glucose from capillaries from tissue utilization. This difference may be increased by 20% or greater in the postprandial state. A previous study of PBGM accuracy using capillary versus venous whole blood demonstrated that either capillary or whole-blood glucose concentrations may align more closely with serum levels measured by a reference analyzer depending on the PBGM model. Pet owners managing diabetic animals may opt to use PBGMs with capillary blood samples in domestic settings, conducting blood glucose curves while their pets maintain their normal eating habits to effectively monitor glycemic control. Therefore, we measured capillary and venous blood glucose concentrations on the PBGM in approximately 20% of dogs and cats to evaluate the accuracy of the PBGM using capillary whole blood in comparison to venous whole blood on the PBGM and plasma on the reference analyzer. Our findings indicate that capillary blood glucose levels did not significantly differ from peripheral blood glucose levels measured by the PBGM, consistent with previous research. However, capillary blood exhibited lower analytical accuracy compared to venous blood as measured by the reference analyzer in the same patients. Instances where capillary blood failed to meet analytical accuracy criteria included samples from both fasted and nonfasted patients. Nevertheless, it’s crucial to note that capillary blood glucose measurements still yielded clinically accurate results and remain suitable for use in home settings.

The impact of PCV on the analytical accuracy of a PBGM varies by device. Many PBGMs, whether designed primarily for use in veterinary patients or people, measure higher glucose concentrations in whole blood compared to the glucose measured in the plasma by the reference analyzer. PBGMs typically overestimate the blood glucose in anemic blood. This is because PBGM’s correction of PCV in anemic samples is less accurate and anemic blood has lower viscosity, which is interpreted as a higher glucose concentration with devices that use electrochemical measurements. Anemic blood also contains a higher concentration of water in plasma than red blood cells, which may contribute more glucose. In the current study, we found a low correlation between PCV and the difference in blood glucose measurement between the PBGM and reference analyzer in both dogs and cats. In dogs, the PBGM overestimated the blood glucose concentration in anemic samples compared to those with normal PCVs. Unexpectedly, in cats there was a negative correlation between hematocrit and the difference in blood glucose concentration measured by the reference analyzer and PBGM. However, no statistically significant difference between anemic cats and
those with normal PCVs was found. Potential explanations for the different impact of PCV on the difference in blood glucose concentration measured by the PBGM and reference analyzer between dogs and cats include a small number of relatively mild anemic patients included in the study for each species and differences in the normal reference range for PCV in both dogs and cats. Additionally, the effect of PCV also depends on the glucose concentration, and different degrees of error can occur in the hypoglycemic, euglycemic, and hyperglycemic ranges. Although additional studies may be required to describe the effect of PCV more thoroughly on the accuracy of this PBGM, clinicians should keep in mind that the PBGM may overestimate blood glucose concentrations in anemic dogs.

Limitations to the current study include the potential for unknown preanalytical errors, leading to an inaccurate characterization of discrepancies between the PBGM and reference analyzer. Additionally, although this study compared the agreement between the PBGM and reference analyzer to the ISO15197:2013 standards, we did not have the recommended distribution of blood glucose measurements (5% < 50 mg/dL, 15% ≥ 50 to < 80 mg/dL, 20% ≥ 80 to < 120 mg/dL, 30% ≥ 120 to < 200 mg/dL, 15% 200 to < 300 mg/dL, 10% ≥ 300 to < 400 mg/dL, 5% ≥ 400 mg/dL). However, samples from both dogs and cats covered the hypoglycemic, euglycemic, and hyperglycemic ranges. The Parkes error grid analysis used to assess the potential clinical consequences of differences read by the PBGM and reference analyzer is designed for use in people; however, the same analysis has been applied to dogs and cats.6,9,11,22

The PETRACKR PBGM produces clinically accurate results in dogs and cats and is suitable for use in veterinary and home settings to measure blood glucose.

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References


**Supplementary Materials**

Supplementary materials are posted online at the journal website: avmajournals.avma.org.