Carbohydrates Impact in Type 2 Diabetes in Cats

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ABSTRACT

Diabetes is one of the most commonly diagnosed endocrine diseases in cats. Of all types of diabetes, type II is the most frequent one, 80% of the diabetic cats have type II diabetes. Even though it's a multifactorial disease, obesity was found to be the most important risk factor in developing diabetes, obesity increases the chances of developing this disease to up to 4 times. The study was conducted on a number of 9 cats with uncomplicated diabetes with the purpose of monitoring the effects of the commercial dry food (with a high percentage of carbohydrates) and the commercial canned food (with a higher percentage of proteins and a lower percentage of carbohydrates) on the glycemic index. For this study, we considered the occasional administration of raw chicken and turkey meat because it wasn't given for a long enough period of time. The diet is very important for diabetic cats because a lot of sick cats enter remission after a couple of months of being fed wet canned food and they no longer need the administration of insulin, but owners are instructed to carefully monitor glycaemia for the rest of the pet's life.

Key words: *cats, diabetes, insulin, diet.*

INTRODUCTION

Diabetes (mellitus) is one of the most commonly diagnosed endocrinopathies in dogs and cats and classifies in four major categories (Rand *et al.*, 2004):

Type I diabetes is specific to dogs and is characterized by hypoinsulinemia (Couto *et al.*, 2014). A marker of the disease is represented by the presence of circulating autoantibodies: autoantibodies to islet cells, insulin autoantibodies or autoantibodies of enzymes involved in carbohydrate metabolism (Rijnberk *et al.*, 2010).

Type II diabetes is predominant in cats (Couto *et al.*, 2014), based on histological findings and clinical signs, about 80-95% of the diagnosed cats suffer from type 2 diabetes (Rand *et al.*, 2004). It is characterized by insulin resistance and β -cells dysfunction (Rijnberk *et al.*, 2010).

In the third category there are included "other types of diabetes" (Rand *et al.*, 2004), i.e. diabetes secondary to different pathologies: pancreatitis,

pancreatic carcinoma, hyper-somatotropism, hyperthyroidism or subsequent to glucocorticoids and progestin (Rijnberk *et al.*, 2010).

The fourth category includes gestational diabetes in humans, but in dogs and cats this has not been reported. Diabetes associated with diarrhea in dogs may be considered, however, its equivalent (Rand *et al.*, 2004). Diabetes mellitus encountered in cats resembles to type II diabetes encountered in humans in several aspects, including clinical, physiological and pathological signs of the disease (Henson *et al.*, 2006). For example, the typical cat encountered with type II diabetes is obese and middle-aged and has low insulin levels. However, the main common feature is the appearance of amyloid IA (islet amyloid) in almost all cats with diabetes and in 90% of cases in humans (O'Brien, 2002). The classic symptoms presented by diabetic cats are polyuria, polydipsia, polyphagia accompanied by weight loss (Rijnberk *et al.*, 2010). These may be accompanied by lethargy, lack of

grooming behavior and the appearance of dry, scratchy and unhealthy fur. Cats may also show weakness in the hind limbs, decreased ability to jump or adopting the plantigrade position (Couto *et al.*, 2014).

Factors that may lead to diabetes are: age, sterilization, gender and obesity (Hoenig, 2002). Although diabetes can occur at any age, the average age diagnosed is 10 years old (Couto *et al.*, 2014). Sterilized cats have twice as much chance of developing diabetes and 1.5-fold more in tomcats (Hoenig, 2002). Obesity and lack of activity are the main causes that lead to insulin resistance and thus to the development of type II diabetes (Öhlund *et al.*, 2017). Obesity and associated pathologies underlie metabolic diseases, including diabetes. Due to abnormal cytokine production, to acute phase reactants and to inflammatory pathway activation, obesity is associated with a chronic under-inflammation condition and appears to have a direct implication in insulin resistance, but the mechanisms by which it works are not perfectly elucidated (Wellen *et al.*, 2003). It appears that regulating carbohydrate metabolism in tissues, such as muscle and fat, is an important factor in sensitivity to insulin.

Obesity, which is associated with reversible insulin resistance, affects the secretion and the action of insulin either by alterations to insulin receptors or by alterations to post-receptor processes (Rotlewicz *et al.*, 2010). Even the fat tissue build-up pattern affects the severity of insulin resistance. In humans, abdominal obesity is more often associated with insulin resistance than peripheral obesity (Rand *et al.*, 2004). Burmese cats are considered to be the most susceptible race to diabetes (Rucinsky *et al.*, 2010), accumulating fat in the abdominal area, unlike other races that accumulate subcutaneous fat in the groin area (Rand *et al.*, 2004).

Dietary opinions regarding diabetic animals have changed over the last few years (Rijnberk *et al.*, 2010). Until recently, there have been applied recommendations from human medicine, which contain a diet rich in complex fibers and carbohydrates (Nelson, 1992), now the domestic cat is recognized as a true carnivore, metabolically adapted to primarily use protein and fat, and carbohydrate-rich diets appear to be unfavorable (Rijnberk *et al.*, 2010). Thus, the traditional recommendation is contested

by the hypothesis that continued intake of high amounts of carbohydrates promotes obesity and overloads pancreatic β -cells (Rand *et al.*, 2004), and high protein and low carbohydrate diets may be beneficial to diabetes management (Frank and contributors, 2001).

MATERIALS AND METHODS

In this study, we followed how glycaemia of diabetic cats is influenced by diet, especially the carbohydrate content of the administered food. The study was conducted between 2015 and 2017 at the Nutrition Department of the Faculty of Veterinary Medicine in Cluj-Napoca in collaboration with a veterinary clinic in Cluj-Napoca, two veterinary cabinets in Oradea and a veterinarian from Oșorhei, Bihor County. The collaboration was primarily with cat owners, keeping in touch with them via email, and having access to cats tracking through Google Docs.

Nine cats entered the casuistic: six sterilized males, two sterilized females, and a non-sterilized male. Of the nine cats, six have uncomplicated diabetes and did not show any major pathology before or after diagnosis, a cat developed iris melanoma 2 months after diagnosis of diabetes and two cats were also diagnosed with pancreatitis; one of them two years before the diagnosis of diabetes, and in the case of the other the diagnosis were put concomitantly. The latter was also diagnosed with chronic renal failure prior to the diagnosis of diabetes.

In the diagnosis of cats an important share was the anamnesis, the great majority of the owners observing polydipsia, polyuria and polyphagia with weight loss. Venous blood was collected from the jugular vein (to avoid blood clotting) with non-sedated cats, except for a sedentary cat. Biochemical analyses (ARKRAY- Spotchem ez sp 4430 Chemistry Analyzer) were performed for renal, hepatic and glucose monitoring or equal to or more than 300 mg / dl, in the sphere of diabetes. Urinary analyses were performed with urine bands (PocketChem UA PU-4010, Arkray strips) and microscopic examination of sediment on urine collected by the owners. Glucose occurs in urine at blood glucose levels around 300 mg / dl.

Because of the fact that in cats, blood glucose increases greatly in stressful situations, such as the visit to the veterinarian, the best monitoring is

For the most complete monitoring of the cats, spreadsheets have been used in the Excel program, which looks at: blood sugar, insulin dose, type of cat food, and cat behavior. The first line is color coded and shows blood glucose. The desired glycaemia is represented by dark green, but the blue blood glucose is also acceptable: if the two spreadsheet predominates → good glycemic control; one day begins with AMPS hour: morning

RESULTS AND DISCUSSION

Of the nine cats enrolled in the study, four entered the remission, three had a stable glycaemic curve with low blood glucose, and two had irregular glucose. All the four cats that entered the remission did so only after they went to a low-carbohydrate diet. As Marshall *et al.* said in their study of 2009, the chances of getting into remission are greater with Lantus insulin, which is confirmed by 3 of the cases in the study that are in remission.

[illegible]

Fig. 1. Monitoring spreadsheet of feline diabetes (www.felinediabetes.com)

Fig. 2. Glycemia values mainly in 300-400 mg/dL zone

Of the cases that came into remission, we present case number 9, a sterilized male, 6 years old at diagnosis and 5 kg weight, the date of diagnosis being February 2017. After diagnosis, the cat started the treatment with Lantus insulin, and the diet within the first 5 days after diagnosis was dry food with approx. 30% carbohydrates, and then switched to wet food for diabetic cats with 16.3% carbohydrates (Fig. 2).

From March the 10th, he is passed on wet food with less than 10% carbohydrates, figure 3. Very unstable glycemic curve until 08.03. when it starts to adjust. On 09.03 it has a very high spike of over 400 mg / dl, and thereafter the values decrease

in the desired area below 120 mg / dl. Very good glycaemic curve. On March 12 he enters remission. It is a clear example of a cat diagnosed on time, fast-tailed food and the right insulin. Of the regulated glycaemic cats, case number 8, represented by a sterilized tomcat that at the time of diagnosis (07.10.2016) was 13 years of age and weighing 7 kg. The cat has chronic renal failure for many years, and when presented to the veterinarian in 2016, he was also diagnosed with pancreatitis. After diagnosis of diabetes, Lantus insulin treatment was initiated, and the owner wanted to try the dry diet for cats with renal insufficiency which he used until 12.10, figure 4.

Fig. 3. Dynamics of glycemic normalization

Fig. 4. Various glycemic values with many spikes

From 13.10. to 30.10. it is fed with 9% carbohydrate wet food. The evolution of blood glucose over a two-week period can be seen in figure 5. From December, the diet changes with food with less than 3% carbohydrates, figure 6.

Year 2017 is promising with stable values and decreased insulin dosage, figure 7. Blood glucose values ranging from 100 to 200 mg / dl after changing food to one with less than 3% carbohydrates, its blood sugar slowly begins to fall. Blood glucose values are not yet within

physiological limits: 60 mg / dl - 120 mg / dl, but they are in the blue area of the spreadsheet with maximum values of 200 mg / dl.

Of the non-regulated glycaemia cats, case number 6 is a sterilized female, aged 11 years and weighing 2 kg. The cat was diagnosed on August 23, 2016, with a high blood glucose value of 741 mg / dl. After diagnosis, the cat began treatment with ProZinc insulin and was taken on dry commercial meals with a carbohydrate content of less than 1.5% and raw meat (Fig. 8). Very high

Fig. 5. Glycemic values between 200-400 mg/dL, with much less spikes

Fig. 6. Only some glycemic values in 300 mg/dL zone but glycemic curve is not yet under control

Fig. 7. Glycemic values between 100-200 mg/dL

Fig. 8. Very high glycemic values, uncontrolled glycemia

blood sugar values, uncontrolled blood glucose. Due to very high blood glucose values (many days over 500 mg / dl), it was recommended to switch to Lantus insulin, but for personal reasons, the owner refused and decided to stay on ProZinc insulin. In addition, despite high blood glucose levels, in the next period the owner decided to lower the insulin dose a lot: from 3 units, it reached 0.5 units in October 2016. In 2017 the insulin dose is slightly increased but still does not keep blood sugar under control, with very high values being recorded (Fig. 9 and Fig. 10).

Year 2017 continues to be with very high blood glucose levels, most over 400 mg / dl, the only time

when blood glucose starts to fall is in mid-May, figure 11. In addition to two values above 300 mg / dl, the glycaemic curve appears to stabilize, even though the values are elevated, predominantly in the 100-200 mg / dl range. This case is quite a clear example that only a good diet is not enough for glycaemic control. The cat is hyperglycaemic for a long time due to lack of cooperation of the owner who does not want to change insulin and greatly afraid of hypoglycaemic shock and does not want to use a proper dosage of insulin recommended to blood glucose levels.

There are a lot of factors that need to be taken into account in order to lead a cat in remission:

Fig. 9. Very high glycemic values, the insulin dose is very low

Fig. 10. The insulin dose oscillates between one unit and 1.5 units. Blood glucose is no more than 600 mg / dL but is not controlled

Fig. 11. Glycemic values predominantly in the 100-200 mg/dL range

- The diet: all the 4 cats who have entered the remission have done it only after they passed to a low carbohydrate diet; - Insulin: as Marshall and contributors' study said in 2009, the chances of getting into remission are greater when using Lantus insulin. This is confirmed by 3 of the cases in the study that are in remission. Of course, this does not mean that other types of insulin cannot lead to remission, for example, case number two, a sterilized female, who has entered remission using insulin Vetsulin; - Stress factors management: Because stress causes blood sugar to rise, cats diagnosed with diabetes should be as safe as

possible from any stress factor. The most relevant example is case number seven, a sterilized tomcat which has high blood glucose values when it is exposed to a strong stress for it - the presence of foreign animals - for almost one year period. The hypothesis released by McCann *et al.* in 2007, according to which the ad libitum feeding with a diet with high protein content and low in carbohydrates, leads to the promotion of weight gain (by accruing fat tissue) and implicitly to insulin resistance development, was not confirmed by our study. All the cats included in our study lost

weight after passing to such a diet, including the cats that have not entered remission.

CONCLUSION

Food is very important for cats. Because they are hyper carnivores, cats do not require carbohydrates in the diet, and they have the ability to procure the necessary glucose from the protein. The attending vet should take this into account especially for type II diabetic cats who can receive adequate nutrition and appropriate insulin treatment.

As a result of our study, we have come to the conclusion that it does not matter if the food is wet or dry but it matters the carbohydrate content. That is why the recommendation is for owners to check the product label, not to rely on the fact that food is for diabetic cats, because many of them have a carbohydrate content of more than 10%.

REFERENCES

1. Coutto CG, Nelson RW (2014). Small animal internal medicine. Ed. Elsevier, 5:798 – 803.
2. Frank G, Anderson W, Pazak H, Hodgkins E, Ballam J, Laflamme D (2001). Use of high-protein diet in the management of feline diabetes mellitus. *Veterinary Therapeutics*, 2(3): 238 – 246.
3. Henson MS, O'Brien TD (2006). Feline models of type 2 diabetes mellitus. *ILAR Journal*, 47(3): 234 – 242.
4. Hoenig M (2002). Comparative aspects of diabetes mellitus in dogs and cats. *Molecular and cellular endocrinology*, 197:221 – 229.
5. Marshall RD, Rand JS, Morton JM (2009). Treatment of newly diagnosed diabetic cats with glargine insuline improves glycaemic control and results in higher probability of remission than protamine zinc and lente insulins. *Journal of Feline Medicine and Surgery*, 11: 683 – 691.
6. McCann TM, Simpson KE, Shaw DJ (2007). Feline diabetes mellitus in the UK: The prevalence within an insured cat population and a questionnaire-based putative risk factor analysis. *J Feline Med Surg*, 9:289 – 299.
7. Nelson RW (1992). Dietary management of diabetes mellitus. *Journal of Small Animal Practice*, 33(5): 213 – 217.
8. O'Brien TD (2002). Pathogenesis of feline diabetes mellitus. *Molecular and Cellular Endocrinology*, 197:213 – 219.
9. Öhlund M, Egenvall A, Fall T, Hansson-Hamlin H, Röcklinsberg H, Holst BS (2017). Environmental risk factors for diabetes mellitus in cats. *Journal of Veterinary Internal Medicine*, 31:29– 35.
10. Rand SJ, Fleeman LM, Farrow HA, Appleton DJ, Lederer R (2004). Canine and Feline Diabetes Mellitus: Nature or Nurture. *The Journal of Nutrition*, 134(8):2072 – 2080.
11. Rijnberk Ad, Kooistra HS (2010). *Clinical Endocrinology of Dogs and Cats*. Ed. Schlütersche, 167.
12. Rotlewicz BN, Gallelli MF, Blatter MF, Miceli DD, Castillo VA (2010). Pathophysiology of diabetes mellitus and its relationship with obesity in cats. *Slovenian Veterinary Research*, 47:29 – 34.
13. Rucinsky R, Cook A, Haley S, Nelson R, Zoran DL, Poundstone M (2010). AAHA diabetes management guidelines for dogs and cats. *Journal of the American Animal Hospital Association*, 46:215– 224.
14. Wellen KE, Hotamisligil GS (2003). Obesity-induced inflammatory changes in adipose tissue. *The Journal of Clinical Investigations*, 112(12): 1785-1787.
15. www.felinediabetes.com