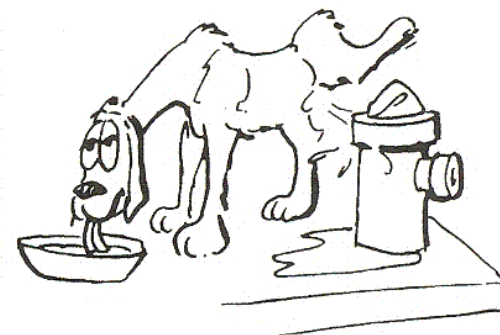
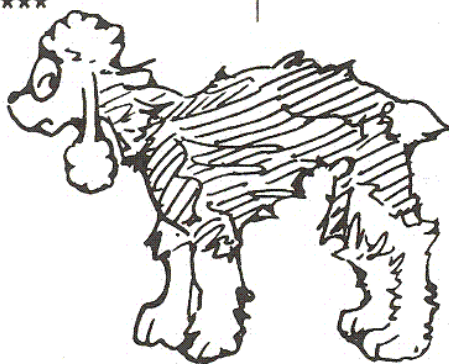


Hyperadrenocorticism

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ENDOCRINE SYSTEM

Condition	Facts/Cause	Presentation/CS	Sequelae
Canine Hyperadrenocorticism, Cushing's syndrome, Cushing's diz, Hyperglucocorticoidism VetMed 710, 1997; M8k 387, 407; Mk 261, E-hb 585; SAP 240; H3B 473; H2B 534; I2M 775; IM 587; 5min 690, 40; IM-WW 404; Cat 1481; C12T 416,421,336,356,C11T396t, 345, 349,1062, 310; E 1538, R&E-F 187; R&E-M 216; Derm 635, D-CT 273; D-Sy 102, 151, 192, D-Mi 275; Phys-B 905, 958, 970; Lab-S 338; Lab-C 220; Pa-T 258; Sx-S-hb 503, 758; Sx-S 1496, 2293; Sx4B 539; Sx3B 431; Sx-WW 181; NB 9. 7 ***	<ul style="list-style-type: none"> • Chronic exposure to excess GCC (glucocorticoids) • Insidious onset, slowly progressive • One of most common endocrine dize in dogs • Rare in cats • Causes: <ol style="list-style-type: none"> 1. Pituitary dependent (85%)(PDH): excessive ACTH - hyperplasia 2. Adrenal tumor 15% (AT): excessive cortisol 3. Iatrogenic: prolonged steroid Tx - adrenal atrophy • Breeds: PDH: Boxer, Boston terrier, Dachs-hund, Poodle, terrier breeds, all breeds can be affected; AT: Ger. shepherd & toy poodle • Middle aged (8-9 years, range 0.5-17 yrs) • No sex predilection in PDH, 70% female in AT 	Insidious & progressive <ul style="list-style-type: none"> • PU/PD #1 CS >85% (polyuria/polydypsia) • Polyphagia (PP) (ravenous appetite due to develop-ing DM, cortisol interferes w/ insulin at cellular level) • "Potbelly" 90%: muscular wasting, pendulous abdo-men • Dermatologic changes: <ul style="list-style-type: none"> - Thin, wrinkled skin (atrophy of skin due to catabolism, especially abdomen) - Bilateral, symmetrical, nonpruritic alopecia (thin, dry, broken hair) - Hyperpigmentation (cause unclear) - Calcinosis cutis: uncommon - Hematomas after venipuncture, bruising - Pressure necrosis - Pyoderma (immunosuppression) • Muscle weakness/wasting 70% - trembling, weak, atrophy of limb muscles • Redistribution of fat: neck & shoulder thickened • Mineralization (lungs, skeletal muscles, adrenals, skin & stomach wall) • Lethargy (CNS) • Immunosuppression <ul style="list-style-type: none"> - Infections - skin, UTI, lungs - Poor healing of wounds - Rapid spread of corneal ulcers - Urinary tract infections/pyelonephritis - Bronchopneumonia • Panting: respiratory system <ul style="list-style-type: none"> - Thromboembolism - uncommon sequelae • Hypertension 	<ul style="list-style-type: none"> • Sequelae/complications: average lifespan after diagnosis is 2 years due to complica-tions: <ul style="list-style-type: none"> - Diabetes mellitus 80% of cases <ul style="list-style-type: none"> . PU/PD & polyphagia . Insulin-resistant - Pulmonary thromboembolism - Infection - Congestive heart failure - Recurrence of symptoms - Progression of pituitary tumor growth - Complication due to underdosage or overdosage of mitotane or ketoconazole <ul style="list-style-type: none"> . Must persistently monitor



Endocrine Tune up -The Big 6

Guide to Small Animal Clinics, Pasquini, 3rd ed

HYPERadrenocorticism continued

Pathogenesis:

- **1 - PDH/Pituitary dependent hyperadrenocorticism 80%**
 - Hypothalamic dysfunction
 - **Pituitary gland tumor: #1 Adenoma**, 85% (90% microadenomas, < 10% macroadenomas, hyperplasia rare)
 - **Secretes excessive ACTH which is unresponsive to negative feedback**
 - Causes bilateral adrenal cortical **hyperplasia**
 - Adrenals secrete excess of cortisol (CCS)
 - Negative feedback not effective at resulting cortisol levels (high exogenous doses will suppress)
 - Small dogs
- **2 Adrenal tumors 15% (ATs)**
 - **50/50 rule** = 50% malignant (carcinomas: malignant, large locally invasive & metastasizes); 50% benign (adenomas - smaller); < 15% mineralize on radiographs
 - **Secretes excess cortisol, independent of ACTH** (autonomous)
 - ↓ ACTH due to negative feedback resulting in contralateral adrenal hypoplasia
 - Usually unilateral
 - Big dogs; female > Male
- **3 Iatrogenic:** prolonged exogenous GCC (glucocorticoid) administration (2° to Tx for atopy, immunological diz, eye, ear medicines)
 - **Bilateral adrenocortical atrophy**
- **Hormones involved:**
 - CRH (corticotropin releasing hormone from hypothalamus) stimulates release of ACTH
 - ACTH (from anterior pituitary): stimulates adrenal cortex to secrete glucocorticoids, mineralocorticoids & androgenic steroids
 - Negative feedback on CRH
 - Corticosteroids have negative feedback on ACTH

Steroid excess

CS: PU/PD, Pot bellied, Alopecia

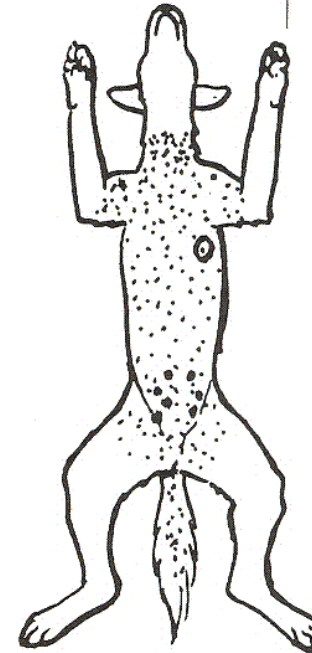
Dx: CS, PE, Lab, Rads; Tests

Tx: Pituitary: Mitotane or Depranil

Adrenal: Adrenalectomy

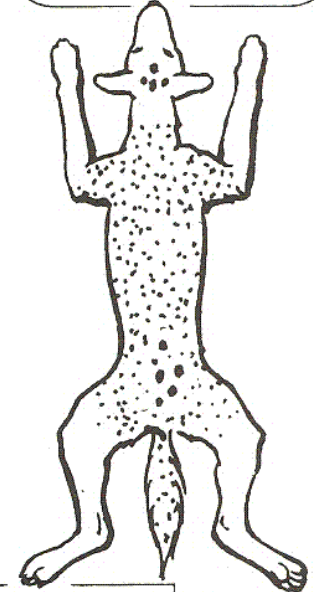


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DDx:

- Diabetes mellitus
- Liver diz
- Renal diz
- Hypothyroidism
- Hypercalcemia
- Pyelonephritis
- Diabetes insipidus
- Hyperthyroidism
- Psychogenic polydipsia
- Acromegaly



Glucocorticoid effects

- Gluconeogenesis
- Lipolytic
- Protein catabolic
- Anti-inflammatory (suppresses phagocytosis, lympholytic & ↓ Ig)

**Diagnosis & treatment:
following page**



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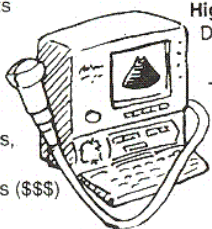
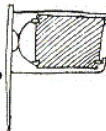
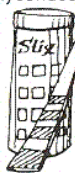
Diagnosis - Hyperadrenocorticism

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ENDOCRINE SYSTEM

Diagnosis - Cushing's diz

- Hx (steroid Tx)
- CS: PU/PD/PP, weakness, skin, "pot bellied"
- Occasionally insulin resistant DM: 10% of cases
- Palpation: CS & hepatomegaly
- Blood values
 - **Stress leukogram** (↑ PMNs & monocytes, ↓ lymphocytes & eosinophils,)
 - ± ↑ RBCs (PCV > 55)
 - ↑ ALP, 80% dogs only (alkaline phosphatase) > 1000 IU/dl common
 - ± ↑ Blood glucose - overt diabetes mellitus (> 250 mg/dl in 10% of cases)
 - ↑ Cholesterol (> 290 mg/dl) > 50%, triglycerides, ± ALT
 - ↓ BUN from diuresis (↑ free water loss)
- UA (urinalysis):
 - Low specific gravity < 1.007 from PU, still maintains ability to concentrate
 - ± Proteinuria
 - Glycosuria in 10% = DM
- Hypertension
- Radiology:
 - Enlargement of adrenals can't be seen
 - **Calcification of adrenals - < 15%**
 - ± Calcification of bronchial wall
 - Distended abdomen w/out effusions
 - **Hepatomegaly:** ↑ fat & glycogen deposits
 - Distended urinary bladder
 - Osteoporosis (GCC increases bone resorption)
 - Ectopic calcification in lungs & skin
 - **Calcinosis cutis**
- Ultrasound (look for tumors on adrenal glands, to differentiate from pituitary tumor) 50%
- CT (computed tomography) of pituitary & adrenals (\$\$\$)



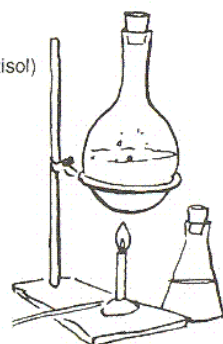
- Presumptive diagnosis: CS, PE, Lab & rads
- Diagnostic tests (ACTH, LDDST, HDDST)
 - Done if owner willing to consider surgery or interested in prognosis
 - If not willing - medical therapy for PDH (85% chance of being right)
 - None of tests are foolproof! Repeat if questionable in 1 month
- ACTH stimulation to diagnose Cushing's
 - PDH (85%), AT (50%): exaggerated response
 - Normal: normal or ↑ in cortisol
 - Iatrogenic: blunted or no increase
- LDDST: diagnose Cushing's - PDH or AT
 - < 1.5 µg/dl cortisol at 8 hrs = normal
 - > 1.5 at 8 hours: may be PDH or AT
 - < 1.5 at 4 hours & > 1.5 at 8 hours: suggests PDH
- HDDST: "differentiate" PDH vs AT
 - < 50% or pre-value at 4 hrs: PDH more likely
 - ≥ 50% of pre-value at 4 hrs: AT more likely
- Thyroid function tests
 - Serum T3 & T4 low in 50% of cases, but response to exogenous TSH parallels that of normal

Low - dose Dex	4 hr-post	8hr-post	µg/dl
-	< 1.5	< 1.5	Normal
-	< 1.5	> 1.5	PDH more likely
-	> 1.5	> 1.5	AT more likely

High dose Dex	Post Dex. cortisol	µg/dl
DDx PDH vs AT	< 50% of pre-value	PDH most likely
	≥ 50% of pre-value	AT most likely

Pituitary-adrenal function tests

- Basal cortisol levels - 1-5 µg/dL: not very useful because of constant fluctuation throughout day (Cushing's dogs often fall w/in this range so use suppression & stimulation tests)
- ACTH stimulation (most commonly used, inexpensive & quick)
 - Diagnoses Cushing's & differentiates from iatrogenic Cushing's
 - PDH (85%) & adrenal tumors (50%): show an exaggerated response
 - Normal: normal or ↑ (but doesn't rule out Cushing's; if CS, do LDDST)
 - Iatrogenic (steroid Tx): "blunted" or no increase - "flat line"
 - Protocol: Obtain serum samples of cortisol analysis before & after IM injection of ACTH (Vedco®, Cortrosyn®)
- LDDST (Low dose dexamethasone suppression test - 0.01 mg/kg)
 - Confirm Cushing's diagnosis: separates normal from PDH & AT
 - Dexamethasone supplies negative feedback on ACTH production resulting in ↓ blood cortisol in normals
 - Normal: ↓ cortisol < 1 µg/dL at 8 hrs
 - PDH & Adrenal tumors: no suppression > 1 µg/dl at 8 hrs
 - 1/3rd of PDH are suppressed at 2-4 hours, but "escape" & are > 1 µg/dl at 8 hours, "escape" doesn't happen w/ AT
- HDDST (High dose dexamethasone suppression test - 0.1 mg/kg)
 - May differentiate pituitary & adrenal tumors
 - Adrenal tumors: ACTH independent, thus not suppressed, not diagnostic
 - PDH threshold for steroid negative feedback on ACTH is higher than normal - suppression of cortisol diagnostic (75% of cases); 25% fail to suppress, especially large pituitary tumors
- ACTH plasma concentrations to separate PDH from AT
 - PDH: ACTH elevated (tumor producing ACTH)
 - AT: ACTH low (not producing)
 - Expensive & difficult to perform, not done often
- Cortisol:creatinine ratio
 - New test, sensitive, but not specific (many causes of ↑ cortisol)
 - Creatinine & cortisol in urine measured
 - Cortisol to creatinine ratio > 35 suggestive of Cushing's, < 35 normal



Treatment of hyperadrenocorticism

• PDH/Pituitary dependent hyperadrenocorticism

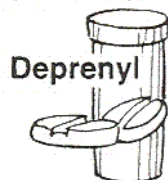
- Mitotane, Lysodren® (o,p'-DDD):

- Causes selective necrosis of adrenal cortices (zona fasciculata & zona reticularis)
- 2 phases: initially dose to cause remission, PO 7-10 days
 - .. Glucocorticoid (prednisolone or prednisolone) during induction to prevent 2° hypoadrenocorticism effects
- Lifelong maintenance once normalized: Mitotane PO 1-2 x week
- Fludrocortisone acetate or DOCP (mineralocorticoids): generally lifelong supplementation required
- Dramatic reversal of signs
- Side effects usually mild - stop & give prednisone or prednisolone if side effects (lethargy, vomiting, anorexia, CNS, ataxia & diarrhea)
- Monitor Tx w/ ACTH stimulation test every 5-10 days
 - .. Goal: basal & post ACTH cortisol between 1-5 µg/dl
 - .. If serum cortisol falls to < 1 µg/dl stop & supplement w/ GCC until normalized
- Owners carry prednisolone for times of major stress (2.2 mg/kg)
- M/ cause hypoadrenocorticism (5% of cases): tell owners to look for signs: vomiting & diarrhea
- Many relapse in 12 months & require reloading w/ ↑ dosage of mitotane for maintenance



- Selegiline (Deprenyl®), L-deprenyl, Eldepryl®: for uncomplicated PDH

- ↑ Dopamine by ↓ metabolism of dopamine using monoamine oxidase (MOA) type B
- Avoid with other MAO inhibitors
- Decreases CS, monitor CBC, Chem & UA



- Ketoconazole (Nizoral®) reversibly inhibits enzymes needed in GCC production (steroidogenesis)

- Start w/ 5 mg/kg & work up (↑ mg/kg every 7-10 days) to level that controls cortisol levels
- ACTH stimulation after 7-10 days
 - .. Goal 1-5 µg/dl cortisol
 - .. Once adequate control lifelong BID Tx
- Disadvantages: cost & lifelong BID Tx

Ketoconazole



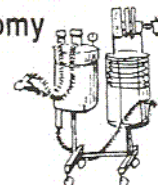
- Radiation: PDH: for pituitary macroadenoma or macrocarcinoma
 - Radiation delivered in fractions over a period of 4-6 weeks
 - Disadvantages: cost & limited availability
- Cobalt irradiation for pituitary macroadenoma

• PDH + concurrent diabetes mellitus & PDH

- Mitotane - o,p'-DDD (Lysodren®)

- Induction 25-35 mg/kg/d 7-10 d
- ↓ insulin by 10% w/ each negative glucose (monitor urine glucose BID)
- Maintenance: follow above regime for PDH w/o DM
- Comment: Mitotane removes cause of insulin resistance so insulin dose reduced

Adrenalectomy



• Adrenal tumor

- Adrenalectomy TOC, surgical removal of affected adrenal gland

- Check that not bilateral & for metastasis
- Post surgical: low cortisol due to atrophy of opposite adrenal
 - .. Ketoconazole to prepare for surgery (normalizes hypercortisolemia as well as removes negative feedback on contralateral normal adrenal allowing it to return to function sooner post-op)
 - .. DOCA, prednisolone (corticosteroid w/ hi mineralocorticoid) administered 1-2 days before surgery
 - .. IV steroids during surgery
- Post surgical monitor Na:K levels & for shock, Tx w/ DOCA if necessary
- Continual steroid not necessary usually unless bilateral adrenalectomy
- Mineralocorticoids necessary if bilateral adrenalectomy
- Anatomical note: adrenal glands located under phrenicoabdominal vein, near cranial pole of kidney
- Mitotane, Lysodren® (o,p'-DDD) for AT
 - If surgery not acceptable to owner
 - .. Initially dose higher than for PDH to cause remission, PO 7-10 days
 - .. Goal: serum cortisol < 1 µg/dl (< 30 nmol/l), check w/ ACTH



stimulation every 2 weeks

- .. Prednisolone or prednisolone: during induction to prevent 2° hypoadrenocorticism effects
- .. Lifelong maintenance once normalizes: High dose mitotane PO 1-2 x week
- .. If side effects stop Tx & restart at lower dosage

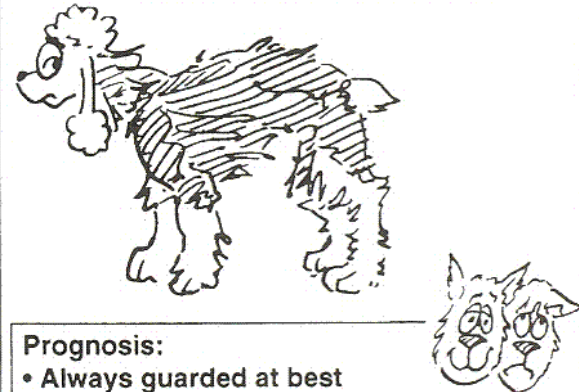
• Pulmonary thromboembolism

- General supportive care
- Oxygen
- Anticoagulants + time

• Monitor Cushing's patients

- Lifelong monitoring necessary because mitotane overdosage or underdosage can complicate Tx
- ACTH stimulation test every 3-6 months to guide mitotane & ketoconazole adjustment

Drugs on horizon: Bromocriptine, Cyproheptadine, Metyrapone, Aminoglutethimide, Etomidate, Trilostane, Suramin







Prognosis:

- Always guarded at best
- Pituitary tumors: good - life span 2 yrs
- Benign adrenal tumors: good
- Poor: malignant adrenal tumors: - metastasis
- PDH + CNS CS: grave

Hypoadrenocorticism

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ENDOCRINE SYSTEM

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Addison's disease, Hypo-adrenocorticism M8k 391; Mk 264; E-hb 597; SAP 238, 1175, 802; H3B 471; H2B 531; I2M 798; IM 600, 742; 5min 716; IM-WW 401; E 1579; Cat 1490; C12T 425; R&E-F 266; R&E-M 216; NS-W 203; NS-HB 332; NS-L 89; Phys-B 970; Lab-C 222; Pa-T 259; Emrg 224, 255; Sx-S-hb 512, 758; Sx-S 2294; NB 9.11	<ul style="list-style-type: none"> • Uncommon endocrinopathy • ↓ Glucocorticoids &/or mineralocorticoids from adrenal cortex - Usually due to adrenal atrophy • Young to middle aged, female dogs - < 7 years (range 0.5-10 yr) - Any breed, black standard poodles 	<ul style="list-style-type: none"> • "Great pretender": CS mimic other dizzs • Chronic - No pathognomonic signs - Waxing & waning course - Anorexia, weight loss - Dullness, lethargy - Muscle weakness (exercise intolerance) - Vomiting & diarrhea - PU/PD - Stress often exacerbates CS • Acute, end-stage: from similar but more severe CS - Weakness to collapse - Severe vomiting/dehydration - Bradycardia - Cardiac arrhythmias (K+) - Hypovolemic shock & death w/o Tx 	<ul style="list-style-type: none"> • Difficult - confused w/ other dizzs • Hx (history), CS (clinical signs) • Physical exam - Weak femoral pulse - Dehydration, CS • Auscultation: bradycardia • ACTH stim. for definitive Dx - "Blunted" or no cortisol response - Takes time to get results back - < 1 µg/dl in 1°, > 2.5 µg/dl for 2° • Plasma ACTH concentrations - > 500 pg/ml in 1°, < 20 pg/ml in 2° • Blood values: - Na:K ration < 27:1 - hyponatremia: hyperkalemia, normal 27:1 - 40:1 - ↑ K, Ca, ↓ Na, Cl - K & Na m/b normal in 2° - Hypercalcemia 25% - Prerenal/renal azotemia (BUN) - Mild acidosis - ↑ Lymphocytes, eosinophils - Anemia (normocytic, normochromic nonregenerative) - ↑ PCV - dehydration - ± Hypoglycemia (rare) • UA: Specific gravity often increased, but m/b decreased due to medullary Na washout • ECG: depends on ↑ of K (see box) • Radiology: - Microcardia - Small aortic arch - Narrow caudal vena cava - ↓ Pulmonary vasculature - Megaesophagus (rare) • Necropsy: Small adrenal w/ thin cortex 	<ul style="list-style-type: none"> • See below - expanded • Acute: medical emergency (life threatening hypercalcemia & hypoglycemic) - Rapid IV normal saline (40-80 ml/kg/h IV) w/o food or water for 24 hours past crisis - Glucocorticoids • Dexamethasone (Azium®) .. Repeat in 2-6 hours if needed .. Convert to SCC maintenance over following 3-5 days - Hyperkalemia • NaCl 0.9% fluids usually enough - Acidosis: ± Na bicarbonate if total CO2 < 12 mg/dl • Chronic or subacute - Fluid Tx: normal saline - Maintenance • Mineralocorticoids: .. DOCP IM or SQ, monthly injections .. Florinef® tablets DOC (drug of choice) • ± Glucocorticoids maintenance not always required: Cortisone or prednisolone - Steroids on hand for crisis • Monitor - Initially monitor serum electrolytes every 1-2 weeks until patient stable - Once stable check Na, K, BUN every 3 months 
Causes of Addison's 1°: diz of adrenals (usually defc of both mineralo- & glucocorticoids) - Unknown/idiopathic #1 - Destruction of adrenals • Autoimmune • Granulomatous fungus • Hemorrhage/Infarction • Metastatic tumors - Overdose of o,p'-DDD (mineralocorticoids usually normal) 2°: Pituitary ACTH deficiency (glucocorticoid deficiency, mineralocorticoids usually remain normal) - Iatrogenic - termination of steroid Tx: (sudden) prolonged or hi doses of glucocorticoids (ACTH suppressed) - Megestrol acetate (Ovaban®) Tx in cats - Destruction of pituitary or hypothalamus by tumors - Idiopathic ACTH deficiency (rare)	Low steroids, Female dogs CS: Great pretender - PU/PD, Weak Dx: ACTH stim. - Blunting Tx: Glucocorticoids, Mineralocorticoids			

HYPOadrenocorticism, continued



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Endocrine Tune up -The Big 6

Guide to Small Animal Clinics, Pasquini, 3rd ed

Pathophysiology:

- Glucocorticoids & cortisol deficiency
 - ↓ Gluconeogenesis & glycogenolysis, energy metabolism
 - Depletion of hepatic glycogen, ↓ fat metabolism, ↓ mentation, GI disturbances, impaired water excretion, impaired tolerance to stress
- **Lack of aldosterone (mineralocorticoid)**
 - **Loss of Na, Cl, H₂O & retention of K⁺ & H⁺** leads to:
 - . Hypovolemic shock, ↓ cardiac conduction & output, ↓ blood press, ↓ renal perfusion
 - . Muscle weakness & nausea, mineralocorticoid deficiency
 - . Early: normal electrolyte levels, but can't deal w/ stress
- Glucocorticoids (CCS) can be deficient w/o aldosterone deficiency



ECG - life threatening hyperkalemia

- "Hold ECG at T wave & before P wave & stretch out"
- Peaked T wave
- Fattening of P wave
- Prolonged PR interval
- Widening & flattening of QRS complex
- ↓ or absent P waves as K⁺ rises
- Bradycardia
- Sinoatrial standstill (no P waves)
- Ventricular astole or fibrillation w/ severe hyperkalemia



Memory aid: Add steroids to Tx Addison's

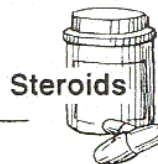
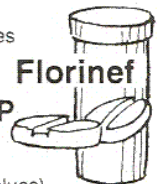
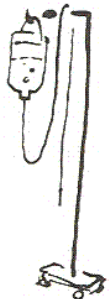
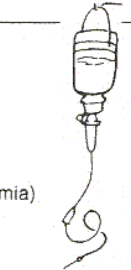
DDx:

- 1° GI disturbance
- Renal failure
- Acute pancreatitis
- Ingestion of toxins
- Collapse or weakness
 - Cardiovascular diz
 - Neuromuscular dizz
 - Metabolic disorders
- Hyperkalemia
 - Chronic renal failure
 - Urethral obstruction
 - Ruptured urinary bladder
 - Severe acidosis
 - Surgical tissue destruction
 - Crush injury
 - Extensive infection
- Massive hemolysis
- Hyponatremia
 - Renal tubular diz
 - Diuretic induced sodium loss
 - Urinary sodium loss from osmotic diuresis - Diabetes mellitus
 - Inadequate intake
 - Vomiting
 - Diarrhea
 - Polydipsia
- Other causes of hypercalcemia
- Crisis - life threatening
 - Diabetic ketoacidosis
 - Necrotizing pancreatitis
 - Septic peritonitis



TREATMENT:


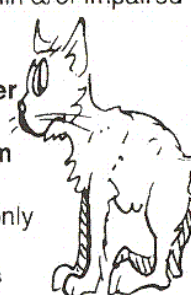
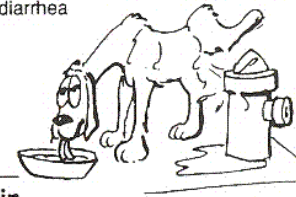

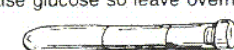

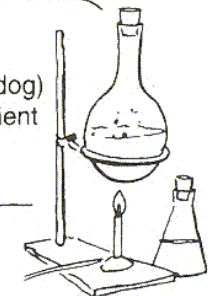
- **Acute: medical emergency** (life threatening hypercalcemia & hypoglycemia), correct hypotension & hypovolemia, give immediate CCS, correct electrolyte imbalance & acidosis
 - Obtain blood & urine before initiating Tx, ACTH stimulation can be performed simultaneously
- 1. **Hypovolemia IV catheter**
 - **Rapid IV normal saline** (40-80 ml/kg in 1st hr)(90% of time will take care of hyperkalemia)
 - **Dexamethasone (Azium®)** (doesn't interfere w/ ACTH test) or Dexamethasone sodium phosphate
 - . Repeat in 2-6 hours if needed
 - **Convert to prednisolone, prednisone or cortisone acetate** over following 3-5 days
- 2. **Hyperkalemia - Tx increased K if needed**
 - **Usually corrected w/ normal saline**
 - . Indication for more aggressive Tx: severe bradycardia & sinoatrial standstill
 - . Insulin-dextrose Tx (Regular insulin IV bolus + Dextrose IV fluid over 4-6 hr)
 - . Ca gluconate or Na bicarbonate, administer cautiously/serious side effects
 - . Antagonize K effect on heart
 - . Cautiously give Na bicarbonate over 10-20 min (temporary transcellular shift of potassium)
- 3. **Acidosis:** Na bicarbonate if pH < 7.1 or total CO₂ < 12
 - . 1/4 calculated dose IV during first 6 hr if serum bicarbonate < 12 mEq/L
- 4. **Supportive care**
 - Correct hypothermia
 - Hypoglycemia: 50% dextrose 0.5-1.5 ml/kg IV slowly
- 5. **When stabilized Tx as for chronic Addison's**
- **Chronic or subacute**
 - **Fluid Tx:** normal saline (60-80 ml/kg/d IV), decrease over 48-96 hours as normalizes
 - Maintenance therapy
 - **Mineralocorticoids**
 - .. DOCP® (desoxycorticosterone) **monthly** injections; long acting mineralocorticoid, not approved for small animals, get a client waiver
 - .. Oral Florinef® (fludrocortisone acetate) tablets DOC (check w/ serial electrolyte values)
 - **"Steroids"/glucocorticoids** maintenance not required by all
 - .. Prednisolone, prednisone or cortisone acetate
 - **Steroids on hand for crisis** (stress - owners should carry prednisolone tablets)
 - . Salt supplementation may enable to decrease of DOCP or Florinef (which is expensive)
 - . Monitor: Initially monitor serum electrolytes every 1-2 weeks until patient stable
 - . Once stable check Na, K, BUN every 3-4 months



Diabetes mellitus

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ENDOCRINE SYSTEM

Condition	Facts/Cause	Presentation/CS	Diagnosis
Diabetes mellitus, DM M8k 394, 913; Mk 267; E-hb 576, 318; SAP 249, 1168; H3B 463, 281; H2B 523, 311; I2M 737, 734; IM 563, 573(f), 595, 798; IM-WW 394; 5min 520; E 1510, 706; Cat 1465, 1459, 1555; C11T 311; C12T 393, 403, 390, 384; R&E-F 339; R&E-M 194; NS-C 383; NS-W202, 216, 228; NS3hb 194, 351; NS-hb 192, 331; NS-O 362, 270; NS-L 79; NS-Pa 462; Phys-B 851; Derm 706; Pa-T 276; Sx-S-hb 756, 66; Sx-S 2290, 140; NB 9.2 ***	<ul style="list-style-type: none"> • Pancreatic islets inability to secrete insulin &/or impaired insulin action in tissues • Incidence about 1:500 in dogs & cats • Insulin deficiency - metabolic disorder <ul style="list-style-type: none"> - CHO (carbohydrate) intolerance - Abnormal protein & lipid metabolism • Adult: 4-14 yrs (rare dogs < 1 yr) - Male cats & female dogs more commonly • Breeds: pulis, cairn terriers, miniature pinschers, poodles, dachshunds, miniature schnauzers, beagles • Types: <ul style="list-style-type: none"> - Type 1 - Insulin dependent (IDDM, Type 1) (ketosis prone) #1 <ul style="list-style-type: none"> . Can't make insulin (β cells nonfunctional) . Irreversible, life long therapy - Type 2 - Non-insulin dependent (NIDDM) <ul style="list-style-type: none"> . Relative insulin deficit, insulin antagonism, abnormal carbohydrate metabolism, some function of β cells of pancreas . Cats 20%, less common in dogs . Some insulin secreted so mild hyperglycemia & ketoacidosis uncommon - Type 3 - 2° Diabetes: associated w/ other dzs (pancreatic dz, endocrine disorders, drug-induced (steroids, megestrol acetate), hyperadrenocorticism, acromegaly) <ul style="list-style-type: none"> . Requires insulin treatment • Causes - multifactorial <ul style="list-style-type: none"> Genetic, drugs (steroids, megestrol acetate), immune-mediated destruction of beta cells, amyloidosis, hormonal abnormalities (excess growth hormone), hyperadrenocorticism (rare), pancreatic dz, obesity & hi CHO diets, infectious viral dzs • Pathophysiology: <ul style="list-style-type: none"> - ↓ Insulin - ↑ Hepatic gluconeogenesis & glycogenolysis - ↓ Glucose utilization & impaired glycolysis - Ketoacidosis (↑ ketone bodies due to underuse of glucose) - Results in hyperglycemia & glycosuria (PU/PD [osmotic diuresis], polyphagia, weight loss, dehydration) 	<ul style="list-style-type: none"> • PU/PD (polyuria/polydipsia) • PP (polyphagia) • Weight loss, many obese until late in untreated dz • Plantigrade walk - cats (hocks touching ground); neuropathy? • Cataracts (dogs common, cats uncommon) • Skin manifestation: rarely or in 1/3rd cases <ul style="list-style-type: none"> - Bacterial pyoderma, seborrhea, thin, hypotonic skin, varying degrees of alopecia <p>Complications:</p> <ul style="list-style-type: none"> • Hypoglycemia (iatrogenic) • Cataracts (not in cats) • Infections (especially urinary tract) • DKA (diabetic ketoacidosis) • Lipidosis - hepatic • Pancreatitis (dog, less common in cat) • Peripheral neuropathy (common in cat [plantigrade walk], uncommon in dog) • Uncommon sequelae: glomerulonephropathy, glomerulosclerosis, retinopathy, gastric paresis, diabetic diarrhea 	<ul style="list-style-type: none"> • Hx, CS (PU/PD, weight loss, PP) • Physical exam: unremarkable unless DKA <ul style="list-style-type: none"> - Hepatomegaly (hepatic triglycerides - "fatty liver") • Persistent hyperglycemia & glycosuria • Fasting hyperglycemia (Chemstrip®) <ul style="list-style-type: none"> - Dog > 200 - 250 mg/dl - Cat > 300 mg/dl • R/O transient stress hyperglycemia (lasts only a few days), Cats: stress can raise glucose so leave overnight & test again • Lab chemistries <ul style="list-style-type: none"> - Hyperglycemia > 300 mg/dl (Chemstrip®) - UA (urinalysis) <ul style="list-style-type: none"> - Glycosuria (Ketodiastix®) - Ketonuria (Ketostix®, Ketodiastix) for DKA <ul style="list-style-type: none"> - ± UTI (urinary tract infection)(proteinuria, pyuria, hematuria) • CBC: Stress leukogram, infec/inflam. if present <ul style="list-style-type: none"> - ↑ Cholesterol, triglycerides, ALT, AST, ALP • Differentiate IDDM from NIDDM <ul style="list-style-type: none"> - IV glucose tolerance test (for β cell function) <ul style="list-style-type: none"> . IDDM = insulin within or below normal (≤20 μU/ml) . NIDDM = insulin > 20 μU/ml (some NIDDM cats don't respond) <p>DDx:</p> <ul style="list-style-type: none"> • 1° renal glycosuria • Chushing's hyperglycemia (dog) • Stress hyperglycemia (transient epinephrine-induced) (no glycosuria)
		 <p>Insulin</p> <ul style="list-style-type: none"> • Regular (crystalline zinc) • NPH (Iosphane®), Lente • Ultralente 	    <p>short acting (5-8 hr) intermediate acting (8-16 hr) long acting (14-24 hr)</p>

Endocrine Tune up -The Big 6

Guide to Small Animal Clinics, Pasquini, 3rd ed

Diabetes mellitus, continued

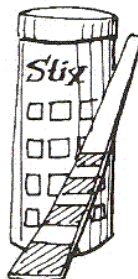
Treatment summary

- **Insulin**
 - Regular - short acting
 - **NPH, Lente** - intermediate acting
 - PZI, Ultralente - long acting
- **Balanced diet**, feed BID
- **Exercise** (↓ Insulin requirement)
- **Home monitor**: Keto-Diastix for morning urine
 - Adjust dose (see box)
 - Feed 1/2 of day's food
 - Feed other 1/2 in evening



Patient monitoring

- Home monitoring by owner
 - Subjective evaluation of water intake, urine output & normal body weight; good, not ravenous appetite; vomiting, diarrhea, anorexia, weight loss or weakness
 - Check urine daily for glucose & ketones prior to evening meal (not in morning) - (Test-Tape, Keto-Diastix, Clinitest®), urine monitoring not necessary in cat
 - Negative for glucose indicates correct response to injections
 - Persistent glycosuria: bring in for in-hospital serial blood glucose determinations
- Periodic serial blood glucose curves in hospital every 2-4 weeks to adjust insulin dose

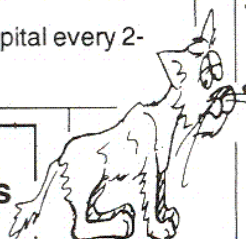


Insulin defc

CS: PU/PD, Polyphagia, Weight loss, Cataracts

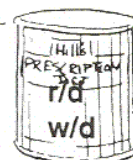
Dx: CS, Hyperglycemia + Glycosuria

Tx: Diet, Exercise, Insulin



Treatment nonketotic DM

- **Balanced diet**, feed BID
 - High-fiber, highly digestible, complex carbohydrate diets (Hill's r/d (reducing), w/d diets)
 - Nibblers: Free choice + 2 small meals of canned food; 2 meals for gluttons)
 - Obesity: gradually reduce over 2-4 months: Hill's r/d, Gaines cycle 3 or high-fiber, low calorie food
 - Thin dog & cats: high-caloric, low fiber diet (w/d or p/d); once ideal weight gradually change to high fiber
- **Exercise** (↓ Insulin requirement)
- **Ovariohysterectomy** of intact females: progesterone in diestrus complicates management
- **Insulin**: maintain blood glucose between 100-180 mg/dl in noncataract dogs & 100-250 mg/dl in cataract dog & cat (> 80 mg/dl glucose strip). Or, in cats, less than 200 mg/dl for ≥ 80% of day
- Guard against hypoglycemia from overzealous insulin Tx
- **Dogs: intermediate acting**: Lente or NPA - sid in morning
- **Cat**: 75% require insulin twice a day (bid), tight regulation not as important as in dog because of lower complication rate & potential neurological damage
- **Long-acting**: Ultralente or protamine zinc sid in morning
- **Intermediate acting insulin**: Lente or NPH bid



Cats w/ Type 2 DM (NIDDM) non-insulin dependent may often be controlled w/o insulin

- Diet, Exercise, OVH as above
- **Glipizide (Glucotrol®)** (sulfonylureas): oral hypoglycemics (requires some functional β cells) control glycemia in some NIDDM cats when used w/ dietary Tx & obesity correction (duration from weeks to > 1 year), wait a month to see improvement in blood glucose; little use in dogs.
- Discontinue & re-evaluate in 1 week if hypoglycemia or euglycemia (reinstitute if hyperglycemia returns, initiate insulin therapy if CS worsen or hyperglycemia over 2 months)



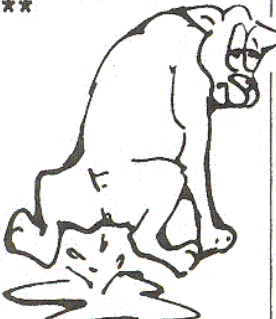


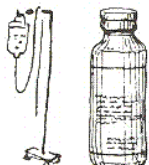



- **Hyperadrenocorticism in dogs**: control hyperadrenocorticism 1st then control DM
 - Conservative dose (0.5-1 U/kg) sid or bid to prevent ketoacidosis & severe hyperglycemia
 - Owners monitor urine glucose (strip); if negative decrease insulin 10-20% to avoid hypoglycemia
 - If persistent hypoglycemia stop mitotane Tx & do a ACTH stimulation test
 - As control Cushing's, insulin requirement usually decreases
 - Monitor ACTH response 3-4 x/year

Prognosis:

- Cat: Guarded
- Dog: Good

Endocrine Tune up -The Big 6

Guide to Small Animal Clinics, Pasquini, 3rd ed

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
DKA, Diabetic ketoacidosis Mk 267; E-hb 579; SAP 249; H3B 467; H2B527; I2M 759; IM 578; 5min 516; 1518; IM-WW 395, 396; Cat 1470; C12T 384, 394; C11T 359; E&R 392; Lab-S 330; Emrg 251 ★★ 	<ul style="list-style-type: none"> • Severe stage of DM (diabetes mellitus) <ul style="list-style-type: none"> - Undiagnosed IDDM • Hyperglycemia, hyperketonemia & metabolic acidosis • Pathophysiology: <ul style="list-style-type: none"> - Insulin defc causes peripheral lipolysis w/ massive influx of fatty acids into liver - Ketogenesis: excess FAs converted to ketones (acetoacetate & hydroxybutyrate or acetone) - Metabolic acidosis • 4 Factors involved in DKA (all 4 needed); therefore NIDDM/type 2 don't get because make some insulin <ol style="list-style-type: none"> 1. Insulin deficiency 2. Starvation/fasting 3. Dehydration 4. Diabetogenic hormones (GCC, glucagon, catecholamines, growth hormone) • Bacterial or viral infections sometimes precipitate onset 	<ul style="list-style-type: none"> • Acute or chronic onset • Early signs of DM <ul style="list-style-type: none"> - PU/PD - \pm Polyphagia - Weight loss • DKA (diabetic ketoacidosis) <ul style="list-style-type: none"> - Depression, weakness - Vomiting, diarrhea - Acetone breath (Juicy Fruit odor) - Kussmaul respiration (slow, deep breathing due to acidosis) - Coma 	<ul style="list-style-type: none"> • CS, DM, ketonuria, acidemia, glycosuria, ketonemia • Lab: as for DM <ul style="list-style-type: none"> - Hyperglycemia <ul style="list-style-type: none"> > 250 mg/dl (Chemstrip®) - Plasma pH < 7.3 w/ anion gap <ul style="list-style-type: none"> - Plasma bicarbonate < 15 mEq/l, decreases total carbon dioxide - Ketonemia <ul style="list-style-type: none"> - \uparrow Liver enzymes (ALP, AST) - BUN normal to \uparrow • UA (urinalysis) <ul style="list-style-type: none"> - Glycosuria (Ketodiastix®) - Ketonuria (Ketostix®) - \pm Pyuria & bacteria (UTI infection) • CBC: stress leukogram, infec/inflam. if present • Plasma pH < 7.3 w/ anion gap • Radiography: hepatomegaly • Physical exam: <ul style="list-style-type: none"> - Dehydration - Check for coexisting disorders (acute pancreatitis) 	<ul style="list-style-type: none"> • Emergency • Rehydrate & maintenance fluids • 0.9% saline w/ KCl over 24-48 hrs <ul style="list-style-type: none"> - Initially 1.5-2 x maintenance (60-100 ml/kg/d) - KCl sol. to IV maintenance fluids for hypokalemia, if no accurate K level add 40 mEq K/liter, not to exceed 0.5 mEq/kg/hr - Monitor electrolytes bid: if Na 140-155 mEq/l change fluids to lactated Ringer's, if 140 mEq/l keep on 0.9% saline, if > 155 mEq/l give hypotonic 0.45% saline • Insulin to lower glucose slowly to 200-250 mg/dl over 8-10 hours <ul style="list-style-type: none"> - Regular crystalline insulin if clinically ill (IV, IM or SQ) (depressed, dehydrated) - Rapid action (immediate IV or IM, SQ -30-60 min) - Short duration - If patient alert: NPH, Lente or Ultralente • Treat concurrent illness: bacterial infections, pancreatitis, congestive heart failure, renal failure, hyperadrenocorticism & diestrus • Spay all intact females when diabetes is diagnosed 
Serious sequela to DM = Metabolic acidosis CS: Depression, Sick, Acetone, Coma Dx: DM + Ketonemia Tx: Emergency, Saline w/ KCl, Insulin		$\text{Replacement} = \% \text{ dehydration} \times \text{kg (BW)} \times 1000 \text{ ml}$ <p>Maintenance</p> <ul style="list-style-type: none"> - Normal urine output: 60 ml/kg/d - Oliguria: = amount of urine output + insensible loss (20 ml/kg/d) - Anuria: insensible loss (20 ml/kg/d) 		Prognosis: <ul style="list-style-type: none"> • Guarded to poor
Nonketotic hyperosmolar diabetic syndrome (NKHDS) C12T 384; 5min 518; IM-WW 395; Cat 1473; Emrg 253 ★ 	<ul style="list-style-type: none"> • Severe form of DM • Hyperosmolar blood, no ketones • Pathophysiology: osmotic gradient between intracellular & extracellular compartments of brain - Causes: cellular dehydration & dysfunction 	<ul style="list-style-type: none"> • Early: PU/PD <ul style="list-style-type: none"> - Weakness - Vomiting - Thirst may diminish even w/ increasing hyperglycemia • CNS signs <ul style="list-style-type: none"> - Mental depression - Grand mal seizures - Hemiparesis - Hyperreflexia - Muscle fasciculations - Nystagmus 	<ul style="list-style-type: none"> • Hx, CS • Physical exam: dehydration, hypotension & mental depression • Hyperglycemia often above 800 mg/ml • Serum osmolality > 350 mOsm/kg body water (normal 290-310) • Most have renal or prerenal azotemia (BUN, creatinine) • NO ketones, but may be acidotic 	<ul style="list-style-type: none"> • Emergency: objectives: rehydrate & normalize urine output • Fluid: 0.9% saline if hypotensive or hyponatremic, change to 0.45% saline when blood pressure & hydration normal - Monitor electrolytes bid: if Na 140-155 mEq/l change fluids to lactated Ringer's, if 140 mEq/l keep on 0.9% saline, if > 155 mEq/l give hypotonic 0.45% saline • Regular crystalline insulin (short acting) to avoid precipitous drop of blood glucose - Fear of brain edema 2^o to rapid fluid appear unwarranted (C12T 385) • Potassium supplementation <p>Px: Poor</p>

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Diabetes insipidus

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ENDOCRINE SYSTEM

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Diabetes insipidus, DI M8k 412; H3B 443; H2B 502; E-hb 549; SAP 268; I2M 673; IM 458, 527; 5min 514, 130, 274; IM-WW 384; E 1428; Cat 1410; R&E-F 2; R&E-M 251; Phys-B; Psy-R 195; Lab-C 219; Pa-T 254; DDx 68 ★★	<ul style="list-style-type: none"> • See Urinary pg 378 • Disorder of water metabolism: characterized by polyuria/polydipsia (PU/PD, low specific gravity of urine) <div> 3 basic types see pg 378 1. Nephrogenic DI (NDI): inability of renal tubules to respond to ADH - Causes: 2° to renal & metabolic disorders (endocrine & electrolyte) see pg 378 for list 2. Pituitary/Central DI (CDI): deficiency of ADH - Cause: Idiopathic (#1), head trauma or neoplasia 3. Psychogenic/D psychogenic DI: excessive water intake - Cause: disorder of thirst centers, behavior problem, pharmacological agents </div>	<ul style="list-style-type: none"> • PD/PU (polyuria/polydypsia) • Nocturia • ± CNS signs (expanding brain tumor) • ± CS of renal diz  <div> DDx: • Diabetes mellitus • Hyperadrenocorticism • Hyperthyroidism • Hypertension (severe) • Liver diz • Hypercalcemia • Chronic renal failure • Pyelonephritis • Hypokalemia • Hyperviscosity syndromes </div>	<ul style="list-style-type: none"> • Hx, CS (PU/PD) • Physical exam: usually unremarkable, m/b thin (thirst overshadows hunger) • Dehydration if water unavailable for 4-6 hours • Water deprivation if not azotemic - Central or nephrogenic: neither concentrates (< 1.025) - Psychogenic: concentrates (> 1.025) unless medullary wash-out • Water deprivation + ADH - Central: concentrates w/ ADH (> 1.025) unless medullary wash-out - Nephrogenic: no response to ADH (< 1.025) • Gradual water deprivation to check for medullary washout - Psychogenic: concentrate (> 1.025) - Central or Nephrogenic: no response (< 1.025) • Gradual H₂O deprivation + ADH - Central: concentrates (> 1.025) - Nephrogenic: no response (< 1.025) 	<ul style="list-style-type: none"> • Central DI - Idiopathic: Tx not mandatory if unlimited water • Repositol vasopressin (Pitressin® tannate) IM • Synthetic vasopressin (Desmopressin acetate DDAVP) drops intranasal or conjunctival • Chlorpropamide (Diabinese®) (sulfonylurea - potentiates renal tubular effect of ADH) • Diuretic w/ salt restriction - Tumors: Cobalt teletherapy, Carmustine (BCNU) • Nephrogenic DI - Tx predisposing cause - Not mandatory if unlimited water • Psychogenic • Nothing, behavior modification, slow restriction <div> Prognosis: • Central: good for idiopathic or congenital - Guarded if trauma induced - Guarded to grave: tumor • Nephrogenic: depends on response of underlying cause - 1° NDI (rare) guarded to poor • Psychogenic: good </div> 

3 types: NDI, CDI & Psychogenic

CS: PD/PU, Nocturia, ± CNS signs or Renal diz

Dx: Water deprivation + ADH

Tx: CDI (ADH, Diabinese®), NDI (Tx cause, H₂O), Psychogenic (none)

Prognosis: CDI: Good, NDI: Varies, Psychogenic: Good



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HYPERthyroidism

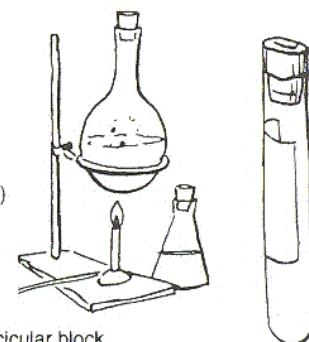
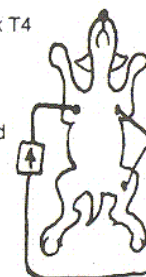
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ENDOCRINE SYSTEM

Condition	Facts/Cause	Presentation/CS	Diagnosis
Thyrotoxicosis, Feline hyperthyroidism, Thyrotoxic myocardial diz, 2° hypertrophic cardiomyopathy, HCM M8k 419; Mk 284; SAP 221; E-hb 561, 417; H3B 451; H2B511; 5min 708, 98; IM-WW 392; I2M 720; IM 552; E 1466; C11T 756, 334; F-N 401; F3IM 155; F2IM 143; H-T/M 295; H-F 734, 255, 459, 565; Cat 1416; R&E-F 118; R&E-M 274; Phys-B 902; Lab-C 222; Pa-T 266; Sx-S-hb 508; Sx-S 1517; Sx-WW 183; Sx4B 542 ***	<ul style="list-style-type: none"> Excessive T₃ & T₄ in blood Multisystemic disorder <ul style="list-style-type: none"> #1 feline endocrine disorder > 10 years-old 95% Usually bilateral 70% Uncomplicated cases common Cardiac involvement fortunately uncommon Cause: <ul style="list-style-type: none"> Thyroid hyperplasia/adenoma: functional > 95%, benign Thyroid carcinoma rare < 2% Mechanism of PU: unknown <ul style="list-style-type: none"> Medullary washout &/or thyrotoxic psychogenic polydipsia 	<ul style="list-style-type: none"> Common CS <ul style="list-style-type: none"> Looks healthy Weight loss (95%) Polyphagia Unkept hair coat (50%) Excellent appetite & active (hyperactive) Frantic, anxious, aggressive (70%) CNS: hyperactivity, weakness Respiratory: dyspnea, panting ± breathlessness PU/PD (50%): renal GI: vomiting (40%), diarrhea (40%), anorexia (10%) Apathetic hyperthyroidism > 10% (opposite what would expect) <ul style="list-style-type: none"> Depression, lethargy, anorexia & weakness Weight loss Cardiac abnormalities Sequelae: <ul style="list-style-type: none"> Cardiovascular failure (10-15%) Hypertension Hypertrophic cardiomyopathy Congestive heart failure (15% of hyperthyroid cats) Weakness, dyspnea, lethargy Dilative cardiomyopathy (rare) 	<ul style="list-style-type: none"> Hx (history), CS (clinical signs) Physical exam (PE): <ul style="list-style-type: none"> Goiter (thyroid enlargement) (90%), normally can't be palpated Aggressive behavior during PE Laboratory: <ul style="list-style-type: none"> CBC: stress response (leukocytosis & eosinopenia), ↑ PCV (50%) ↑ Liver enzymes (ALT, AP, LDH - 80%), BUN (30%) ↑ Resting T₄ (multiple samples) (normal = 15-55 mmol/l; 12-43 ng/ml) ↑ Free T₄ in early cases Nuclear imaging (technetium-99 pertechnetate) taken up in thyroid - shows thyroid involvement & metastasizes (rare) T₃ suppression test - give T₃ for a couple of days then check T₄ <ul style="list-style-type: none"> Normal cats: T₄ suppressed Hyperthyroid cats: T₄ not suppressed UA: ± low SG, ± ↑ BUN & creatinine Thyroid stimulating hormone (TSH) response test not recommended Thyrotropin-releasing hormone (TRH) stimulation test <ul style="list-style-type: none"> Normal cats: causes rise in T₄ of 60% Mildly hyperthyroid cats: causes rise less than 50% Cardiac involvement <ul style="list-style-type: none"> Physical exam: weak pulse, muffled heart & lungs (effusions), tachycardia, apical systolic murmur (50%) Bounding arterial pulse, mildly distended jugular veins, jugular venous pulse Echocardiography <ul style="list-style-type: none"> Lt ventricular hypertrophy (70%) Thick ventricular septum (40%) Lt atrial dilation (70%) Ventricular dilation (45%) Myocardial hypercontractility (20%) Radiology: <ul style="list-style-type: none"> Cardiomegaly (50%) Pulmonary edema/pleural effusion (10%) ECG (electrocardiography): <ul style="list-style-type: none"> Sinus tachycardia (70%) Large R waves (30%) APCs/Atrial fibrillation (10%) VPCs (2%) Conduction defects (10%), left anterior fascicular block



Multisystems, #1 Endo & Geriatric diz
CS: Thin & gluttonous, Frantic, Cardiac
Dx: Large thyroid, TSH, Rads, Echo, ECG
Tx: Sx - Excision



Endocrine Tune up -The Big 6

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HYPERthyroidism, continued



Pathophysiology - heart

- T₄/T₃ direct effects on heart (↑ HR & contractility)
- Increased sympathetic ANS: ↑ heart activity
- Indirect effects: increase demand on heart (↑ metabolism)

DDx:

- Weight loss + good appetite
- Malassimilation (GI infiltration, neoplasia, inflammation, pancreatic exocrine insufficiency)
- Other 1° dizzs
 - Chronic renal failure
 - Hepatic diz
 - Cardiomyopathy

Treatment: minimal for uncomplicated cases

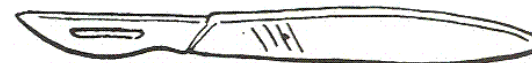
- NO spontaneous remission
- **Methimazole (Tapazole®)**: chronic antithyroid drug, safer than propylthiouracil (PTU); prevents iodination of thyroglobulin: does not treat adenoma itself (side effects = anorexia, blood dyscrasias, allergic dermatitis, possible lupus development). Daily Tx for life.
- **Surgical thyroidectomy** stabilize w/ methimazole 1st for 1-3 weeks, β-blocking drugs (propranolol or atenolol) to protect from cardiac complications, calcium channel blockers (diltiazem) for HCM
 - Complication: hypoparathyroidism & hypocalcemia, death, Horner's syndrome, laryngeal paralysis
 - Bilateral thyroidectomy: monitor serum calcium daily until stabilizes in normal range, start T₄ supplementation 1-2 days after surgery, usually only needed for 2-3 months
- **Radioactive iodine** ¹³¹ I TOC if available: least evasive, curative; into thyroid tumor, kills benign adenoma; not widely available, often expensive

Cardiac complication

- Stabilize before above Tx
- **Arrhythmias**
 - Propranolol (Inderal®)
 - β blocker for sinus tachycardia, supraventricular or ventricular arrhythmias
- **CHF clinical signs:**
 - Hypertrophic cardiomyopathy
 - Diuretic (furosemide [Lasix®])
 - Diltiazem (Cardizem®), digoxin or propranolol (Inderal®) carefully
 - Dilatative (rare)
 - Furosemide (Lasix®)
 - Digoxin (contractility)
 - Thoracocentesis (effusions)
 - ± ACE inhibitors (captopril [Capote®] or enalapril [Vasotec®])
 - .. Antithyroid Tx

Prognosis:

- Uncomplicated cases: good
- After correction of hyperthyroid state
 - Good: hypertrophic cardiomyopathy usually partially reversible
 - Poor: dilative cardiomyopathy usually not reversible



Feline hypothyroidism: SAP 220; H3B 447; H2B507; 5min 726; IM-WW 390; I2M 719; Cat 1452; F3IM 147; F2IM 150; R&E-F 111; R&E-M 68; Phys-B 935; Lab-C 227; Pa-T 266;

Sx-S-hb 507; Sx-S 1515;

*



- **Extremely rare in cat**, Cause: #1 Tx of hyperthyroidism (usually transient)
- CS: Asymptomatic, dwarfism/cretinism, lethargy, mental dullness, seborrhea sicca, dry haircoat, obesity, bilaterally symmetrical alopecia does not occur
- Dx: Hx, CS, subnormal resting serum T₄ level that fails to respond to TSH stimulation
- Tx: **T₄ supplementation**
- Px: Adult - good, Congenital - guarded

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HYPOthyroidism

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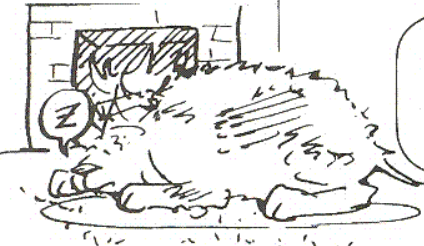
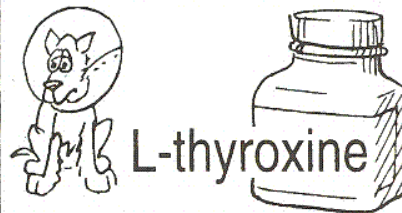
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Endocrine Tune up -The Big 6

Guide to Small Animal Clinics, Pasquini, 3rd ed

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Canine Adult onset hypothyroidism M8k 415, 913; Mk 280; SAP 218, 1168; H3B 447, 282; H2B 507, 312; IM 544; E-hb 568, 321; IM-WW 390; 5min 726, 40, 80; E 1487, 710; C12T 346; C11T 310; H-T/M 300; R&E-F 70; R&E-M 68; NS-C 285; NS-W 205; NS3hb 194, 351; NS-hb 191; NS-O 270; NS-L 79; NS-Pa 462; Phys-B 930, 935; Lab-S 344; Lab-C 228; Pa-T 266; Sx-S-hb 507; Sx-S 1515; NB 9.15  *** 	<p>• #1 canine endocrinopathy maybe</p> <p>• Also see pg 674 & 673</p> <p>• Slows cellular metabolism</p> <p>• 4-10 yrs, medium to large breeds</p> <p>• Breeds: goldens, Irish setters, min. schnauzer, dachshund</p> <ul style="list-style-type: none"> - Spayed > intact bitches, bitches > dogs - Rare in toys & miniatures - Extremely rare in cats (Sx removal of thyroids in hyperthyroid) <p>• Causes:</p> <ul style="list-style-type: none"> - 1° - thyroid problem, no T4 or T3 (95% of cases) • Lymphocytic thyroiditis: probably immune-mediated • Idiopathic atrophy of thyroid • Neoplastic: 1° > metastasizes • Iatrogenic: radioiodine (¹³¹I), surgical thyroidectomy or antithyroid drug (hyperthyroid cat) - 2° - pituitary problem, no TSH • Rare < 5% • Pituitary tumors - 3° - hypothalamic disorder (no TRH) rare <p>• Pathophys.: ↓ metabolic rate</p>	<p>• Dullness, lethargy</p> <p>• Tiring (exercise intolerance)</p> <p>• "Heat-seekers": cold intolerant</p> <p>• Skin changes</p> <ul style="list-style-type: none"> - Alopecia: symmetric <u>nonpruritic</u> truncal alopecia - "Rat tail", Flakes - Hyperpigmentation - "Tragic" facial expression (thickening of skin on face, puffy - myxedema [thickening of dermis]) <p>• Weight gain w/o increase in appetite</p> <p>• Reproductive:</p> <ul style="list-style-type: none"> - Male: ↓ libido, testicular atrophy, hypospermia, infertility - Female: anestrus, sporadic cycling, infertility, abortion, poor litter survival - Galactorrhea (25% of intact bitches) <p>• Bleeding disorders</p> <ul style="list-style-type: none"> - Exacerbation of Von Willbrand's dz? <p>• CNS: peripheral neuropathy rare</p> <ul style="list-style-type: none"> - Dragging of front feet - Lateral head tilt - Facial nerve paralysis - Myxedema coma <p>• Cretinism/dwarfism: see congenital above</p> <p>• Eye (rare): corneal lipid deposits, Chronic uveitis, 2° glaucoma, Keratoconjunctivitis sicca</p> <p>• Other pituitary signs</p> <ul style="list-style-type: none"> - Hyperadrenocorticism - Hypoadrenocorticism - Diabetes mellitus - Hypogonadism <p>• Sequela:</p> <ul style="list-style-type: none"> - Pyoderma ± pruritus 	<p>• 1 of most over diagnosed dizz</p> <p>• Hx (history), CS (clinical signs)</p> <p>• Best: unresponsiveness to TSH stimulation test</p> <ul style="list-style-type: none"> - Resting level, TSH stimulation, 4- 6 hr later level - < 2.0 µg/dl ↑ of T4 <p>• Very low resting T3/T4 with CS & no other illness highly suggestive, but not diagnostic as other dizz & drugs can lower</p> <ul style="list-style-type: none"> - If normal basal levels, not hypothyroid <p>• Differentiate from euthyroid sick syndrome (low T4) & T4 lowering drugs: respond normally to TSH suppression test</p> <p>• Biopsy: differentiate 1° from 2° (histo)</p> <p>• UA: NSF (no significant findings)</p> <p>• Blood values:</p> <ul style="list-style-type: none"> - Anemia: nonregenerative (normochromic, normocytic) 25-40% - ↑ Cholesterol (≥ 75%) - ± Triglycerides - ± ↑ CK (creatinine phosphokinase) <p>• Cardiovascular CS</p> <ul style="list-style-type: none"> - Bradycardia - Weak apical beat - Low amplitude ECG 	<p>• Thyroid replacement - lifelong</p> <ul style="list-style-type: none"> - Synthetic L-thyroxine DOC (Levothyroid®, Synthroid®) • Usually required for life • Gradually introduce & ↑ 25% increments daily over 4-8 wks to desired level • CS resolve in a few months - Other products (not recommended) • Desiccated thyroid: cheapness outweighed by short shelf life & variable contents • Synthetic L-triiodothyronine • Synthetic combination of L-T4 & L-T3 • Myxedema stupor or coma - IV L-thyroxine, IV steroids, broad spectrum ABs, passive rewarming w/ blankets  <p>L-thyroxine</p> <p>Monitor Tx: CS of overdose</p> <ul style="list-style-type: none"> - PU/PD, nervousness, wt. loss, ↑ appetite, panting, fever - Dx: Elevated T4 &/or T3, amelioration of CS by discontinuance of Tx <p>• Access 1-2 months after Tx started</p> <ul style="list-style-type: none"> - Haircoat & body weight <p>Prognosis: Good</p>
<p>#1 Endo - Dog, Slow metabolism</p> <p>CS: Tiring, Heat seeker, Skin, Wt. gain, Low libido</p> <p>Dx: CS, No TSH response,</p> <p>Tx: L-thyroxine (T4)</p>	<p>DDx: < T3, T4</p> <ul style="list-style-type: none"> • Obesity • Exercise intolerance • Skin problems <p>Heart relationship not proven</p>	<p>675</p>	<p>DDx: low T4 levels</p> <ul style="list-style-type: none"> • Canine "euthyroid sick" syndrome - Nonthyroidal illness causing ↓ T3/T4 • Cushing's • Addison's • Diabetes mellitus • Chronic renal failure • Hepatic dz • Other critical medical illnesses • Calorie or protein deficiency • Surgery or anesthesia 	<ul style="list-style-type: none"> • Drugs suppressing T3, T4 - Glucocorticoids, anabolic steroids - Anticonvulsants (phenytoin & phenobarbital) - Salicylates, flunixin, phenylbutazone - Iodate (radiographic contrast agent) - Furosemide (Lasix®) - Thipental, methoxyflurane, halothane - Mitotane - Fatty acids



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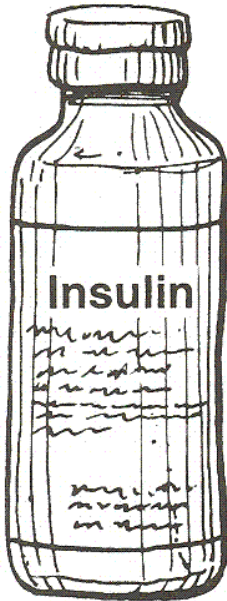
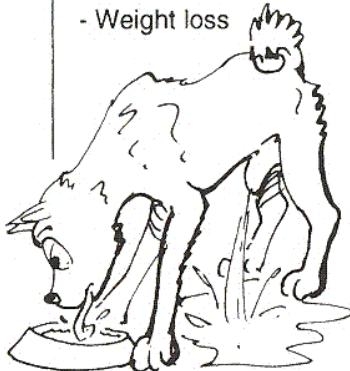
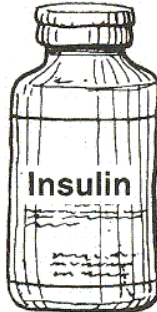
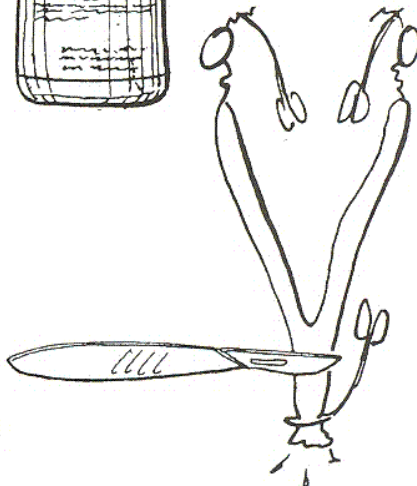
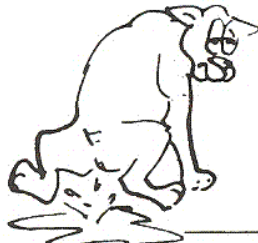
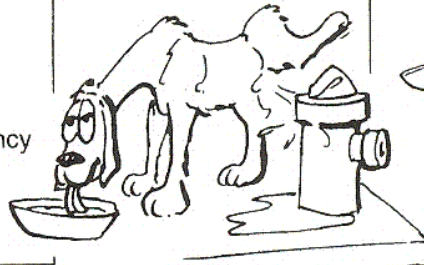


Miscellaneous conditions related to diabetes mellitus

Diabetes mellitus

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ENDOCRINE SYSTEM

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
<div>Insulin-resistant Diabetes mellitus</div> <div>E-hb 584; H2B526; SAP 254; C12T 390</div> <div>★★</div> <div></div>	<div>• Normal amounts of insulin result in subnormal response</div>	<div>• CS of diabetes</div> <div>- PU/PD/PP</div> <div>- Weight loss</div> <div></div>	<div>• Hx, CS</div> <div>• Suspect insulin resistance when:</div> <div>- Insulin dosage >1.5 U/kg (dog) or 6 U (cat) + blood glucose over 300 mg/dl</div> <div>- > 2.2 U/kg necessary to maintain blood glucose < 300 mg/dl</div> <div>• R/O problems w/ insulin activity or administration</div> <div>• R/O & Tx coexisting disorders: infection, Cushing's (20%), progesterone [diestrus], exogenous steroids, Ovaban, acromegaly</div>	<div>• Treat all existing disorders</div> <div>• Spay all intact females after diabetes diagnosed</div> <div>• Insulin: titrate to effect as long as no hypoglycemia</div> <div>- Cats ≤ 2.2 µg/kg/day</div> <div>- Dogs > 2.2 µg/kg/day</div> <div>- No maximum dosage</div> <div></div> <div></div>
	<div>Causes of insulin resistance or ineffectiveness</div> <div>• Insulin therapy</div> <div>- Inactive insulin</div> <div>- Dilute insulin</div> <div>- Improper administration</div> <div>- Inadequate dose</div> <div>- Somogyi phenomenon</div> <div>- Inadequate frequency of Tx</div> <div>- Impaired insulin absorption</div> <div>- Anti-insulin antibody excess</div> <div></div>	<div>• Concurrent disorders</div> <div>- Diabetogenic drugs</div> <div>- Hyperadrenocorticism</div> <div>- Diestrus (bitch)</div> <div>- Acromegaly (cat)</div> <div>- Infections (esp. oral & urinary)</div> <div>- Hypothyroidism (dog)</div> <div>- Hyperthyroidism (cat)</div> <div>- Renal insufficiency</div> <div>- Liver insufficiency</div> <div>- Cardiac insufficiency</div> <div>- Chronic pancreatitis</div> <div>- Exocrine pancreatic insufficiency</div> <div>- Glucagonoma (dog)</div> <div>- Hyperlipidemia (?)</div> <div>- Pheochromocytoma (?)</div> <div></div>		

↑ Dose until control

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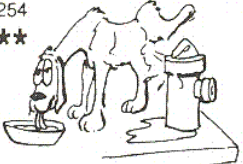

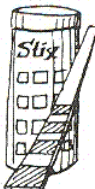








Miscellaneous conditions related to diabetes mellitus

Hypoglycemia

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ENDOCRINE SYSTEM

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Post-insulin hypoglycemia E-hb 583; H2B527; IM 572; C12T 385; R&E-F 198; Emrg 254 	<ul style="list-style-type: none"> Decline in blood glucose < 70 mg/dl after insulin dose 13% of hospital cases Causes: <ul style="list-style-type: none"> Insulin excess No food (anorexia, vomiting, malabsorption) Cats that regain ability to make insulin months after insulin therapy started 	<ul style="list-style-type: none"> Asymptomatic in most Weakness Anxiety Behavioral changes Muscle twitching, ataxia Head tilting Generalized seizures Coma 	<ul style="list-style-type: none"> Hx & CS 2-6 hrs after insulin injection ↓ Blood glucose < 70 mg/dl 	<ul style="list-style-type: none"> Temporary withhold insulin If conscious - carbohydrates orally <ul style="list-style-type: none"> Karo syrup (15 g / 5 ml) 1.0 ml/kg PO If unconscious: <ul style="list-style-type: none"> 50% Dextrose 1 ml/kg IV & maintain on 5% dextrose sol. Glucagon 0.03 mg/kg IM, IV Readjust insulin dose <p>Prognosis: Guarded:cat; dog: good</p>
Somogyi overswing, Induced hyperglycemia, Posthypoglycemic hyperglycemia E-hb 584; H2B526 	<p>Overdose of insulin causes hypoglycemia w/ subsequent hyperglycemic compensatory response</p> <ul style="list-style-type: none"> Hyperglycemia due to ↑ secretion of glucagon, epinephrine, cortisol & growth hormone 	<ul style="list-style-type: none"> CS of hyperglycemia <ul style="list-style-type: none"> Continued PU/PD Weight loss 	<ul style="list-style-type: none"> Suspect in persistent morning glycosuria (1 gm/dl) Demonstrate hypoglycemia (< 65 mg/dl) followed by hyperglycemia (> 300 mg/dl) w/in one 24 hours period following insulin administration 	<ul style="list-style-type: none"> Reduce dose 25-30% or split dose  <p>/2</p> <p>Prognosis: guarded:cat; dog: good</p>
Juvenile-onset DM (Diabetes mellitus) H2B 523; * C12T 348 	<ul style="list-style-type: none"> Rare < 1.5% of diabetic dogs; Insulin dependent diabetes, (IDDM) in dog < 1 year old; keeshond & golden; not recognized in cat; Cause: parvovirus? exocrine pancreatic insufficiency/pancreatic atrophy CS: PU/PD/ PP evident at 2-6 months old, ± nocturia, stunted growth & weight loss, ± cataracts, ± soft stool, pelvic limb polyneuropathy Dx: Fasting hyperglycemia (200 mg/dl) + glycosuria diagnostic, ± ketoacidosis; fat absorption test for pancreas Tx: Emergency as in adult for KA: fluids, insulin; Maintenance: balanced diet bid; Tx concurrent PEI (pancreatic enzyme supplementation) Px: Good if not DKA 			
Transient insulin response E-hb 584; H2B526; SAP 254; IM 570 	<ul style="list-style-type: none"> Short duration of action of insulin <ul style="list-style-type: none"> NPH & Lente (intermediate duration) usually & occasionally in Ultralente (long acting) in cats Ideally duration from injection until blood glucose > 200-250 mg/dl at least 22-24 hours Insulin works faster than normal: hypoglycemic then persistent hyperglycemia 	<ul style="list-style-type: none"> Evening PU/PD Weight loss 	<ul style="list-style-type: none"> Hx (insulin Tx) + CS Marked morning glycosuria Hypoglycemic episode 2-6 hours after injection Confirm w/ blood glucose curve: <ul style="list-style-type: none"> Hyperglycemia > 250 mg/dl w/ in 18 hours or less of insulin Tx, while lowest level > 80 mg/dl 	<ul style="list-style-type: none"> Tx: Reduce insulin 25-30% & split dose, or use longer acting insulin Dog <ul style="list-style-type: none"> Reduce insulin 25-30% & split dose, given 12 hours apart, or If Lente or NPH, consider change to Ultralente If Ultralente: consider supplementation w/ a dose of regular or Lente in evening or switch to Lente or NPH bid Cat <ul style="list-style-type: none"> Ultralente to short, switch from sid to bid & adjust dose to prevent hypoglycemia, or Switch to Lente insulin bid