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# Urolithiasis: Diagnosis, Treatment and Prevention

Liz Lee, DVM, Residency Trained in Small Animal Internal Medicine

MedVet Northern Utah

MedVet Salt Lake City

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# Learning Objectives

- Recognition and differentiation of the most common stone types in dogs and cats
- Differentiating when medical dissolution, minimally invasive or surgical treatment options are most appropriate
- Understanding the pathophysiology of different stone types in order to best aid in preventative management

# Outline

- Most common stone types
- Pathophysiology
  - Calcium oxalate
  - Struvite
  - Cystine, urate, silica
- Diagnosis
- Treatment
  - Medical dissolution
  - Minimally invasive
  - Surgical
- Prevention

# ACVIM Consensus Statement

Journal of Veterinary Internal Medicine



Open Access

## *ACVIM Consensus Statement*

*J Vet Intern Med* 2016;30:1564–1574

*Consensus Statements of the American College of Veterinary Internal Medicine (ACVIM) provide the veterinary community with up-to-date information on the pathophysiology, diagnosis, and treatment of clinically important animal diseases. The ACVIM Board of Regents oversees selection of relevant topics, identification of panel members with the expertise to draft the statements, and other aspects of assuring the integrity of the process. The statements are derived from evidence-based medicine whenever possible, and the panel offers interpretive comments when such evidence is inadequate or contradictory. A draft is prepared by the panel, followed by solicitation of input by the ACVIM membership which may be incorporated into the statement. It is then submitted to the Journal of Veterinary Internal Medicine, where it is edited before publication. The authors are solely responsible for the content of the statements.*

## **ACVIM Small Animal Consensus Recommendations on the Treatment and Prevention of Uroliths in Dogs and Cats**

J.P. Lulich, A.C. Berent, L.G. Adams, J.L. Westropp, J.W. Bartges, and C.A. Osborne

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# Primary Suspects: Dogs

- Struvite
- Calcium oxalate
- Urate
- Calcium phosphate
  - Apatite, brushite
- Cystine
- Silica



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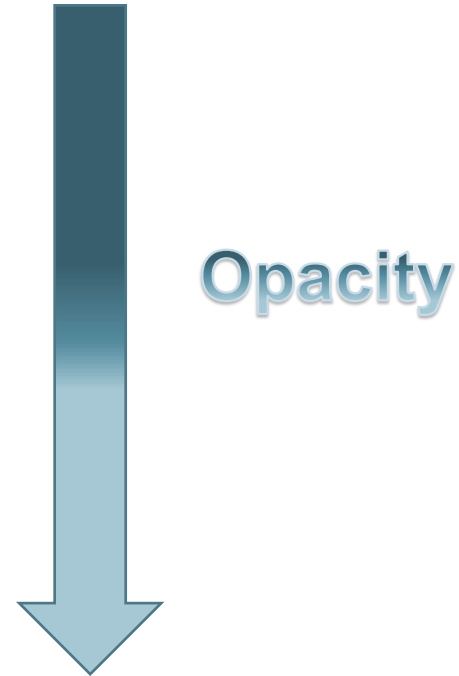
# Primary Suspects: Cats

- Struvite
- Calcium oxalate
- Urate
- Dried solidified blood
- Calcium phosphate
  - Apatite
- Cystine
- Silica



# Primary Suspects: Radiopacity

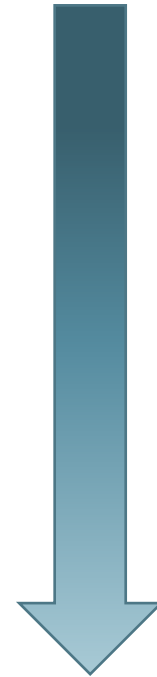
- Calcium oxalate, phosphate
- Silica
- Struvite
- Mixed
- Cystine
- Urate





# Primary Suspects: Radiopacity

- Calcium oxalate, phosphate
- Silica
- Struvite
- Mixed
- Cystine
- Urate



Opacity

- Improved imaging capacity has closed this gap

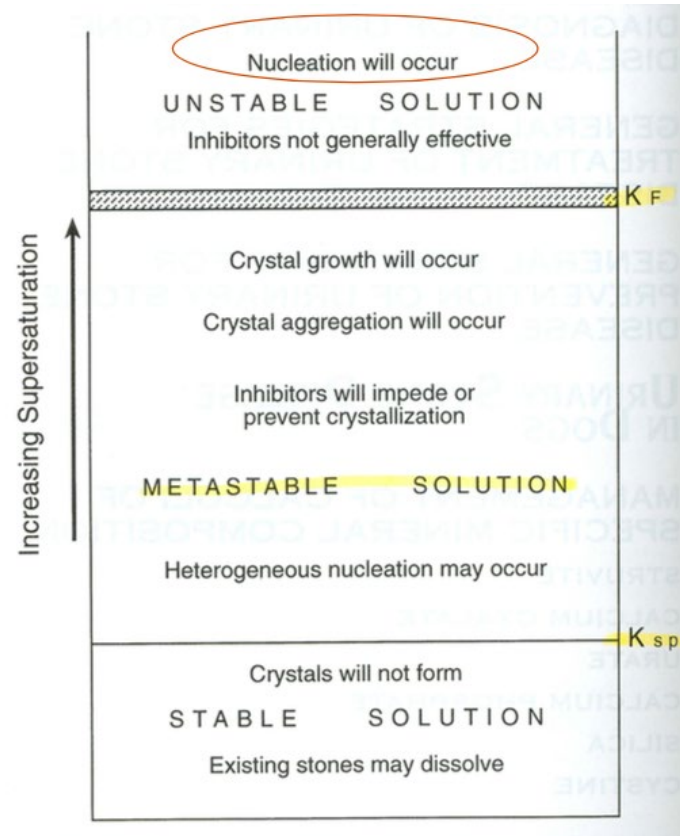
# Pathophysiology

# Pathophysiology: Multifactorial

- Precipitation - Crystallization
  - Presence of a precipitant
- Crystallization – Inhibition
  - Absence of an inhibitor
- Matrix Nucleation Theory
  - Abnormal substance in urine acts as nucleus for stone formation
  - Differs from inhibitor or precipitant, which can be normally found in urine

# Pathophysiology: Relative Super Saturation Theory

- The more “saturated” a solution the more likely stone formation will occur
- Dependent on
  - Urine pH
  - Interaction between minerals
  - Concentration of precursors
- Independent of inhibitors/precipitants



# Pathophysiology: Calcium Oxalate

- Hypercalciuria
  - Impaired renal absorption
  - Increased GI absorption
  - Excessive skeletal mobilization
- Hyperoxaluria
- Imbalance of promoters or inhibitors
  - Inhibitors
    - Citrate, magnesium, phosphate
  - Promoters
    - Lipids
- Acidic urine – mobilizes Ca
  - Can still form at all pHs

# Pathophysiology: Calcium Oxalate

- Breeds
  - Small white fluffy things
  - Miniature Schnauzers
  - Himalayans, Persians
- Hypercalcemia
- Acidified urine
- Obesity
- Hyperlipidemia
- Diet
- Stress?

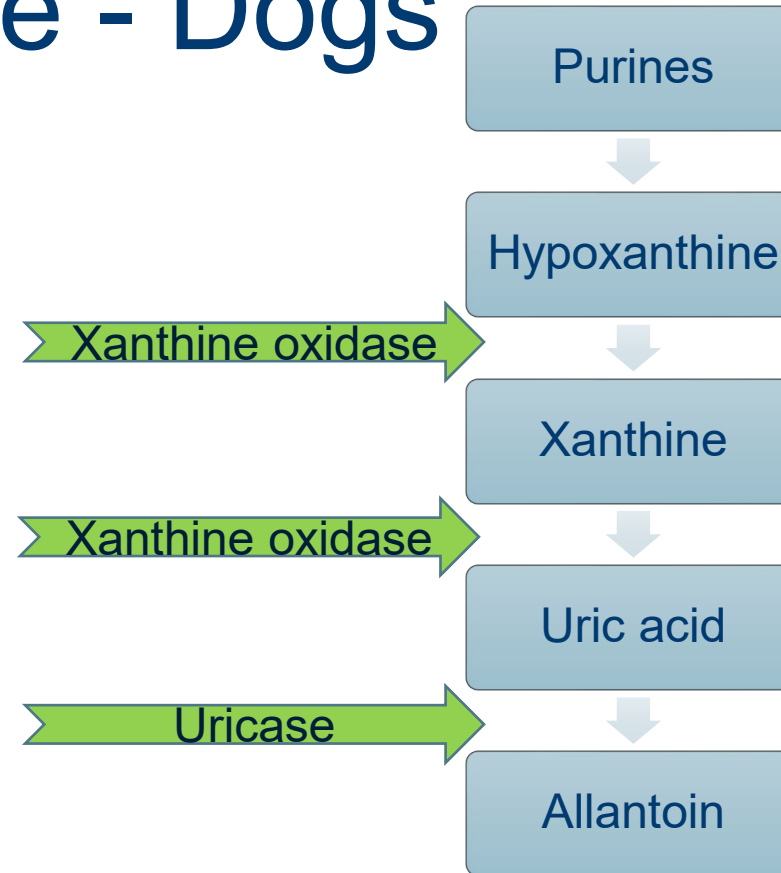
# Pathophysiology: Struvite

- Dogs - nonsterile
  - Urease producing bacteria
    - *Staphylococcus ssp*, *Proteus ssp*, *Klebsiella*
  - Often large angular shaped stones
- Cats – sterile
  - Alkaline urine
  - Smaller elliptical shaped



# Pathophysiology: Urate - Dogs

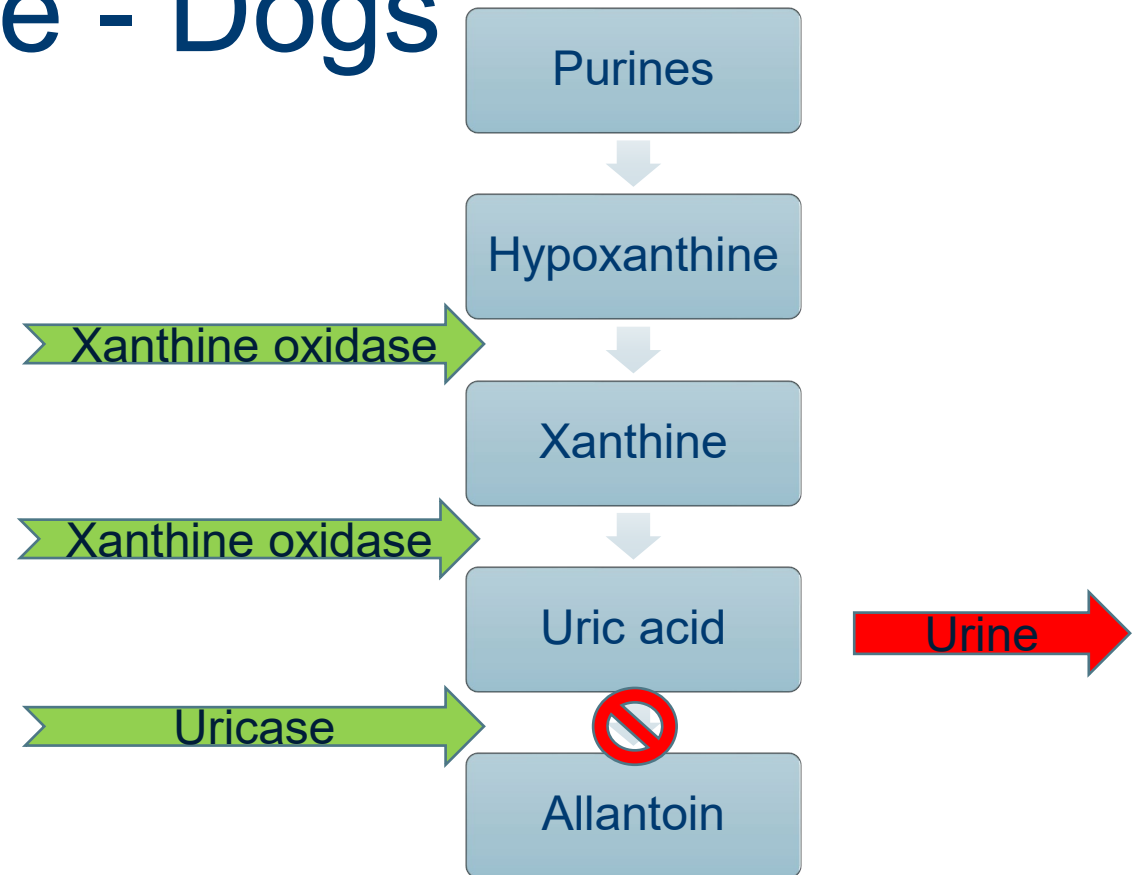
- Hyperuricosuria
  - Defect in uric acid transporter in liver
  - PSS
- Breeds – Mutation SLC2A9
  - Dalmatians
  - English bulldogs
  - Black Russian Terrier, Jack Russel Terrier, American Staffordshire, Giant Schnauzers, GSD, Weimaraner





# Pathophysiology: Urate - Dogs

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# Pathophysiology: Urate - Cats

- 3<sup>rd</sup> most common urolith
- Egyptian Maus, Siamese
- Most do not have underlying hepatopathy



# Pathophysiology: Cystine

- Genetic defect in proximal tubule transport
- COLA transport
  - Cystine, ornithine, lysine, arginine
- Cats
  - Siamese

	Inheritance	Gene	Breed	Sex
Type IA	Autosomal recessive	SLC3A1	Newfies, Labs	M/F
Type IIA	Autosomal dominant	SLC3A1	Australian Cattle dog	M/F
Type IIB	Autosomal dominant	SLC7A9	Min Pin	M/F
Type III – Androgen dependent	-	-	Mastiff, Scottish Deerhound, Irish Terrier	MI

# Pathophysiology: Silica

- High silica consumption
  - Soil, well water
  - Corn gluten or soybean hulls
- Breeds
  - German Shepard
  - Labrador Retriever
  - Golden Retriever
- “Jack like” appearance
- Rarely reoccur



# Pathophysiology: Calcium Phosphate

- Just along for the ride



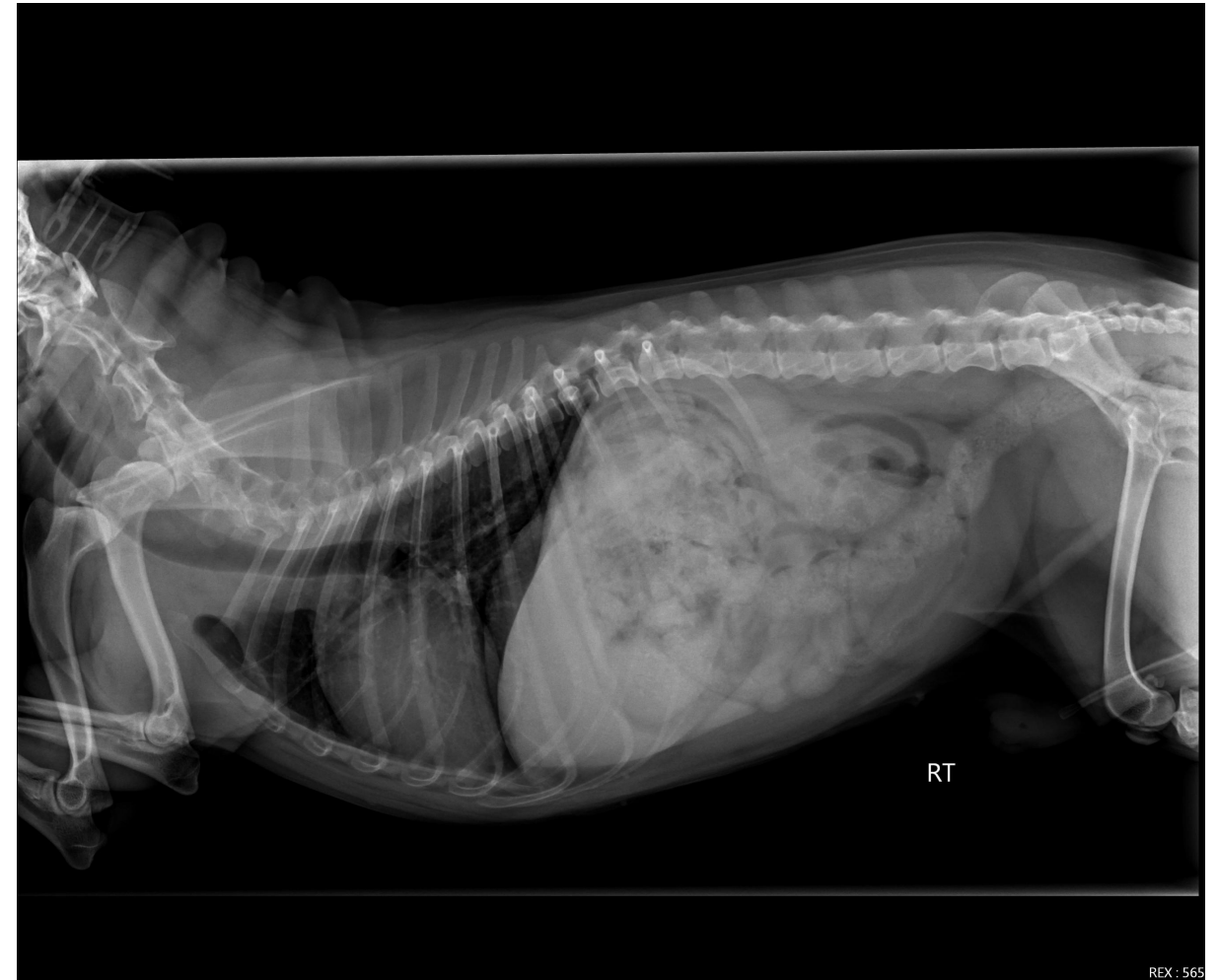
# Diagnosis

# Diagnosis

- Clinical presentation
  - Signalment
  - Concurrent disease
- Imaging
  - Radiolucency
  - Radiographs and ultrasound
- Urinalysis
  - pH
  - Bacteruria
  - Crystalluria??

# Diagnosis

- Radiographs
  - Include the “butt”
  - Legs forward view
  - Paddle view





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REX: 635

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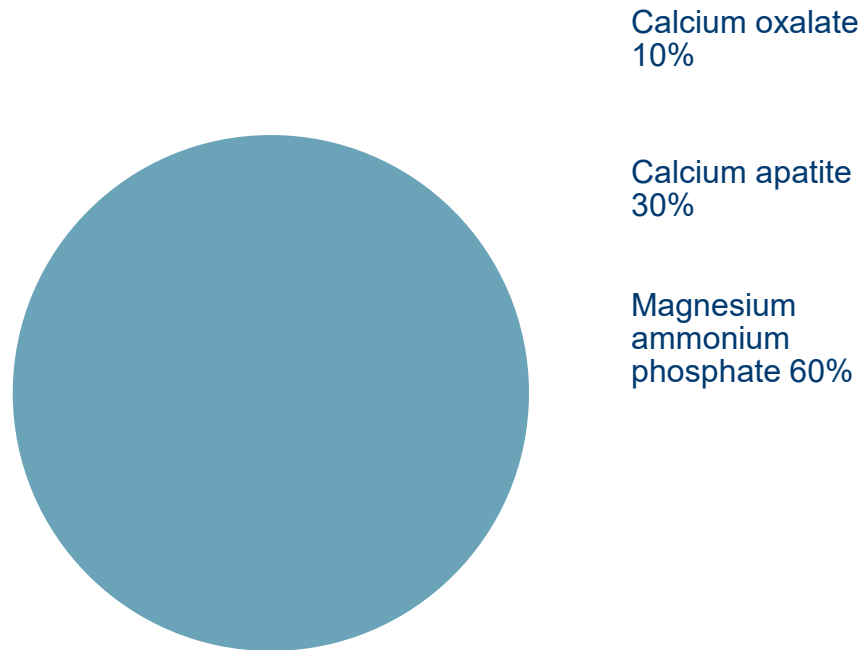
# Diagnosis: Crystalluria

- Crystalluria ≠ urolithiasis
- Spontaneous crystallization
  - After an hour or if refrigerated
  - CaOx, struvite, amorphous phosphate
- Crystal does not always indicate stone type
- Exceptions
  - Urate, Cystine

# Diagnosis: Stone Analysis

- Quantitative Analysis
  - Examines components of all layers
- Core vs Shell layer
  - Core represents initial stone
  - Shell forms around
- Culture
  - Bacteria can be trapped within
- Minnesota Urolith Center
- Gerald V Ling Urinary Stone Analysis Laboratory – UC Davis

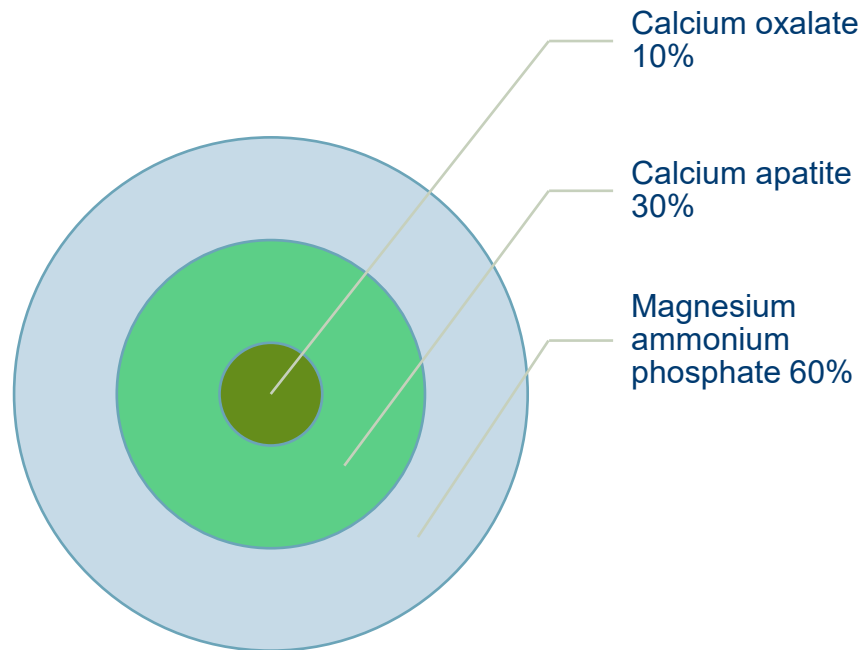
# Diagnosis: Stone Analysis



How would you focus your preventative treatment?

- a) Acidifying diet for struvite urolithiasis
- b) Assess for underlying hypercalciuria
- c) Urine culture

# Diagnosis: Stone Analysis



How would you focus your preventative treatment?

- a) Acidifying diet for struvite urolithiasis
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# Treatment

# Treatment: Dissolution - Struvite

- Dissolution diets
  - Acidifying, pH <6.8
  - Low protein, PO<sub>4</sub> and Mg
  - High in fat
  - Hill's S/D not for long term management
- Increase water intake
  - USG <1.030 cats, <1.020 dogs
- Dogs
  - Treat the underlying UTI based on C&S
  - Maintain on antibiotics during course of dissolution if culture positive
- Recheck radiographs
  - Dogs 4 weeks
  - Cats 2 weeks



# Treatment: Dissolution - Urate

- Low purine diets
  - Vegetarian or low protein diets
  - Hill's U/D, RC UC, Purina HA, Eukanuba Vegetarian
- Alkaline urine
  - Potassium citrate
  - pH >7.5
- Allopurinol 15mg/kg PO q12h
  - Must be given with low purine diet
  - Increased risk xanthine stones
- Contraindications
  - Hepatic disease
- 30-40% effective

# Treatment: Dissolution - Cystine

- Low protein diets
  - Vegetarian or low protein diets
  - Hill's U/D, RC UC, Purina HA, Eukanuba Vegetarian
- Alkaline urine
  - Potassium citrate
  - pH >7.5
- Thiola 15-20mg/kg PO q12h
  - Binds to cystine
  - \$\$
  - Side effects: GI, aggression, myopathy
- 50-60% effectiveness reported

# Treatment: Dissolution - Contraindications

- Urinary obstruction or high risk of obstruction
- Inability to achieve appropriate bathing of modified urine
- Significant clinical signs\*\*
- Young, pregnant or lactating animals
- Fat intolerance
- Inability to tolerate oral medications

# Treatment: Minimally Invasive - Pros

- Associated with decreased hospitalization time\*
- Shorter recovery time
- Improved visualization of urinary tract
- May be preferred if ongoing infection
- Owners often prefer
- It's fun!

# Treatment: Minimally Invasive - Cons

- Specialized equipment and facility
- More costly
- If unsuccessful may still require surgical intervention
- Patient specific limitations
  - Size, number of stones
- Multiple passes of scope can be irritating to urethra

# Treatment: Minimally Invasive

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Voiding  
Urohydropropulsion (VUH)

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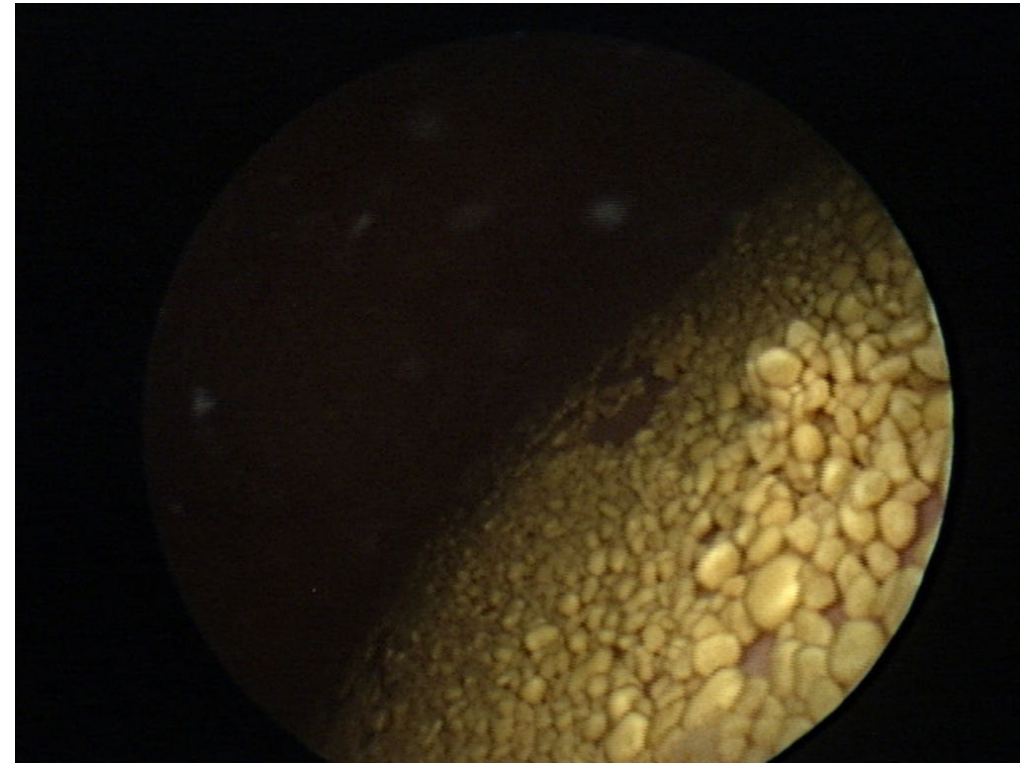
Basket Retrieval

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Laser Lithotripsy

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Percutaneous  
cystolithotomy



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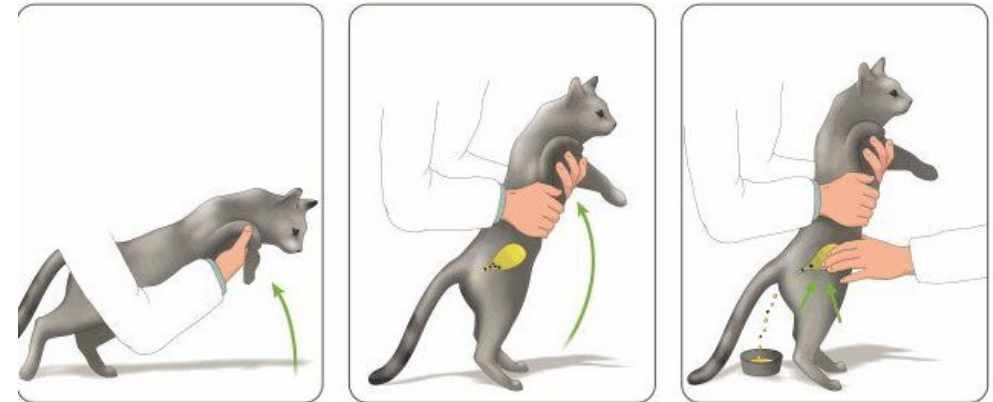
# Treatment: Minimally Invasive

- Voiding Urohydropropulsion (VUH)
  - Ideal for females
  - Small to medium patients
  - Smaller stones
  - No need for specialized equipment

Antegrade urohydropropulsion

NATOMEXPLORER  
BY CALLIMEDIA  
CAT & DOG

ROYAL CANIN



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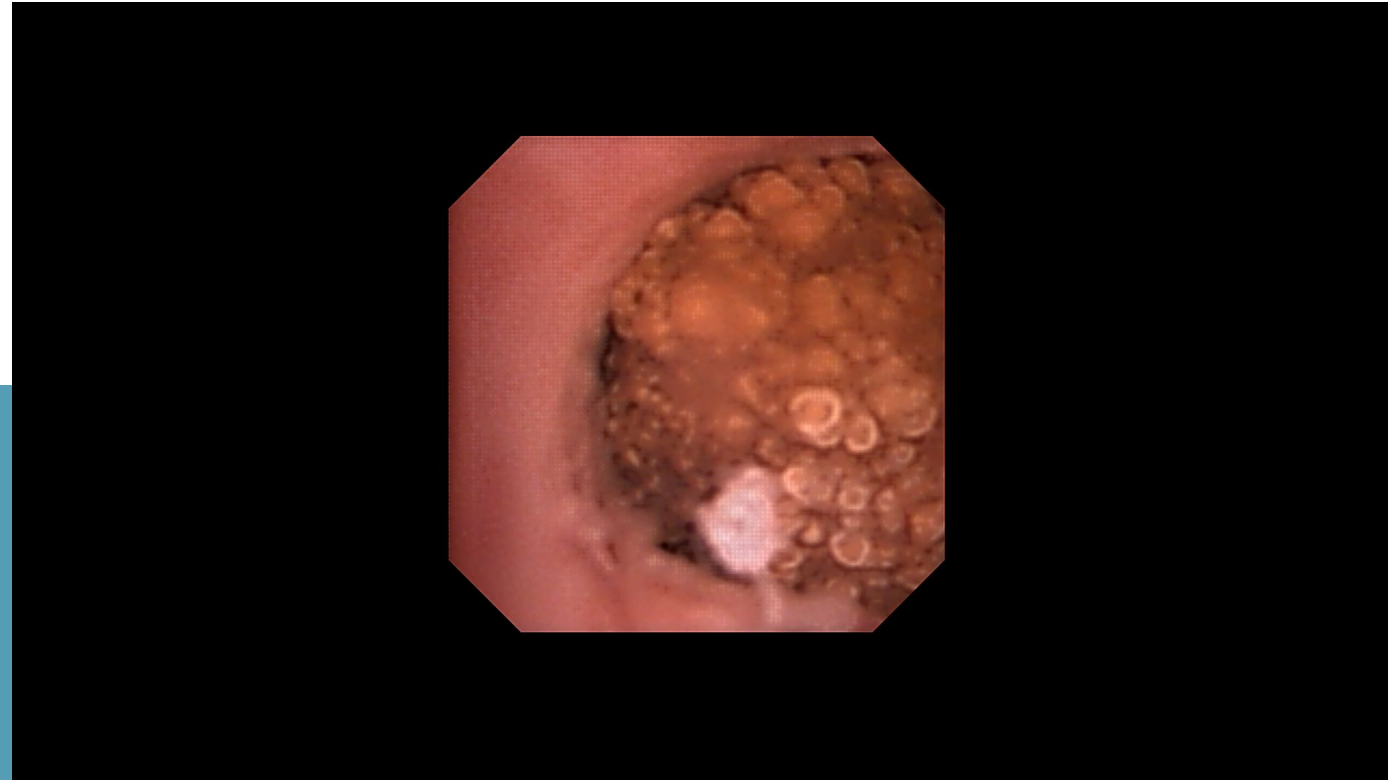
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# Treatment: Minimally Invasive

- Basket Retrieval
  - <5-10 stones
  - <1cm stones\*\*
  - 8 Fr red rubber must be passable through urethra
- Laser Lithotripsy
  - Urethral obstructions or larger 1-2 cystoliths
  - Combined with basket retrieval or VUH

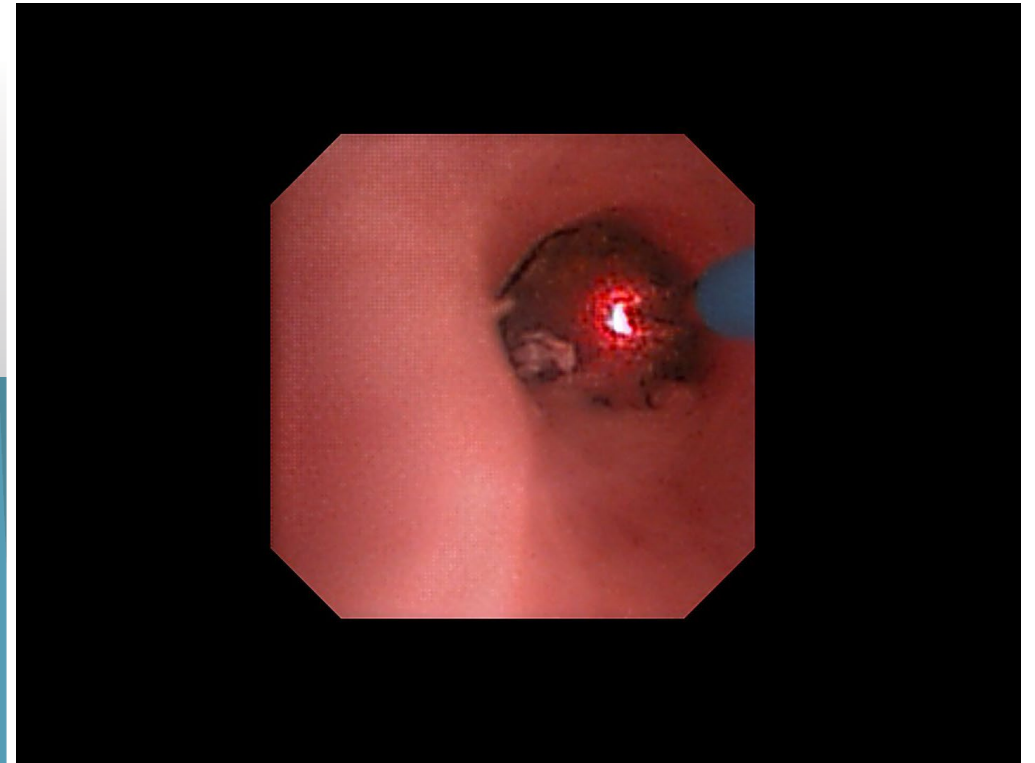


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# Treatment: Minimally Invasive

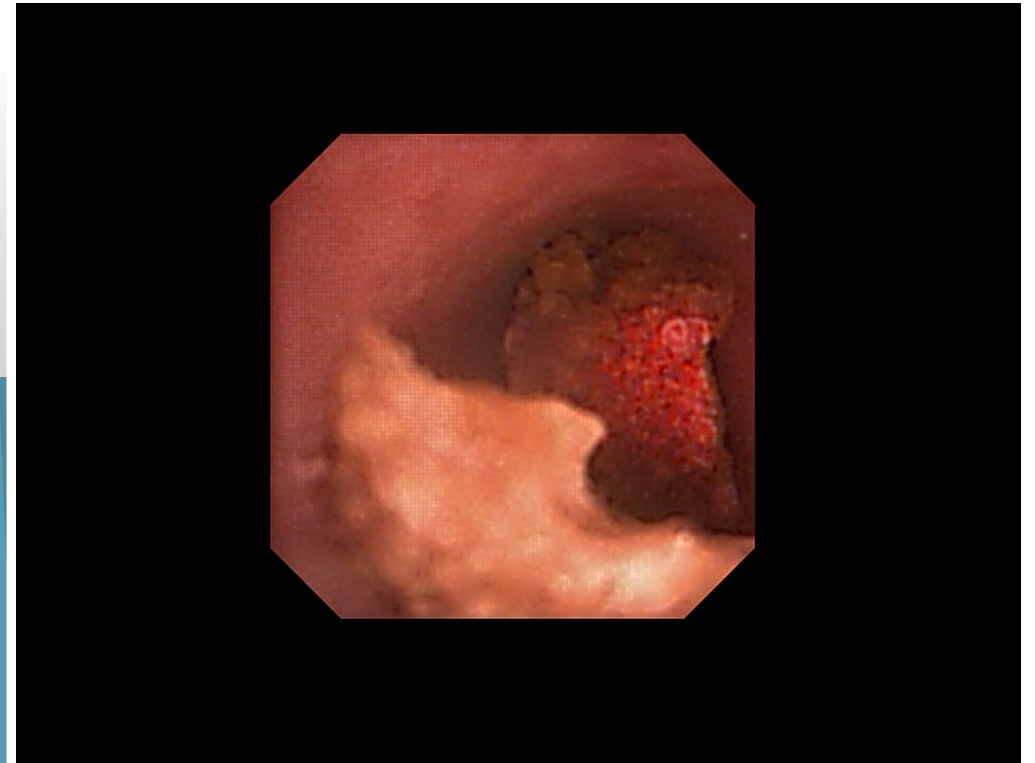
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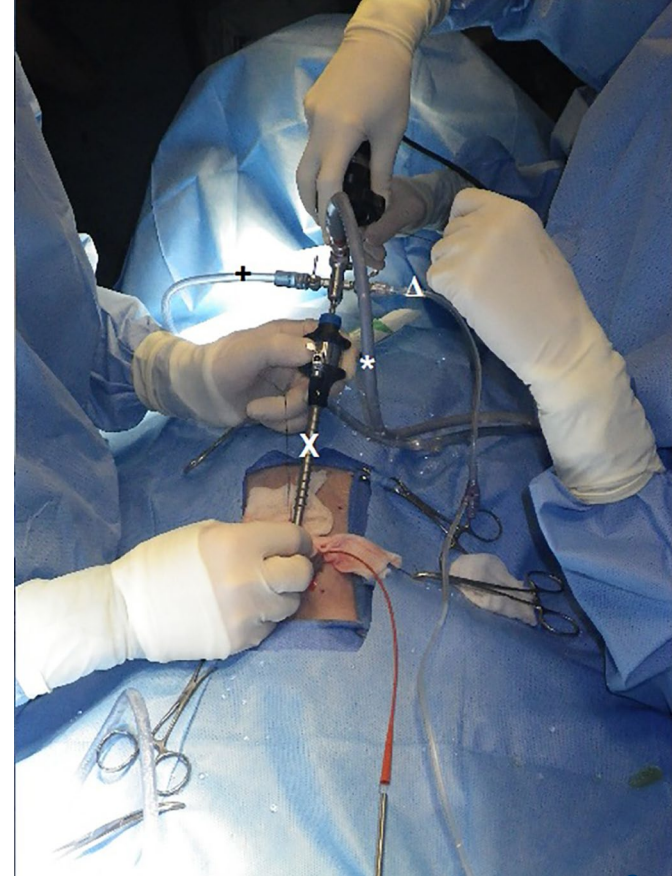
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# Treatment: Minimally Invasive

- Percutaneous cystolithotomy
  - Transvesicular cystoscopy
  - Decreases incision size
  - Not limited by urethral size or number of cystoliths



Cruciani et al Vet Surg 2020

# **Transvesicular percutaneous cystolithotomy for the retrieval of cystic and urethral calculi in dogs and cats: 27 cases (2006–2008)**

Jeffrey J. Runge, DVM, DACVS; Allyson C. Berent, DVM, DACVIM;  
Philipp D. Mayhew, BVMS&S, DACVS; Chick Weisse, DVM, DACVS

## Case Study

- Retrospective
- Median procedure time 66 min (50-80 min)
- All discharged within 24 hours
- No reported complications

## Removal of lower urinary tract stones by percutaneous cystolithotomy: 68 cases (2012–2017)

Benoît Cruciani DVM<sup>1</sup>  | Catherine Vachon DVM, DACVIM<sup>2</sup> | Marilyn Dunn DVM, DACVIM<sup>2</sup>

# Case Study

- Retrospective
- Median procedure time 95 min (45-420 min)
- 83% discharged within 24 hours
- 16/68 LUTs post procedure, 1 surgical dehiscence
- No head-to-head comparison to surgical cystotomy

# Treatment: Surgical

- Cystotomy
  - No special equipment
  - Fast
  - Can be cost effective
  - Decreased visualization



# Treatment: Ureteral Obstruction

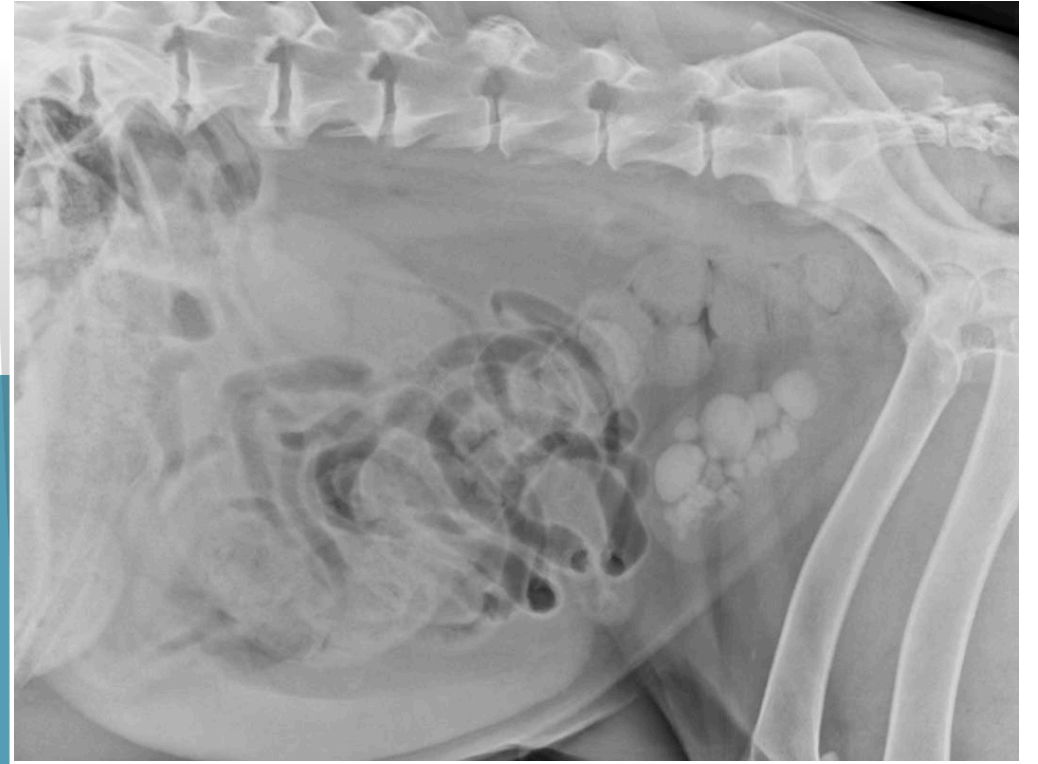
- Ureteral Stents
  - Removeable
- Subcutaneous ureteral bypass
  - Permanent
- Ureterotomy
  - Risk of stricture
  - Very surgeon dependent



# Treatment: Case Example

4-year-old FS mixed breed dog with one-week LUTs. Urine culture growing *Klebsiella spp.*

- a) Cystotomy
- b) Rx Hill's S/D and appropriate antibiotic
- c) Voiding urohydropropulsion
- d) Lithotripsy



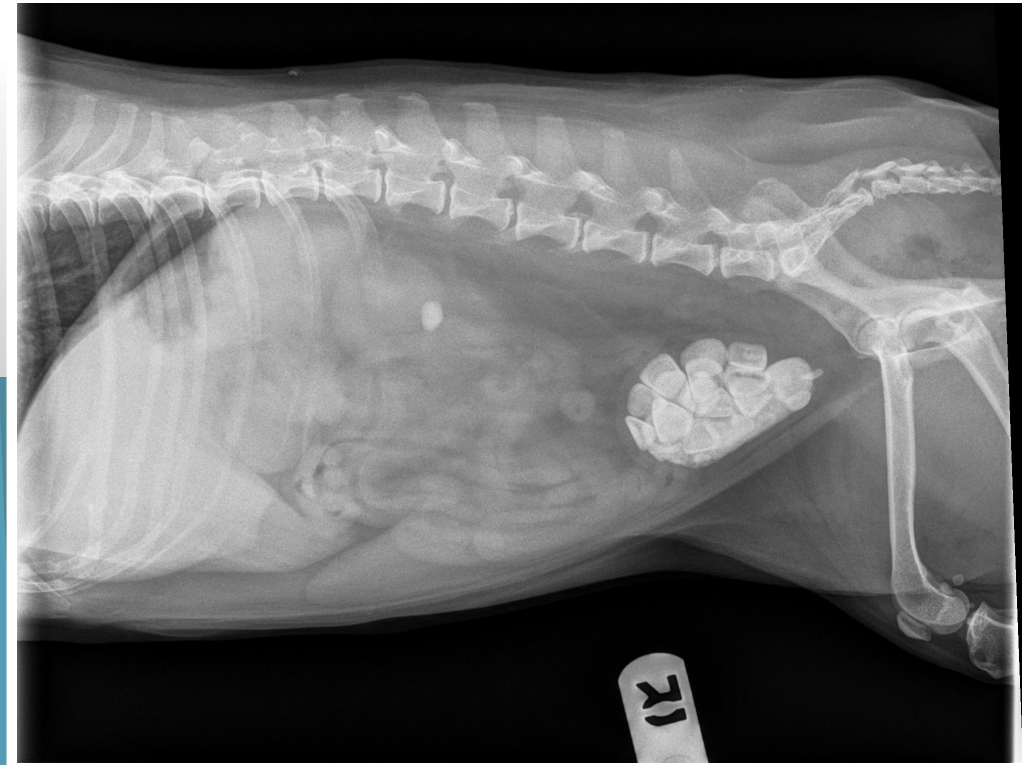
Dear etal BMC Vet Res 2019



# Treatment: Case Example

6-year-old FS Shih Tzu straining to urinate two-week duration, pain on abdominal palpation, decreased appetite. CBC/Chem unremarkable.

- a) Cystotomy
- b) Rx Hill's S/D and appropriate antibiotic
- c) Voiding urohydropropulsion
- d) Lithotripsy



# Treatment: Case Example

4-year-old MI GSD, straining to urinate, enlarged bladder, radiolucent stone within urethra on penile ultrasound.

- a) Medical dissolution
- b) Voiding urohydropropulsion
- c) Lithotripsy + basket removal
- d) Lithotripsy + basket removal + neuter



# Prevention

# Prevention: Water Intake



- Increased water intake
  - Cats <math><1.030</math>, Dogs <math><1.020</math>
- Most important factor to reducing RSS score
- Implement immediately, regardless of stone
- Wet foods
  - With additional water if tolerated
  - Soaked kibble
  - >75% moisture content
- Water fountains, esp cats
- Ice cube treats

# Prevention: Diet

- Struvite
  - Low Mg, Phos and moderate protein
  - Acidifying
  - Diet change likely unnecessary for dogs
- Calcium Oxalate
  - Low oxalate, moderate protein

- Royal Canin
  - Urinary S/O
  - Urinary S/O modified calorie
  - Multifunction diets
- Hill's C/D
- Purina UR



# Prevention: Diet

- Cystine & Urate
  - Low purine diets, less animal protein
  - Alkalinizing



- Royal Canin Vegetarian
- Hill's U/D
- Purina HA
- Natural Balance Vegetarian

# Prevention: Additional Considerations

- Calcium oxalate
  - Address underlying cause of hypercalcemia if present



- Potassium citrate (150mg/kg/day)
  - if persistently acidic urine, pH <6.8
- Hydrochlorothiazide
  - Enhances renal tubular calcium reabsorption
  - Dog 2mg/kg q12h, Cats 1mg/kg q12h

# Prevention: Additional Considerations

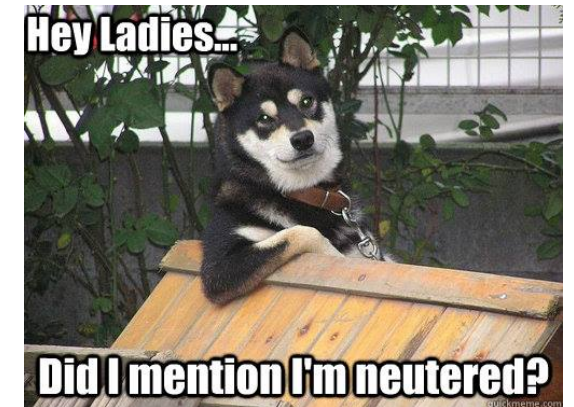
- Urate

- Address underlying hepatopathy if present
- Allopurinol



- Cystine

- Castration
- Thiola - Not available in US, must be compounded





# Take Home Points

- Crystalluria ≠ urolithiasis
- Always take a radiograph with LUTs
- If obstruction is present or imminent medical dissolution is inappropriate
- >5-10 or very large stones are inappropriate for some minimally invasive techniques
- Submit for quantitative analysis
- When in doubt more water

Thank You

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