Retrospective study of owners' perception on home monitoring of blood glucose in diabetic dogs and cats

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Abstract — Home monitoring of blood glucose (HMBG) concentrations has been recommended in the monitoring of human diabetics for 3 decades. During the last number of years, it also gained popularity in long-term follow-up of diabetic cats and dogs. The aim of this retrospective study was to evaluate the practical feasibility of and identify the major problems encountered with HMBG in diabetic pets. A standard questionnaire was filled in by owners of 9 diabetic pets monitored with HMBG. The need for more than 1 puncture to obtain a blood drop, the creation of a sufficient blood drop, the need for assistance in restraining the pet, and the resistance of the pet were the most frequently encountered problems during HMBG. The major obstacles for the owners to start with HMBG were also identified. In conclusion, HMBG is a practical and simple technique for most owners and, overall, owners were satisfied.

Résumé — Étude rétrospective de la perception des propriétaires relativement à la surveillance à domicile de la glycémie chez les chiens et chats diabétiques. Depuis trois décennies, l'autosurveillance glycémique (ASG) a été recommandée pour réaliser le suivi des humains diabétiques. Depuis quelques années, l'ASG est également devenue populaire dans le suivi des chiens ou chats atteints de diabète. Le but de cette étude rétrospective était d'évaluer la faisabilité et d'identifier les problèmes majeurs rencontrés avec l'ASG chez nos patients diabétiques. Un questionnaire standard a été rempli par les propriétaires de neuf animaux diabétiques réalisant le suivi du diabète grâce à l'ASG. La nécessité de réaliser plus d'une ponction par mesure, la création d'une goutte de sang suffisante, la nécessité d'une personne supplémentaire pour contentionner le patient étaient les problèmes rencontrés le plus fréquemment lors d'ASG. Les obstacles majeurs pour débuter l'ASG étaient également identifiés. En conclusion, l'ASG est techniquement facile à réaliser pour la plupart des clients et généralement ceux-ci étaient satisfaits d'appliquer ce type de suivi.

(Traduit par les auteurs)

Can Vet J 2005;46:718–723

Introduction

Diabetes mellitus is a commonly diagnosed endocrine disease in middle-aged to older dogs and cats. The diagnosis, based on the presence of appropriate clinical signs (polyuria, polydipsia, polyphagia, and weight loss), hyperglycemia, and glucosuria is most often straightforward (1). Treatment usually involves appropriate insulin therapy, an adapted diet, and exercise. The major goals of treating diabetic patients are to alleviate clinical signs of diabetes and to prevent complications, including hypoglycemia (2).

The difficulty with the disease resides in appropriate monitoring of therapy. The combination of history, physical examination, and changes in body weight is effective for initially assessing control of glycemia in diabetic dogs and cats. However, correlation between owner observations and glycemic control measured by laboratory findings was less reliable in cats compared with dogs (3,4).

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The measurement of glucose in the urine, although easy to obtain, is not recommended. The Somogyi phenomenon is a physiologic counter regulation following a hypoglycemic period (blood glucose < 3.6 mmol/L) that results in persistent hyperglycemia for 24 to 72 h. Therefore, glucosuria can persist for several days following insulin overdosage (1,2).

Serum fructosamine concentration reflects changes in serum glucose concentrations over the preceding 1 to 3 wk (5). Both sensitivity and specificity of serum fructosamine concentrations for diagnosing diabetes mellitus in dogs are high, 0.93 and 0.95, respectively (6). When serum fructosamine is increased, it indicates poor glycemic control, but it does not identify the underlying problem (1). Some diabetic dogs and cats can have normal serum fructosamine values, because in early-diagnosed diabetes mellitus, the duration or degree of elevated serum glucose concentrations is insufficient to raise fructosamine values above the reference range (7).

For all these reasons, serial blood glucose concentrations (BGCs) are an excellent tool in evaluating the response of diabetic dogs and cats to insulin therapy. But even more importantly, serial BCGs allow identification of the cause of inadequate regulation. The results of serial BGCs, together with history and clinical signs, allow appropriate treatment adjustments to be made (1,2,8). However, several factors can influence the results

Figure 1. Marginal ear vein technique. The marginal ear vein is easily recognized in dogs and cats. In longhaired pets, a small part of the pinna can be shaved to obtain better visualization of the vein. A stable background is created with the use of a cylindrical shaped object (bandage roll). The vein is punctured with a needle or a lancet device and a sufficient blood drop can be obtained. The use of alcohol on the ear as a disinfectant is not advised because of the risk of dispersing the blood drop. A portable blood glucose meter (PGBM) is used to measure blood glucose concentrations. The PBGM is fast (30 s) and easy to use, requiring as little as 3 to 5 μL of blood. Afterwards pressure is applied on the punctured area to avoid excessive bleeding.

of serial BGCs and, thus, the decisions made regarding insulin administration. Most important, 24 h of hospitalization is required. During the hospitalization period, differences in the feeding schedules and the amount of exercise of the diabetic pet are often encountered. Also, stress due to an unfamiliar environment or repeated vein punctures can lead to hyperglycemia, especially in cats (1). Furthermore, serial BGCs are often time-consuming and costly for the owner. For these reasons, BGCs are frequently performed less often then required (9,10).

In humans, self-monitoring of blood glucose (SMBG) was introduced in the late 1970s and is now widely recommended in type I and II diabetic patients who are pharmacologically treated (11–13). Self-monitoring of blood glucose has been shown to result in better glycemic control in humans (14–16).

In accordance with human medicine, capillary blood samples can be taken from the ear in pets (9,17,18) and blood glucose concentrations measured by using portable blood glucose meters (PBGM) (19,20). Most PBGMs require as little as 3 to 5 μL of blood (21). Since home monitoring of blood glucose (HMBG) in pets is a fairly new procedure that has to be carried out by the owner, the purpose of this study was to evaluate retrospectively the practical feasibility and the major problems encountered with HMBG in diabetic pets.

Materials and methods

All owners performing HMBG between November 2001 and February 2003 were included in the study. Their dogs and cats had been examined previously at the Department of Medicine and Clinical Biology of Small Animals at the Faculty of Veterinary Medicine, University of Ghent, Belgium, and diagnosed with diabetes mellitus, based on the occurrence of appropriate clinical symptoms (polyuria, polydipsia, polyphagia, and weight loss), increased fasting serum glucose values, and glucosuria. A complete blood (cell) count (CBC), a serum biochemical panel with serum fructosamine concentrations, and a urinalysis with bacterial culture were performed as part of the routine evaluation of diabetic patients. All pets received insulin, SC, q12h, and individually adjusted dietary therapy.

The owners involved were educated on the treatment and other aspects of diabetes mellitus at the first consultation. They also received instruction on the optimal use of the PBGM. The marginal ear vein technique was explained in detail and the owners were allowed to practise this technique under our supervision. The technique for HMBG most commonly taught to the owners in our hospital is illustrated in Figure 1.

First, the required equipment (bandage roll, needle or lancet device, PBGM, test strip, and gauze or cotton) is placed in close proximity to the pet. Second, after localization of the marginal ear vein on the margins of the ear pinna and the creation of a stable background with a hard cylindrical shaped object, the vein is punctured with a needle or a lancet device. Third, after an adequate blood drop has formed, the PBGM is brought into contact with the drop and blood is absorbed on the test strip in the PBGM. Finally, while the PBGM is counting down for

Table 1. The standard questionnaire: summary

1/General information about the pet and the pet's illness
- — signalment
- — diagnosis of diabetes mellitus
- — treatment: type of insulin and dosage, diet, activity, logbook
- — time between diagnosis and start of HMBG
- — any concurrent illness

2/The technique used for generation of BGCs
- — type of PBGM, with lancet device or needle
- — number of BCGs
- — duration and time intervals of BCGs
- — preparation of the ear

3/The difficulties encountered during HMBG when starting and currently
- — resistance of the pet
- — restraining of the pet
- — need for more than 1 puncture due to the resistance of the pet
- — creation of a blood drop
- — need for more than 1 puncture due to technical problems
- — formation of visible puncture sites due to local hemorrhage
- — absorption of blood on the test strip
- — need for more than 1 test strip
- — possible problems encountered with the PBGM

4/The reasons for reluctance to start HMBG initially, including insufficient clarity, insufficient guidance, the responsibility, fear of hurting the pet, the complexity of the technique, blood sampling, the use of the PBGM, the costs, and the time required.

5/The perceived beneficial effects of HMBG by the owner
- — communication with the veterinarian
- — evolution of the clinical signs
- — subjective beneficial effects
- — medical background or experience with diabetes mellitus of the owner
- — any suggestions concerning HMBG

HMBG — Home monitoring of blood glucose; BGC — Blood glucose concentrations; PBGM — Portable blood glucose meter

30 s, gauze is pressed against the puncture site to stop the bleeding, if necessary.

Owners were advised to measure blood glucose concentrations before the administration of insulin and then every 2 h for a 12-h or 24-h period. All blood glucose concentrations were measured with PBGMs. Further controls and treatment adjustments were planned according to the recommendations made by the clinician.

A standard questionnaire was sent by mail to all owners performing HMBG, after verbal approval was received by telephone. Twenty-four questions were divided into 5 sections. Each section contained a number of questions related to the following aspects: general information about the pet and the pet's illness; the technique used for the generation of serial BGCs; the difficulties encountered during HMBG, initially and current; the reasons for reluctance to start HMBG initially; and the perceived beneficial effects of HMBG by the owner for their pet. A summary of the questionnaire is given in Table 1.

Results

General information about the pet and the pet's illness

Nine owners who were or had been performing HMBG between 2001 and 2003 were contacted, all 9 owners agreed to fill in the questionnaire. Seven dogs between 7 and 14 y of age (mean 11 y) were included. The breeds represented were fox terrier, rottweiler, keeshond, Border collie, golden retriever, and mixed breed (n = 2). All 5 female dogs were spayed and the 2 male dogs were intact. Two female spayed cats, a Blue Russian aged 13 y and a mixed breed aged 15 y, were also included. The time period between the diagnosis, the start of treatment of diabetes mellitus, and the beginning of HMBG ranged from 1 mo to 5 y (mean 14.5 mo). The number of serial BGCs performed per owner ranged from 1 to 8 (mean 4). All pets were treated with insulin, SC, q12h, at an individually adjusted dose (initial starting dose 0.5 U/kg body weight [BW], q12h). Eight pets received Caninsulin (Intervet, Boxmeer, the Netherlands) and 1 cat received Mixtard 30/70 (Novo Nordisk, Alphen aan den Rijn, the Netherlands). Three of the 5 female dogs were spayed after diabetes mellitus had been diagnosed. Both cats were spayed at young ages (1 and 2 y). Two dogs had concurrent diseases. One dog had been diagnosed with primary epilepsy several years before diabetes mellitus was diagnosed and was treated with phenobarbital 0.5 mg/kg BW, q12h and 1 female dog had a mammary gland tumor. Four of the 9 owners kept a logbook of their pet.

The technique used for generation of BGCs

Slight differences in the technique were noted in comparison with the technique described in Figure 1. These differences consisted of a slightly different preparation of the ear, the type of glucometer used, and the use of a lancet rather than a needle.

To prepare the ear, 4 owners shaved a part of the ear for better visualization of the marginal ear vein. Two owners cleaned and dried the ear before puncturing it. One owner applied gentle massage on the ear to achieve hyperemia. Most owners used the Glucometer elite (Bayer, Antwerp, Belgium), which is also the PBGM most commonly used in our hospital. Three owners used 3 different PBGMs, Glucocard memory PC (Menarini, Ricerche Sud, Pomezia, Italy), Gluco Touch (Johnson and Johnson, Dilbeek, Belgium), and One Touch Basic (Johnson and Johnson, Dilbeek, Belgium). Four owners used needles to puncture the ear vein, 2 preferred to use the lancet enclosed with the PBGM.

The protocol used for the generation of BGCs was adjusted to the owner and the pet, mostly 24-h curves were made with measurement of blood glucose values every 2 h during daytime and every 2 to 3 h at night. One owner performed 12-h curves on occasion, namely, when the pet seemed clinically well controlled. One owner always performed 12-h curves.

The difficulties encountered during HMBG at start and current

The difficulties encountered more than 50 percent of the time with HMBG, initially, were the need for assistance in restraining the pet (n = 4), the need for more than 1 puncture to obtain a blood drop due to pet resistance (n = 3), the creation of a blood drop of sufficient size (n = 3), and the resistance of the pet (n = 2). Later, at the time the questionnaire was filled in by the owner, 3 owners had difficulties with the need for assistance, 2 owners encountered resistance of the pet, 1 owner needed more

Table 2. Overview of the results concerning the major problems encountered during home monitoring of blood glucose

	Never		< 50% of time		> 50% of time		Always	
Problems	At start	Now	At start	Now	At start	Now	At start	Now
Resistance of the pet	5	5	1	1	1	0	1	2
Several punctures[a]	5	5	0	2	1	0	2	1
Extra person needed	4	5	0	0	0	0	4	3
Insufficient blood drop	3	3	3	3	3	1	0	0
Several punctures[b]	2	4	4	3	1	0	0	0
Visible puncture site	7	6	1	1	0	0	0	0
Absorption blood	4	5	3	2	1	0	0	0
Additional strip needed	2	3	6	5	1	0	0	0
Problems with use of glucometer	6	5	1	1	0	0	1	0

The total of each problem does not always equal 9 because not all the questions were answered by all owners. For example, 1 owner performed only 1 blood glucose concentrations (BGC) at home; therefore, the answers were considered to be in the beginning of home monitoring of blood glucose (HMBG) and were not added to the now-column.
[a]Needed because of pet resistance
[b]Needed because of technical problems

than 1 puncture to obtain a blood drop due to pet resistance, and 1 encountered difficulties in creating a sufficient blood drop more than 50 percent of the time. Other difficulties were seen less than 50 percent of the time with every blood glucose measurement. These included the need for more than 1 test strip (n = 7 at start, n = 5 later), the need for more than 1 puncture due to technical problems (n = 5 at start, n = 3 later), and inadequate absorption of the blood drop (n = 4 at start, n = 2 later). A visible puncture site secondary to a local bleeding was seen in only 1 dog. These results are summarized in Table 2.

Reasons for reluctance to start HMBG initially

The major reasons for the reluctance of the owners to start HMBG, initially, were the fear of hurting their pet (n = 5/9), taking a blood sample themselves (n = 4/9), and the costs involved (n = 4/9). Several owners also considered the complexity of the technique (n = 3/9) and the fact that HMBG is time-consuming (n = 3/9) as drawbacks of the technique. On the other hand, insufficient clarity about the technique or insufficient guidance, the responsibility involved, or the use of the PBGM were not considered to be obstacles for starting HMBG.

Subjective beneficial effects of HMBG

All owners believed HMBG helped in the glycemic control of their pet. This belief was based on the improvement of the clinical signs of the pet, the stability of the pet's overall condition, and the active participation of the owner in the management of his pet's illness. Despite these conclusions, 2 of the owners preferred to have the serial BGCs performed by a veterinarian; both found HMBG to be too time-consuming and 1 of them was also afraid of hurting his pet too much.

Discussion

Self-monitoring of blood glucose concentrations is considered to be the most important step forward in the treatment of diabetic humans since the discovery of and the treatment with insulin (10). In this retrospective study, all owners were able to generate a blood glucose curve at home. A previous study conducted in healthy pets showed that 7/7 owners and 3/7 cat owners were able to generate a reliable blood glucose curve (10). Another recent study demonstrated that 10/12 owners of diabetic dogs were able to perform blood glucose curves at home (22). Good owner communication and education were essential in obtaining these results (10,22). Also, in human medicine, repeated educational sessions and proper patient guidance were essential in obtaining improved glycemic control in diabetic patients (11). The fact that all owners in this study were successful in completing a BGC at home was also due to owner selection and motivation. The concept of HMBG was only introduced at our hospital when the clinician judged that treatment of diabetes mellitus was sufficiently understood by the owner. Also, owners were able to refuse HMBG and these pets were further evaluated in the hospital. Therefore, only highly motivated owners interested in performing HMBG were included in this study.

The need for assistance in restraining the pet was the problem most frequently encountered. However, mostly only 1 extra person was needed to keep the dog or the ear of the dog in a fixed position to facilitate blood drop formation and blood glucose measurement.

A comparison between the results in the beginning of HMBG and at the time the questionnaire was filled in gives an indication of the fact that fewer problems were encountered with increasing experience with the technique, in keeping with previous studies (10,22).

Casella et al (22) reported that the problems initially encountered with HMBG in diabetic dogs were the production of the required negative pressure with the lancing device, the restraint of the dog, the production of a blood drop, the absorption of a blood drop, and the correct use of the test strips and the PBGM. In their study, a different technique to obtain a blood drop was described. An automatic lancing device that creates negative pressure, (Microlet Vaculance, Bayer Diagnostics, Zurich, Switzerland) was used to puncture the ear. Although this technique was described as the best method in obtaining capillary blood samples from the ear of a dog (10), it was also responsible for most of the initial problems, including the fact that too much pressure was applied on the outer pinna by the owner, preventing the formation of an adequate blood drop. In our study, owners were taught

to puncture the marginal ear vein, which can be identified visually in most dogs and cats. This technique is similar to the one described by Thompson et al (23). Because it is a vein that is being punctured, a blood drop forms quickly without the need for negative pressure. Therefore, the most important problem concerning HMBG encountered in other studies was avoided. The marginal ear vein technique could represent a more accessible technique for owners. This could influence the decision of the owner to start with HMBG in a positive way. In addition, the major problems initially encountered with HMBG were the use of the PBGM and the test strips (10,22). In this study, 7 owners needed extra punctures due to technical difficulties in the beginning of HMBG, but less than 50 percent of the time. This indicates that, although these problems were frequently encountered, they did not represent a major obstacle.

In accordance with other studies (9,10), the sites of blood collection were not painful and hardly visible. A visible puncture site caused by local bleeding was recognized after puncture in 1 dog (keeshond).

It became increasingly difficult to measure reliable glucose concentrations in 2 dogs (keeshond and fox terrier), because of increased resistance to the puncture. Both owners of these dogs preferred to have the serial BGCs done by a veterinarian. In contrast, both cat owners reported that their cats became increasingly tolerant with time, especially when the punctures were performed at a place freely chosen by the cat.

The limitations of this study are that is was a retrospective study and different clinicians were involved in the follow-up of the patients. This also explains the slight differences seen in the technique used to perform HMBG and in the protocol used for HMBG. The clinician was also responsible for making the initial selection of owners. Only owners who were considered to be accurately informed about all the aspects of diabetes mellitus were selected to perform HMBG. The results of this study should also be seen in light of the low case number. An additional fact that could have influenced the results is that 3 owners had some medical education: 1 owner was a nonpractising veterinarian and 2 were veterinary students. Two owners had come in contact with human diabetic patients in their home environment.

This study also identified some fields to which special attention should be given in preparing an owner for HMBG. First, only 4/9 owners kept a logbook of their diabetic pet routinely. Recommendations to keep written information about the pet, including changes in appetite, attitude, body condition, water intake, urination, and body weight, have been made previously (1,5). A logbook is a helpful tool in long-term follow-up of the diabetic pet.

Second, good explanation concerning the PBGM and the test strips, including maintenance and calibration, is important. Most PBGMs are delivered with information brochures concerning maintenance and calibration. The owners should pay attention to it and the veterinarian should go through the important issues with the owner. Giving written handouts that cover all aspects on HMBG serve as a guideline and allow the owner to read through the procedure again.

Third, when owners are performing HMBG, easy access to veterinary consultation and advice should always be available. Good education leads to better compliance and is associated with improved metabolic control in human and veterinary diabetics (10,16).

In diabetic dogs, serial blood glucose curves show significant day-to-day variability. In the study of Fleeman et al (24), significant differences in blood glucose measurements were noted on 2 consecutive days when insulin dose and meals were kept constant. Comparison of the BGCs obtained at day 1 with those on day 2 led to the same recommendations regarding insulin dose adjustment in only 57% of cases. This implies important clinical implications, especially in well-controlled dogs. Therefore, appropriate treatment adjustments should be based on the results of serial BGCs, together with history and clinical signs (1,2,12). However, day-to-day variability of serial BGCs was seen in a hospital environment with the same disadvantages as discussed before, although special attention was paid to keep the amount of food constant each day (24). There are no studies so far that have looked at this aspect in a home environment.

Human studies show that self-monitoring of blood glucose by the diabetic patient is correlated with lower blood glycosylated hemoglobin concentrations (15,16). The effects of SMBG on patient morbidity and mortality, however, have not yet been evaluated. Few studies in dogs and cats have looked at this aspect. Twenty-eight cats controlled with HMBG received higher insulin doses compared with diabetic cats without HMBG, but the difference was not statistically significant (25). Therefore, further studies are needed to confirm that HMBG is really effective in improving glycemic regulation in diabetic cats and dogs.

One of the major problems encountered with SMBG in humans is limited compliance with the technique (11). The SMBG is an invasive method. The fingertips of humans contain high numbers of nerve endings and therefore repeated pricking is associated with a painful sensation. Also, the cost to be paid by the patient was an obstacle for good compliance. Only 1 veterinary study has looked at the compliance with HMBG in owners of diabetic cats (25). In this study, the long-term compliance with HMBG was considered good and client binding was not altered. However, identical obstacles to those in humans can be expected with pets. Continuous glucose monitors have been developed for use in human diabetics (26,27). Minimally invasive glucose sensors are placed on the skin and interstitial fluid glucose concentrations are measured. Besides detecting fluctuations in blood glucose over a prolonged period, these sensors no longer require repeated punctures. A continuous glucose monitoring system was evaluated in 10 cats with diabetes mellitus (28). Mostly the device was well tolerated and able to generate a continuous glucose curve. However, stress hyperglycemia and the working range of the monitor (between 2.2 to 22.2 mmol/L) limited its practical use.

In conclusion, a slightly different technique to produce serial BCGs at home is described here. Also some fields requiring special attention while applying HMBG are identified. For most owners, HMBG is a feasible technique and is relatively easy to perform, especially if

adequate education of the owner by the veterinarian is provided. Furthermore most pets seem to tolerate it well. Therefore, it represents a useful tool in the follow-up of diabetic pets.

Acknowledgments

The authors thank all owners involved in this study for their collaboration without which this study would not have been possible. CVJ

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