

# Azotemia

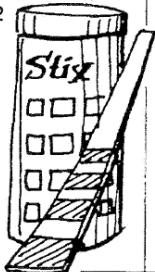
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## URINARY SYSTEM

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
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### Azotemia

M8K 1134; Mk 877;  
E-hb 645; SAP 799;  
H3B 493; 5min 216;  
I2M 585; IM 463; IM-  
WW 323; CM 424,  
470; Pa-T 211; NB  
21.22



- **↑ Blood Urea Nitrogen (BUN) &/or creatinine**
- **Types: prerenal, renal or postrenal azotemia**
- **Differentiating the type is important for accurate diagnosis, treatment & prognosis**
- **Uremia:** clinical syndrome resulting from the accumulation of metabolic waste products due to renal failure

#### DDx: Azotemia

- **↑ BUN - normal creatinine - normal GFR**
  - High protein diet
  - Excess protein catabolism
  - Intestinal bleeding
  - Fever
- Trauma
- Infection
- Toxemia
- **↑ Fractional reabsorption of urea as with dehydration**

<b>Prerenal azotemia</b>	Reduced renal perfusion	<ul style="list-style-type: none"> <li>↑ BUN &amp; creatine</li> <li>↑ Urine specific gravity &gt; 1.030</li> </ul>
<b>Renal Azotemia</b>	Loss of 75% of nephrons	<ul style="list-style-type: none"> <li>↑ BUN &amp; creatinine</li> <li>↓ Urine specific gravity &lt; 1.017</li> </ul>
<b>Postrenal azotemia</b>	Blockage of urine outflow	<ul style="list-style-type: none"> <li>↑ BUN &amp; creatinine</li> <li>Oliguria or anuria</li> <li>Hyperkalemia</li> </ul>

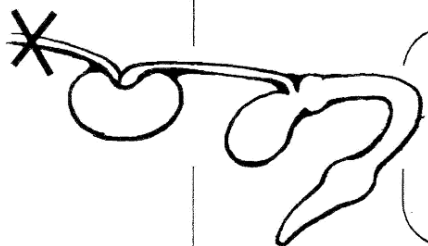


### • Prerenal azotemia \*\*\*

- **↓ Renal perfusion** causing ↓ glomerular filtration of metabolites
  - Results in ↑ BUN &/or creatinine in blood-stream
  - Urine concentration ability remains normal (tubular function remains normal)
- If decreased perfusion corrected rapidly kidney will return to normal function
- If not corrected: renal ischemia & kidney destruction
- CS of cause
  - Anuria, oliguria
- Sequela:
  - Renal diz
  - Renal failure

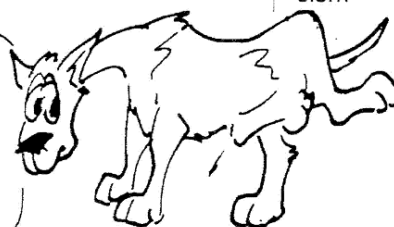
- **↑ BUN & creatine**
  - If ↑ BUN & normal creatinine check diet or protein catabolism
- **High urine specific gravity > 1.030**
- Adrenocorticotrophic hormone stimulation test to diagnose hyperadrenocorticism

- **Kidney normal**
- **Restore circulating fluid volume & renal perfusion**
  - Correct electrolyte abnormalities
- Treat cause:
  - Dehydration: fluids
  - Shock: fluids, steroids
  - Hypoadrenocorticism: fluids
  - Heart failure: ????



#### Causes - prerenal azotemia

- Dehydration
- Shock
- Hypoadrenocorticism
- Heart failure



> 1.030



- Prognosis: usually resume normal function when re-perfusion reestablished if not prolonged ischemia



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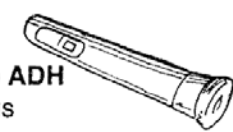
Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
<b>• Renal (1°) azotemia</b> <b>***</b>	<ul style="list-style-type: none"> <li>• ↓ GFR due loss of &gt; 75% of nephrons</li> <li>• Renal dz resulting in azotemia = renal failure</li> <li>- Acute renal failure: reversible or irreversible</li> <li>- Chronic renal failure: irreversible</li> </ul>	<ul style="list-style-type: none"> <li>• Acute                             <ul style="list-style-type: none"> <li>- Anuric, oliguric, occasionally polyuric</li> </ul> </li> <li>• Chronic                             <ul style="list-style-type: none"> <li>- PU/PD</li> <li>- GI (vomiting &amp; diarrhea)</li> <li>- Oral ulcers</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• ↑ BUN &amp; creatinine</li> <li>• Acute &amp; chronic</li> <li>- Low SpG &lt; 1.017</li> </ul> <div style="border: 1px solid black; padding: 5px; margin-top: 10px;"> <b>Cause renal azotemia</b> <ul style="list-style-type: none"> <li>• Acute renal failure                                     <ul style="list-style-type: none"> <li>- Ischemia (prerenal)</li> <li>- Dehydration</li> <li>- Hypovolemia</li> <li>- Toxins   <ul style="list-style-type: none"> <li>- Ethylene glycol</li> <li>- Aminoglycosides</li> <li>- Heavy metals</li> </ul> </li> <li>- Hypercalcemia</li> <li>- Infections (leptospirosis)</li> <li>- Others</li> </ul> </li> <li>• Chronic renal failure</li> </ul> </div>	<ul style="list-style-type: none"> <li>• <b>Acute:</b> <ul style="list-style-type: none"> <li>- <b>Support until repair itself</b> <ul style="list-style-type: none"> <li>. Fluids, Tx hyperkalemia &amp; acidosis</li> <li>. Initiate urine flow (Lasix, mannitol)</li> </ul> </li> </ul> </li> <li>• <b>Chronic:</b> <ul style="list-style-type: none"> <li>- NO cure, palliative</li> <li>- Fluids</li> <li>- <b>Diet:</b> restrict proteins &amp; phosphorus (Hill's k/d)</li> </ul> </li> </ul>
<b>• Postrenal azotemia</b> <b>***</b>	<ul style="list-style-type: none"> <li>• Blockage of urine outflow</li> <li>• Hyperkalemia develops (potassium can't be eliminated)                             <ul style="list-style-type: none"> <li>- <b>Life-threatening:</b> effects cardiac conduction, causing bradycardia &amp; death</li> </ul> </li> <li>• Initially kidneys resume normal function if corrected. With time obstruction may result in renal lesion; e.g., hydronephrosis</li> </ul>	<ul style="list-style-type: none"> <li>• Oliguria</li> <li>• Straining</li> <li>• Abdominal discomfort</li> <li>• Sequelae:                             <ul style="list-style-type: none"> <li>- Heart failure: hyperkalemia</li> <li>- Hydronephrosis</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• ↑ BUN &amp; creatinine</li> <li>• Oliguria or anuria</li> <li>• CS: dysuria, discomfort</li> <li>• ECG (hyperkalemia)                             <ul style="list-style-type: none"> <li>- Bradycardia</li> <li>- Spiked T-waves</li> <li>- Absence of P-waves</li> </ul> </li> <li>• Check creatinine of abdominal fluid if rupture suspected</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Hyperkalemia - priority</b> <ul style="list-style-type: none"> <li>- Unblock animal</li> <li>- Cystocentesis if can't immediately unblock</li> <li>- Fluid therapy                                     <ul style="list-style-type: none"> <li>. Sodium bicarbonate: 0.5-1 mmol/kg by slow IV over 15 min</li> <li>. 20% dextrose: 0.5-1 g/kg IV w/ ≤1 U regular insulin per 3 g dextrose</li> <li>. 10% calcium gluconate: up to 0.5-1 g/kg IV. Rapid, but short-lived effect (minutes)</li> </ul> </li> </ul> </li> </ul>



## Polyuria & Polydipsia

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## URINARY SYSTEM

Condition	Facts/Causes	Presentation	Diagnosis
<b>Polyuria &amp; polydipsia; PU/PD</b> M8k 412, 1734; E-hb 85; SAP 269, E 159; H2B 502, 556f, 574; 5min 130; I2M 581; IM 458, 598, 527; IM-WW 53 Pys-R 195; DDx 55; Dx-L 39 *** 	<ul style="list-style-type: none"> <li>• <b>Increased thirst &amp; urine production</b> <ul style="list-style-type: none"> <li>- Urine production &gt; 25 ml/lb/day (50 ml/kg/day)</li> <li>- Water consumption &gt; 50 ml/lb/day (100 ml/kg/day)</li> </ul> </li> <li>• <b>Manifestation of diz; not a diagnosis</b></li> <li>• <b>PU &amp; PD usually exist concurrently</b></li> <li>• <b>Mechanism of polydipsia:</b> <ul style="list-style-type: none"> <li>- Low plasma osmolality stimulates chemoreceptors in thirst center (hypothalamic supraoptic nuclei)</li> <li>- Posterior pituitary gland releases ADH (antidiuretic hormone)</li> <li>- Renal response to ADH is to concentrate urine requiring 1/3rd functioning nephrons &amp; a hypertonic renal medullary interstitium</li> <li>- 2/3rds nonfunctional nephrons for kidney not to concentrate urine (polyuria)</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• <b>Polyuria</b> <ul style="list-style-type: none"> <li>- Nocturia</li> <li>- Inappropriate urination</li> <li>- Incontinence</li> <li>- Pollakiuria (frequent urination)</li> </ul> </li> <li>• <b>Polydipsia</b> (excess drinking)   </li> </ul>	<ul style="list-style-type: none"> <li>• <b>History</b> (empty water dish, constant drinking) <ul style="list-style-type: none"> <li>- Lymphadenopathy (lymphoma), cataracts (diabetes mellitus), symmetrical alopecia (hyperadrenocorticism), vaginal discharge (pyometra), small kidney (chronic FR)</li> </ul> </li> <li>• <b>Metabolism cage: Urine volume: 25-45 ml/kg/24 hrs</b></li> <li>• <b>Urinalysis:</b> <ul style="list-style-type: none"> <li>- USpG (urine specific gravity) <ul style="list-style-type: none"> <li>&gt; 1.030 unlikely to be polyuria</li> <li>&lt; 1.007 (hyposthenuria) tentative Dx of CDI, NDI or PPD</li> <li>&gt; 1.025 + PU/PD suggests hypoadrenocorticism, diabetes mellitus or renal glycosuria</li> </ul> </li> </ul> </li> <li>• <b>Blood values:</b> <ul style="list-style-type: none"> <li>- Azotemia (↑ BUN/creatinine) indicates renal diz</li> <li>- Liver enzymes</li> <li>- CBC: infection (pyometra)</li> </ul> </li> <li>• <b>Radiographs, ultrasound</b></li> <li>• <b>Other tests</b> <ul style="list-style-type: none"> <li>- Lymph node biopsy (lymphoma)</li> <li>- Low dose dexamethasone suppression test (hypoadrenocorticism)</li> </ul> </li> <li>• <b>Provocative tests to differentiate normal psychogenic polydipsia, hyperadrenocorticism, pituitary DI, nephrogenic DI or medullary washout</b> <ul style="list-style-type: none"> <li>- <b>Water deprivation</b> if PU/PD &amp; no signs or diz (kidney, liver, etc.) <ul style="list-style-type: none"> <li>• USG &gt; 1.025 - <b>psychogenic polydipsia or Cushing's diz</b></li> <li>• USG &lt; 1.025 - then do ADH test</li> </ul> </li> <li>- <b>ADH test</b> <ul style="list-style-type: none"> <li>• USG &gt; 1.025 - <b>pituitary diabetes insipidus</b> (no ADH)</li> <li>• USG &lt; 1.025 - then do gradual H<sub>2</sub>O deprivation test</li> </ul> </li> <li>- <b>Gradual H<sub>2</sub>O test</b> (to correct possible medullary washout) <ul style="list-style-type: none"> <li>• USG &gt; 1.025 - <b>psychogenic polydipsia or Cushing's diz</b></li> <li>• USG &lt; 1.025 - then do ADH test</li> </ul> </li> <li>- <b>ADH + gradual H<sub>2</sub>O deprivation tests</b> <ul style="list-style-type: none"> <li>• USG &lt; 1.025 - <b>kidney unresponsive to ADH</b></li> <li>• USG &gt; 1.025 - <b>pituitary diabetes insipidus</b></li> </ul> </li> </ul> </li> </ul>
	<b>DDx - Polyuria/Polydipsia</b> <ul style="list-style-type: none"> <li>• <b>Dipsogenic diabetes insipidus (DDI)/Psychogenic polydipsia</b></li> <li>• <b>Pituitary diabetes insipidus</b></li> <li>• <b>1° renal diz</b> <ul style="list-style-type: none"> <li>- Chronic primary renal failure</li> <li>- Hydronephrosis??</li> <li>- Renal amyloidosis</li> <li>- Chronic pyelonephritis</li> <li>- Familial renal diz</li> <li>- Primary renal glycosuria</li> <li>- Fanconi's Syndrome</li> <li>- Acute renal failure</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• <b>Pyometra</b> (uterine infection)</li> <li>• <b>Hyperadrenocorticism</b></li> <li>• <b>Liver diz</b></li> <li>• <b>Hypercalcemia</b></li> <li>• <b>Hyperparathyroidism</b></li> <li>• <b>Hypoparathyroidism</b></li> <li>• <b>Hyperthyroidism</b></li> <li>• <b>Hypoadrenocorticism</b></li> <li>• <b>Lymphosarcoma</b></li> <li>• <b>Pheochromocytoma</b></li> <li>• <b>Diabetes mellitus</b></li> </ul> 	



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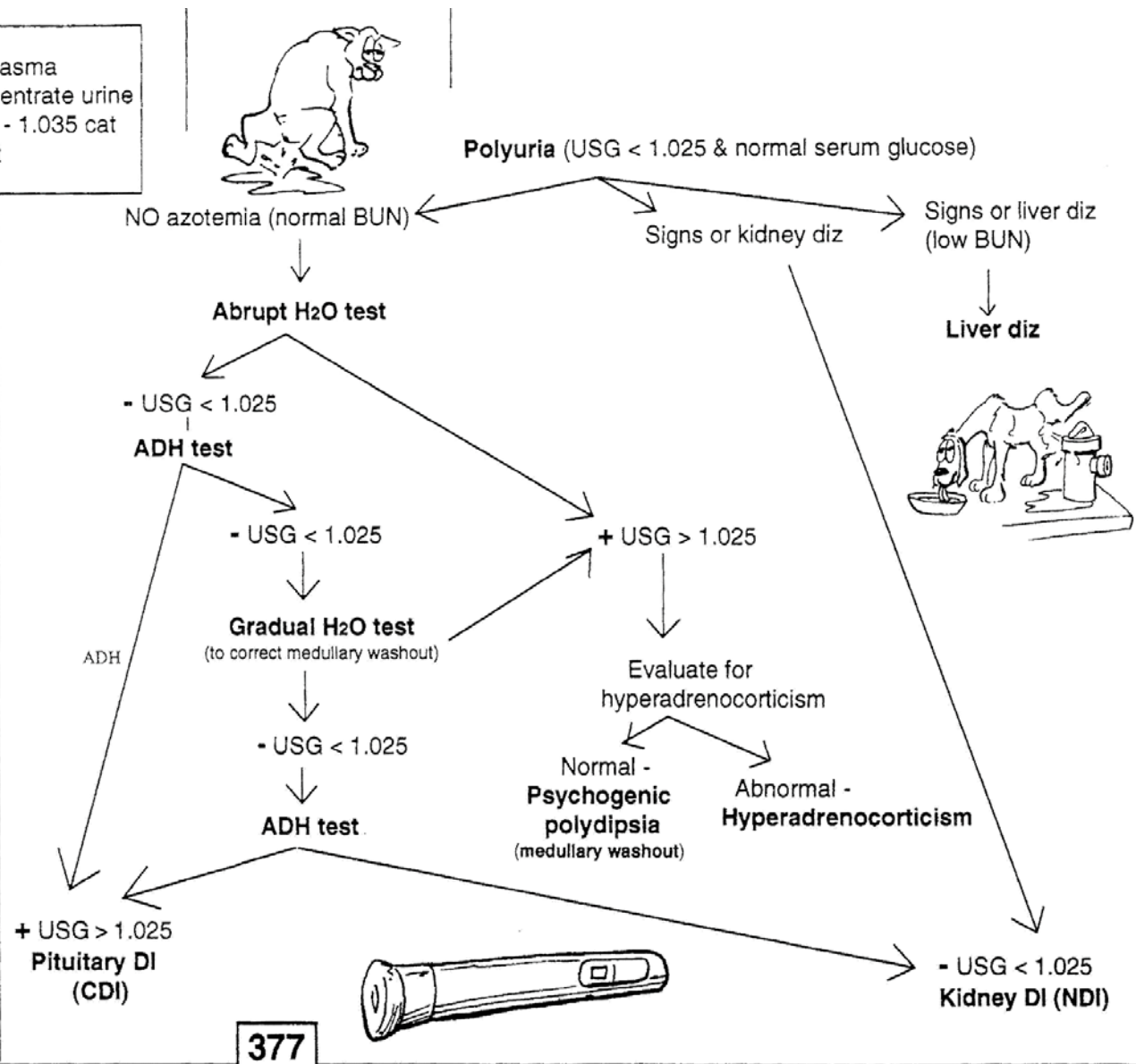
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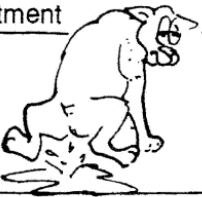

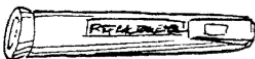




**Isosthenuria:** 1.008-1.012, same as plasma  
**Hyposthenuria:** < 1.007: inability to concentrate urine  
**Minimal concentration:** 1.013 -1.030 dog, 1.013 - 1.035 cat  
**Hypersthenuria:** > 1.030 dog, > 1.035 cat




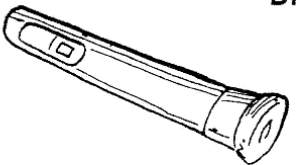
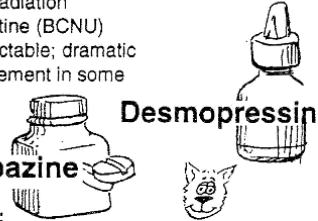

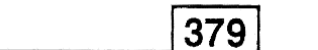

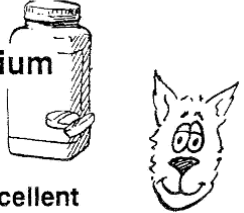
## Water deprivation test:

- Determines if:
  - 1. ADH released in response to subclinical dehydration
  - 2. If kidneys can respond to ADH & concentrate urine
- Contraindications (potentially dangerous - death):
  - Dehydration
  - Azotemia (BUN, creatinine)
  - Hypercalcemia
- Terminate test when:
  - Urine concentrated > 1.025
  - > 5% weight loss
  - Azotemia
  - Dehydration
- Abrupt water deprivation test**
  - Normal animal concentrate USG to 1.075 - cats: 1.045 - dogs: > 1.025 considered adequate for test
  - Negative result** (failure to concentrate - USG < 1.025) w/o renal diz or other laboratory abnormalities indicates **neurogenic** or **nephrogenic diabetes insipidus** &/or **medullary washout (DDI)**
- Gradual water deprivation test**
  - For **psychogenic polydipsia** w/ medullary washout (can't concentrate on abrupt test), allows gradient to be reestablished
  - Procedure: Reduce water intake by 5% daily
  - Results: **Negative result** (failure to concentrate) w/o renal diz or laboratory abnormalities indicates **neurogenic** or **nephrogenic diabetes insipidus** not DDI
- ADH response test** (after abrupt or gradual H<sub>2</sub>O deprivation tests)
  - If inadequate concentration after water deprivation test
  - Tests renal tubular ability to concentrate urine
  - Procedure:
    - Vasopressin (Pitressin®) IM
    - Measure USG at 30, 60, 90 & 120 min
  - Interpretation:
    - Negative Water deprivation + positive ADH concentration** > 1.025 diagnostic of **neurogenic DI**
    - Both **negative water deprivation** & **negative ADH tests** indicates **nephrogenic DI** or **DDI** if after abrupt H<sub>2</sub>O deprivation








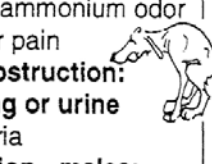
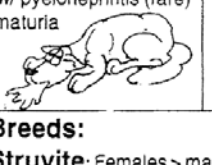
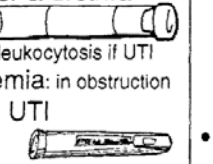
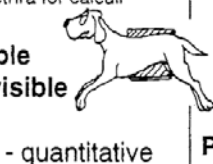




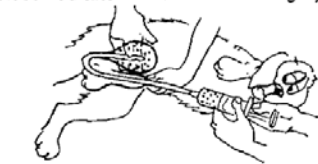
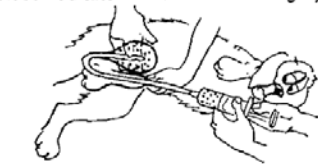
PU/PD		378	URINARY SYSTEM	
Condition	Facts/Causes	Presentation	Diagnosis	Treatment
<b>Diabetes insipidus</b> M8k 412, 1734; H2B 502, E-hb 85, 549; Dx-L 39	<b>3 basic types - Also see Endo pg 670</b> 1. Nephrogenic DI (NDI) partial or complete renal tubule insensitivity to ADH 2. Central DI (CDI): partial or complete primary deficiency of ADH 3. Dipsogenic DI or psychogenic polydipsia/polyuria: excessive water intake		- Neg H <sub>2</sub> O & ADH test - Neg. H <sub>2</sub> O, positive ADH - Positive H <sub>2</sub> O (abrupt or gradual)	
<b>Nephrogenic diabetes insipidus, NDI</b> M8k 412, 1734; E-hb 666, 85, H3B 514; H2B 502, 564; SAP 268, 812; IM-WW 338; IM 458, 528; IM-WW 338; 5min 514, 130, 1020; E 1804; Cat 1410; R&F 2; R&E-M 251; Lab-C 219; Psy-R 195; DDx 68; Dx-L 39 <b>**</b>	<ul style="list-style-type: none"> <li>• <b>Renal tubules nonresponsive-ness to ADH</b> <ul style="list-style-type: none"> <li>- Distal tubules &amp; collecting ducts</li> <li>- ADH levels normal to increased</li> <li>- Partial or complete unresponsiveness to ADH</li> </ul> </li> <li>• <b>Causes: see rounded box</b> <ul style="list-style-type: none"> <li>- Congenital: rare</li> <li>- Acquired secondary NDI <ul style="list-style-type: none"> <li>• Renal &amp; metabolic disorders affecting renal tubules' ability to respond to ADH</li> <li>- Most acquired forms reversible following correction of cause</li> </ul> </li> </ul> </li> <li>• Similar CS, Hx &amp; physical to pituitary diabetes insipidus, except for trauma</li> </ul>	<ul style="list-style-type: none"> <li>• CS: similar to pituitary DI except for CNS signs &amp; history of trauma</li> <li>• <b>PD/PU</b></li> <li>• Nocturia</li> <li>• Distended abdomen related to over distention of bladder w/ urine</li> </ul> 	<ul style="list-style-type: none"> <li>• Hx (no brain trauma), CS</li> <li>• Same as pituitary diabetes insipidus except for challenge test</li> <li>• Blood values normal</li> <li>• <b>Urine SpG: 1.001–1.006</b>; Normal kidney &gt; 1.025 unless medullary washout</li> <li>• <b>Water deprivation + ADH tests</b>  USG &lt; 1.025 (tubules unresponsive)  - Water deprivation = &lt; 1.025 =  - <b>No response to ADH - USG &lt;1.025 (neg. test)</b>  - Gradual water deprivation + ADH: &lt; 1.025 (neg.); normal kidney &amp; CDI &gt;1.025</li> <li>• Biopsy</li> </ul> 	<ul style="list-style-type: none"> <li>• <b>Acquired -</b> <ul style="list-style-type: none"> <li>- <b>Tx predisposing cause</b> - most reversible following correction</li> <li>- <b>Unlimited water supply</b></li> </ul> </li> <li>• <b>Congenital (rare)</b> <ul style="list-style-type: none"> <li>- <b>Unlimited water supply</b></li> <li>- <b>Low sodium &amp; protein diet</b></li> <li>- <b>Chlorothiazide (Diuril®) diuretics</b> to enhance proximal tubular reabsorption of Na, Cl &amp; H<sub>2</sub>O - may reduce urine output by inhibiting sodium resorption, up to 60% reduction</li> </ul> </li> </ul>   
		<b>Nephrogenic diabetes insipidus</b> • <b>2° nephrogenic DI</b> <ul style="list-style-type: none"> <li>- Renal disorders <ul style="list-style-type: none"> <li>• Acute renal failure</li> <li>• Chronic primary renal failure</li> <li>• Hydronephrosis</li> <li>• Renal amyloidosis</li> <li>• Chronic pyelonephritis</li> <li>• Familial renal diz</li> <li>• Primary renal glycosuria</li> <li>• Fanconi's Syndrome</li> </ul> </li> <li>- 2° renal disorders <ul style="list-style-type: none"> <li>• Pyometra (uterine infection)</li> <li>• Diabetes mellitus</li> <li>• Liver diz</li> <li>• Lymphosarcoma</li> </ul> </li> </ul> <ul style="list-style-type: none"> <li>- Pheochromocytoma</li> <li>- Endocrine <ul style="list-style-type: none"> <li>• Hyperadrenocorticism</li> <li>• Hypoadrenocorticism</li> <li>• Hyperthyroidism</li> <li>• Hypoparathyroidism</li> </ul> </li> <li>- Metabolic disorders <ul style="list-style-type: none"> <li>• Hypercalcemia</li> <li>• Hypokalemia</li> </ul> </li> <li>- Drugs <ul style="list-style-type: none"> <li>• Corticosteroids</li> <li>• Anticonvulsants</li> <li>• Diuretic</li> </ul> </li> </ul> <ul style="list-style-type: none"> <li>• <b>Congenital 1° NDI (rare)</b></li> </ul>		
<b>Unresponsive renal tubules</b> <b>CS: PU/PD</b> <b>Dx: No response to water or ADH tests</b> <b>Tx: Tx cause, Unlimited H<sub>2</sub>O</b>		<b>Prognosis:</b> • 2° NDI: depends on response of underlying cause • 1° NDI (rare) guarded to poor		

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
<b>Pituitary diabetes insipidus, *</b> <b>Central diabetes insipidus, CDI,</b> <b>Neurogenic diabetes insipidus,</b> <b>Neurohypophyseal diabetes insipidus</b> M8k 412, 1734; E-hb 549; IM 458, 527; SAP 268; H2B 502; E 1428; Psy-R 195; DDx 68; Dx-L 39	<ul style="list-style-type: none"> <li>• <b>Lack of ADH (antidiuretic hormone):</b> either formation &amp;/or release of endogenous ADH</li> <li>• Cause of CDI (central DI)                             <ul style="list-style-type: none"> <li>- Idiopathic (most common)</li> <li>- CNS trauma</li> <li>- CNS infection</li> <li>- Parasitic migration</li> <li>- Neoplasia (craniopharyngioma, metastatic tumors - mammary carcinoma, lymphoma, melanoma, pancreatic carcinoma) or diminished blood flow</li> <li>- Congenital defects (rare)</li> </ul> </li> <li>• Pathophysiology                             <ul style="list-style-type: none"> <li>- ADH acts on distal tubules &amp; collecting ducts ↑ reabsorption of water</li> <li>- ↓ ADH = water diuresis (polyuria)</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• <b>PD/PU</b></li> <li>• <b>Nocturia</b></li> <li>• ± Weight loss (if preoccupied with drinking)</li> <li>• ± <b>CNS signs</b> (expanding tumor)                             <ul style="list-style-type: none"> <li>- Stupor, disorientation, circling, pacing, convulsions</li> </ul> </li> <li>• Distended abdomen related to over distention of bladder with urine</li> </ul>	<ul style="list-style-type: none"> <li>• CS: PU/PD: Hx PU/PD &gt;100 ml/kg/d normal 40-70</li> <li>• <b>Urine specific gravity: Dog 1.000-1.007, Cat 1.008-1.012</b> <ul style="list-style-type: none"> <li>- Partially concentrated</li> </ul> </li> <li>• Physical exam: usually unremarkable, m/b thin (thirst overshadows hunger)                             <ul style="list-style-type: none"> <li>- Dehydration if water unavailable for 4-6 hours</li> </ul> </li> <li>• Lab: persistent hypernatremia, CBC normal or consistent with dehydration</li> <li>• Water deprivation + ADH tests                             <ul style="list-style-type: none"> <li>- Water deprivation = SpG &lt; 1.025 = (CDI or nephrogenic)</li> <li>- ADH + H<sub>2</sub>O deprivation = USG &gt; 1.025 = CDI unless medullary washout, so</li> <li>- <b>Gradual H<sub>2</sub>O deprivation + ADH = &gt; 1.025 - CDI</b></li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• <b>Not mandatory if unlimited water</b></li> <li>• <b>Unlimited water paramount</b></li> <li>• Desmopressin (DDAVP® - synthetic vasopressin analog) drops in conjunctival sac                             <ul style="list-style-type: none"> <li>- Limit water for couple of hours after Tx to avoid over hydration</li> </ul> </li> <li>• Repositol vasopressin (Pitressin®) IM</li> <li>• <b>Chlorpropamide</b> (Diabinese®) sulfonylurea agent for <b>partial</b> CDI, potentiates renal tubular effect of ADH. Ineffective in complete CDI &amp; NDI, needs some ADH</li> <li>• Chlorothiazide diuretics + oral salt restriction may reduce urine output by inhibiting sodium resorption; up to 60% reduction                             <ul style="list-style-type: none"> <li>- Chlorothiazide (Diurik®), Hydrochlorothiazide</li> </ul> </li> <li>• <b>Pituitary or hypothalamic tumors</b> <ul style="list-style-type: none"> <li>- Cobalt radiation</li> <li>- Carmustine (BCNU)</li> <li>- Unpredictable; dramatic improvement in some</li> </ul> </li> </ul>
				
<b>Lack of ADH</b> <b>CS: PU/PD, ± CNS</b> <b>Dx: + ADH tests</b> <b>Tx: Unlimited water, Drugs</b>	<b>DDx:</b> <ul style="list-style-type: none"> <li>• Nephrogenic diabetes insipidus</li> <li>• Psychogenic polydipsia</li> <li>• Other causes of PU/PD</li> </ul>			
<b>Psychogenic polydipsia,</b> <b>Primary polydipsia,</b> <b>Dipsogenic diabetes insipidus, Compulsive water drinking</b> M8k 412, 1734; E-hb 85; IM 459; H2B 502; 5min 514; DDx 68; Dx-L 39 <b>**</b>	<ul style="list-style-type: none"> <li>• Cause:                             <ul style="list-style-type: none"> <li>- Disorder of thirst centers, resulting in 1° PD</li> <li>- Behavior problem</li> <li>- Pharmacologic agents: salt, diuretics, glucocorticoids, fluids, anticonvulsants</li> </ul> </li> <li>• <b>2° Polyuria</b> to rid excessive H<sub>2</sub>O</li> <li>• Large breed dogs</li> <li>• Kidney is usually functional</li> <li>• Causes <b>medullary washout</b></li> </ul>		<ul style="list-style-type: none"> <li>• Hx (large breeds), CS (PU/PD)</li> <li>• <b>Urinalysis: USG 1.001-1.003</b></li> <li>• <b>Water deprivation = concentrated urine</b> <ul style="list-style-type: none"> <li>- Abrupt water deprivation: diagnoses 2/3rds of cases</li> <li>- Gradual water deprivation in other third to eliminate medullary washout</li> <li>- Results in concentrated urine &gt; 1.030 dog, 1.035 cat</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• <b>Nothing</b></li> <li>• <b>Gradual water restriction</b> to restore renal hypertonic medullary interstitium</li> <li>• Behavior modification (diazepam (Valium®), chlorpromazine (Thorazine®))</li> </ul>
				
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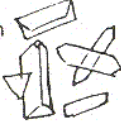


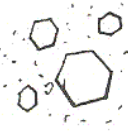


# Urolithiasis





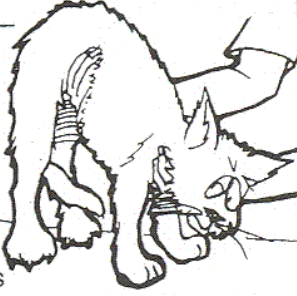
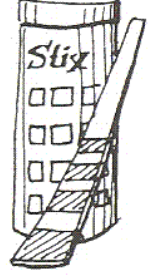
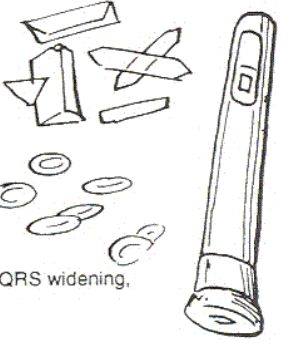
# URINARY SYSTEM

Condition	Facts/Causes	Presentation	Diagnosis	Treatment
<b>Urolithiasis - Dog</b> M8k 1143; Mk 886; E-hb 676, 668; H3B 560, 537; H2B 601; 5min 77, 1124, 172; SAP814, 828; I2M688, 574, 573; IM 501, 451; IM-WW341; E 1837; C12T980; C11T 886, 892, 900; CM 480; Sx-WW 157, 164, 167; Sx-S-hb 500; Sx-S 1488; Pa-T 241; DDx 558 ***   	<ul style="list-style-type: none"> <li>• <b>Uroliths: crystal of minerals in matrix material</b> <ul style="list-style-type: none"> <li>- 95% organic or inorganic crystalloids, &lt; 5% organic matrix</li> </ul> </li> <li>• <b>Struvite #1 in dog &amp; cats</b></li> <li>• <b>Dog: &lt; 3% prevalence, 3-7 yrs old</b></li> <li>• <b>Location:</b> <ul style="list-style-type: none"> <li>- <b>Urinary bladder: bladder stones</b></li> <li>- <b>Urethra:</b> partial or complete obstruction</li> <li>- Ureter calculi (rare): hydronephrosis</li> <li>- Kidney (rare): pyelonephritis</li> <li>- Usually originate in bladder, but may come from kidney or ureter into bladder</li> </ul> </li> <li>• <b>Cause in dogs:</b> <ul style="list-style-type: none"> <li>- <b>UTI</b> (urinary tract infec.) commonly present in all, except oxalate uroliths (cat not due to UTI)</li> <li>- <b>Staphylococcus aureus</b> or proteus spp (split urea to ammonium)</li> <li>- Alkaline urine precipitates</li> <li>- Metabolic disorders</li> <li>- Urate: <ul style="list-style-type: none"> <li>.. Dalmatian: inborn error in purine metabolism</li> <li>.. Portal vascular shunts</li> </ul> </li> <li>- Cystinuria: cystine uroliths</li> <li>- Calcium phosphate: hyperparathyroidism</li> <li>- Dietary factors <ul style="list-style-type: none"> <li>.. High magnesium alkalinizing - struvite</li> <li>.. Corn gluten or soybean hull diets - silica</li> <li>.. Hi Ca or P diets - calcium phosphate</li> </ul> </li> <li>- Idiopathic conditions: Ca oxalate, sterile struvite, silica</li> </ul> </li> </ul> <div style="border: 1px solid black; padding: 5px; margin-top: 10px;"> <b>DDx:</b> <ul style="list-style-type: none"> <li>• UTI</li> <li>• Neoplasia of bladder</li> <li>• FUS</li> <li>• Coagulation disorders</li> </ul> </div>	<ul style="list-style-type: none"> <li>• <b>Variable</b> depending on size, # &amp; location of uroliths</li> <li>• <b>Asymptomatic</b> in some: <ul style="list-style-type: none"> <li>- <b>Lower UTI</b> (cystitis/urethritis) <ul style="list-style-type: none"> <li>. Dysuria (painful)</li> <li>. Pollakiuria (frequent)</li> <li>. Bloody (hematuria)</li> <li>. Strong ammonium odor</li> <li>. Lumbar pain</li> </ul> </li> </ul> </li> <li>• <b>Partial obstruction:</b> <ul style="list-style-type: none"> <li>- Dribbling or urine</li> <li>- Stranguria</li> </ul> </li> <li>• <b>Obstruction - males:</b> <ul style="list-style-type: none"> <li>- Anuria</li> <li>- Frequent attempts to urinate</li> <li>- Reduced force &amp; size of urine stream</li> <li>- Uremia: vomiting, anorexia, Depression</li> </ul> </li> <li>• If associated w/ pyelonephritis (rare) <ul style="list-style-type: none"> <li>- Fever &amp; hematuria</li> </ul> </li> </ul>  	<ul style="list-style-type: none"> <li>• Hx, CS</li> <li>• Palpation: bladder &amp; urethra</li> <li>• Blood values <ul style="list-style-type: none"> <li>- CBC usually normal leukocytosis if UTI</li> <li>- Postrenal azotemia: in obstruction</li> </ul> </li> <li>• <b>Urinalysis (UA): UTI</b> <ul style="list-style-type: none"> <li>- Hematuria</li> <li>- Pyuria/Bacteriuria</li> <li>- Urease-producing - <i>Staph. aureus</i> - struvite</li> <li>- <b>± Crystalluria - ID</b> usually same as uroliths, not always</li> <li>- pH: see chart</li> </ul> </li> <li>• <b>Urine culture &amp; sensitivity</b></li> <li>• <b>Radiographic density</b> (see chart) <ul style="list-style-type: none"> <li>- Kidneys, ureters &amp; urethra for calculi</li> <li>0 = not visible</li> <li>1+ = barely visible</li> <li>2- 4+ = readily visible</li> </ul> </li> <li>• Ultrasound</li> <li>• Uroliths analysis - quantitative (crystallographic) <ul style="list-style-type: none"> <li>- Commercial kits not recommended</li> </ul> </li> <li>• Hepatic function tests if urate uroliths (except in Dalmatians)</li> </ul>  	<ul style="list-style-type: none"> <li>• <b>ABs for 2-3 wks for UTI &amp; struvite</b> <ul style="list-style-type: none"> <li>- Ampicillin if no culture or trimethoprim-sulfonamide</li> <li>- Give after urination &amp; discourage urination as long as possible to keep drug where needed</li> <li>- Re-culture 5 days after stop ABs, if + reinstitute</li> </ul> </li> <li>• <b>Obstruction</b> <ul style="list-style-type: none"> <li>- Fluid &amp; electrolytes immediately</li> <li>- Relieve bladder distention (cystocentesis)</li> <li>- Open urethra: catheter &amp;/or flush</li> </ul> </li> <li>• <b>Medical: for struvite, urate &amp; cystine</b> <ul style="list-style-type: none"> <li>- Not effective for oxalate, Ca-P, or silica</li> <li>- Dissolve uroliths w/ diet, urine pH manipulation &amp; drugs (see chart)</li> </ul> </li> <li>• <b>Surgical removal</b> <ul style="list-style-type: none"> <li>- <b>For obstruction</b></li> <li>- <b>Required for Oxalate, Ca-P, or silica</b></li> <li>- <b>Those that med. Tx doesn't effect</b></li> <li>- Flush back into bladder &amp; cystostomy</li> </ul> </li> </ul>    
		<b>Breeds:</b> <b>Struvite:</b> Females > males: Miniature Schnauzer, also Welsh Corgis, Dachshunds, Poodles, Pugs, Pekingese, Beagles, Scottish terriers <b>Oxalate:</b> Males - Miniature Schnauzer, Miniature Poodles, Yorkshire terriers, Lhasa Apsos, Shih Tzus & Dalmatians <b>Urate: dalmatian</b> (60% of all urate uroliths) Portosystemic shunts (Miniature Schnauzers, Yorkshire terriers, Pekingese) <b>Silica:</b> German shepherd <b>Cystine:</b> Males: Dachshund, also Basset hounds, English bulldogs, Yorkshire terriers, Irish terriers, Chihuahua		<b>Prevention:</b> <ul style="list-style-type: none"> <li>• 5-50% recur</li> <li>• Diet, urine pH modification &amp; drugs (see chart below)</li> </ul> 
				<b>Monitor monthly</b> for dissolution of uroliths: Complete urinalysis & radiographs; ABs - culture & sensitivity if UTI. If not dissolved after 2 mo. consider surgery  <b>Prognosis: Guarded to good</b> , depending on calculi & owner/dog dietary compliance

# Renal Review-Azotemia, PU/PD, Urolithiasis, Incontinence, Glomerulonephropathy Guide to Sm An Clinics, Pasquini, 3<sup>rd</sup>

Types of stone	Facts/cause	Rads	Diagnosis	Treatment	Prevention
<b>• Dogs &amp; Cats</b> <b>- Struvite</b> (magnesium ammonium-phosphate)	 <b>90% Cats - 60% Dogs</b> Urease-producing bacteria - <i>Staph. aureus</i> - dog - Sterile in most cats	2 -4+	<b>pH: alkaline</b> <b>UTI</b> - urease bacteria (UA) Smooth, rounded or faceted	<b>Med: ABs (UTI)</b> s/d Hill's diet (don't add salt) ± Acetohydroxamic acid Sx: those that don't dissolve or obstruct	<b>&lt;pH</b> Control UTI c/d Hill's diet (low-protein, Ca, P)
<b>- Oxalate</b> (Ca, Mg, & ammonium)	 <b>20% - dog -</b> Calcinuria (hyperparathyroidism, excessive Vit D intake, osteolytic neoplasm, hypercalcitonism & prox. renal tubular damage)	4+	UTI Hypercalcemia pH: variable Rough, quartz-like	<b>Sx - removal</b>	Hill's u/d diet? Urocit-K® ± Thiazide diuretics
<b>- Urate</b> (ammonium)	 Dalmatians & others Hepatic dysfunction/shunts 5% dog, 4% cats 2+ years old	0- 2+	UTI pH: neutral - acidic Smooth, round, oval - Jack-stone	<b>Med: ABs (UTI)</b> u/d diet Allopurinol ± Correct hepatic diz + k/d Sx: those that don't dissolve or obstruct	Alkalinize urine (Bicarb) Allopurinol (Zyloprim®) u/d diet (low purine)
<b>- Ca-phosphate</b> (apatite)	Metabolic disorders Excessive Ca & P diet, renal tubular acidosis, Hyperparathyroidism	4+	Hypercalcemia Smooth, round or faceted	<b>Sx - removal</b>	Acidify urine s/d diet?? Control hypercalcuria - diet?
<b>• Dog Only</b> <b>- Cystine</b> (amino acid cystine)	 Genetic defect/metabolism < 2%, 1.5 - 4 years	1-2+	<b>pH: acidic</b> <b>Urinary cystine</b> Smooth, small round to oval	<b>Med:</b> u/d diet Potassium citrate (alkalinizes) D-penicillamine or MPG Sx: those that don't dissolve or obstruct	u/d diet Potassium citrate (alkalinize urine) D-Penicillamine Don't breed males
<b>- Silica calculi</b>	Rare < 2%- Many breeds (Germ. Shepherd) Diet: corn gluten, soybean hulls	2 - 4+	UTI pH: neutral - acidic Jack stone	<b>Sx - removal</b>	Meat-based diet, Salt (diuresis)
<b>• Mixed</b>	15%				



FUS	374	URINARY SYSTEM
Condition	Facts/Causes	Presentation
<p><b>Feline urolithiasis</b> <b>FUS</b> <b>Feline urologic syndrome</b> <b>Urethral plug</b> Idiopathic lower urinary tract diz <b>ILUTD; FLUTD</b> <b>Feline lower urinary tract diz</b> M8k 1149; Mk 889; H2B 598; SAP 844; E-hb 673; I2M 651, 575; IM 509; IM-WW 352; IM-WW352; 5min 590; E 1829; C12T 981, 1007; C11T 883, 905; Sx-B 386; Sx-G 254; Sx-S-hb 495; Sx-S 1473; X-T 475; DDx 5E<sup>7</sup> *</p> 	<ul style="list-style-type: none"> <li>• <b>Variety of lower urinary tract disorders</b> <ul style="list-style-type: none"> <li>- Cystitis</li> <li>- Urethritis</li> <li>- Obstruction: urethral plugs or urethral stenosis</li> </ul> </li> <li>• <b>Male &gt; female, house cats 2-6 years</b> <ul style="list-style-type: none"> <li>- 4-10% of all cat hospital visits</li> <li>- <b>Urethral obstruction in males</b></li> <li>- Cystitis &amp; urethritis in female</li> </ul> </li> <li>• <b>Struvite plugs/uroliths (see box)</b></li> <li>• <b>Cause: unknown</b></li> <li>• <b>Predisposing factors:</b> <ul style="list-style-type: none"> <li>- Bacterial, viral infection</li> <li>- Decreased activity (house cats, castration, weather, illness, obesity)</li> <li>- Dirty litter box</li> <li>- Alkaline urine</li> <li>- High Mg/ammonium diets</li> <li>- Castration</li> <li>- Urethritis/cystitis, urethral abnormalities</li> <li>- Dry &gt;&gt; canned food</li> </ul> </li> <li>• <b>High incidence of recurrence - 30-70%</b></li> <li>• <b>Penile urethra #1 blockage site</b></li> </ul> <p><b>DDx:</b></p> <ul style="list-style-type: none"> <li>• <b>Constipation (straining)</b></li> </ul> 	<ul style="list-style-type: none"> <li>• <b>Calculi w/o obstruction</b> (females &amp; males) <ul style="list-style-type: none"> <li>- <b>Dribbling of urine</b></li> <li>- <b>Frequent urination</b> (pollakiuria, owners think trying to defecate)</li> <li>- Strong ammonia-like odor</li> </ul> </li> <li>• <b>Obstruction males</b> <ul style="list-style-type: none"> <li>- Squat &amp; strain (stranguria)</li> <li>- Hematuria, anuria</li> <li>- Lick penis (traumatize)</li> <li>- <b>Screaming</b> (vocalization)</li> </ul> </li> <li>• <b>Postrenal uremia</b>, depending on duration: <ul style="list-style-type: none"> <li>- Anorexia, lethargy, depression</li> <li>- ± Vomiting &amp; dehydration</li> <li>- Bradycardia</li> <li>- Hypothermia, muscle weakness</li> <li>- Coma &amp; death in 3-5 days if complete obstruction</li> </ul> </li> <li>• <b>Sequelae:</b> <ul style="list-style-type: none"> <li>- Chronic renal diz due to ascending pyelonephritis (especially if repeated catheterization)</li> <li>- Rupture bladder</li> </ul> </li> </ul>  
		<p><b>Diagnosis</b></p> <ul style="list-style-type: none"> <li>• <b>History</b> (house cat, etc.)</li> <li>• <b>CS (straining to urinate)</b></li> <li>• <b>Physical exam - palpation</b> <ul style="list-style-type: none"> <li>- <b>Obstructed cat</b> <ul style="list-style-type: none"> <li>• <b>Distended, turgid bladder</b>, inability to express bladder (careful)</li> <li>• Hard, inflamed, discolored penis</li> <li>• ± Protruding plug</li> <li>• Thickened bladder wall w/ grating</li> </ul> </li> <li>- <b>Unobstructed cat</b> <ul style="list-style-type: none"> <li>• Painful bladder &amp;/or caudal abdomen</li> <li>• Bladder usually empty</li> </ul> </li> <li>- Lumbar pain</li> </ul> </li> <li>• <b>Blood values (obstructed)</b> <ul style="list-style-type: none"> <li>- CBC no specific abnormalities, ↑ PCV/TP (dehydration), stress leukogram</li> <li>- <b>Hyperkalemia</b> (may be life threatening)</li> <li>- <b>Acidosis</b> (life-threatening), ↓ Blood pH &amp; HCO<sub>3</sub></li> <li>- <b>Postrenal azotemia</b> (increased BUN, creatinine), hyperphosphatemia, hyperglycemia (stress)</li> </ul> </li> <li>• <b>Urinalysis (UA):</b> <ul style="list-style-type: none"> <li>- <b>Hematuria</b></li> <li>- ± <b>Struvite crystalluria</b> (variable)</li> <li>- Aciduria</li> <li>- Culture 90% sterile</li> </ul> </li> <li>• <b>ECG if uremic: hyperkalemia</b> <ul style="list-style-type: none"> <li>- <b>Tall T waves</b></li> <li>- <b>Bradycardia</b></li> <li>- ↑ PR interval, no P waves, ST depression, QRS widening,</li> </ul> </li> <li>• <b>Radiology: not used to Dx FUS</b> <ul style="list-style-type: none"> <li>- Obstructed - distended bladder</li> <li>- Non-obstructed or rupture - small bladder</li> <li>- Contrast (after stabilized) retrograde of urethrography, cystourethrography, pneumocystography (obstruction)</li> </ul> </li> <li>• <b>US (ultrasound)</b> often equivocal: Thickening of bladder wall</li> </ul>   

## Treatment:

### • Obstruction

- **Emergency:** life-threatening hyperkalemia, acidosis, postrenal azotemia or ruptured bladder
- IV catheter (draw blood for electrolyte & acid-base)
- **Unblock cat** (see box) (before giving fluids), sedate
  - Massage penis or catheterization
  - Cystocentesis if can't immediately unblock
- Indwelling catheter 1-3 days to prevent re-blocking
  - Routine use not recommended, remove as soon as possible (12-36 hours)
- **Fluids** to stabilize cat & for life-threatening hyperkalemia & acidosis
  - Saline + unblocking will quickly ↓ potassium
- **Antibiotics** 7-10 days
- **Polyuric renal failure** often ensues following relief of obstruction:
  - Hyponatremia: Salt tablets: 1 gm tid initially PO, normal saline IV to correct
  - Hypokalemia: K<sup>+</sup> elixirs PO, K<sup>+</sup> salts in parenteral fluids (< 20 mEq/hour)
  - Elizabethan collar if self-trauma
  - Monitor for re-blockage
  - Atonic bladder from over distention: manually express 1-3 days
  - Bethanechol (Urecholine®) if detrusor atony
- **Treatment of unobstructed/unplugged cat**
  - Hill's Feline s/d diet - to dissolve struvite uroliths (acid, low Mg, hi salt)
    - Only long enough to dissolve crystals (30 d past radiographic evidence)
  - Dysuria/stranguria
    - Propantheline bromide (Pro-Banthine®), diazepam (Valium®)
  - Corticosteroids - controversial
  - ABs if infection

### • Surgery:

- **Penile urethrostomy** m/b considered w/ multiple recurrence (≥ 2x)
  - Altered cat m/b more prone to cystitis

## Prognosis:

- **Guarded**

## Unblock cat (before giving fluids)

- **Sedate, don't stress** - fatal arrhythmias w/ catecholamine & hyperkalemia (not required in moribund cat, but most others, PAINFUL, carefully)
  - Gas anesthesia: mask down - Isoflurane & O<sub>2</sub>
  - Acepromazine: reduce dose - <0.1 mg total IV
  - Ketamine (reduced dose because removed by kidney) - <5 mg/kg IV
- **Massage distal end of penis** to try to dislodge distal plug
  - Protrude penis & massage
  - Keep gentle pressure on urinary bladder (if dislodges, urine will flow, yeah!)
  - Manually empty bladder
  - If this doesn't work:
- **Catheterize** (lubricated Tom cat catheter)
  - Extrude penis (pull caudally on prepuce to line the penis up parallel w/ the spine to straighten its normal curve)
  - Advance catheter (gently, if obstruction)
  - Gently flush calculi back to bladder (occlude penis around catheter)
  - Collect urine for urinalysis & culture
  - Lavage bladder w/ sterile saline to remove all crystalluria (100 -200 ml)

## Fluids for life-threatening hyperkalemia & acidosis

### • ECG rhythm strip to evaluate

- **0.9% saline** + unblocking will quickly ↓ potassium
  - If doesn't: glucose & insulin therapy IV (IU Regular insulin w/1-3g glucose)
- Bicarbonate if acidotic (pH < 7.2) 1-2 mEq/kg IV slowly
- Calcium gluconate if life-threatening arrhythmias (0.5-1 ml/kg of 10% solution) slowly IV
- Fluid therapy for dehydration & maintenance, postobstructive diuresis, phenomena in unblocked cats
- Monitor & replace fluids and electrolytes (K<sup>+</sup>)

## Prevention:

- Tends to recur in 70% of cats
- **Low Mg diet** (Hill's c/d diet or homemade) <20 mg of magnesium/100 kcal
- Canned food over dry, Mix water w/ food
- Salt food lightly (not if S/D diet)
- Encourage exercise, free choice water
- ± Urinary acidifiers: methionine, ammonium chloride added to diet if not on c/d or s/d
- Prednisolone considered for persistent hematuria & urethritis
- Clean litter box often

Male, neutered, obese house cat on dry food  
 CS: Straining, Uremia  
 Dx: Hx, PE, UA  
 Tx: Unblock, Fluids, ABs, S/D diet, Sx



## Urinary Incontinence

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## URINARY SYSTEM

### Micturition disorders, Urinary incontinence

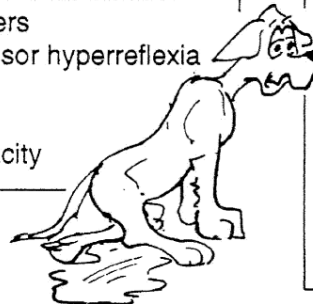
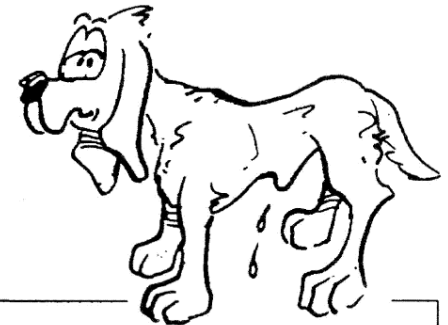
M8k 1141; Mk 884; E-hb 88; SAP 858; H2B 611, 613t; H3B 545; 5min 82, 86; I2M 659, 579; IM 456, 517; IM-WW 349; C12T 1018; C11T 875; CM 486; Pys-R 197; DDx 565; Sx-WW 169; Sx-S-hb 474; Sx-S 1404; DDx 565; Dx-L 345

\*\*\*

- Inappropriate passage of urine
- Needs to be differentiated from abnormal elimination behavior & inadequate house training
- Middle aged & geriatric dogs > 5 yrs-old
- Definitions:
  - **Micturition: voiding of urine**
    - . 2 stage process: passive storage & active voiding
  - **Incontinent:** loss of voluntary control of micturition
  - **Enuresis:** urinary incontinence while animal is asleep
  - **Nocturia:** urge or need to urinate at night

#### Causes: Incontinence

- Nonneurogenic
  - Hormone-responsive incontinence
  - Stress incontinence, urethral incompetence
  - Pelvic bladder
  - Urachal remnant
  - Idiopathic urinary incontinence
  - Ectopic ureters
- Neurogenic
  - Lower motor neuron, atonic bladder
  - Upper motor neuron, automatic bladder
  - Detrusor-urethral disorders
  - Urge incontinence, detrusor hyperreflexia
- Others
  - Senility
  - Decreased bladder capacity



### Clinical signs

- **Urinary incontinence**
  - Dribbling of urine
  - Loss of voluntary control
  - Urine-scalding dermatitis
- **Abnormal micturition**
  - Inability to urinate
  - Disruption of urine stream (dyssynergia)
  - Stranguria/Dysuria
  - Abdominal pain/discomfort

### Normal micturition

- Storage (filling) phase
  - Sympathetic (ANS): relaxes bladder detrusor muscle & increases internal urethral sphincter tone
  - Somatic: external urethral sphincter (urethralis muscle)
- Stretch of bladder wall: sensory fibers to reflex & brain
- Voiding (emptying) phase
  - Parasympathetic (ANS): contraction of detrusor muscle
  - Inhibition of sympathetic & somatic urethral sphincters



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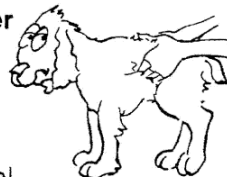
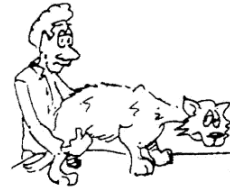
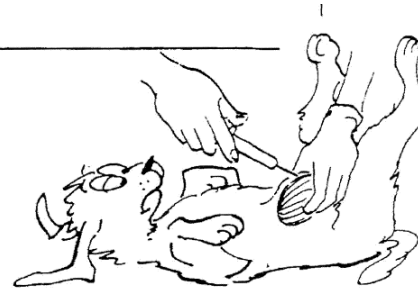
## Diagnosis urinary incontinence:

### • History: very important - Questions to ask:

- Chronology of progression?
- Ability to voluntarily initiate & maintain urination?
- Reproductive status (neutered or not)?
- Trauma?
- Age of onset?
- Previous problems (especially urinary)?
- Description of abnormality - night? dribbling? etc.
  - . Continuous or intermittent? Amount passed?
- Frequency of urination?
- Current medication?
- Dysuria, nocturia, hematuria?

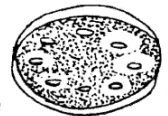
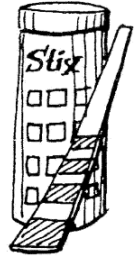
### • Physical exam:

- Examine perineum for urine scalding
- **Palpation of urinary bladder before & after urination**
  - . Small bladder: bladder hypercontractility or ↓ urethral resistance
  - . **Distended bladder: ↑ urethral resistance or ↓ bladder contractility**
  - . Evaluate distention, tone, ease of expression
    - .. UMN - difficult
    - .. LMN - easy
- **Neurogenic exam:** check integrity of sacral reflex arc (pudendal nerve [sensory & motor] & sacral cord segment)
  - . Perineal reflex: pinch perineum = contraction of anal sphincter & ventroflexion of tail
  - . Bulbospongiosus reflex: squeeze distal penis or vulva = constriction of anus
  - Rectal exam: prostate gland, anal tone, pelvic diaphragm, pelvic urethra, trigone of bladder
- Observe urination: Measure residual volume after urination (catheterization) normal < 0.4 ml/kg



### DDx:

- Causes of polyuria
- Causes of pollakiuria
- Causes of stranguria
- Causes of nocturia

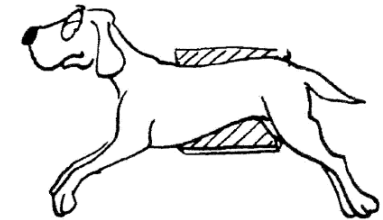


### • Blood values

- ↑ BUN & creatinine - renal function
- Urinalysis in all incontinent animals
  - Urine culture (cystocentesis)
- R/O Polyuria/polydipsias which can result in urge incontinence
  - Diabetes mellitus, pyometra, hyperadrenocorticism & hypercalcemia

### • Radiography:

- Survey: for obvious abnormalities of bladder, urethra, pelvis or spine
- Contrast radiographs
  - . Excretory urogram
  - . Positive contrast vaginogram
  - . Vaginourethrography or retrograde urethrography
- Vaginoscopy w/ or w/o new methylene blue dye (dogs); visualization of contrast for ectopic ureter
- Check for: urachal diverticulum, bladder wall thickening, calculi, prostatic enlargement, urethral strictures, pelvis bone abnormalities
- Urodynamic studies for micturition disorders
  - Cystometrogram: bladder tone & volume, detrusor reflex
  - Urethral pressure profile: intra-urethral resistances
- Electromyography (EMG): coordination of detrusor & urethral sphincter by checking anal sphincter

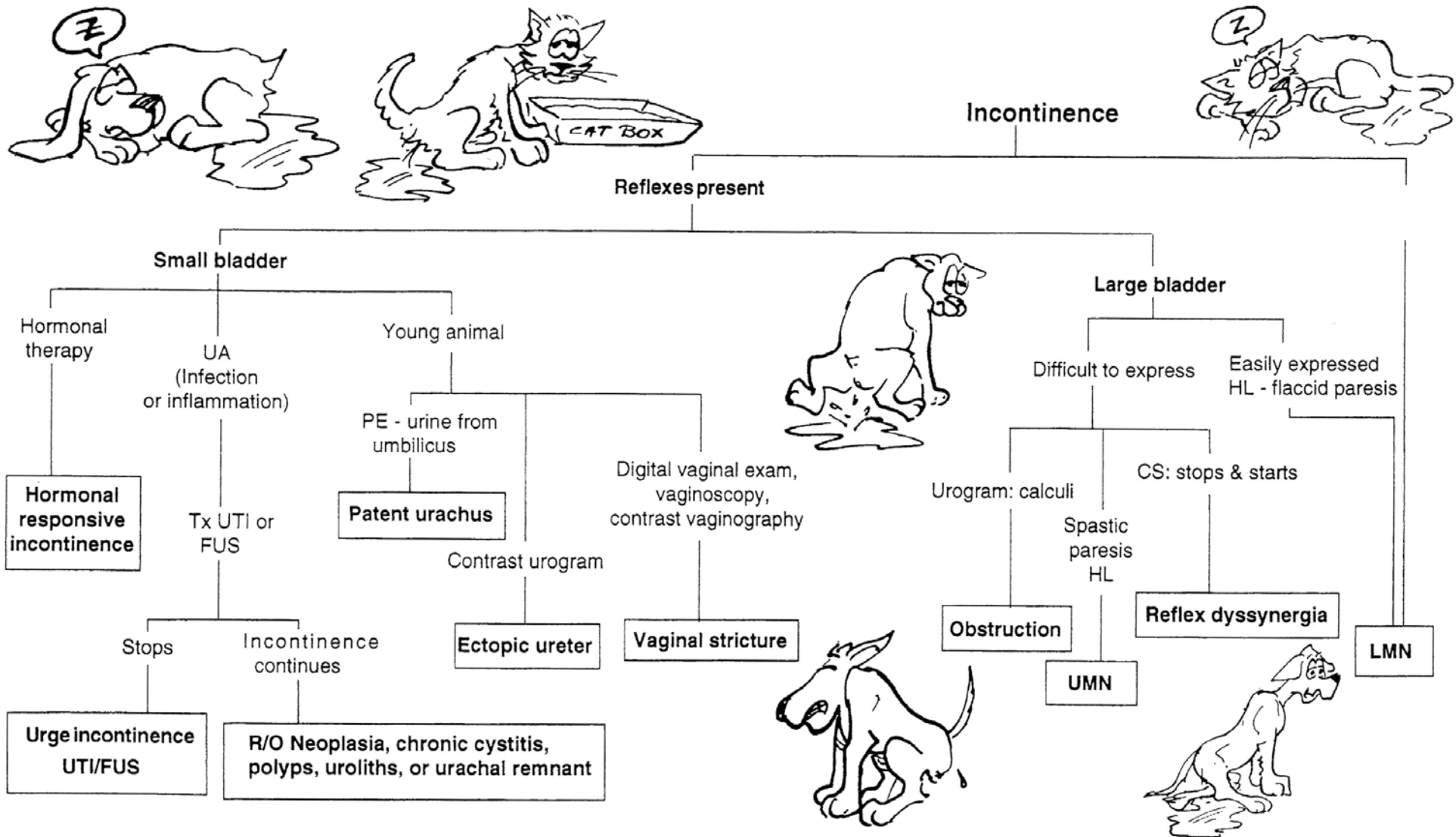




## Urinary Incontinence

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## URINARY SYSTEM



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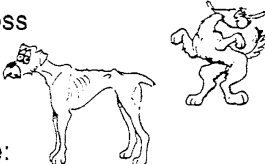

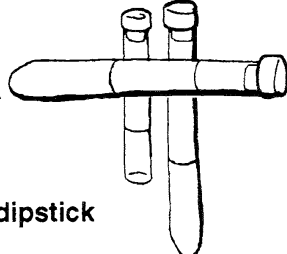


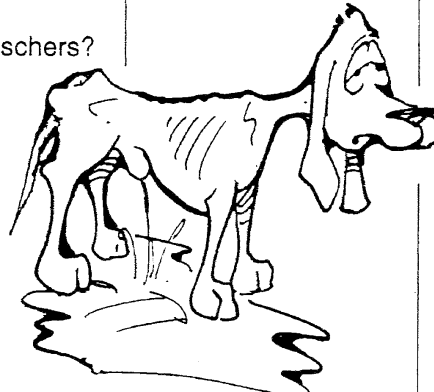
Condition	Cause	Clinical signs	Diagnosis	Treatment
<b>Neurogenic</b>				
<b>LMN - atonic bladder</b>	Trauma - LMN	Continuous dribbling Involuntary <b>Hindlimb: flaccid paralysis</b>	<b>No perineal reflex</b> <b>Large, expressible bladder</b>	<b>No effective Tx</b> Manually express tid ± Bethanechol (Urecholine®), ABs
<b>UMN/automatic bladder</b>	Trauma - UMN	Intermittent incontinence Involuntary <b>Hindlimb: spastic paresis</b>	<b>+ Perineal reflex (hyperactive)</b> <b>Large turgid, nonexpressible bladder</b>	<b>Intermittent catheterization</b> ABs - frustrating
<b>D-U (reflex) dysynergia</b>	Trauma - ANS	<b>Start &amp; abrupt stop</b> urination w/ stranguria Voluntary	<b>CS, + Perineal reflex</b> <b>Large, nonexpressible bladder</b> Easily catheterized	<b>↓ Alpha sympathetic tone</b> - Phenoxybenzamine (Dibenzyl®) - ± Bethanechol (Urecholine®)
<b>Nonneurogenic</b>				
<b>Hormone-responsive incontinence</b>	<b>Older, spayed female</b>	Voluntary control Intermittent dribbling	<b>Hx, Tx response</b> Normal reflexes & bladder	<b>Diethylstilbestrol</b> ± Phenylpropanolamine (Triaminic®)
<b>Urethral incompetence</b>	<b>Stress</b>	Voluntary control Stressful incontinence	<b>Hx, Tx response</b> Normal reflexes & bladder	<b>↑ Alpha sympathetic urethral tone</b> - Phenylpropanolamine (Triaminic®)
<b>Urge incontinence</b>	<b>UTI, FUS, etc.</b>	Frequent small urinations Urine spraying, Stranguria	<b>Hx, CS (UTI, FUS) - Tx response</b> Hyperreflexive detrusor, normal bladder	<b>Treat cystitis/FUS</b> <b>Inhibit detrusor</b> - Propantheline (Pro-Banthine®)
<b>Atony over distention</b>	<b>Obstruction</b>	Continuous dribbling - long Involuntary	<b>Large, flaccid bladder</b> - Large residual urine volume Difficult catheterization	<b>Remove obstruction</b> <b>Indwelling catheter</b> Bethanechol (Urecholine®)
<b>Paradoxical incontinence</b>	<b>Partial obstruction</b>	Continuous dribbling - short Involuntary	<b>Large, turgid bladder (nonexpressible)</b> Normal reflexes	<b>Remove obstruction</b> <b>Indwelling catheter</b>
<b>Ectopic ureters</b>	<b>Young</b>	Continuous dribbling Voluntary urination	<b>Hx (young), CS</b> Bladder, reflexes normal	<b>Ureteral transposition</b> ± Phenylpropanolamine (Triaminic®)



# Glomerulonephropathies

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## URINARY SYSTEM

Condition	Facts/Causes	Presentation	Diagnosis
<b>Glomerulonephropathies</b>  M8k 1137; Mk 880; E-hb 649; SAP 808; H2B 566; H3B 504; 5min 637; I2M 605; IM 474; IM-WW 333; CM 448; C11T 823, 827; Pa-T 224; DDx 555 <b>**</b>	<ul style="list-style-type: none"><li>• <b>Hallmark: proteinuria in absence of urinary tract inflammation</b></li><li>• <b>Causes:</b> unknown in most cases<ul style="list-style-type: none"><li>- Immune complexes in glomerulus in most</li><li>- Amyloidosis rare cause</li></ul></li><li>• <b>Can lead to nephrotic syndrome</b></li></ul>	<ul style="list-style-type: none"><li>• <b>Some asymptomatic w/ proteinuria</b></li><li>• <b>CS of predisposing illness</b></li><li>• <b>PU/PD more severe late in diz</b></li><li>• <b>Weight loss</b></li></ul>  <ul style="list-style-type: none"><li>• <b>Sequelae:</b><ul style="list-style-type: none"><li>- <b>Uremia:</b> if &gt;75% of nephrons effected<ul style="list-style-type: none"><li>. Anorexia, depression</li><li>. Vomiting</li><li>. Diarrhea</li><li>. Oliguria or anuria</li><li>. Oral ulcers</li></ul></li><li>- <b>Pulmonary thromboembolism</b>, hypercoagulable states (loss of antithrombin 3)<ul style="list-style-type: none"><li>. Panting</li><li>. Acute dyspnea</li></ul></li><li>- <b>Nephrotic syndrome</b> from prolonged proteinuria &amp; hypoalbuminemia<ul style="list-style-type: none"><li>. <b>Edema</b></li><li>. <b>Ascites</b></li></ul></li><li>- Hypertension</li><li>± Blindness</li><li>- Glomerulosclerosis</li></ul></li></ul> 	<ul style="list-style-type: none"><li>• Look for predisposing diz - Hx, PE, lab.</li><li>• <b>CS</b></li><li>• <b>Physical exam:</b> ± peripheral edema, ascites, thin, poor hair coat<ul style="list-style-type: none"><li>- Enlarged, normal, or small kidneys</li></ul></li><li>• <b>Blood values:</b><ul style="list-style-type: none"><li>- Nonregenerative anemia</li><li>- <b>Hypoalbuminemia/hypoproteinemia</b></li><li>- Hypercholesterolemia</li><li>- Metabolic acidosis</li></ul></li><li>• <b>UA (urinalysis)</b><ul style="list-style-type: none"><li>- <b>Persistent proteinuria (hallmark): dipstick</b><ul style="list-style-type: none"><li>- In absence of pyuria or hematuria</li><li>- Specific gravity variable, often able to concentrate urine</li><li>- Unremarkable sediment findings: acid pH, hyaline castes, RBCs</li></ul></li></ul></li><li>• <b>Assess magnitude of proteinuria</b><ul style="list-style-type: none"><li>- <b>U Pr:Cr ratio</b> (urine protein:creatinine) alternate to 24 hr collection<ul style="list-style-type: none"><li>. U Pr:Cr &gt; 1 abnormal<ul style="list-style-type: none"><li>.. 1-5 - chronic interstitial nephritis; 3-40 - glomerulonephritis; 10-40 - amyloidosis</li></ul></li></ul></li><li>- 24 hour loss of protein in urine<ul style="list-style-type: none"><li>. Abnormal: dog: &gt; 30 mg/kg/d; Cat: &gt; 35 mg/kg/d</li></ul></li></ul></li><li>• Late: progressive tubular involvement<ul style="list-style-type: none"><li>- Loss of ability to concentrate</li><li>- Hypoproteinemia, hypoalbuminemia or dilute urine</li><li>- Hypercholesterolemia</li><li>- Hypertension</li></ul></li><li>If renal failure/decreased GFR<ul style="list-style-type: none"><li>. Hyperglobulinemia</li><li>. Azotemia (BUN)</li><li>. Hyperphosphatemia if RF</li><li>- Low specific gravity</li></ul></li><li>• <b>Renal biopsy</b> only way to differentiate glomerulonephritis from amyloidosis, <b>Do only w/ caution</b></li></ul>   
<b>Associated conditions - causes</b> <ul style="list-style-type: none"><li>• <b>Idiopathic</b></li><li>• <b>Familial - Doberman pinschers?</b></li><li>• <b>Infectious</b><ul style="list-style-type: none"><li>- Bacterial endocarditis</li><li>- Infectious canine hepatitis</li><li>- Brucellosis</li><li>- Ehrlichiosis</li><li>- Pyometra</li><li>- Dirofilariasis</li><li>- Borreliosis (Lyme diz)</li><li>- Systemic mycosis</li><li>- Feline leukemia virus infection</li><li>- Feline infectious peritonitis</li></ul></li><li>• <b>Miscellaneous</b><ul style="list-style-type: none"><li>- Hyperadrenocorticism</li><li>- Chronic glucocorticoid treatment</li><li>- Bacterial endocarditis</li><li>- Mercury intoxication</li></ul></li><li>• <b>Neoplasia</b><ul style="list-style-type: none"><li>- Lymphosarcoma</li><li>- Mast cell tumor</li><li>- Others</li></ul></li><li>• <b>Inflammatory/immune mediated</b><ul style="list-style-type: none"><li>- Systemic lupus erythematosus (SLE)</li><li>- Chronic pancreatitis</li><li>- Chronic pyoderma</li><li>- Polyarthritis</li></ul></li></ul> 	<b>GN or amyloidosis to nephrotic syndrome</b> <b>CS: Asymptomatic to Edema</b> <b>Dx: Proteinuria, U Pr:CR</b> <b>Tx:: Diet, Vasodilators, Diuretics</b>		



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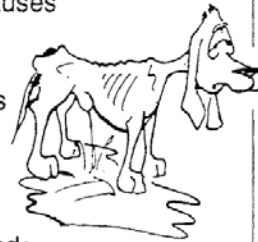
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## • Glomerulonephritis, GN, Immune complex glomerulonephritis

M8k 1138; E-hb 649; SAP 808; H2B 566; H3B 507; I2M 605; IM 474; IM-WW 334; E 1769; CM 450

★★

- Causes: unknown in most cases
  - 2° to inflammation/infectious dzs, neoplasia or other causes
- Pathophysiology:
  - Deposition of antigen-antibody complexes in glomeruli
  - Immune complexes changes permeability of glomerulus
  - **Proteinuria & hypoproteinemia**
- Dogs over 5 years old, cats
- Familial - Dobermans?
- Reversible or irreversible



Prognosis: guarded

## • Amyloidosis

M8k 1138; E-HB 649; SAP 809; H2B 568; 5min 338; IM-WW 335; I2M 607; IM-WW 334; E 1763; CM 448; C11T 823; Pa-T 229

★

- Disposition of fibrillar glycoprotein in organs
  - Results in organ dysfunction
  - Dogs: disposition primarily in glomeruli
    - . Results in protein losing glomerulonephropathy
  - Cats: disposition 1° in renal medullary interstitium
    - . Results in chronic renal failure
- Causes:
  - Idiopathic
  - 2° to inflammatory or neoplastic process
  - Tissue injury stimulates liver amyloid precursor
    - . Liver, spleen, & kidney primarily affected
    - . Progressive kidney dysfunction
- Familial form in Shar Pei, Abyssinian & possibly Beagles



Prognosis: poor

## • Nephrotic syndrome; NS

Mk 880; E-hb 543; SAP 808; IM 477; IM-WW 333; H2B 567; 5min 874, 19; IM-WW 333; CM 453; C11T 827; NB 21, 24

★

- Descriptive term, not a diagnosis - edema, ascites
- Proteinuria, hypoalbuminemia, hypercholesterolemia & edema
  - Proteinuria of sufficient magnitude to cause hypoalbuminemia
    - . ↓ Oncotic pressure - edema
  - Hypercoagulopathy - loss of antithrombin III protein
    - . Thromboembolism
  - ± Compromised immunological system
- Dogs & cats
- Cause:
  - Glomerulonephritis
  - Amyloidosis
- Most patients w/ glomerular dz don't develop nephrotic syndrome



## Treatment:

- Difficult & often unrewarding
- Treat underlying cause if found
- Corticosteroids controversial, not recommended unless specific underlying dz indicates (SLE)

### • Diet:

- Sodium restricted diets
- Protein restricted diet (Hill's k/d)
  - . If proteinuria remains great consider protein supplementation (boiled egg)
- Enalapril (Enacard®) vasodilator, ↓ sodium retention in some, ↑ proteinuria hypertension in some
- Diuretics as needed w/ caution
- Anticoagulants Tx if antithrombin III < 70% of normal & fibrinogen > 300 mg/dl
  - Aspirin, Coumadin®, heparin
- Vitamin B & C, Free choice water



### • Amyloidosis

- No specific treatment proven effective - most terminal
- DMSO & Colchicine mentioned in addition to above Tx
- Glomerulonephritis: often unrewarding, but may be reversible as apposed to amyloidosis

## Prognosis:

- Glomerulonephritis: Guarded
- Amyloidosis: Poor, dz relentlessly progressive to CRF & uremia
- Nephrotic syndrome: Guarded

