Journal of Feline Medicine and Surgery (2009) **11**, 668–682
doi:10.1016/j.jfms.2009.04.010

ELSEVIER

jfms

Intensive blood glucose control is safe and effective in diabetic cats using home monitoring and treatment with glargine

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Human diabetic patients routinely self-adjust their insulin dose using a protocol and home monitoring, and perform equally well or outperform physician directed adjustments. The objective of this study was to report the outcome of home monitoring of diabetic cats by owners using a protocol aimed at achieving euglycaemia, using ultra-low carbohydrate diets (≤10% metabolisable energy) and the insulin analogue glargine for >10 weeks and/or until remission was achieved. Fifty-five cats diagnosed with diabetes mellitus, whose owners joined the online German Diabetes-Katzen Forum, were included. An overall remission rate of 64% was achieved in the cohort. Significantly higher remission rates were observed if good glycaemic control was achieved soon after diagnosis: 84% for cats started on the protocol within 6 months of diagnosis went into remission, and only 35% for cats that began more than 6 months after diagnosis ($P < 0.001$). Only one mild clinical hypoglycaemic episode occurred observed despite tight blood glucose control. In conclusion, intensive blood glucose control is safe and effective in diabetic cats using home monitoring and treatment with glargine.

Date accepted: 28 April 2009

Landmark clinical trials involving human type 1 and type 2 diabetic patients have shown that intensive control of blood glucose, in addition to blood pressure control, prevents and delays the progression of complications related to diabetes.[1,2] While translating these research findings into real world practice is still ongoing,[3] these evidence-based practice standards show great promise in decreasing morbidity and mortality among human diabetics. Tight glycaemic control has not been studied in feline diabetics, but the possible benefits of increased remission rates and reduced levels of complications warrant investigation.

Achieving euglycaemia in feline patients is difficult, because the insulins available often have inadequate duration of action for twice daily administration, and because there is wide variability between and within cats in response to exogenous insulin.[4,5] Glargine (Lantus; Sanofi-Aventis, Paris, France) is an insulin analogue which has a longer duration of action in healthy cats than intermediate-acting insulins[6] and initial studies in diabetic cats[7] suggest it is associated with high remission rates.

In Germany, porcine lente insulin (Caninsulin; Intervet BV, The Netherlands) is currently the only licensed insulin for feline use, and legislation requires that it is the first insulin to be used in treatment of diabetic cats. However, control of blood glucose concentration and remission rates were found to be inferior to glargine when both insulins were used twice daily in diabetic cats.[7,8] Poor glycaemic control led some owners to seek alternative methods of treatment for cats responding inadequately to initial therapy with lente insulin. The web-based German Diabetes-Katzen Forum was established in its current form in April 6, 2006 as a forum for owners of diabetic cats using long-acting insulins such as glargine or detemir.

Recent studies in human diabetic patients have shown that patients that have been taught to use a self-adjusted dosing protocol, perform equally well as physician driven adjustments,[9] or outperform clinic-driven protocols.[10] It was also found that patients that were naive to insulin could effectively implement the dosing algorithm and achieved similar results to patients directed by a physician.[11] Similarly, diabetic cat owners participating in the Diabetes-Katzen Forum, adjusted insulin dose based on a dosing protocol, which encompassed daily home monitoring.

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1098-612X/09/080668+15 $36.00/0

Home monitoring of blood glucose concentrations is standard practice for human diabetic patients, but relatively few pet owners are willing to measure blood glucose concentration multiple times daily to achieve tight glycaemic control for their pets. The German Diabetes-Katzen Forum attracted owners of diabetic cats who performed daily home monitoring and used glargine with a treatment protocol which aimed for euglycaemia. The dosing protocol was developed based on the veterinary literature with input from specialist veterinarians.[12]

Diet is a cornerstone of successful management of diabetic cats. Recent studies demonstrated that diabetic cats fed low carbohydrate, high protein canned food had higher insulin sensitivity and remission rates than cats fed higher carbohydrate diets.[13,14] Cats evolved as strict carnivores, but the diets which have become widespread in the last 20–30 years have moderate to high carbohydrate content (30 to >50% of energy).[15,16] These diets promote post-prandial hyperglycemia and may contribute to the increasing incidence of diabetes in cats.[17] Therefore, low carbohydrate, high protein diets are recommended for management of diabetic cats.[13]

The objectives of this study were to report the outcome of home monitoring of diabetic cats by owners using a protocol aimed at achieving euglycaemia, using an ultra-low carbohydrate diet (≤10% metabolisable energy) and glargine. Specifically the aims were to report (1) the remission rates of cats using such a protocol, (2) the safety and complication rate in cats using this protocol, and (3) the factors which might be prospectively used to differentiate diabetic cats that subsequently became non-insulin dependent from cats which remained insulin dependent.

Materials and methods

Data were provided by owners of diabetic cats who joined the German Diabetes-Katzen Forum (http://www.diabetes-katzen.net/forum/) or an earlier version of the website between October 3, 2004 and April 30, 2007. Data reported from the cats were collected until December 23, 2007 and 55 cats were included in the study. Owners were informed about the study and asked to provide information regarding their cats in spreadsheets and questionnaires. The cats were mostly located within Germany ($n = 49$) and a small number in Switzerland ($n = 4$) and other countries ($n = 2$).

Inclusion criteria for the study were that the owner had to follow the forum's protocol (Table 1) using glargine for more than 10 weeks and/or until remission was achieved, and to supply blood glucose measurements for their cat. This included all daily insulin dosages and measured blood glucose concentrations from the time that they joined the forum, including for insulin used prior to changing to glargine. The owner also supplied as much additional clinical information as possible, collected in the form of questionnaires. The owner estimated the ideal weight of the cat, which was used to calculate the initial insulin dosage used. While on the protocol, cats were fed an ultra-low carbohydrate (generally <8–10% of energy) canned food, or in several cases, ultra-low carbohydrate veterinarian-developed home-made diets.[18]

Of the 209 diabetic cats whose owners joined the forum up until December 23, 2007, 78 cats were excluded from the study because they were not treated with glargine. Of the 131 remaining cats that were treated with glargine, further cats were excluded from the study for the following reasons: acromegaly ($n = 2$), cats known to be on a high carbohydrate diet ($n = 1$), cats whose owners joined the forum very close to the cutoff and did not have >10 weeks of tight regulation data or did not achieve remission by the cutoff date ($n = 11$), cats whose owners dropped out of the forum ($n = 9$), cats whose owners did very little blood glucose home monitoring or who chose not to aim for euglycaemia and used more traditional regulation protocols ($n = 21$), and cats whose owners chose not to provide blood glucose concentration data for the study ($n = 32$). The remaining 55 cats met the inclusion criteria and were included in the study.

Of the 55 cats reported in this study, blood glucose concentrations using the intensive regulation protocol were provided from the time the intensive regulation protocol with glargine was begun to the last insulin injection (median of 3.2 months of data provided (range = 6 days to 25 months)). Two cats had less than 2 weeks of blood glucose data because they achieved remission very quickly (<2 weeks).

High and low blood glucose concentrations that were beyond the measurement ranges of glucometers were very rare occurrences within the cohort. For low values, a blood glucose value of 1.1 mmol/l (20 mg/dl) was used in the calculations and for high values, a blood glucose concentration of 33.3 mmol/l (600 mg/dl) was used. Owners were directed to measure blood glucose concentration a minimum of three times daily (including every pre-insulin concentration and then generally every 3–6 h), but most measured it more often and sometimes in shorter intervals.

Owners were asked to carefully read the protocol upon joining the forum, and were advised of the prerequisites for using the protocol (Table 1). Advice on using the protocol was provided on an ongoing basis within the forum by experienced owners. Owners were directed to general information in the forum or other websites with regard to potential issues such as hypoglycaemia and ketonuria, and were encouraged to maintain close contact with their veterinarian with regard to their cat's diabetic treatment and general health. Advice provided in the forum related only to non-ketotic diabetic cats with signs of uncomplicated diabetes. Owners of cats that developed ketonuria or signs indicating illness were directed to immediately seek veterinary attention.

Owners regularly tested their cat's urine for ketones, generally using urine dipsticks (Keto-Diastix or Ketostix; Bayer, Leverkusen, Germany). This was particularly recommended during the initial regulation