**Sweet Success: Managing the Diabetic in Small Animal Practice**

**Wendy Blount, DVM**

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**The Endocrine Pancreas**

- Islets of Langerhans dispersed in the exocrine pancreas (acinar cells)
  - Alpha cells – secrete glucagon
  - Beta cells – secrete insulin
  - Delta cells – secrete somatostatin
  - Pancreatic Polypeptide (PP) cells – secrete pancreatic polypeptide

- Most common endocrinopathy of the pancreas is diabetes mellitus
  - Insulin deficiency
  - Insulin resistance

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**Clinical Presentation**

- **High Risk Breeds**
  - Mixed Breed most common in dogs and cats
  - Australian Terrier 32x risk
  - Then Schnauzer, Samoyed, Fox Terrier
  - Then Keeshond, Bichon, Spitz, Cairn Terrier, Poodle, Husky, Border Terrier, English Setter, Dachshund
  - Burmese Cat

- **Low Risk Breeds**
  - Boxer is the lowest risk
  - Also GSP, Airedale, GSD, Pekingese, Collie, Weimaraner, Staffordshire Bull Terrier, Golden Retriever, Springer Spaniel

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**Clinical Presentation**

- **Most dogs & cats >5 years**

- **History**
  - PU-PD – bigger clumps in the litter box
  - weight loss, polyphagia
  - Vomiting, illness of DKA
  - History of triaditis, pancreatitis
  - Recent heat

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**Clinical Presentation**

- **Exam**
  - Endocrine alopecia, pyoderma, poor grooming in the cat
  - Pot belied – hepatomegaly
  - Cranial abdominal mass – pancreatitis + pain
  - 10% Diabetic neuropathy in the cat
  - Pregnancy, pyometra, coming out of heat
  - Cats are more likely to be overweight with recent weight loss
  - Dogs more likely to be underweight

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**Steps of Managing the Diabetic**

**As Simple as 1-2-3**

1. **Diagnosis & Stabilization**
   - Monitoring serology is key to success in managing the DKA patient

2. **Insulin Regulation & Treat Complications**

3. **Maintenance & Insulin Adjustment**
Diagnosis

1. Confirm Hyperglycemia
   - Stressed cats can have transient hyperglycemia (200-400)
   - Critically ill non-diabetic dogs can also have marked hyperglycemia (>400)
   - Stress hyperglycemia due to glucocorticoids, epinephrine and insulin resistance
   - Hyperglycemia has adverse effects on the immune system, coagulation, heart and brain
   - Treat with judicious insulin PRN

Diagnosis

2. Stress Hyperglycemia or DM?
   - “No glucosuria” makes DM unlikely
   - Stressed cats can have glucosuria
   - Renal threshold 180-220 mg/dl in the dog
   - 200-300 mg/dl in the cat
   - Ketones in the urine indicate catabolism – investigate DKA
   - DKA = Diabetic ketoacidosis
   - Any sick cat who has not eaten for days can have ketonuria
   - If all else fails, run a fructosamine
   - Fructosamine elevated with DM

Diagnosis

3. Confirm PU-PD
   - Can’t always rely on the history
   - Urine specific gravity higher than usual for PU-PD dog (1.020’s-1.030’s)
     - Glucose increases USG
     - Water intake > 100 ml/kg/day
       - 11 lb. cat > 16 ounces per day
       - 25 lb. dog > 1 quart per day
       - 45 lb. dog > 1 half a gallon per day
       - 85 lb. dog > 1 gallon per day

Diagnosis

4. Initial Work-up
   - Prior to regulation – Why?
   - Assess for DKA, pancreatitis which usually require hospitalization & correction of other problems prior to insulin therapy
   - Assess for pancreatitis, fatty liver which might require feeding tube placement
   - Assess for concurrent problems which might change long term prognosis
   - Identify urinary tract infection or other problems that will complicate regulation

Diagnosis

4. Initial Work-up
   - CBC – evidence of infection or pancreatitis
   - General health profile
     - Include phosphorus
       - If hypophosphatemic, put on IV fluids with potassium phosphates prior to first dose of insulin
     - Especially if acidotic
     - Almost all unregulated diabetics have high liver enzymes
       - Many have hepatomegaly
     - Cholesterol and triglycerides high in dogs with unregulated diabetes
     - Look for CRF if glucose >800

Diagnosis

4. Initial Work-up
   - General health profile
     - Indications of pancreatitis/fatty liver/DKA
       - ALT >500, ALKP >800 (pancreatitis or HAC)
       - Icterus without anemia and maybe without elevated liver enzymes
       - Hypoalbuminemia & hypocalcemia (pancreatitis)
       - Pancreatitis is the most common cause of hyperlipidemia in the cat
       - Cats - GGT elevation significantly exceeds SAP elevation only in hepatic lipodosis
     - Indications of pancreatitis/DKA tell you to provide aggressive fluid support
     - Indications of fatty liver tell you to provide aggressive nutritional support
4. Initial Work-up

- Electrolytes and venous blood gases
  - VetStat, iSTAT and Catalyst all provide in-house blood pH
  - If hypokalemic, put on IV fluids with potassium phosphates prior to first dose of insulin
  - ESPECIALLY IF ACIDOTIC
    - Insulin carries K\(^+\) and Phos into the cell
    - When insulin is given, low serum K\(^+\) and Phos go even lower when ushered into cells
    - Correcting acidosis makes low serum K\(^+\) and Phos even lower
    - Phos <1.5 can cause severe hemolysis
    - Low K\(^+\) can cause weakness and paralysis

- Monitor PCV, K\(^+\) and Phos at least daily until stable, in DKA patients
  - More often if very low or unstable
- Can use 0.5cc lithium heparin tubes to prevent exsanguination
- Place jugular catheter for patient comfort
  - Draw blood without venipuncture
- Replace K\(^+\) according to sliding scale
  - More K\(^+\) supplemented when acidic
  - The lower Phos, the more KPhos:KCl you use
  - Don’t exceed 0.5 mEq/kg/hr potassium

- Eating is important to maintaining K\(^+\)/Phos
  - Things usually begin to stabilize when the cat begins to eat
- REMEMBER
  - KCl contains 2 mEq/ml potassium
  - KPhosphates contain 4 mEq/ml potassium
  - Use half the volume of KCl as KPhos for the same amount of potassium added to fluids
- Be VERY CAREFUL of bicarbonate therapy
  - I almost never give bicarb to DKA patients
  - Bicarbonate can exacerbate low Phos and K
- Regular insulin given PRN to keep glucose 100-250, checking glucose q2-4 hrs

5. If panel or exam indicates pancreatitis

- cPLI for dogs (in house SNAP - Idexx)
- fPLI for cats ????
- Can follow these long term to monitor resolution of pancreatitis
- Abdominal US

\textbf{cPLI is the best test for pancreatitis in the dog}

Ultrasound is the best test for pancreatitis in the cat

4. Initial Work-Up

- Urinalysis + urine culture
  - Check for ketones (look for DKA)
  - Glucosuria, dilute urine and immunosuppression predispose to UTI
  - 25% of new diabetics have a UTI, often without clinical signs
  - Immunosuppression prevents detection of bacteriuria
  - Dilute urine prevents detection of bacteriuria
  - Blood pressure
  - FeLV/FIV for cats, HWAg for dogs
  - For A+ Clients
    - Imaging “looking for trouble”
    - Chest x-rays, Abdominal US
    - Look for pancreatitis, IBD, infection, concurrent problems

6. Middle aged to older cats

- TT4, fT4 if >5 years old

7. Dogs with endocrine alopecia

- After stabilization, during regulation
  - TSH, TT4, fT4
  - If symptoms of hyperadrenocorticism
    - ACTH Stim, Low Dose Dex Test, Abdominal US
**Insulin Regulation**

Don’t be in a hurry
- It can take a few months (2-3 months ave.)
- Prepare the owner
- Insulin needs often change over the first weeks of insulin therapy
  - Control symptoms of hyperglycemia, while avoiding hypoglycemia
  - Severe hypoglycemia is immediately life threatening
  - Severe hyperglycemia a problem only when prolonged
  - Not quite enough insulin is better than a little too much

**Insulin Starting Dose**

<table>
<thead>
<tr>
<th>Insulin</th>
<th>Starting Dose</th>
<th>Median Dose</th>
<th>Dose Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>NPH</td>
<td>0.25-0.5 U/kg</td>
<td>0.5 U/kg</td>
<td>0.2-1 U/kg</td>
</tr>
<tr>
<td>Lente</td>
<td>0.25-0.5 U/kg</td>
<td>0.7 U/kg</td>
<td>0.3-1.4 U/kg</td>
</tr>
<tr>
<td>PZI</td>
<td>0.5 U/kg</td>
<td>1 U/kg</td>
<td>0.4-1.5 U/kg</td>
</tr>
<tr>
<td>Glargine</td>
<td>0.5 U/kg</td>
<td>0.6 U/kg</td>
<td>0.1-1.1 U/kg</td>
</tr>
<tr>
<td>Detemir</td>
<td>0.1-0.2 U/kg</td>
<td>??</td>
<td>0.07-0.23 U/kg</td>
</tr>
</tbody>
</table>

- For every insulin, the starting dose of 0.5 U/kg is more than the lower end of the dose range
- Some pets will be overdosed
- For NPH, half of the patients will be overdosed

**Insulin Regulation**

Start insulin at 1-2 units per 10 pounds
- Dogs:
  - 1 unit per 10 lbs if glucose <350
  - 2 units per 10 lbs if glucose >350
- AAHA Guidelines – 0.25U/kg BID
- Cats (Feldman & Nelson)
  - 0.5 U BID for very small cats (<2 kg)
  - 1 U BID for cats < 4 kg
  - 1.5 U BID for cats >4 kg
  - 2 U BID for very large cats (>8 kg)

**Insulin Regulation**

0.5 mg/kg is too high to start
Catherine Scott-Moncrief, CVMA 2013

- For every insulin, the starting dose of 0.5 U/kg is more than the lower end of the dose range
- Some pets will be overdosed
- For NPH, half of the patients will be overdosed

**Insulin Regulation**

First insulin dose:
- Glucose checks to rule out hypoglycemia
  - 3, 6 and 9 hours post insulin
- If well, send home that evening if curve shows no hypoglycemia
- Even if glucose values are high
- Reduce dose if any value <80 and repeat the next day
- Keep no more than one night, if you can help it
- If sick, keep in hospital until stable

**Insulin Regulation**

Recheck one week for glucose curve
- sooner if problems

Owner instructions
- Talk owner through the first injection
  - Draw up insulin without bubbles
- Give owner handouts
  - diabetes in dogs, diabetes in cats
  - Insulin and Feeding Instructions
  - Insulin Handout
- Save home glucose testing for later, when they are ready

**Insulin Regulation**

Weekly to bi-weekly rechecks until regulated
- Even every 3-4 weeks when very stable
- Indicators longer recheck intervals are OK
  - PU-PD is relatively well controlled
  - No significant weight loss since the last visit
  - Feeling well, no vomiting, eating well
  - Owner is coping well

Once you get a good curve – recheck in 6-8 weeks or so
Which Insulin for Dogs?

Regular Insulin (Humulin R®, Novolin R®, Lispro®) – *U100* - short acting
- Used only in the hospital, for critical care IV/IM q 1-6 hrs
- Shortest acting

NPH – neutral protamine hagedorn (Humulin N®, Novolin N®) - *U100* - medium acting - BID
- Often used because affordable, but too short acting for some dogs
Lente (Vetsulin®, Caninsulin®) – 30% semilente + 70% ultralente – *U40* - medium to long acting - BID
- An excellent first choice – actual canine insulin
Protamine zinc (ProZinc®) - *U40* - long acting - BID
- Now approved for dogs – longer than ideal for most dogs

Which Insulin for Dogs?

Glargine – insulin analog (Lantus®) - *U100* - very long acting – SID-BID
- Erratic absorption in dogs
- Not a good first choice, as regulation is often difficult
Detemir – insulin analog (Levemir®) - *U100* - very longest acting – SID-BID (usually BID)
- Seems to be more reliable than Lantus if a long acting insulin is needed
- But still not a first choice
- Starting dose much lower – 0.1 U/kg SID
- Can be an affordable option for the occasional dog that may need a longer acting insulin

Pens available - NPH, Lente (VetPen®), glargine & detemir

Which Insulin for Cats?

NPH – neutral protamine hagedorn (Humulin N®, Novolin N®) - *U100* - very short acting
- Usually too short acting for cats – not recommended
Lente (Vetsulin®, Caninsulin®) – 30% semilente + 70% ultralente – *U40* - short acting
- Works for many cats, but may be too short acting for some
- Feline differs from canine insulin by 3 AA
- $40 per bottle (400 units - $0.10/U)
- “Buy In” is the cheapest - $18 a month for a cat that takes 3U BID

Protamine zinc (ProZinc®) - *U40* - medium acting
- A good first choice for cats
- Cats burn through insulin faster than dogs
- Costly - $100 per bottle (400 units - $0.25/U)
- $45 a month for a cat that takes 3U BID

Which Insulin for Cats?

Glargine – insulin analog (Lantus®) - *U100* - long acting
- Probably the best first choice for cats
- Most likely to result in remission, with low carb diet
- Curves are smoother
- Costs ~$300 for 10ml (1000 units - $0.30/U)
- For a cat taking 3U BID, it is $54 a month
- 3 ml pen is $80 (300 units - $0.27/ml) – 3U BID - $50/month
- It pays for itself in saved vet bills

Detemir – insulin analog (Levemir®) - *U100* - long acting
- Starting dose much lower – 0.1 U/kg
- Many cats would take less than a unit BID

Original PZI and ProZinc are not the same insulin
- Original PZI (Idexx) was beef and pork – most likely to produce insulin antibodies.
- ProZinc (Bi) is recombinant human – unlikely to produce insulin antibodies.

AAHA Guidelines recommend Lantus® and ProZinc® as best insulins for cat
- Lantus® preferred by most endocrinologists
- Some cats have a flat curve with Lantus® and others a significant peak

Which Insulin for Cats?

Which Insulin for Cats?

Once a Day Insulin?

- Virtually all dogs and cats do better on BID insulin
- Very few dogs or cats will have acceptable quality of life on SID insulin
  - detemir may be the exception, if a dog happens to do well on it
- Cats on Lantus have the best chance for SID
  - Studies show glycemic control is better when given BID
- Better to give BID in every day possible, and SID when that’s the best that can happen, than to resign to SID every day
**Oral Hypoglycemics?**

**Type I Diabetes – IDDM – Insulin Dependent Diabetes Mellitus**
- Minimal spontaneous secretion of insulin
- Almost all dogs have this type
  - Most often caused by immune mediated destruction of the beta cells
- Insulin injections required for survival
- Oral hypoglycemics do not work on this type
  - thus have no effect on most dogs with DM

**Type II Diabetes – NIDDM – Non-Insulin Dependent Diabetes Mellitus**
- Abnormal insulin secretion, Peripheral insulin resistance
- Controlled with diet, weight control and oral hypoglycemics
- Most cats have this type, rare in the dog
  - Exceptions for the dog are intact females that go into remission after OHE
  - Consider ovarian remnant syndrome in the spayed female
  - Another exception for the dog is pancreatitis

**Criteria for Glipizide**
- Good physical condition
  - Non-ketotic
- Mild to moderate symptoms of diabetes
- Can be monitored closely

**Starting Dose**
- 2.5 mg/cat PO BID, with food
- Increased to 5 mg PO BID in 2 weeks if:
  - Hyperglycemia still present
  - No unacceptable side effects

**Continue as long as symptoms controlled**
- Stable weight, Glucose curve 80-300
- Liver toxicity can occur (icterus)
Oral Hypoglycemics?

**Glinides also increase insulin secretion**
- natglinide

*Some inhibit glucagon secretion* (gliptins)

*Some enhance tissue sensitivity to insulin*
- Biguanides - Metformin
- Thiazolidinediones (TZDs), aka glitazones
- Chromium, vanadium

*Some slow post-prandial intestinal glucose absorption*
- Alpha-glucosidase inhibitors (acarbose)

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**GLP-1 (glucagon like peptide) receptor antagonists (incretin antagonists)**
- Injectable
- No data in diabetic cats
- Exenatide - $$$$$

**DPP-4 (dipeptidyl peptidase) inhibitors**
- DPP-4 breaks down GLP-1
- Oral
- No data in diabetic cats
- Sitagliptin - $$$$$

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**Metformin**
- Does not cause weight gain as glipizide
- Contraindicated if impaired renal function, cardiopulmonary disease, liver disease
- Most serious adverse effect is lactic acidosis (rare)
- Dose varies from 10-50 mg per cat PO BID
- Very little data on its use in cats

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**Acarbose**
- Effective only with high carb foods (no effect with low carb diet)
- 12.5 mg PO BID with each meal
- GI side effects can be reduced by lowering the dose
- Contraindicated in people with renal disease
- No useful application in cats, unless the cat needs a high carb diet for reasons other than renal disease

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**Chromium – enhances tissue insulin sensitivity**
- chromium deficiency can cause insulin resistance
- One study showed it did not improve glycemic control in diabetic dogs
- Few side effects
- Chromium chloride, nicotinate or picolinate
  - Picolinate absorbed most consistently
- No data in diabetic cats

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**Vanadium –insulinomimetic properties**
- All vanadium salts seem to be similar
- Improved glycemic control in people, but GI side effects
- One study shows slightly improved glycemic control in diabetic cats treated with P2I
  - 45 mg PO SID vanadium dipicolinate
  - Can cause anorexia and vomiting
Nutrition for Diabetic Dogs

- **High complex carbs (>50% dry matter)**
  - Low glycemic index
- **High fiber (>10% dry matter)**
  - Increased soluble fiber slows GI transit and potentiates insulin in tissues
    - Fruits, legumes, oats
  - Increased insoluble fiber slows GI transit time, starch hydrolysis and glucose absorption
    - Cellulose in vegetables and grains
  - Reduced fats to prevent pancreatitis

Nutrition for Diabetic Dogs

- Diets recommended for diabetic dogs in good body condition:
  - Eukanuba Restricted Calorie, Glucose Control, Adult Reduced Fat
  - Hill’s w/d, r/d
  - Purina DCO, OM
  - Royal Canin Diabetic
- **Contraindications to the recommended diet**
  - Emaciation
  - Chronic constipation or obstipation
  - Severe recurring pancreatitis that needs lower fat, or other co-morbidities that require a different diet

Nutrition for Diabetic Dogs

- **Feeding Schedule**
  - Dogs treated with BID insulin
    - Half of caloric intake offered at insulin time
  - Dog treated with SID insulin (glargine or detemir)
    - Half of caloric intake at insulin time
    - Half 8 hours later
  - Dogs do not have to meal feed
    - Munching on food available throughout the day seems to work well as long as ideal weight is maintained
    - Offer at insulin time, and when it’s gone, it’s gone

Nutrition for Diabetic Cats

- For many years, we fed diabetic cats high fiber, low fat diets, just like dogs & people
- 2001 - ACVIM – carbs also important
  - 31% fed Low Carb diet were able to d/c insulin, and an additional 46% decreased insulin dose
  - None of the High Carb cats were able to reduce or discontinue insulin
  - Confirmed by numerous studies since
  - Remission achieved by using low carb-high protein diets with long acting insulin (glargine – Lantus®)
  - Some papers have reported remission rates 60-80%
  - Chance of remission increases four-fold by feeding low carb-high protein diet

Ideal diet for diabetic cats

- >40% protein and <10% carbs, as % of calories
- A little different from % of Dry Matter basis (fat is 2x as calorie dense as protein & carbohydrate)
- Percent Calories Calculator can estimate percent calories from Guaranteed Analysis
- If a flatter curve is needed, insoluble fiber (Metamucil) could be added to canned low carb diet to slow GI transit time without adding carbs
- No studies on doing this
- Hill’s Studies comparing 2 high carb diets with differing fiber shows diabetics do better on high fiber diet, when carbs are equal

*Hill’s Studies comparing 2 high carb diets with differing fiber shows diabetics do better on high fiber diet, when carbs are equal*
**Ideal diet for diabetic cats**

- If ideal diet is rejected, consistency in food intake and consistency of diet are important
  - Regulate around food the cat will eat
- Diet for the most serious disease should take priority
  - **NOTE:** some feline experts no longer recommend protein restriction for chronic renal disease.
  - Currently no studies for or against
  - Most agree phosphorus restriction is appropriate
  - It’s difficult but not impossible to produce a high protein, low phosphorus diet

**Prescription renal diets** phos 68-120mg/100kcal & protein 21-27%

**Commercial maintenance diets** phos 200-700mg/100kcal

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**Myth #1: Diabetic cats should be meal fed if they are to be well regulated**

- Fresh food BID – allowed to eat ad lib
- Multiple small meals eaten throughout the day and night
- 24 hour glucose curve done (q2h)
- No correlation between blood glucose and the amount of food consumed over the previous 2 hours
- Overnight fast did not significantly alter morning blood glucose

**Fresh food BID – allowed to eat ad lib**


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**Myth #2: You shouldn’t give insulin to pets who aren’t eating**

- Diabetics that don’t eat still need insulin – they just need less (50% of usual dose for complete anorexia)
- If glucose >300 for any period of time, insulin needs to be given to prevent diabetic ketoacidosis
- Dogs and cats with DKA will remain acidotic until they get insulin
- If you are chicken, give small amounts only as needed
- A small amount of insulin can do a great deal of good in a DKA patient

**Dogs and cats with DKA will remain acidotic until they get insulin**

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**Myth #3: If the owner is resistant to insulin injections, it is reasonable to start high protein diet alone while they weigh options**

- Diet alone is very unlikely to induce remission in a cat, due to glucose toxicity
- Better to try diet and oral hypoglycemics than diet alone, if glucose <300
- Allowing any cat with glucose persistently >300 (not due to stress) to go without insulin risks the cat’s life
- **REMEMBER:** it is easier to give most cats an insulin shot than to give them a pill

**Diet alone is very unlikely to induce remission in a cat, due to glucose toxicity**

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**Dogs and cats with DKA will remain acidotic until they get insulin**

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**Cats have carnivore dentition & retractive claws for holding prey**

- Dogs grind their food, cats do not
- Cats have no lateral-medial movement of the jaws
- Cat teeth lack occlusal surfaces for grinding – the molars and premolars interdigitate and are fewer
- Cats crack their kibble into smaller pieces and swallow it

**Cats crack their kibble into smaller pieces and swallow it**

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**Cats lack salivary amylase, so digestion begins in the feline stomach**

**Cats do not have taste buds to taste sweet**

**Feline pancreatic amylase production is 5% of dogs**

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Cats Are Carnivores

Cats need double the protein as dogs
- 5g/kg protein daily to maintain nitrogen balance
- The only reason ever to restrict protein in a cat is to prevent hepatic encephalopathy
- Cats waste muscle when protein is restricted (low creatinine is a clue)
- Cats do not down regulate proteinases well
- Increased transaminases and deaminases that remove the amino groups from the amino acids, converting them to keto-acids to be used for energy or glucose production
- Pyridoxine (vitamin B6) is a prosthetic transaminase. Feline requirement for pyridoxine is about four times that of a dog.
- Cats can not convert tryptophan to niacin (vitamin B3), as do dogs, so they require four times the niacin compared to dogs

Cats Are Carnivores

Cats need more taurine and arginine than dogs
- These AA are rich in animal products
- Cats have decreased ability to produce arginine, and increased need for it
- Taurine is an essential amino acid for cats, but not for dogs
- Adult cats have very low glucokinase activity in the liver as compared to dogs
- In dogs, maximum gluconeogenesis occurs long after a meal is absorbed, and in cats maximum gluconeogenesis occurs as soon as proteins begin absorption from the gut
- Cats have an alternative gluconeogenic pathway that uses the non-essential amino acid Serine (found in large quantities in muscle, milk and egg) to produce glucose
- The intestinal sugar transport system of the cat is not adaptable to varying dietary levels of carbs
- Cats have low intestinal disaccharidase levels (sucrase, maltase, isomaltase)

Cats Are Carnivores

Cats rely on gluconeogenesis (production of glucose from proteins) for energy, as opposed to producing glucose from soluble carbohydrates
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Cats Are Carnivores

Cats have the ability to digest and utilize high levels of dietary fat (as is present in animal tissue)
- Cats don't get pancreatitis from high fat meals
- Cats have a special need for arachadonic acid since they can not make it from linoleic acid as can the dog
- Animal fats are rich in arachadonic acids
- Cats can not convert beta carotene and other carotenoids (in plants) to vitamin A as dogs can
- Vitamin A occurs naturally only in animal tissue
- Cats have more significant post-prandial hyperglycemia than dogs after eating high starch and high sugar diets.

Cats can not convert tryptophan to niacin (vitamin B3), as do dogs, so they require four times the niacin compared to dogs

Weight Loss & Exercise

Obesity causes reversible insulin resistance
- Weight loss can contribute to achieving diabetic remission in the cat
- Weight loss can improve diabetic control and reduce insulin requirements in dogs
- Obese dogs and cats are at greater risk for pancreatitis (4x for the cat), which can be a life threatening complication of diabetes mellitus
- Moderate exercise can increase mobilization of insulin
- Strenuous exercise should be preceded by a reduction in insulin
- Consistent exercise programs are best
Chief Complaint – Not doing well since treating abscess on a toe 1 week ago, vomiting blood

- 3 days ago regular vet did a UA and blood glucose
- UA showed ketones++ and glucose +++, blood glucose 296
- Has been treating with IV fluids since, getting worse
- Did not start insulin because cat not eating

Exam
- Dehydrated, lethargic
- Icteric
- RR 56
- Vomited coffee grounds and collapsed on abdominal palpation
- HR dropped to 65/bpm
- Responded to atropine IV and fluid bolus

Diagnostics
- CBC – granulocytes 16,000
- Profile – glucose 200, BUN 41
  - TG 500, Chol 297
  - Bili 4.2, ALT 148, ALP normal
  - Ca 7.0, Phos 1.6
- UA – SG 1.027, ketones ++, glucose +++, inactive sediment
- Electrolytes – K+<2.0, Na* 133, iCa** 1.08
  - pH 7.032, BE -24, HCO3 7, TCO2 8
  - pCO2 26.5
- No chest rads or abdominal US done
- Urine culture pending

Initial life threatening problems
- Severe ketoacidosis
  - Treatment – insulin, (bicarbonate), IV fluids
- Severe hypokalemia
  - Treatment – IV KCl or K-phosphates
- Severe hypophosphatemia
  - Treatment – IV K-phosphates
  - (pancreatitis, hematemesis, abscess on toe)
  - (treatment – feed, antacids, sucralfate, antibiotics)

Treatment
- IV fluids – 45 ml/lb/day
  - Rehydrates and corrects acidosis – which fluids?
  - Buffered – LRS, Ringers, Normosol, Plasmalyte, etc.
- Potassium chloride – disadvantage limits phosphates
- Potassium phosphates – no disadvantage
  - 100mEq/L (25cc Kphos/L)

Insulin –
  - Advantage – corrects ketoacidosis
  - Disadvantage – makes hypokalemia and hypophosphatemia worse

Bicarbonate –
  - Advantage – corrects acidosis
  - Disadvantage – will make hypokalemia worse

Cefazolin 100 mg IV TID

Famotidine 5 mg IV BID

Cerenia 1.5cc IV SID
Reassess in 2 hours
- No longer laterally recumbent – sitting up
- Glucose - 310
- PCV – 28%
- K+ 2.9
- Gave 1 unit NPH SC

Reassess in 2 more hours (4 hours total)
- Glucose - 99
- PCV – 23%
- pH 7.228, HCO₃ 10, TCO₂ 11
- pCO₂ 23.9
- iCa++ 1.07, Na+ 130, K+ 2.3
- Phosphorus 0.7
- Red tinged urine, serum icteric
- Hydration normal, general condition slightly improved, no vomiting, not eating

2 days later
- Glucose - 325
- PCV – 20%
- pH 7.403, HCO₃ 18.8, TCO₂ 20
- pCO₂ 30
- iCa++ 0.92, Na+ 134, K+ 3.7
- Phosphorus 3.4
- Urine clear, serum slightly icteric
- Hydration normal, general condition greatly improved, eating small amounts, no vomiting
- Began the process of regulation via weekly visits

Hypoglycemia
Signs of Hypoglycemia
- Make sure client knows what to look for
- Mild
  - Lethargy, weakness
  - Poor appetite
- Moderate
  - Vomiting
  - Head tilt, ataxia
- Severe
  - Seizures, coma
  - Blindness – temporary or permanent

Treatment of Hypoglycemia
- No insulin until hyperglycemia returns
- Reduce insulin dose when resumed
- Asymptomatic - reduce insulin by 10-20%
- Mild – Feed, reduce insulin by 20% when resumed
- Moderate - Karo syrup or 50% dextrose PO
  - Monitor blood glucose by curve until recovered
  - Reduce insulin by 20-50% when resumed
- Severe - Dextrose IV immediately
  - If life threatening, consider glucagon, epinephrine, dexamethasone
  - Monitor blood glucose by curve until recovered
  - Reduce insulin by 50% when resumed

Regulation
Weekly to Bi-weekly rechecks
- Weight and exam
- If still showing clinical signs of DM, do glucose curve without fructosamine
- If clinical signs under control, do Fructosamine (FRA)
  - Resolution of PU-PD and weight stabilization are key
- If FRA high or low, do glucose curve
  - Adjust insulin and recheck 1-2 weeks
  - Sooner if problems
- If FRA acceptable, no curve needed
  - send home on that dose and recheck in 1 month
  - Sooner if problems
**Fructosamine** – glycosylated serum protein
- Averages blood glucose levels over the past 1-3 weeks
- Not affected by acute stress hyperglycemia
- Falsely decreased by
  - Hypoproteinemia, Hemolysis
  - Hyperlipidemia
  - Azotemia
  - Prolonged storage at room temperature
  - Hyperthyroidism, thin body condition
- Falsely increased by
  - Hyperglobulinemia
  - Hypothyroidism
- In house – HESKA, Idexx, Abaxis
- Or send out (freeze until shipped)

**Fructosamine Low (<200)**
- Mild to moderate hypoglycemia
- Not enough to cause Somogyi (glucose 65-80)
- Decrease insulin by 10-20%

**Normal range (200-350)**

**Good diabetic control (350-450)**

**Fructosamine High (>450 mcmol/L)**
- >600 – danger zone
- Significant periods of hyperglycemia
- Not enough insulin, or too much insulin
  - Hypoglycemia, rebound hyperglycemia

Low FRA with poor glycemic control – check T4
Remission is defined as normal FRA

**Glycosylated Hemoglobin**
- Average blood glucose over past 2-4 months
- HbA\(_1c\) alone is used in diabetic people
- ‘A1c’ alone is not helpful in dogs – there are 2 other fractions (HbA\(_{1a}\), HbA\(_{1b}\)) that must be measured
- Need all three fractions in dogs
- In house assays for people are all A1c alone
- Must send out – not widely available
- 2-5% - normal (lower values in cats)
- <3% - likely periods of hypoglycemia in diabetic dog
- 4-6% - good diabetic control
- >7% - poor control
- >8% - danger zone

**Glucose Curve Protocol**
- Owner feeds and gives insulin
- Bring pet to clinic within 2 hours
- Glucose (+ fructosamine) on arrival
- Glucose every 2 hours when >100
  - Once you know the insulin duration, you may be able to take the first glucose 4 hrs after insulin
- Glucose every hour when <100
  - Can miss nadir (low point) if you don’t do this
- Continue until you get 2 values 2 hours apart that are upwardly trending
- Usually can be completed in a business day, but not always
  - Some require 12-24 hours
  - Have owners finish at home or take to E-clinic

**Home Glucose Curves**
- Really are better than “in clinic”
- Stress increases glucose
  - Especially in cats
- Many owners can learn to do it
- It’s very helpful for owners to be able to check blood sugar in an emergency
- Entire curve does not have to be finished the same day
- Have owners come in for appointment to discuss the glucose curve

**Home Glucose Curves**
1. Warm the ear
   - Lateral to the ear vein in cats, or inner surface
   - No need to warm lip, foot pad, elbow callus
2. Apply vaseline if area is haired
3. If you use alcohol, allow it to dry
4. Prick with human lancet
   - Can use 27 gauge needle
   - Use roll of gauze inside the ear for cats

**Cat – Ear Prick**
Dog – Lip, Elbow, Footpad, Ear
**Home Glucose Curves**

**Choosing a glucometer**
- Low sample volume
- Inadequate sample volume prevents sample from running
- EDTA (purple top) and LiHep (green top) blood are fine
- Plasma calibrated rather than whole blood

\[
\text{Glucose}_{\text{plasma}} = \frac{\text{Glucose}_{\text{whole blood}}}{1.0 - (0.0024 \times \text{Hct})}
\]
- Auto-calibration of test strips
- Calibrate to in house machine
- Enter species code for veterinary meters
- Glucometers are most accurate <100mg/dl

**Continuous Glucose Monitoring (CGM) Systems**
- Probe measures glucose in interstitial fluid every 5 minutes
- Wireless transmission to a pager size display (2-3m range)
- Can be used to regulate difficult cases
- Human devices are available
  - Have not been validated for dogs and cats
- Device is worn in a vest

**Interpreting Glucose Curves**

**Duration of the curve**
- If your curve is 12 hours or less, you need to give insulin BID, not SID

**Glucose range**
- If all values are 100-250, leave it alone if symptoms are controlled
- Avoid values above 300 and below 80
- Average of 6 values taken in a 12-hour curve should be less than 250

**Glucose nadir**
- If < 80 reduce the insulin dose
- If >130, consider increasing insulin dose, unless all values less than 250
- Ideal nadir is 80-130

**Glucose Peak**
- If nadir 80-130 and peak too high, change to longer duration insulin
  - regular < NPH < Lente
  - < PZI < glargine < detemir

**Somogyi Effect**
- Rebound hyperglycemia follows blood glucose < 65
  - usually within 12 hours
  - Lasts 24-72 hours
  - Often >400 mg/dl
- Due to epinephrine and glucagon release (counter-regulation)
- A cyclic response of 1-2 days of “good control” followed by several days of poor control should increase suspicion
- Fructosamine usually >500 mcmol/dl
- Reduce insulin and recheck FRA + curve in 1 week

**Home Urine Testing**
- I don’t use urine strips for glucosuria
- Renal threshold can vary
- Many well regulated diabetic dogs and cats will have daily glucosuria
- It is reasonable to have owners keep KetoDiastix
- Ketonuria indicates seeing the vet ASAP
- Increasing insulin based on glucosuria can result in Somogyi effect
Spot Checking Diabetics

- Which values in a glucose curve are used to determine dose?
  - Nadir (lowest glucose values - insulin peak)

- Which values on a glucose curve are used to determine interval and insulin type?
  - Peak glucose values (insulin nadir)
  - If glucose nadir is ideal, and glucose peaks are too high, then you need to give insulin more often, or you need a longer acting insulin.

If you were only allowed two glucose checks in every 24 hour period, when would you want to take them?

- At Insulin Time?
- 5-7 hours after insulin?
- One of each?

Quiz – Spot glucose checks at insulin time

What Would you do?

1. 250, 260
2. 350, 335
3. 245, 265
4. 200, 200

Correct Your Quiz

1. 250, 260

Correct Your Quiz

1. 250, 260

Correct Your Quiz

1. 250, 260

- Need to decrease insulin
2. 350, 335
Spot Checking Diabetics

Correct Your Quiz

1. 250, 260
   - Need to decrease insulin

2. 350, 335
   - Increasing insulin would probably make this dog or cat hypoglycemic
   - Need to change to longer insulin instead

3. 245, 265
   - Need to increase insulin

4. 200, 200
   - Insulin should not be changed
Maintenance

Recheck Every 3-4 months
- Exam, weight, urinalysis

Every 6 months
- Exam, weight, UA
- CBC, panel electrolytes, urine culture
- fructosamine
- Blood pressure

Yearly
- Thyroid testing for middle aged to older cats

Regular dental cleanings

Glucose curves only when clinical problems or FRA abnormal

Long Term Goals

- Learn home blood glucose testing
- Achieve ideal pet weight
  - Especially important in cats
- Transition pet to ideal diet & feeding program
  - Especially important in cats
- Institute regular exercise program
- Never, never, never run out of insulin

Remission

- Not uncommon in cats
  - Endogenous insulin production varies with the state of chronic pancreatitis
  - Type II diabetes is possible
- More common with Lantus®/Levemir® insulin in combination with high protein/low carb diet
  - 50-60% or more with Lantus® and Levemir®
  - 38% for ProZinc, and 25% for Vetsulin®
- Rare in dogs, except after recovery from severe acute pancreatitis or OHE
- Temporary or permanent
- Short or long
- Individual cat can have multiple remissions, but they are more common early in disease

Insulin Resistance

- Normal amount of insulin produces subnormal response
  - Insulin binding antibodies
  - Insulin resistance (decreased receptor binding)
  - Insulin signal transduction
- Greater than 2-3 units/lb, with all curve values remaining very high
  - No glucose values below 300, FRA >500
  - **Any dose is fine if pet is regulated**
  - >0.5 U/lb warrants investigation for co-morbidities
  - >3 U/lb warrants investigation for insulin resistance
- Glycemic control is erratic
- True insulin resistance is very rare
- More often a co-morbidity causing temporary insulin resistance (dysregulation)

Insulin Resistance/Dysregulation

1. Check for the Obvious
- Make sure females are spayed
- Check insulin
  - Expired? Discolored? Cloudy?
  - Exposed to extreme heat or freezing?
- Check Administration
  - Check for skin thickening at injection site
  - Make sure they have the correct syringes
  - Make sure they are administering regularly
  - “How many doses do you miss monthly?”
- Exam & Check History for co-morbidities
  - Dental infection, skin or other infection
  - Heart murmur, GI symptoms, neoplasia
  - Endocrine alopecia (polyendocrine co-morbidity)
  - Variation in diet, exercise, stress

1. Check for the Obvious
- Eliminate insulin antagonistic drugs
  - Glucocorticoids, progestagens
  - Glucosamine, theoretically
  - Try cyclosporine, azathioprine for immune mediated disease
  - Try Apoquel for pruritus, allergic bronchitis, etc.
- Check regulation of co-morbidities
  - ACTH stim for adrenal disease
  - TT4 for thyroid disease
  - GI panel for IBD, lymphangiectasia, pancreatitis, etc.
  - Renal panel for renal disease
  - Chest x-rays + echo + ECG if heart murmur
  - Obesity in cats, severe obesity in dogs
**Insulin Resistance/Dysregulation**

2. **Look for new Co-Morbidities**
   - CBC, panel, lytes, UA
     - Elevated liver enzymes – hyperadrenocorticism?
     - Azotemia – renal disease
     - Low albumin + globulin – PLE
     - Hyperlipidemia
   - Urine Culture, thyroid testing, HW Test, FeLV/FIV
     - Hypothyroidism in dogs – TSH, TT4, TT4
     - Hyperthyroidism in cats – TT4, fT4
   - cPLI, TLI, B12, folate
     - Chronic pancreatitis
     - Exocrine pancreatic insufficiency
     - Inflammatory bowel disease

3. **Look for Zebras**
   - Insulin binding antibodies
   - IGF-1 - acromegaly in the cat
   - Glucagon – glucagonoma
   - Pheochromocytoma

4. **Change Insulin**

5. **Long term – weight reduction**

   REMEMBER TO DECREASE INSULIN AND WATCH FOR HYPOGLYCEMIA WHEN CO-MORBIDITIES ARE CORRECTED

**Insulin Antibodies**

- Can result in erratic glucose curves and poor glycemic controls

- **Diagnosis**
  - MSU Endocrine Lab will assay for insulin antibodies
    - Normal – 15% or less
    - Significant antibody problem if >40-50%
  - Insulin antibodies can increase insulin assay just as Thyroid antibodies do
  - Insulin typically <50 mcU/ml 24 hours after insulin in diabetic dogs
  - Will be >400 if insulin antibodies

- **Treatment**
  - Switch to a different insulin
  - Vetsulin is least likely to cause antibodies
    - Pork insulin = canine insulin
  - Recombinant human is less likely to cause antibodies, but usually too short acting
  - Insulin analogs (gliargine, detemir) are unlikely to create antibodies
  - Avoid protamine containing insulins (PZI and NPH)
  - Beef-pork and beef insulins (not on the market now) are most likely to cause antibodies.

**Erratic Glycemic Control**

- **Brittle Diabetic**
  - Rule out Somogyi
  - Rule out difficulty with injections
    - Frequent skipped doses
    - Difficulty with injection technique
  - Rule out absorption problems and antibodies to insulin
    - Type II diabetes, pancreatitis
      - Sometimes all we can do is monitor and respond
      - Make sure clients understand signs of hypoglycemia and hyperglycemia
      - Astute clients can make minor adjustments on their own
Erratic Glycemic Control
“Brittle Diabetic”

- Type II diabetes, pancreatitis
  - 25-50% of diabetic dogs & cats have chronic pancreatitis
  - Ultra low fat diet, antioxidants and support of hydration can minimize pancreatitis flares
  - Treat hyperlipidemia if present
    - Can cause insulin resistance and pancreatitis

- Chronic kidney disease
  - Insulin requirements can fall
    - Decreased renal clearance of insulin
    - Decreased renal gluconeogenesis
  - Cannot rely on PU-PD as an indicator of glycemic control

Willie

- 17 year old DLH, has been a diabetic for about 3 years
- Had an “insulin vacation” for about six months during the first year
- Was taking 2 units NPH BID for about a year prior to boarding for 10 days
  - Eats Innova EVO dry free choice (crunchy junkie)
    - He doesn’t eat well when he boards
- Since coming home from boarding a month ago, Willie has felt terrible
  - Pu/PD
  - Doesn’t eat chicken jerky snacks as voraciously
  - Very lethargic

Willie

- In the past month
  - Weekly visits to regular vet for spot checks at insulin time
  - Fasted overnight and no insulin prior to coming in for glucose checks
  - Insulin given at clinic, Willie doesn’t eat all day
  - All glucose values > 400
  - Insulin gradually increased to 6 units BID
  - Willie just keeps getting worse, now he won’t eat at home, still PU-PD
  - No new findings on exam, except weight loss of 1.5 lbs over past year
    - Other than glucose, last bloodwork done 2 yrs. ago

Willie

- Bloodwork at 2pm (insulin 7am)
  - CBC – NSAF
  - Profile & electrolytes – BUN 68, creat 4, phos 9, glu 31
  - UA – SG 1.015, no bacteriuria
  - Urine culture negative
  - TT4 – 6.5, FT4 – 63
  - No chest x-rays or abdominal US
    - This may have sent Willie over the edge
      - Sedation might compromise the kidneys
  - New Diagnoses – hyperthyroidism, CRF, insulin overdose

Willie

- Plan
  - 100 ml LRS SC (owners not ready for home fluids)
  - No insulin tonight, reduce insulin to 4 units BID
  - Recheck in 1 week, or sooner if problems continue
  - Provide owner with list of canned moderate protein, low carb foods – wishful thinking
  - 1 week later, Willie “is a new cat” ;)
    - Eating well and happy, but still PU-PD
    - With CRF & hyperT4, we likely won’t be able to use PU-PD as a marker for good regulation
    - 2 pm glucose 67, BUN 49, creat 2, phos normal
    - Reduce insulin to 3 units BID, recheck 1 week
1 week later, Willie still feeling good
– still PU-PD
– Fructosamine high
  • BUN 59, creat 5, phos normal
– Glucose curve
  • Time 0 – 365
  • 2 hours – 71
  • 4 hours – 143
  • 6 hours – 310
– Change to Lantus 3 units BID, recheck 1 week

Willie

1 week later, Willie still feeling good
– still PU-PD
– Fructosamine within normal range
– Begin methimazole 2.5 mg PO SID
– Decrease Lantus to 2 units BID, recheck 1 week
  • Why?
  • Hyperthyroidism causes relative insulin resistance

Willie

We eventually weaned Willie down to 0.5 unit every other day
– If we stopped, he got hyperglycemic and did not feel good
– If we increased, he go hypoglycemic and did not feel good
– We continued this for 2 years, until he suffered an episode of acute renal failure at 19 years of age
– His temperament was not suitable for hospitalization, and he was humanely euthanized

Lesson from Willie
– PU-PD in an unregulated diabetic does not always mean more insulin is needed
  • Insulin overdose can cause PU-PD, due to rebound hyperglycemia
  • Other problems can cause PU-PD – CRF & hyperT4 in this case
– Regular rechecks can nip problems in the bud and prevent illness from dysregulation
– Glucose curves are not always necessary – one mid-day value can tell you a great deal

Lesson from Willie
– I prefer owners to give insulin and feed prior to bringing in for glucose curve
– In-house fructosamine can preclude need for glucose curve

SPOT CHECKING GLUCOSE ONLY AT INSULIN TIME SUCKS BIG TIME!!!!

Sequellae of Diabetes Mellitus
• Blindness – most common canine sequella
  – Cataracts – dogs >> cats
    • 14% at the time of diagnosis
    • 25% at 60 days
    • 50% at 6 months
    • 75% at 1 year
    • 80% at 1 year 3-4 months
    • Vision restored by surgery in 80% of diabetics
  – Aldose reductase inhibitor (Kinostat®) can delay diabetic cataract formation – not available
  – PRAA > Diabetic retinopathy
    • OcuGlo® can delay onset
    – Glaucoma secondary to uveitis
    – Severe hypoglycemia

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Sequellae of Diabetes Mellitus

• Kinostat® Trial – no longer taking patients
  – Dr. Mary Glaze, Dr. Robert Munger
  – Eligibility:
    • Diabetes recently diagnosed
    • No cataracts present
  – Requirements:
    • Eyedrops TID
    • 6 visits in 9 months
    • May get placebo
  – Medication, eye exam and bloodwork paid for by the study

• Lens induced uveitis
  – Lens proteins exposed during cataract formation
  – Must be controlled prior to surgery
  – Diclofenac (Voltaren®) or flurbiprofen (Ocufen®)

• Corneal ulcers
• Chronic pancreatitis
• Recurring infection
• Ketoacidosis
• Hypertension – 50%
  – Start hydralazine or amlopidine if >160mmHg

• Diabetic neuropathy (cats 10% >> dogs)
  – Risk factors: obesity, hypertension, hyperlipidemia
  – Segmental demyelination, then remyelination
  – Pelvic limb weakness, inability to jump
  – dropped hocks, plantigrade stance
  – Loss of muscle tone and atrophy
  – LMN reflexes
  – Rule out hypokalemic weakness
  – Treatment:
    • Best is optimizing control
    • Pain control – gabapentin
    • Antioxidants: alpha lipoic acid, acetyl-L-carnitine, benfotiamine
    • Aldose reductase inhibitors have been tried with little success

• Diabetic nephropathy
  – Occasionally seen in the dog and cat
  – Protein losing nephropathy
    • UPC >1 is diagnostic
    • UPC >5 = grave prognosis
  – With progression, azotemia
  – Monitor diabetics for proteinuria (rule out UTI)
  – Treat with ACE inhibitor

**Severity of Diabetic Neuropathy**

<table>
<thead>
<tr>
<th>Severity</th>
<th>Criteria</th>
<th>Neuromuscular Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Mild</td>
<td>Base narrows gait</td>
<td>Neuro exam normal</td>
</tr>
<tr>
<td></td>
<td>Difficulty jumping</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Not plantigrade</td>
<td></td>
</tr>
<tr>
<td>Mild</td>
<td>Base narrows gait</td>
<td>Mild postural deficits</td>
</tr>
<tr>
<td></td>
<td>Feet sensitive to touch</td>
<td>Normal tendon reflexes</td>
</tr>
<tr>
<td></td>
<td>Paralytic plantigrade &amp; crouched walking</td>
<td></td>
</tr>
<tr>
<td>Mild-Moderate</td>
<td>Base narrows gait</td>
<td>Moderate postural &amp; spinal reflux</td>
</tr>
<tr>
<td></td>
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<td>Normal tendon reflexes</td>
</tr>
<tr>
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<td>Paralytic plantigrade &amp; standing</td>
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<td>Moderate</td>
<td>Feet sensitive to touch</td>
<td>Decreased postural &amp; tendon reflex</td>
</tr>
<tr>
<td></td>
<td>Paralytic walking &amp; standing</td>
<td>Normal muscle atrophy</td>
</tr>
<tr>
<td>Moderate-</td>
<td>Obvious pelvic pares &amp; ataxia</td>
<td>Severe postural &amp; tendon reflex</td>
</tr>
<tr>
<td>Severe</td>
<td>Obvious general pares &amp; ataxia</td>
<td>Normal muscle atrophy</td>
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<td>Generalized muscle atrophy</td>
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</tbody>
</table>

**Prognosis**

• Depends on owner commitment, comorbidities, glycemic control and avoiding DKA
• Dogs & cats that survive the first 6 months are likely to do well for several years
  – Median survival for cats is 2 years
  – Shorter survival rate if elevated creatinine
  – Longer survival if remission achieved
• Dogs - 1st visit fatality was 40% in 1970
  – 10-12% in 1999 (similar for cats)
Diabetic Pearls

• Rolling Lente insulin is passé
  – Study on Vetsulin - shaking Lente vigorously
  – No impact on insulin action
  – More uniform dispersal than rolling
  – Currently recommended
  – No data on NPH and PZI
  – ProZinc recommends rolling
  – Lantus and detemir do not settle out
    • no shaking or rolling needed

Diabetic Pearls

• Lantus does not need to be thrown away after 28 days
  – No loss in activity for at least 6 months when stored in the refrigerator
  – Use until expiration date
  – Discard if it becomes cloudy
  **TELL OWNERS NOT TO RE-USE NEEDLES**

Diabetic Pearls

• Leaving insulin out of the fridge overnight does not inactivate it
  – Keep in fridge for uniform storage and longer life
  – Discard glargine/detemir if it becomes cloudy
  – Discard if discolored
  – Discard if frozen or temp >100°F

Diabetic Pearls

• No need to hospitalize diabetics, unless they are sick
  – Keep overnight or have come back the next day for 3 checks in BG <80 after the first dose
  – It’s rare to get <80 the 2nd day
  – Insulin needs change greatly during the initial weeks – don’t tweak until later
  – Eating/stress levels are different at home
    • normalize these factors as soon as possible and as much as possible
  – Multiple consecutive curves are stressful
    • 1 curve every 1-2 weeks works better
  – A little bit of insulin does a lot of good

Diabetic Pearls

• No need to dilute insulin
  – Diluted insulin is not as stable
    • Replace every 4-8 weeks
  – Diluted insulin is not as uniform
  – Choose U-40 if tiny doses are needed
  – Use 0.3ml syringes for low doses
    • Even U-100 0.3 ml syringes are relatively easy to read
  – Use pens to dial up dose
  – Syringe magnifiers are available
    • Snap on the syringe

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  – Syringe magnifiers are available
    • Snap on the syringe
**Diabetic Pearls**

- **Thumb Rules for insulin**
  - Give BID insulin 10 - 14 hours apart
  - If you are not sure whether a dose went in, skip it
  - If >14 hours, either skip it or gradually work back to the most convenient injection times
  - Skipping a 1-2 doses a month rarely causes harm
  - Never skip 2 doses in a row if you can help it
  - If you double dose by mistake, feed and check blood glucose at peak insulin time, then skip the next dose
    - Call vet if <50
  - Expect rebound hyperglycemia for a few days

- **Delay elective surgeries until well regulated**
  - Control must be near ideal for cataract surgery
    - Especially brachycephalic dogs
    - Use discretion for procedures that can improve glycemic control
      - OHE
      - Dental
  - Proceed with emergency surgeries and hope for the best
    - Aggressive treatment with antibiotics due to immunosuppression
    - Be aware of delayed healing

- **Regulating the Cushingoid Dog**
  - Lysodren is more likely to achieve good glycemic control than Trilostane
  - Starting dose for insulin is higher for Cushingoid dogs – 0.5 U/kg BID
  - Goal for glucose nadir is higher: 100-150 mg/dl
  - The best control that can be achieved in many dogs is nadir 150-200 mg/dl.
  - Most diabetic Cushingoids remain PU-PD, despite the best possible control for that individual.
  - Most of these dogs develop cataracts.

- **Regulating the fractious cat**
  - Rely on fructosamine to tell you whether control is adequate
  - If control not good, glucose curves at home are ideal
  - If that is not possible, mid-day spot checks may rule out severe hypoglycemia
    - Medial saphenous vein
    - Or consider placing a jugular catheter + e-collar.
    - Sedate and place catheter 1-2 days prior to the curve
    - Add extension set for the most fractious cats
    - Remove 5-6cc blood, take a drop for testing, replace 5-6cc blood, flush

- **Peri-anesthetic management**
  - Fast for 12 hours as usual
    - Do not withhold water until 1-2 hours before
  - Give half the usual dose of insulin
  - Blood glucose monitoring
    - on admission and every 2 hours until surgery
    - 1-2x per hour during surgery
    - every 2 hours until recovered and fed a small meal
  - Treat hypoglycemia (<80) with 2.5-5% dextrose to keep glucose 100-250
  - Treat >300 with regular insulin at 20% regular dose IM every 4 hours
  - Watch for dysregulation for 1-2 weeks

**Summary**

- **PowerPoint Handout** goes behind the orange tab
- **Client Handouts**
  - Canine Diabetes
  - Feline Diabetes
  - Home Glucose Testing
    - Home Glucose Testing – Ear Prick
    - Home Glucose Testing – Lip Prick
  - Hyperlipidemia
  - Instructions for Diabetics
Summary

– Drug Handouts
  • Fish Oil
  • Glipizide
  • Insulin
  • Maropitant

– Vet Handouts
  • Bicarbonate Administration
  • Insulin Conversion Chart
  • IV Potassium Supplementation

Summary

– Web Resources
  • Cat Diet PFC Chart
  • Percent Calories Calculator
  • IV Drip Calculator

Acknowledgements

