

## Update on CKD Prevention Strategies and Practical Points

# Prevention of CKD from Renal Calculi

Dhavee Sirivongs, M.D.  
Srinagarind hospital, KKU  
March 2, 2007

# Content

- **Renal stone: clinical aspects**
- **Urinary crystals: from crystals to stones**
- **Absolute treatment**
- **Clinical applications on prevention**

**Renal calculi:  
Cause of CKD in > 5%**

Obstructive uropathy  
Chronic tubulo-interstitial disease  
End stage renal disease

# Renal Stone: Composition

- **Calcium Oxalate**      **70-75%**
- **Calcium Phosphate**      **<5 %**
- **Uric acid**      **10 %**
- **Infectious (Struvite)**      **15 %**
- **Cystine**      **1 %**

**Calcium stone: 10% lifetime prevalence in men**

# Renal calculi: crystalline substances

## Oxalate

- Whewellite      Calcium oxalate monohydrate       $\text{CaC}_2\text{O}_4 \cdot \text{H}_2\text{O}$
- Weddellite      Calcium oxalate dihydrate       $\text{CaC}_2\text{O}_4 \cdot (2+x)\text{H}_2\text{O}$

## Phosphate

- Hydroxyapatite      Basic calcium hydrogen phosphate       $\text{Ca}_5(\text{PO}_4)_3(\text{HO})$
- Brushite      Calcium hydrogen phosphate       $\text{CaHPO}_4 \cdot 2\text{H}_2\text{O}$
- Whitlockite       $\beta$  - tricalcium phosphate       $\beta\text{-Ca}_3(\text{PO}_4)_2$
- Struvite      Mg ammonium phosphate hexahydrate       $\text{Mg}(\text{NH}_4)(\text{PO}_4) \cdot 6\text{H}_2\text{O}$   
Octacalcium phosphate       $\text{Ca}_8\text{H}_2(\text{PO}_4)_6 \cdot 5\text{H}_2\text{O}$

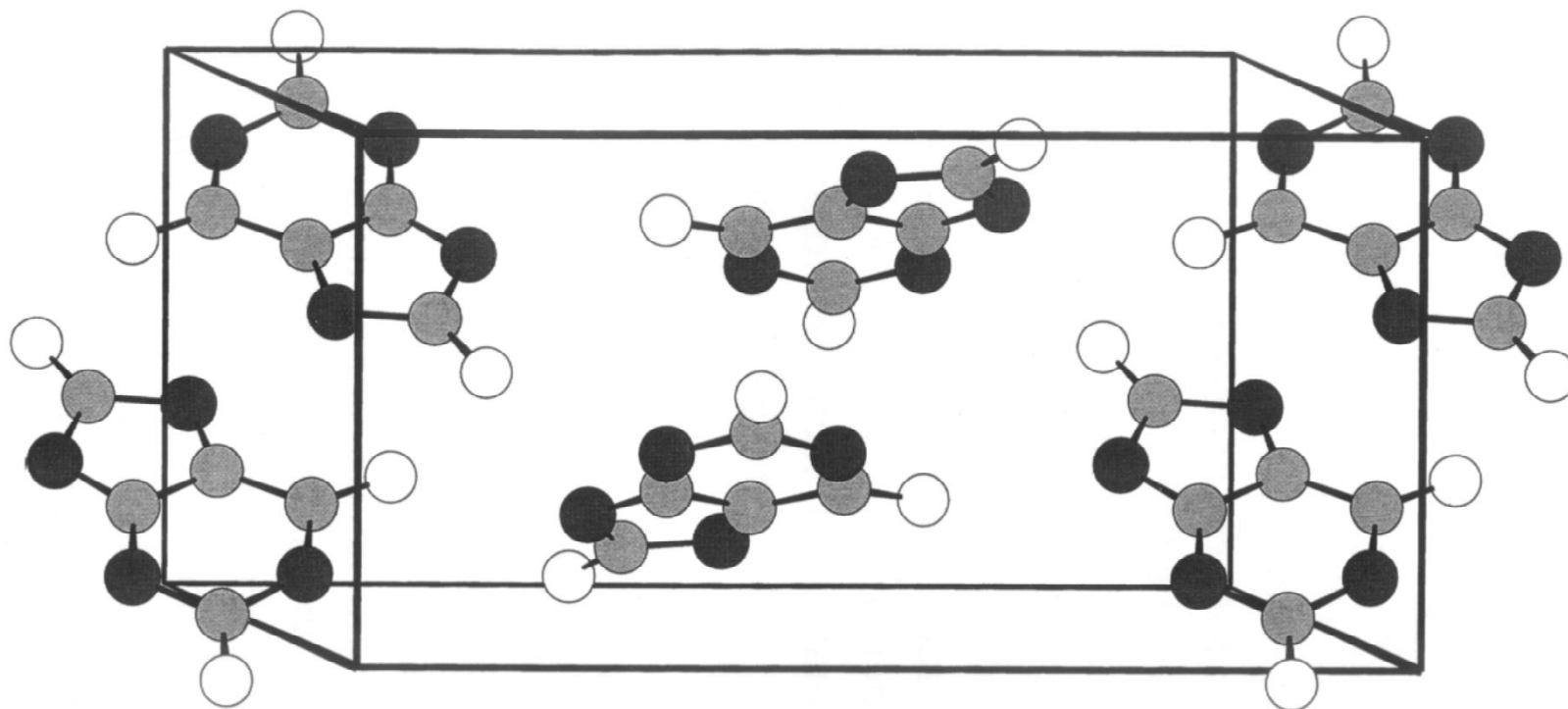
## Uric acid

- Uric acid (dihydrate)       $\text{C}_5\text{H}_4\text{N}_4\text{O}_3 \cdot 2\text{H}_2\text{O}$
- Monosodium urate monohydrate       $\text{Na C}_5\text{H}_4\text{N}_4\text{O}_3 \cdot \text{H}_2\text{O}$

## Others

- $\lambda$ -cystine       $\text{S}_2\text{C}_6\text{H}_{12}\text{N}_2\text{O}_4$

# Crystal structure: Uric acid $C_5H_4N_4O_3$



Legend: Carbon atom (gray sphere), Nitrogen atom (black sphere),  
Oxygen (white sphere)

# **Clinical Presentation of Renal Stone Disease**

- **Passed stone**
- **Positive X-ray film**
- **Obstructive nephropathy**
  - **Back pain, Flank pain**
  - **Painful & painless hematuria**
- **Acute & chronic pyelonephritis**
- **Chronic Kidney Disease: tubulo-interstitial disease**

**Acute Stone  
Episode  
Suspected**

**History, P.E.,  
CBC, UA**

**KUB + U/S or  
CT/IVP confirmed**

**obstruction?  
pain?**

**urine  
infected?**

**stone  
treatment**

**urine  
infected?**

**percutaneous  
nephrostomy**

**antibiotics**



# Management of Acute Pain (Renal colic) I

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Bed rest + IV fluid/KVO

Non-narcotic analgesic

- Ibuprofen\* (400mg PO)
- Ketorac (30 mg IV, 90 mg PO)
- Ketoprofen, Diclofenac IV
- Aspirin ( Gr X)
- Paracetamol\* (1000 mg)

# Management of Acute Pain (Renal colic) II

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## Narcotics


- **Morphine\* (0.1 mg/Kg IM): beware of respiratory suppression + spasmogenic effects**
- **Meperidine (1 mg/Kg IM)**

## Adjuvant agents ( to Narcotics)

- **Amitriptyline\* (25-75 mg PO) anti-depressant + analgesic**
- **Hydroxyzine\* (25 mg IM) anti-histamine + analgesic + anti-emetic**

**Renal stones  
are  
crystals bound together  
with “glues”  
in the proper conditions**

# Pathogenesis & Pathophysiology

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- **Ion excretion**
  - **Nidus**
  - **Crystal formation**
    - **crystal nucleation : Saturation-supersaturation, Homogeneous & Heterogeneous (Epitaxis)**
    - **crystal growth (Inhibitors/Promoters)**
    - **crystal aggregation(Promoters)**
  - **Stone formation**
    - **Free particle theory: Slow urine flow**
    - **Fixed particle theory : (Tubular) Cell-crystal reaction**  
**Tissue damage/Scars/Post-op**

# Promoters & Inhibitors of stone disease

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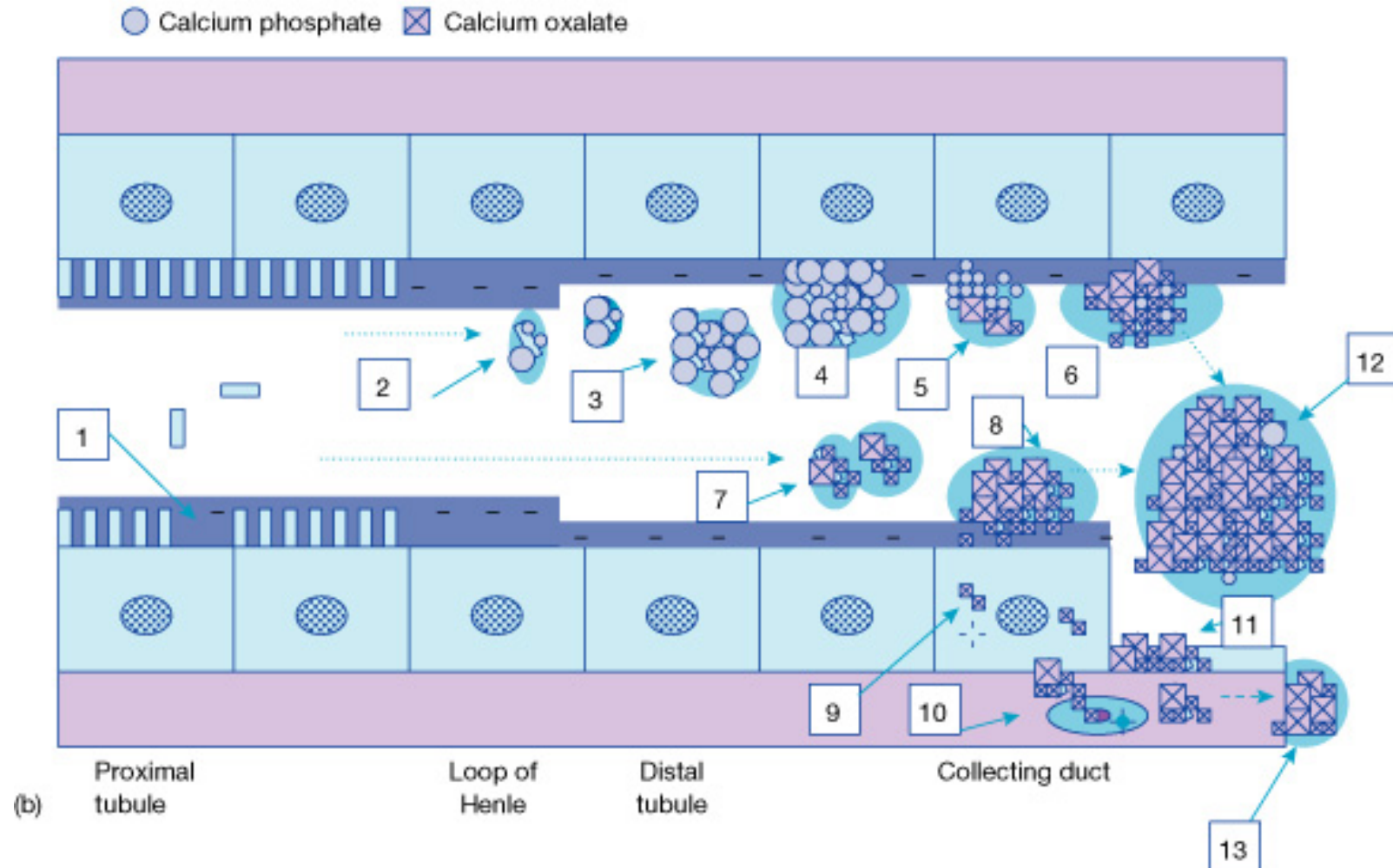
## Promoters

- Uric acid
- Polymerized THP

## Inhibitors

- *Citrate*
- Magnesium
- Pyrophosphate
- Glycosaminoglycans
- Nephrocalcin
- Uropontin
- Non-polymerized THP

# Stone formation



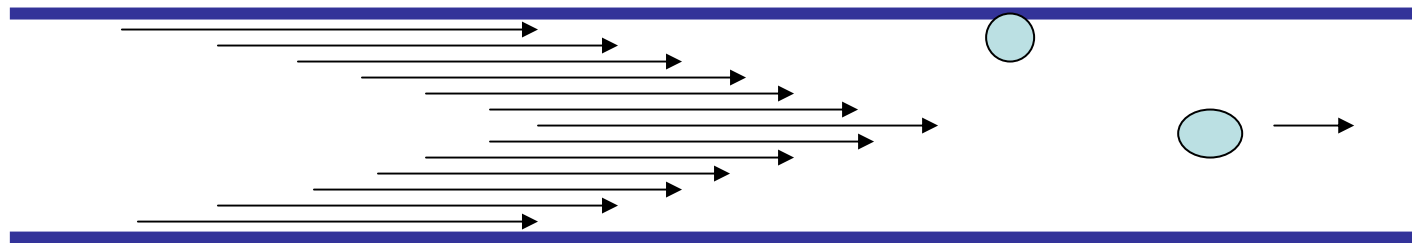
# Timing for Stone Formation

**3 o'clock in the morning**

**Urine flow: 20-30 ml/hour**

**Urine flow rate: 0.00002**

**ml/hr/nephron**



# Renal Stone: Characteristics

- **CaOx.H<sub>2</sub>O:** hard, dark brown, dull grey coat
- **CaOx.2H<sub>2</sub>O:** small, spherical, tan cluster of platelets
- **CaP:** small, white, fine granule surface
- **Uric acid:** small, smooth, yellow-orange, **radiolucent**
- **Struvite:** large, light brown, dendritic/rough surface
- **Cystine:** very small yellow, dendritic, **partial dense**



1



2



3



4



5



6



7



8



# Absolute treatment of Stone

- **Get rid all of stones**
  - **Surgical/Open: No residual stone**
  - **Non-surgical: some stones left**
- **Preventive measures**

**Clinical Application  
on  
stone prevention**

# Possible Prevention Guideline

- **Decrease causative ion(s) in urine**
- **High urine flow: All day ?**
- **Adjust urinary chem./ biochem./  
physic.**
- **Increase citrate in urine**
- **Exercise ?**

# Critical urine pH for crystal formation

## Urine pH

- **< 5.5 for Uric acid**
- **6.0 - 6.5 for CaOx (<6.25)**
- **> 6.5 for CaP**
- **> 7.5 for Struvite**

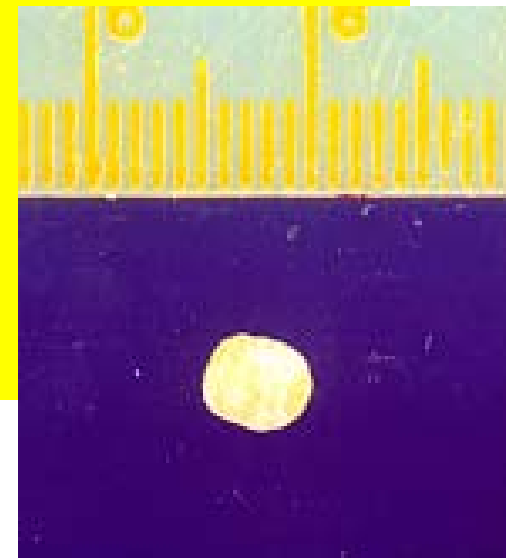
# Preventive Modalities: Drugs

- |                    |                                |
|--------------------|--------------------------------|
| • Hypocitraturia:  | K citrate                      |
| • Idiopathic:      | K citrate/Thiazide/Allopurinol |
| • Hyperuricosuria: | Allopurinol $\pm$ K citrate    |
| • RTA:             | K citrate                      |
| • Struvite stone   | Get rid of UTI, residual stone |

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# Uric acid stone is Preventable

- **Uric acid: small, smooth, yellow-orange, radiolucent**
- **Stone former: urine uric acid**
  - > 800 mg/d (male),
  - > 750 mg/d (female)
- **Possibly induces calcium stone (as nidus)**



# Uric acid stone is Preventable

- **Urine flow > 2000 ml./day**
- **Purine moderation**
- **Urinary alkalination (UpH 7):  
Sodamint, Potassium citrate**
- **Allopurinol**





# Take Home Messages

**Low causative ion in urine**  
**Reduce the promotor**  
**Increase the inhibitor**  
**Proper pH adjustment**  
**Correct UTI**  
**Early stone removal**  
**Regular follow-up**



Appreciate Your Attention