



Scruffy Miller 14y

## Feline Diabetes

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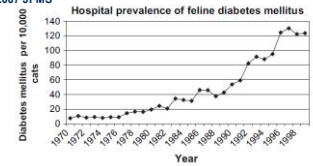
ISFM Consensus Guidelines on the Practical Management of Diabetes Mellitus in Cats.  
Sparkes et al. JFMS 2015;17:235

## Feline Diabetes

Alex Chandler 14y  
Marge Chandler



Prahl et al 2007 JFMS



- **Common - 1 in 200 & increasing**  
Up to 2%?
- **Older - ≥7 years**
- **Male, neutered**
- **Overweight**
- **↓ exercise**
- **Tonkinese, NFC, MC & Siam**
- **Burmese - 1 in 50**



World Health Organization

## Classification of Diabetes Mellitus

### ALIVE system?

#### Type 1 (<5%?)

- Previously: insulin-dependent (IDDM), juvenile or childhood-onset
- **Immune-mediated attack**
- **Idiopathic?**

#### Other (20%?); secondary to:

- **Pancreatitis** >60% DM cats at death; pancreatic adenocarcinoma ~20%
- **Endocrinopathy** e.g. Hypersomatotropism / Acromegaly 18-25%, Hypercortisolism / Hyperadrenocorticism (Cushing's-like disease) 15%
- **Drugs** e.g. corticosteroids, progestogens, cyclosporine
- Hypokalaemia induced DM?

#### Type 2 (~80%?)

- Previously: NIDDM
- **Peripheral resistance**
- **Impaired insulin production**
- **Islet amyloidosis** (humans, cats)
- **Obesity**
- **Adult onset**
- (NIDDM → IDDM)

Gilroy et al. JVIM 2016; 30:927

## Type 2 Diabetes

### Islet amyloidosis

- **Hormone amylin**
- **↓ blood supply**
- **↓ response to glucose**
- **↓ insulin secretion**
- **Toxic to β-cells**

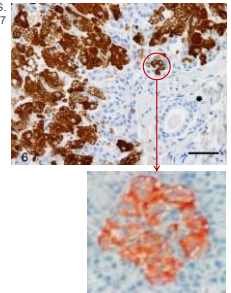
### Peripheral insulin resistance

- **Genetics** e.g. Burmese

### Obesity

- 50% ↑ weight → ~50% ↓ insulin sensitivity; = -5x ↑ risk of DM

Lutz TA, Rand JS.  
J Comp Pathol. 1997

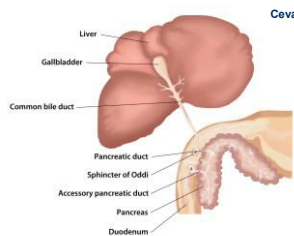


THE UNIVERSITY OF EDINBURGH  
The Royal (Dick) School of  
Veterinary Studies



## Triaditis

Tabitha 7y: IBD, EPI & DM



- **Pancreatitis** (→ exocrine pancreatic insufficiency [EPI] &/or diabetes mellitus [DM])
- **Cholangio - hepatitis**
- **Inflammatory bowel disease (IBD → lymphoma)**

## Transient Diabetes / Diabetic Remission

20-80% of cats get transient DM e.g. normoglycaemia for ≥4 weeks

- Reverse 'glucose toxicity'
- 25-30% relapse again later

### Type 1 - no

### Type 2 - yes

### Obesity

### Islet amyloidosis

### Secondary - yes

### Pancreatitis >60%

### Infection e.g. gingivitis, UTI ~25%

### Endocrinopathy e.g. hypersomatotropism ~20%; ↑IGF-1

### Hypercortisolism / hyperadrenocorticism 15%; ↑UCCR

### Drugs e.g. corticosteroids

Sally 7y: Obesity & DM



Gostelow et al. Vet J. 2014;202:208; Lewitt et al. Acta Vet Scand 2016; 58(suppl 1):63; Schaefer et al. JFMS 2017 19(8): 888

## Diagnosis of Diabetes



Noddy 5y

### Diagnosis requires:

- **Appropriate history & clinical signs** - polyuria, polydipsia & polyphagia
- **Persistent fasting hyperglycaemia** - >11 mmol/l; consider >7.5 mmol/l as pre-DM?  
But remember - stress hyperglycaemia → >16mmol/l
- **Glucosuria**



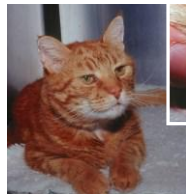
Jojo Pacheco – plantigrade stance



Ellie 8y; IBD, EPI & DM

## Diagnosis

- **Can be very subtle, unless systemically ill**
- **Most consistent** - polyuria, polydipsia & polyphagia
- **Polyphagia** → initial weight gain → weight loss  
**But:** free choice feeding & outdoor lifestyles
- **Acute / chronic pancreatitis** → episodes of depression, anorexia, vomiting, diarrhoea, &/or abdominal pain, &/or signs of EPI (voracious appetite & large quantities of voluminous fatty faeces); >60%; ↑ fPLI
- **UTI** → signs of cystitis &/or renal failure &/or 'dementia' ~25% UTI



Acromegaly & DM – Ginger 14y



Thin skin, obvious veins - Hyperadrenocorticism

## Clinical signs

- **Cholangio-hepatopathy** → abdominal pain, jaundice, depression
- **Heart failure** → congestive heart failure &/or cardiogenic shock
- **Hypersomatotropism (Acromegaly)** - 18-25%
- **Hypercortisolism (Hyperadrenocorticism / Cushing's-like disease)** 15%  
↑UCCR



## Diagnosis of Diabetes



Arias de Hassan 10y

- **Clinical signs**  
Polyuria, polydipsia, polyphagia ...
- **Serum biochemistry** - hyperglycaemia - consider stress  
Serum fructosamine ...
- **Urine analysis**  
Urine glucose – when blood glucose > ~15 mmol/l (ref. 3.3-5.0)  
Urine ketones – 10-40%  
Culture – 15-25% UTI
- **Underlying & concurrent disease**  
Pancreatitis, hepatopathy, hyperthyroidism ...



## Treatment of cats with Diabetes



Anne-Marie Svendsen

### The goals:

- **Limit clinical signs**
- **Avoid hypoglycaemia**
- **Aim for diabetic remission?** Aggressive early treatment e.g. insulin IV, SQ q6-8h, intensive monitoring; → remove need for exogenous insulin?

### Treatment:

- ↓ weight & ↑ exercise
- **Dietary modification**
- **Oral hypoglycaemic drugs**
- **Exogenous insulin**

Manage client expectations ...

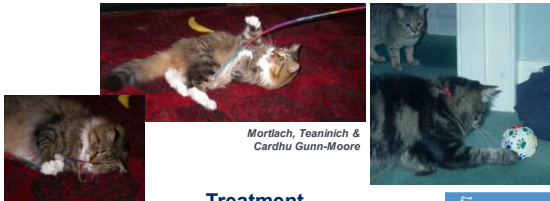


## Tips for optimising client compliance

Cuishla McFarlane



- **Provide information** - causes, diagnosis, treatment & prognosis  
Client hand-outs, good websites
- **Clear expectations** - time for stabilisation, possible complications, changing insulin requirements, role of diet, need for home monitoring, etc.
- **Explain that diabetes may be transient if treatment is prompt & aggressive** ... but this is not without risks ...
- **Allow time to discuss concerns**
- **Nursing staff very helpful**
- **Be flexible & realistic** - esp. regarding timing of feeding & insulin



### Treatment

- ↑ exercise & ↓ weight
- 10 minutes per day every day
- Obese cats → ↓ weight



### Treatment



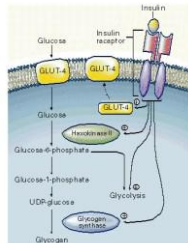
Hugo Boss Simpson with high protein lunch!

### Diet

- High fibre?
- High protein, low carbohydrate



### Treatment - Diet



- Insulin → glucose → cells
- Phosphorylation prevents diffusion
- Hexokinase or glucokinase add phosphate
- Cats lack glucokinase
- Hexokinase most effective at ↓ [glucose] & acts more slowly
- ↑ protein → ↓ & delayed postprandial glucose surge
- ↑ protein → ↑ effectiveness of hexokinase
- → less ↑ glucose in blood & ↓ signs of DM

### Diets for cats with diabetes

Typical analysis	Unit	PVD DM wet	PVD DM dry	Hill's m/d wet	Hill's m/d dry	RCV Diabetic dry	Hill's w/d wet	Hill's w/d dry
Dry matter								
Protein	%	55.6	54.1	52.8	51.1	46	41.5	40
Fat	%	23.1	17.1	19.4	22	12	16.5	9.8
Fiber	%	3.7	1.3	6	6	11.4	10.6	9.2
Carbohydrates	%	3.8	18.2	15.7	15	17.1	24.2	35.3
Declared ME	Kcal/Kg	4100	4100	4000	4200	3800	3800	3500
ME from carbohydrates	%	7	20	14	15	26	26	37

- Vitamin E - ↓ oxidative stress e.g. Nestlé Purina PVD DM
- Carnitine - ↓ risk of hepatic lipodosis e.g. Hills m/d

### Diets for cats with diabetes



- Aim for <12% metabolisable energy (ME) from carbohydrates\*
- Recommend include:
  - Purina DM diabetic wet food
  - Thrive or Untamed cat food<sup>2</sup>
  - Lily's Kitchen Marvellously Mature dry food<sup>2</sup>
  - Lily's Organic Fish tins<sup>2</sup>
- ↓CHO commercial wet foods → 5 x remission (p=0.016), 15 x no relapse (p=0.001)
- v wet or dry DM Prescription diets\*

<sup>2</sup> = 0%

<sup>2</sup><https://endocrinevet.blogspot.com/2014/01/how-to-calculate-carbohydrate-and.html>

<sup>1</sup>Albuquerque et al. 2019; Rothlin-Zachrisson 2021

### Feeding cats with diabetes

- Assist hexokinase activity
- Regular & consistent
- Little & often
- Ad lib feeding
- Consider concurrent disorders
  - e.g. DM & chronic kidney disease
  - Renal diet & insoluble fiber (e.g. psyllium husk)
  - ± Acarbose



Slow Cat Feeders





## Velagliflozin e.g. Senvelgo

Possible adverse reactions include:<sup>12</sup>

### Very common:

- **Loose stool/diarrhoea:** generally lasts for 7 days or less and usually resolves without specific treatment.
- **Polydipsia/polyuria:** resolves without additional treatment; may occur as part of the underlying disease or may be enhanced due to the osmotic effect of velagliflozin.
- **Weight loss:** may occur as part of the underlying disease. An initial weight loss may occur due to the glucosuric effect of velagliflozin.
- **Mild dehydration.**

UTI: 127 cats, Senvelgo (31%) v Insulin q12h (32%); Niessen *et al.*, 2023

### Common:

- **Urinary tract infection:** may occur as part of the underlying disease, although the glucosuric effect of velagliflozin may contribute to urinary tract infection. Standard cystitis/urinary tract infection therapy should be initiated.
- **Hyponatraemia:** usually at initial administration only and occurs immediately following dosing and resolves quickly, without the need for treatment.
- **Diabetic ketoacidosis (DKA):** may be eulycaemic (see pages 14-15). Suspend treatment and initiate insulin therapy and other supportive measures.
- **Diabetic ketonuria:** stop treatment, undertake further investigations and manage accordingly (e.g. initiate insulin therapy).



## Velagliflozin e.g. Senvelgo™

Senvelgo



### In the event of DKA/eDKA:



Suspend use of Senvelgo<sup>®</sup>



Initiate insulin treatment (even with normal glucose levels in cases of eDKA)



Supplement the cat with intravenous dextrose as needed (if blood glucose <15 mmol/l)



Provide appropriate nutrition to prevent or treat possible hepatic lipidosis



If appropriate, resume Senvelgo<sup>®</sup> treatment once the cat is stabilised, hydrated, all signs of DKA and/or ketosis have been resolved



We recommend contacting our Technical Services Team to discuss whether it is appropriate to resume Senvelgo<sup>®</sup> treatment

### Other factors ...

#### SGLT-2 inhibitors:

- **Velagliflozin e.g. Senvelgo™** (PO q24h; solution)
- **Bexagliflozin e.g. Bexacat™** (PO q24h; tablets)

#### Single use plastic syringes:

- **Insulin q12 hours for 3 months n=180**
- **Senvelgo™ n=1**
- **Bexacat™ n=1**

#### Cat-caregiver bond:

- **No twice daily insulin needed**
- **Protects the cat-caregiver bond**



<https://www.felinepurrerspective.com/feeding-diabetes-in-cats-insulin-and-non-insulin-therapies/>



## Tx of cats with Diabetes

### 1<sup>st</sup> Remove causes of peripheral resistance

e.g. drugs, infection, concurrent disease, ↓ weight

### 1<sup>st</sup> Change diet to ↑ protein, ↓ carbohydrate

Monitor

### 1<sup>st</sup> SGLT-2 Inhibitor e.g., Senvelgo

Monitor

### 2<sup>nd</sup> Introduce exogenous insulin

Monitor

### 3<sup>rd</sup> Other oral hypoglycaemic drugs

Monitor



Caring for an overweight cat

Alex Chandler 14y;  
Marge Chandler



## Treatment

### Insulin

- **Lenti, PZI, glargine, detemir:** 1-2 xq12h
- **Start 0.25-0.5 IU/ideal kg/per injection**  
0.25 IU/kg if BG <20 mmol/l  
0.50 IU/kg if BG >20 mmol/l; **Max 3 IU/cat**
- **Adjust by 0.5-1.0 IU per dose**
- **Only ↑ insulin dose q5-7 days**
- **Aim: BG 5.5-14 mmol/l**
- **Match insulin & syringes**
- **Do not dilute insulin**

Gilor & Fleeman 2022



Hafner *et al.* 2014

## Treatment

### Insulin

- **Cats → unpredictable response to insulin**
- **Day 1** - check ~ nadir if > 10 mmol/l → no change  
**Send home**
- **Week 1** - blood glucose curve (BGC); 12 v 24h, sample q1-4h  
**If no ↓ glucose** → ↑ insulin 0.5-1 IU per injection → reassess in 1 week
- **Once nadir 8-13 mmol/l** → perform complete BGC
- **Look for trends**
- **Cannot perform BGC with stress hyperglycaemia**
- **Intensive IV 7-day protocol with SQ constant glucose monitoring<sup>2</sup> ...**

Maya & Mona, 8y  
Burmese with DM



## Owner instructions

- Drug company support documents
- Stabilization will not be achieved within days
- Transition to optimal diet & feeding
- Using correct insulin syringes &/or insulin pens
- Correct handling, storage & injection of insulin
- Clinical signs of hypoglycaemia & how to treat low glucose concentrations



## Treatment

### Signs of hypoglycaemia

- Blood glucose <2 mmol/l
- Sudden desire to hide
- Quiet, weak, lethargy, shaking, ataxia, collapse & coma
- Cats rarely → polyphagia



Teaninich Gunn-Moore 14y

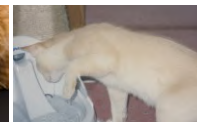


Bubu Aim16y  
Plantigrade hocks



### Stabilization & monitoring

- Appetite
- Body weight
- Body condition score
- General well being
- Energy & muscle strength
- Coat quality



Charlie & Alex Chandler:  
Marge Chandler



### Stabilization & monitoring

- Drinking
- Urination



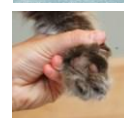
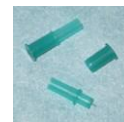
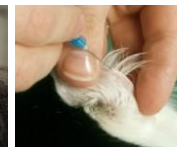
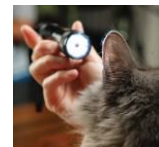
Medicat™  
Size of urine balls



Detects UTI

### Stabilization & monitoring

- Urine testing - glucose should be negative ...  
Unless Tx with SGLT-2 inhibitors  
Ketones (should be negative); culture
- Fructosamine - ~1-2 weeks, ↓ with hyperthyroidism  
Sensitivity 93%, specificity 86%



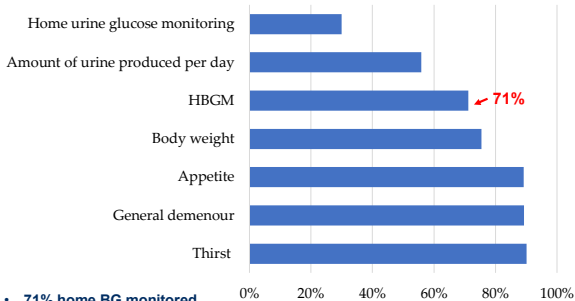
### Stabilization & monitoring

- Glucose curves
- Number of time points
- 12 or 24 hours
- Variability, stress



<http://www.youtube.com/watch?NR=1&v=fRK7QY7ZEK>  
<http://www.youtube.com/watch?v=zE12-4Nv8>

**Preferred methods for monitoring diabetic control (n = 708)**



- 71% home BG monitored
- Only discussed at 40% of initial consults

Albuquerque et al. JFSM 2019

**Continuous glucose monitoring**

- Monitor interstitial fluid glucose concentration
- Guardian RealTime, MiniMed Gold, etc.
- FreeStyle Libre (Abbott) – calibrated in the factory, sensor good for 14 days; median sensor activity for ~7 days (2-13 days); ~80% sensor failure

Guardian RealTime  
Steph Lalor



Xenoulis & Fracassi JFMS 2022

Original Article

**Complications associated with a flash glucose monitoring system in diabetic cats**

Adam M Shoelson<sup>1</sup>, Oriana and Michelle Pavlick<sup>2</sup>

**Abstract**

**Objectives:** Glucose monitoring is an increasingly commonly used monitoring system (FGMS). The associated with the use of an FGMS. **Methods:** The medical records of retrospectively reviewed. Data retrieved included the number of days the sensor remained attached and functional, location of sensor placement and complications associated with the sensor. Complications were defined as early sensor detachment, sensor failure prior to the end of the 14-day monitoring period and dermatologic changes at the sensor site. Descriptive statistics were used to characterize the data. **Results:** Twenty cats had a total of 33 FGMSs placed. The majority (30/33 (91%)) of sensors were placed over the dorsolateral aspect of the thorax just caudal to the scapulae. Twenty (81%) FGMSs remained attached and functional for the full 14 days. The overall incidence of complications associated with FGMS use was 10/33 (30%). The most frequent complication was early sensor detachment (n = 6/33 (18%)). Mild dermatologic changes (erythema, crusts) were noted with 4/33 (12%) FGMSs. More serious complications (skin erosions, abscess formation) were noted with 2/33 (6%) FGMSs. **Conclusions and relevance:** The use of the FGMS is relatively safe in cats, although there are potential complications that owners should be made aware of.

**Keywords:** Continuous, glucose, monitoring, complications

**Accepted:** 16 September 2020



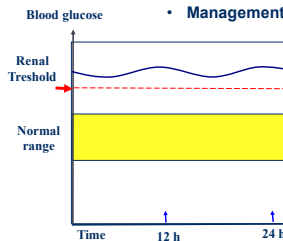
**Short-term & long term monitoring**

Blood glucose	Action
Nadir BG <4.5 mmol/l (80 mg/dl)	<ul style="list-style-type: none"> <li>◆ Reduce insulin dose by 50%</li> <li>◆ Consider longer acting insulin if peak BG &gt;14 mmol/l (252 mg/dl)</li> </ul>
BG 4.5–14 mmol/l (80–252 mg/dl) on all samples measured throughout the day	Maintain therapy
Peak BG >14 mmol/l (252 mg/dl) and nadir BG 4.5–8.0 mmol/l (80–144 mg/dl)	<ul style="list-style-type: none"> <li>◆ Maintain therapy and retest after 1–2 weeks; or</li> <li>◆ Change insulin (if using lente insulin) to a longer acting insulin; or</li> <li>◆ Increase dose by 0.5 U/cat q12h (depending on peak and nadir BG)</li> </ul>
Peak BG >14 mmol/l (252 mg/dl) and nadir BG >8.0 mmol/l (144 mg/dl), with signs of ongoing hyperglycaemia	Increase dose by 0.5–1.0 U/cat q12h

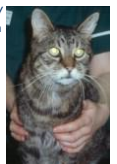
Sparkes et al., ISFM consensus guidelines on the practical management of diabetes mellitus in cats. JFMS, 2015

**Glucose curve**

- No response
- Stress
- Insulin resistance >2.0 IU/kg q12h...
- Management → ineffective



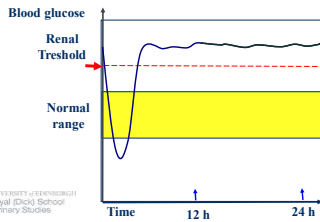
Tigger 17y; Acromegaly / hypersomatotropism



insulin, poor injection technique, insulin overdose  
**True resistance** - failure of insulin absorption, weight gain, infection, pancreatitis, hyper-T<sub>4</sub>, hypersomatotropism, hyper-adrenocorticism, exogenous corticosteroids, etc.

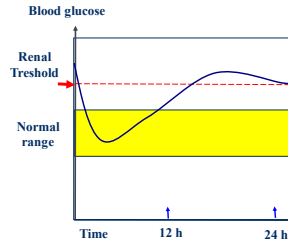
### Glucose curve

- **Insulin overdose** → **Somogyi over-swing**  
~ <2 mmol/l or ↓10 mmol/l/h → Somogyi over-swing that can last only 30-60mins → ↑ glucagon, etc. can last → 72 hours
- **Give a lower dose** (or less potent insulin)



### Glucose curve

- **Duration of action too short**
- **Give more frequently**
- **Give a longer acting insulin** (PZI or glargine)



ISFM Consensus Guidelines on the Practical Management of Diabetes Mellitus in Cats.  
Sparkes *et al.* JFMS 2015;17:235

### Summary

- **Diabetes is common in older cats**
- **Most feline diabetes is Type 2** (insulin resistance)
- **2o diabetes is common** (pancreatitis, hypersomatotropism, hyperadrenocorticism)
- **Subtle to severe clinical signs**
- **Ideally Tx with SGL-2 inhibitor & diet**
- **Concurrent diseases are common**
- **Monitoring can be challenging**
- **Prognosis variable - 50% → † in 12-17 months**  
*i.e. MST = 1-2y*



Zelda Arnott 8y



Thank you!  
Any questions?

