

**Comparative evaluation of the glucose level in dogs and cats obtained by portable
glucometer and colorimetric automated method**

**Avaliação comparativa do nível de glicose em cães e gatos obtida pelo glicosímetro
portátil e pelo método laboratorial**

**Evaluación comparativa del nivel de glucosa en perros y gatos obtenida mediante un
glucómetro portátil y un método de laboratorio**

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Abstract

Glucose is an essential carbohydrate for the good functioning of the organism and in normal conditions it is able to maintain the glucose in adequate levels. The glucose can be measured by the portable glucometer or by the laboratory method, which is considered the standard methodology, but with disadvantages such as cost and the necessary amount of blood. The portable glucometer shows itself to be an applicable option because it is less expensive and faster. This prospective clinical study aimed to compare and evaluate the efficiency between the OneTouch UltraMini® portable monitor and the automated colorimetric method for measuring the blood glucose concentration of 48 dogs and 20 cats. The results obtained from the mean of the portable monitor and laboratory method were 87.54 mg/dL and 94.47 mg/dL for dogs, and 85.95 mg/dL and 100 mg/dL for cats, respectively. It could be concluded that the comparison between the methods showed that the portable meter represents an excellent option for measuring blood glucose in dogs and cats.

Keywords: Glycemia; OneTouch UltraMini®; Automatic biochemical analyzer.

Resumo

A glicose é um carboidrato essencial para o bom funcionamento do organismo e em condições normais o mesmo consegue manter a glicemia em níveis adequados. A glicemia pode ser mensurada através do glicosímetro portátil ou pelo método laboratorial, sendo este considerado a metodologia standard, porém com desvantagens como o custo e a quantidade necessária de sangue. O glicosímetro portátil mostra-se uma opção aplicável por ter menor

custo e maior rapidez. No presente estudo clínico prospectivo teve-se como objetivo comparar e avaliar a eficiência entre o monitor portátil OneTouch UltraMini® e o método automatizado colorimétrico para dosar a concentração de glicose no sangue de 48 cães e 20 gatos. Os resultados obtidos da média do monitor portátil e método laboratorial foram 87,54 mg/dL e 94,47 mg/dL para cães e 85,95 mg/dL e 100 mg/dL para gatos, respectivamente. Pôde-se concluir que a comparação entre os métodos demonstrou que o medidor portátil representa uma excelente opção para aferição da glicemia de cães e gatos.

Palavras-chave: Glicemia; OneTouch UltraMini®; Analisador bioquímico automático.

Resumen

La glucosa es un carbohidrato esencial para el buen funcionamiento del cuerpo y, en condiciones normales, es capaz de mantener la glucosa en la sangre a niveles adecuados. La glucosa en la sangre puede medirse con un glucómetro portátil o con el método de laboratorio, que se considera la metodología estándar, pero con desventajas como el costo y la cantidad de sangre necesaria. El glucosímetro portátil es una opción aplicable porque es menos costoso y más rápido. Este estudio clínico prospectivo tenía como objetivo comparar y evaluar la eficiencia entre el monitor portátil OneTouch UltraMini® y el método colorimétrico automatizado para medir la concentración de glucosa en la sangre de 48 perros y 20 gatos. Los resultados obtenidos de la media del monitor portátil y del método de laboratorio fueron 87,54 mg/dL y 94,47 mg/dL para los perros y 85,95 mg/dL y 100 mg/dL para los gatos, respectivamente. Se llegó a la conclusión de que la comparación entre los métodos mostraba que el medidor portátil representa una excelente opción para medir la glucosa en sangre en perros y gatos.

Palabras clave: Glucosa en la sangre; OneTouch UltraMini®; Analizador bioquímico automático.

1. Introduction

The homeostasis of blood glucose levels is fundamental for the proper maintenance of the functioning of the organism (Kaneko et al., 2008). Glucose is the main carbohydrate used by the central nervous system and essential for the proper functioning of other vital organs such as the kidneys, liver, and heart. Under normal conditions, the organism can keep blood glucose at levels appropriate for proper functioning. However, altered glycemic levels can characterize hyper or hypoglycemia states and can cause severe consequences to the health of

the animals. Blood glucose values below 45mg/dL can lead to neuroglycopenia and stimulation of the sympathoadrenal nervous system, with the consequent manifestation of convulsion, which can, depending on its intensity, frequency and duration, lead to permanent neurological damage or even lead to the animal death (Aleixo et al., 2007; Nelson, 2015). Within each species and their respective reference ranges for blood glucose are observed different values, being 53-117 mg/dL for canine species and 57-131 mg/dL for feline species, according to Willard & Tvedten (2012). This variability is common, being related to nutritional status and carbohydrate stocks inside the animal (Beitz, 2014).

The glycemia can be measured using a portable glucometer or a colorimetric automated method, the latter being more reliable but more costly, time-consuming, and restricted to Veterinary Clinical Pathology Laboratories (Buzzi, 2013; Santos, 2017). Another disadvantage observed in the colorimetric method is the need for larger volumes of blood to perform the test, in addition to accuracy and agility, since the glucose present in the sample can be consumed by red blood cells at a rate of 10% per hour at room temperature, which can be higher if the sample is contaminated with microorganisms or in warm environments (Aleixo et al., 2007; Santos, 2017).

The Food and Drug Administration (FDA) is a federal agency of the United States Department of Health and Human Services and regulates several products, including those for veterinary use, emphasizing the regulation of glycosimeters. The use of human glycosimeters has become frequent in veterinary hospitals and mainly in the glyceimic control of the diabetic patient (Cohn et al., 2000; Wess and Reusch, 2000a; Wess and Reusch, 2000b; Dobromylskyj et al., 2010). Portable digital glucometers represent an applicable option for the measurement of blood glucose in patients whose serum is lipemic, hemolyzed, or icteric, as these changes may result in falsely high values when analyzed by the colorimetric method (Aleixo et al., 2010). Therefore, the portable glucometer has been widely used because it is a secure method, relatively low-cost, and quickly provides the results, which is advantageous specially in emergency situations (Tauk et al., 2015). They are also convenient when multiple glucose measurements are needed within short time intervals (to construct glucose curves) (Gerber; Freeman, 2016). There are many benefits compared to standard automated analyzers used in veterinary clinical laboratories, including the fact that they are small, easy to handle, and require a small amount of blood to perform the test, which is helpful when monitoring patients that are very little or markedly anemic (Aleixo et al., 2010, Tauk et al., 2015). According to Buzzi (2013), the value of glycemia can be influenced by failures caused by inappropriate application of the sample, excessive time in performing the test, lack of

maintenance of the equipment, and inadequate storage of test strips.

The first generation of portable glucometers used photometric measurement, total blood was deposited on an enzymatic tape, and according to Surman & Fleeman (2013), the enzymatic oxidation of glucose generates an electrical current and forms through an indicator a color solution that will be measured by a photodetector, resulting in a color change on the test strip, the intensity of the color is proportional to the amount of glucose in the blood. The equipment currently used quantifies glucose using electrochemical reactions that generate an electrical impulse, which is interpreted by the equipment, providing the concentration of glucose present in the sample (Aleixo et al., 2010).

Most portable biosensors are designed for capillary blood samples. In dogs and cats, many sites can be used for collection, including ear edges (dogs and cats), cushions (dogs and cats), elbow calluses (dogs), and outer lips (dogs). The selection of an appropriate glucometer is essential because some devices designed for humans are variably discrepant when used on canines and cats (Meyrer, 2014).

Accuracy and precision are fundamental. Accuracy is defined as the ability of a test to generate the same result when the sample is analyzed repeatedly. On the other hand, accuracy is characterized by the closeness of the measured values to their "real" (Scott; Stockman, 2011). In veterinary medicine, although many studies show accuracy and reliability in the results achieved by human meters, these differ according to the model and brand. For this reason, this paper aims to compare and evaluate the efficiency between the OneTouch UltraMini® portable monitor and the colorimetric automated method to dose glucose concentration in the blood of dogs and cats.

2. Methodology

Forty-eight samples of dogs and twenty samples of cats were used to demonstrate the analytical feasibility of the proposed approach. Whole blood from males and females of various ages, weights, and breeds, randomly chosen were collected in the routine of care of Veterinary Hospital School (HVE) of the State University of Northern Paraná (UENP). The animals came from the Protective Association of Animals (APA) of Bandeirantes. The sampled animals glycemia was analyzed using the colorimetric automated method (CAM) by the PKL PPC - 125 VET®, a biochemical analyzer (glucose oxidase-GOD – gold standard) and the portable One Touch Ultra Mini (OTUM) glucometer from Johnson & Johnson®.

To perform the blood glucose analysis by CAM, about 3 mL of total blood was

collected via puncture of the jugular or cephalic vein. The site of choice for venipuncture varied according to the characteristics and preferences of each animal, avoiding as much as possible the stress of the animals during collection. The samples were sent to the Laboratory of Clinical Pathology of the Veterinary Hospital School of the State University of Northern Paraná in sodium fluoride tube, where the samples were centrifuged at 2.500 revolutions per minute (rpm) for 15 minutes to obtain the plasma. The plasma was deposited in appropriate containers and analyzed by the automatic biochemical analyzer.

Immediately after venipuncture for blood collection for laboratory analysis, antisepsis was performed with alcohol at 70° GL of the internal surface of the ear of the animal in question, and subsequent puncture of the auricle capillary with a disposable hypodermic needle to obtain the blood sample needed to measure glycemia using the One Touch Ultra Mini® portable meter, strictly following the manufacturer's recommendations for testing.

The data obtained were separated according to animal species (dogs and cats) and statistically analyzed using the T-test (Student) for two paired samples, considering a 5% probability level.

3. Results and Discussion

Portable glycosimeters are rapidly replacing benchtop chemical analyzers for instant analysis to determine blood glucose concentrations in patients. New and different devices are constantly being launched on the market, making it a challenge to choose an appropriate meter, and very few of these devices are validated specifically for use on animals (Johnson et al., 2009).

The glucose concentration of the 48 dogs and 20 cats in the portable device varied between 52 and 106 mg/dL, and 54 and 83 mg/dL, while that in the laboratory method this variation was from 61 and 112 mg/dL, and 61 and 114 mg/dL, respectively.

The mean value of glycemia of the group of dogs (GD) obtained by the portable glucometer method was 87.54 mg/dL and by the colorimetric method was 94.47 mg/dL, while in the group of cats (GC) 85.95 mg/dL was obtained by the portable glucometer method and 100 mg/dL by the colorimetric method (Tab 1). This difference can occur because of the density of red blood cells present in whole blood since the concentration of glucose in whole blood is approximately 10 to 15% lower than in plasma, which is used for biochemical laboratory analysis (Oliveira et al., 2015). The mean glycemic obtained by Aleixo et al. (2010), measured by portable glucometer in dogs, was lower (76.06 mg/dL) than the mean

obtained in a laboratory method (82.53 mg/dL) with central venous plasma, corroborating the results achieved in this study with dogs and cats.

Table 1. Comparison between the glycemic averages obtained by the laboratory method using a plasma sample and by the portable glucometer using a whole blood sample, considering the T- test level at 5% ($p < 0,05$).

Species	Portable Glucometer (whole blood)	Laboratory Method (plasma)	p
Dogs	87,54 mg/dL	94,47 mg/dL	0,07
Cats	85,95 mg/dL	100 mg/dL	0,27

(Miasaki, 2018). Source: Authors.

The averages obtained by the glucose measurement methods in the different methods (glucometer and laboratory) did not differ statistically ($P < 0.05$), the average variation for GD was 9.1%, and for GC was 9.2%, according to the OneTouch UltraMini® meter user's manual and the Food and Drug Administration (FDA) where the meter is considered accurate when the error rate does not exceed 20% for glucose values between 30 and 400 mg/dL (Aleixo et al., 2010).

It was observed in this investigation that the results can be varied, where not always the laboratory value for altered plasmas will be higher than the value obtained by the portable glucometer, and sometimes the variation value can be within the limit stipulated by the FDA, thus, the clinical result would not be affected by the results obtained using the portable OneTouch UltraMini® glycosometer tested in this study.

Accurate measurement of glucose concentration in hospitalized patients is of paramount importance for the timely diagnosis and treatment of many diseases and conditions, including diabetes mellitus (Tauf et al., 2015).

Veterinarians use the statistical results obtained in the validation of the tested instruments as a basis for decision making in choosing the best glycosimeter equipment to be used and recommended to their clients for home use.

The OneTouch UltraMini® portable meter represents an excellent option for measuring dog and cat blood glucose because the difference in values is within limits set by the FDA when compared to the gold standard for measuring serum blood glucose and the

speed, accessibility, ease of performance and the fact that it requires a lower blood volume are essential factors in emergency cases and should be taken into consideration.

It is of fundamental importance that the veterinary clinic, in the impossibility of using veterinary glucometers for being more expensive and less accessible, looks for more reliable and tested devices of human use for use in veterinary medicine, avoiding misunderstandings in the establishment of the clinical conduct.

4. Conclusions

The results of our study indicated that the OneTouch Ultra Mini® portable meter is effective for monitoring dogs and cats blood glucose compared to the colorimetric automated method, making them useful instruments in clinical practice especially in emergency cases.

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