



Kidney stones

Medical Management and Prevention

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Outline...

1. Epidemiology
2. Pathogenesis
3. Types of stones
4. Etiology/Risk factors
5. Evaluation
6. Medical management



Renal Colic: The Experience

- It felt like I was trying to give birth to an elephant, but all that finally came out was a little speck of blood.
- as if someone took a pair of vise grips to my side and started clamping it down without letting up.
- hot needle-like pain radiating down to the end of my penis.
- it felt like a white hot poker was sticking into my side.
- dull ache over the kidney area.

Events before and during medical Treatment

1710

Parks and Coe: Costs of nephrolithiasis prevention

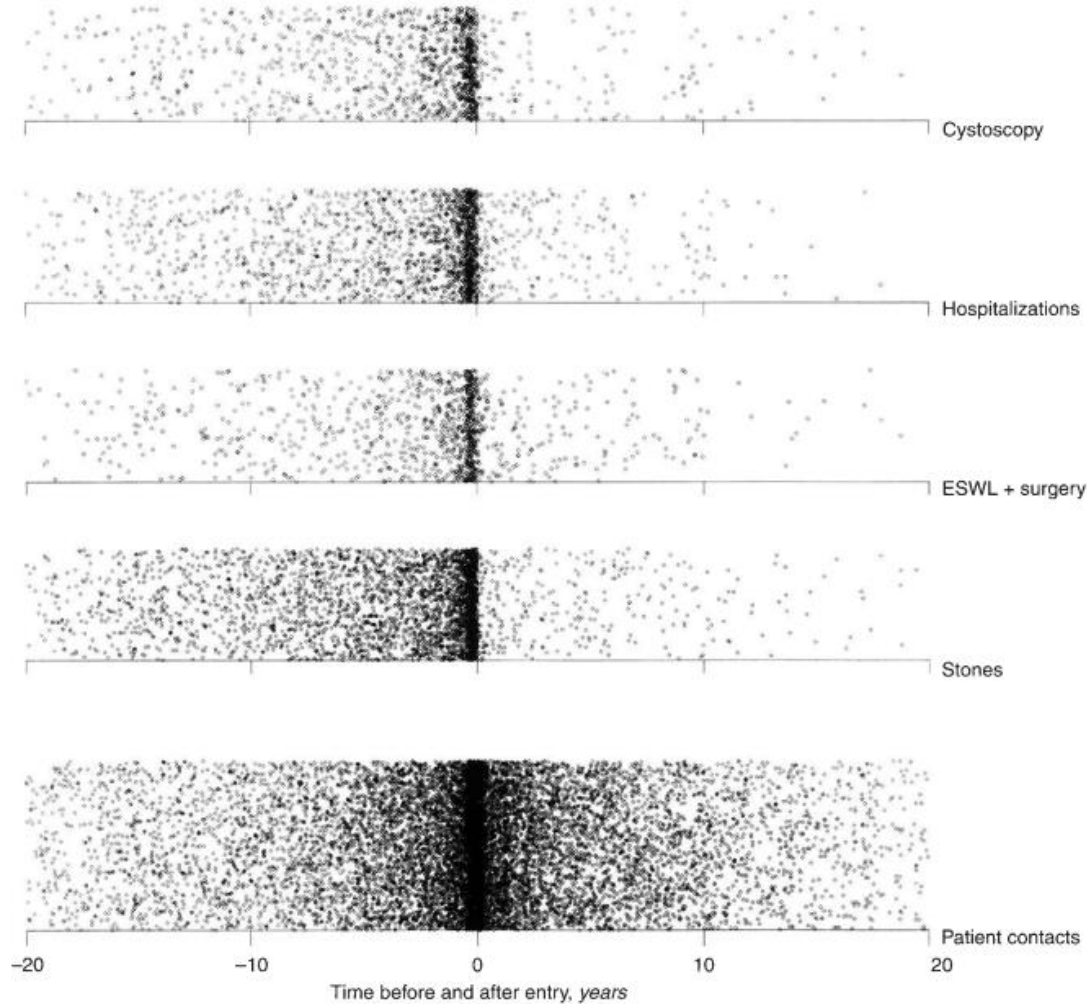
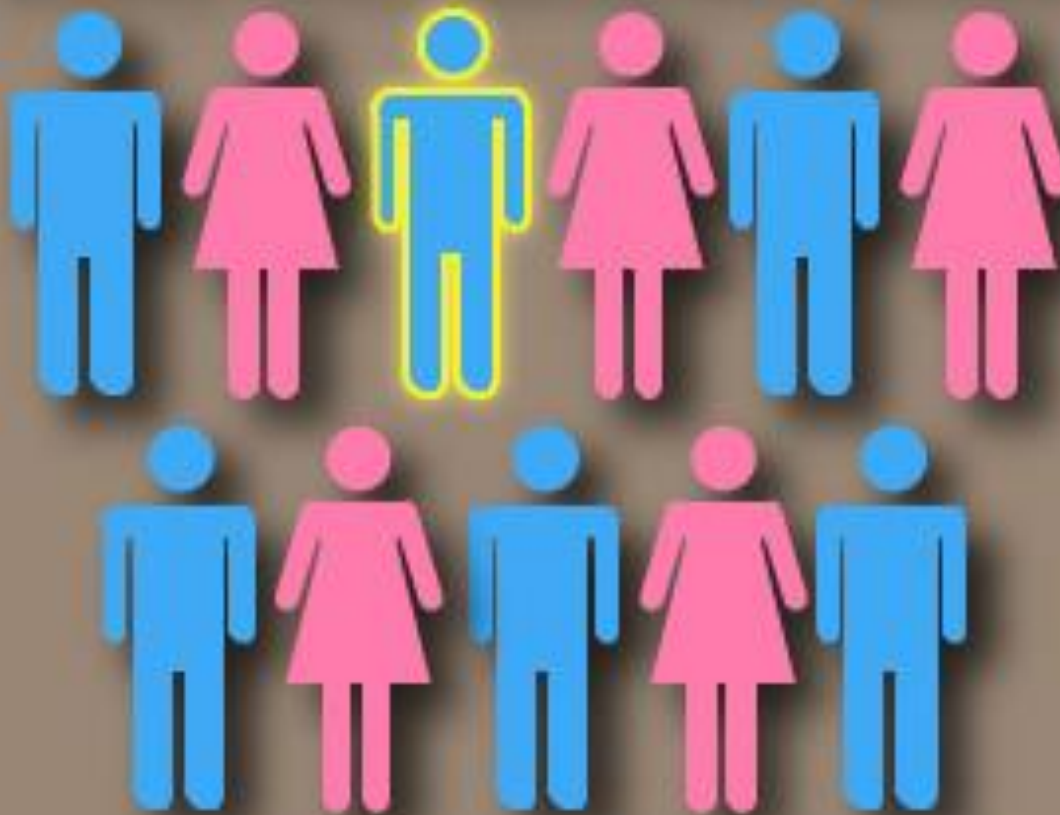


Fig. 1. Patient contacts and stone related events before and during treatment. Each point shows one contact (lowest panel), or stone related event (upper panels); time before entry is shown as negative numbers. Despite large numbers of contacts, stone related events fell in all categories.

1 out of every **11**
American will experience a
kidney stone during their lifetime

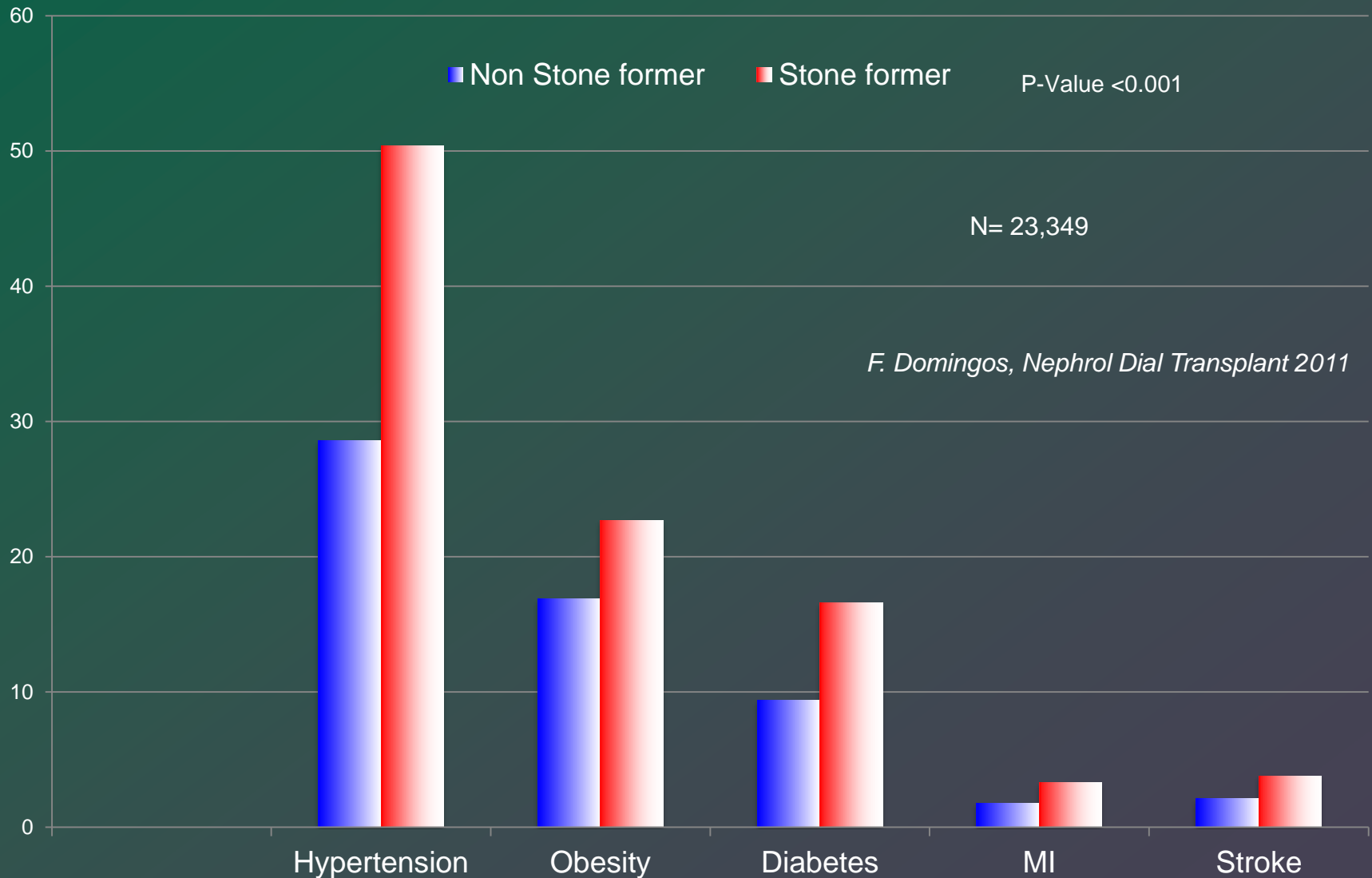


Epidemiology:

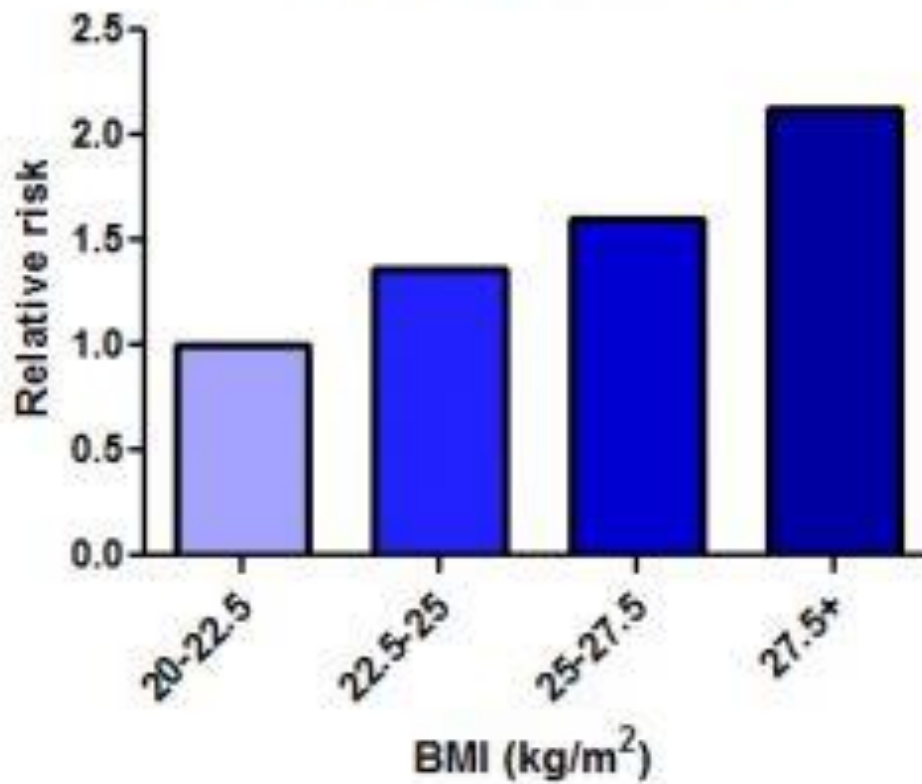
- In 1994 prevalence : 1 in 20 (5.2%)
- In 2010 prevalence : 1 in 11 (10.6%)
- Demographics
 - Men > Women (2 or 3 : 1)
- Cost in 2000 – \$2.1 billion (Pearl, 2005)
- Cost in 2012 - \$10 Billions (Litwin MS et)
- Projected rise in cost 1.24 Billion/year by 2030
- Loss of wages/productivity

Treatment aimed at prevention of stones is critical to decrease cost and morbidity

Kidney stones and associations – a Systemic disease

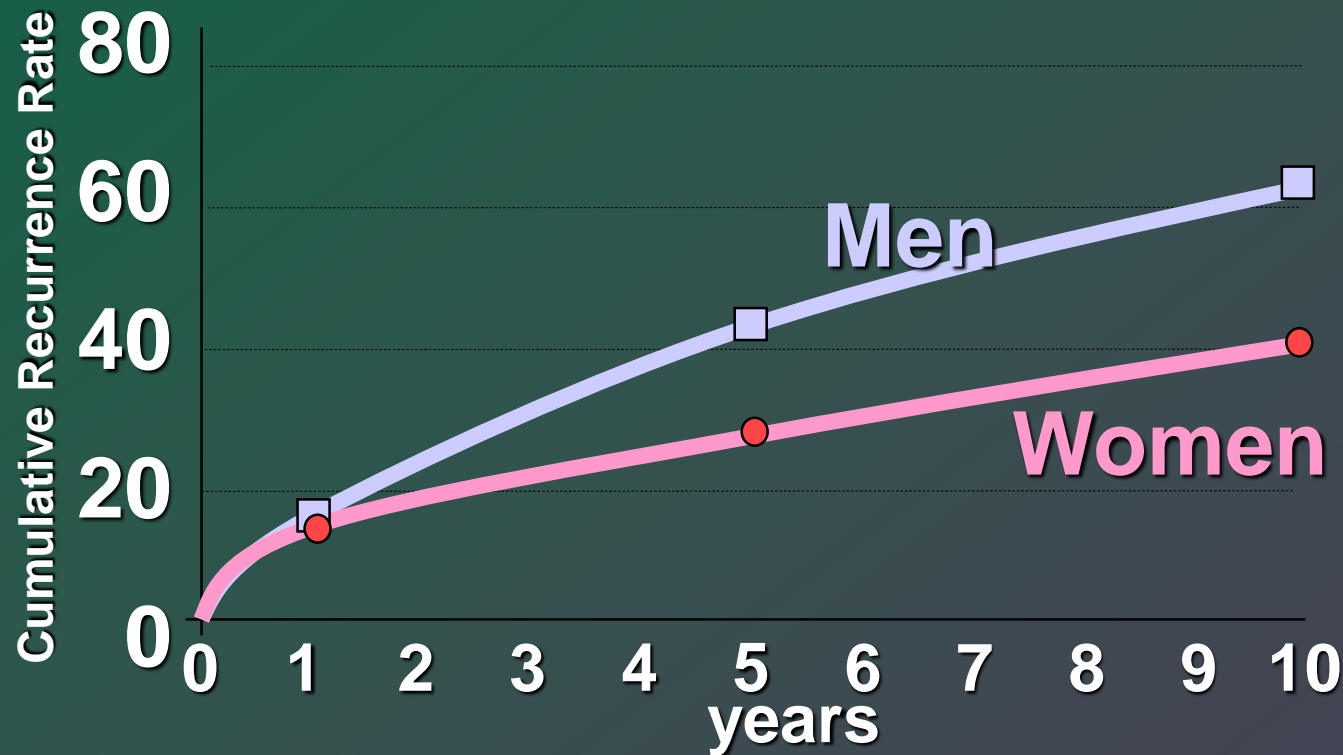


Obesity and Stone Risk



Recurrence of Stones

Recurrence rate after first kidney stone

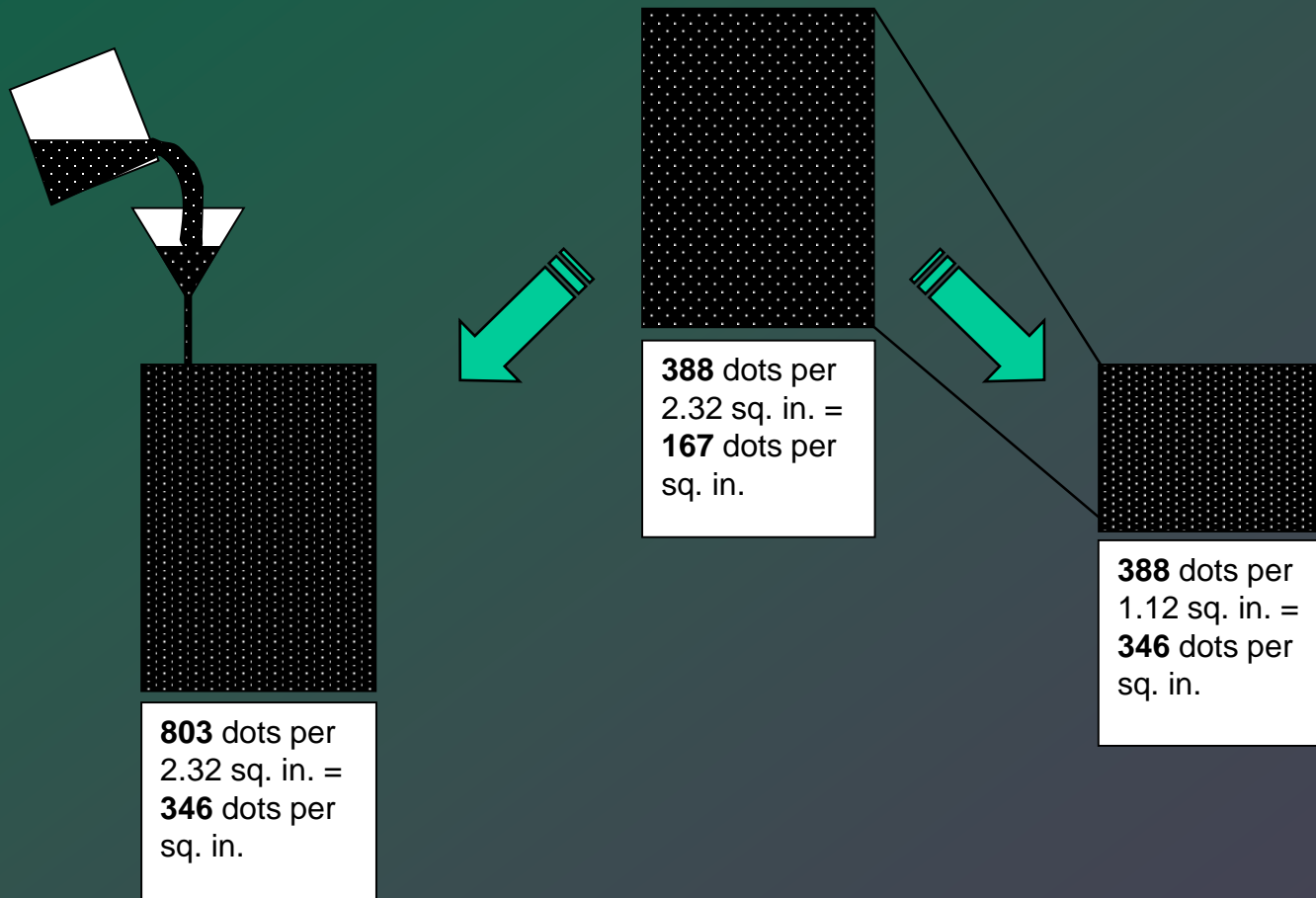


Recurrence 5% per year if untreated

Uribarri, et al, Ann Intern Med 1989; 111;1006

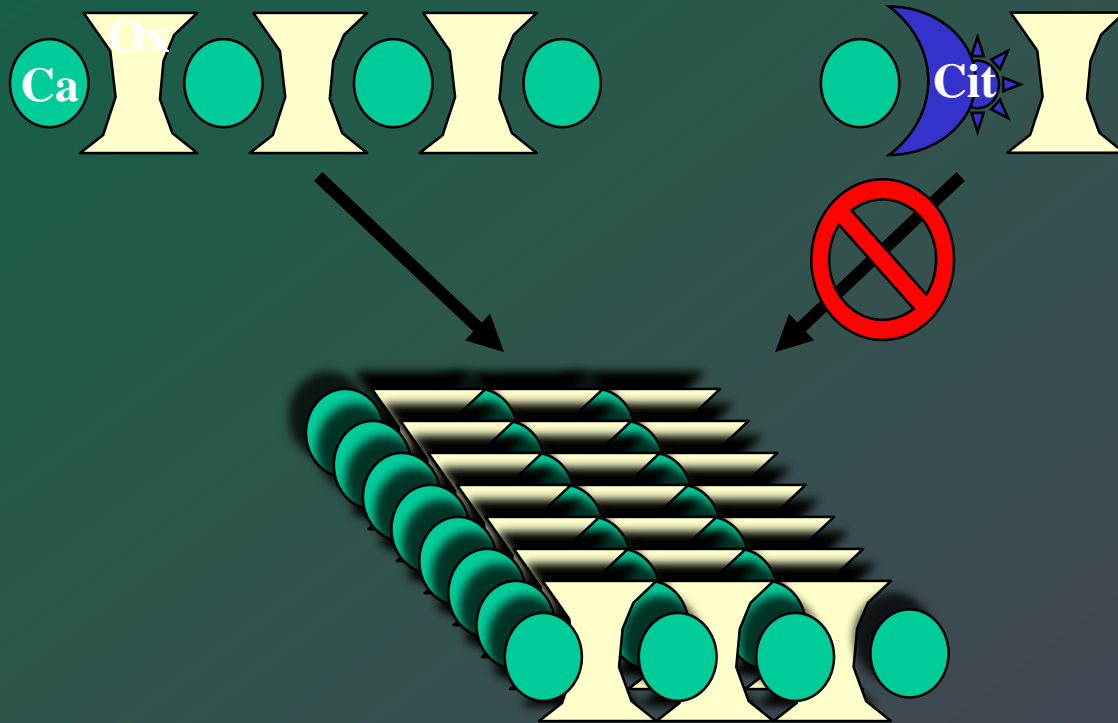
Stone Formation :

SuperSaturated urine



Stone Formation:

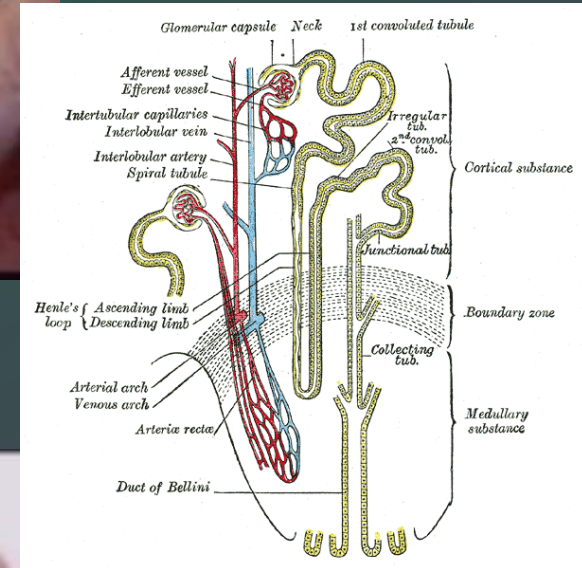
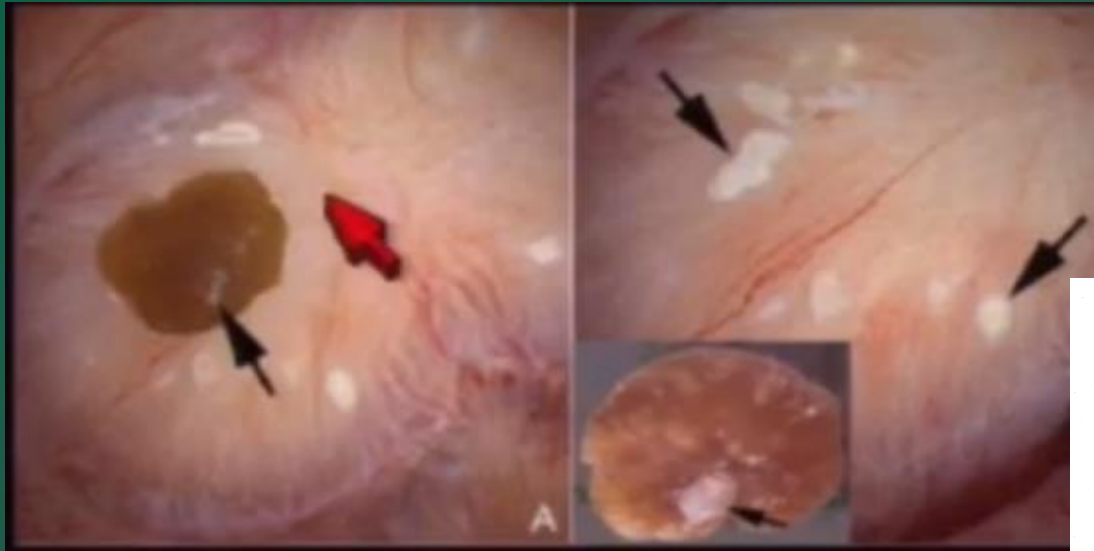
Deficiency of inhibitors



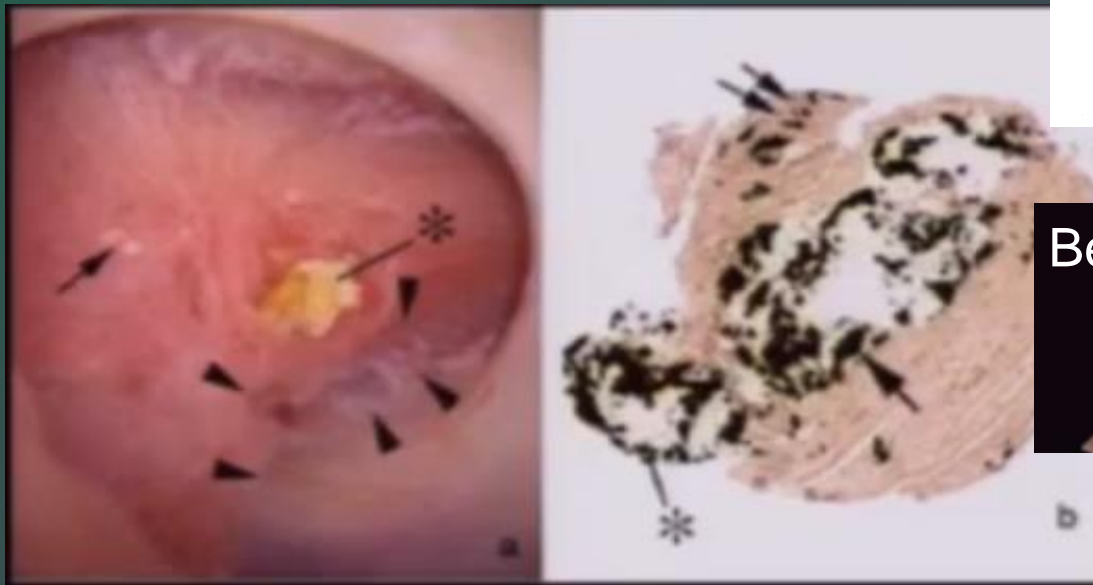
Inhibitors of crystal nucleation, growth and aggregation-

Mg, citrate, macromolecules like glycosaminoglycan, RNA, acidic glycoproteins, Tamm-Horsfall protein, nephrocalcin, uropontine

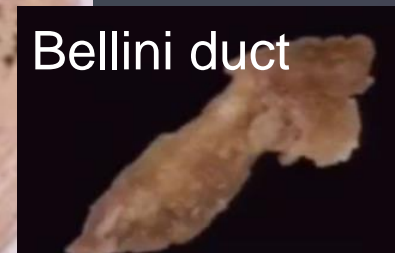
Papillary Interstitium



Intraductal



Bellini duct



Types of Kidney Stones

Type	Percentage
1. Calcium stones	70-75
- Calcium Oxalate.....	26
- Calcium Phosphate.....	7
- Calcium oxalate & phosphate.....	37
2. Struvite.....	15-20
3. Uric acid.....	10-15
4. Cystine.....	1
5. Carbonate Apettite	

Rare types of stones: Xanthine, Oxypurinol, triamterene, indinavir, ephedrine, matrix stones.

Evaluation

Lab Studies

- Stone analysis
- Blood profile
- 24 hr Urine metabolic evaluation:
 - **Metabolic abnormalities in 96%** (Levy et al)
- Urine Microscopy - crystals
- Imaging:
 - CT scan with stone protocol (most sensitive and specific)
 - US kidney

Evaluation

24-Hour Urine Testing

- Volume
- Calcium
- Sodium
- Citrate
- pH
- Oxalate
- Uric Acid
- Potassium
- Creatinine
- Urea Nitrogen
- Sulfate
- Ammonia
- Phosphorus

SuperSaturation calculation

SS CaOx

SS CaP

SS UA

Urinary Risk factors for Calcium Stone Formation

• Low U Vol	> 70-90%
• Hypercalciuria	40-75%
• Hypocitraturia	10-50%
• Hyperuricosuria	30%
• Idiopathic	20%
• Hyperoxaluria	5%

Kidney Stones

Treatment

- Acute Renal colic – ER/PCP/Urology
 - Stone <4 mm: Pain Control and Fluids
 - Stone >5 mm: Obstruction OR infection: Urologic Intervention
- Currently Asymptomatic: Chronic Recurrent Disease:
 - Identify risk factors
 - Medical Rx for Prevention of recurrent stones
 - Int Medicine /FM/ Nephrology

Medical Management

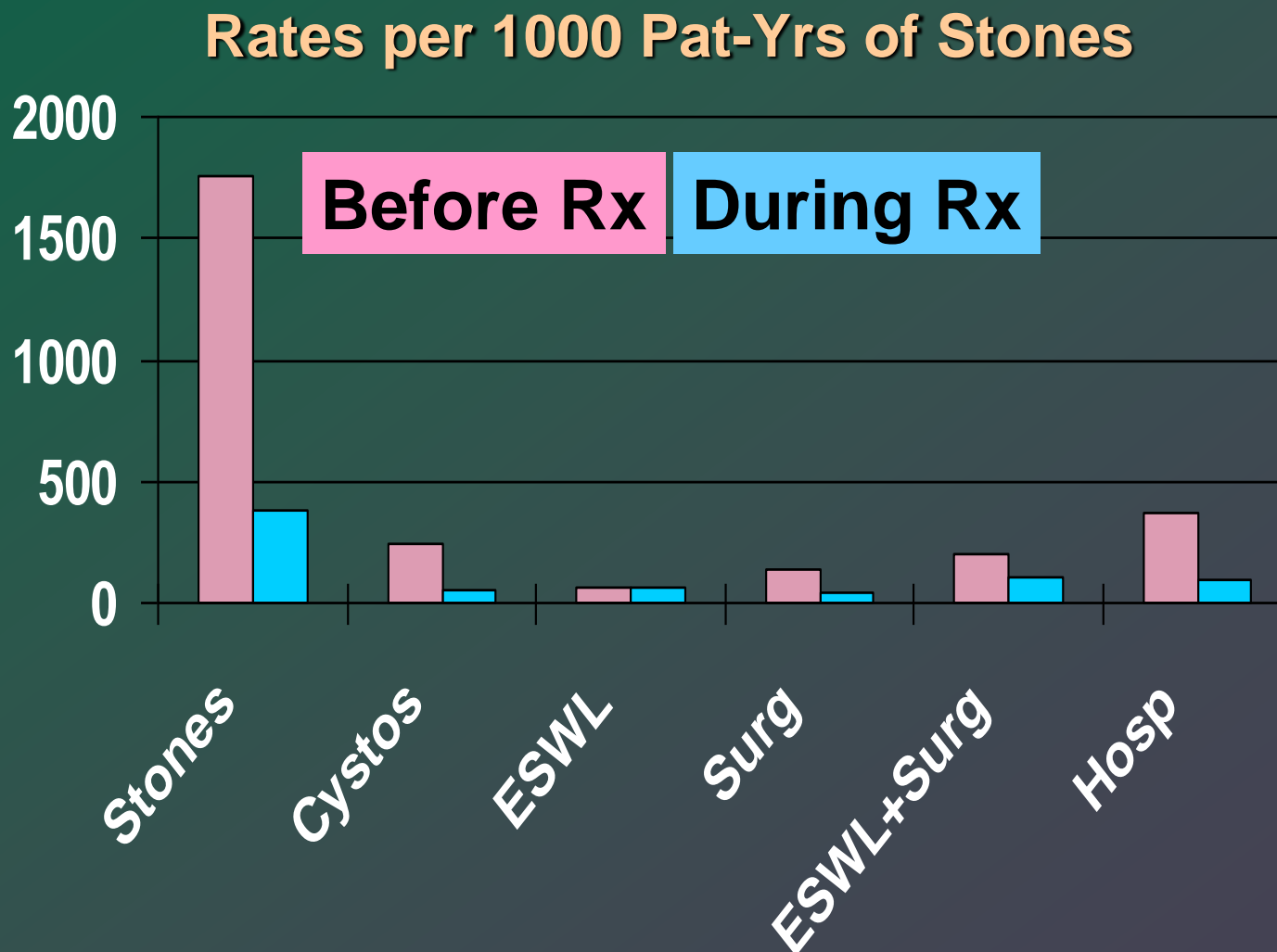
Myths about Kidney stone treatments

- Dr Google
 - Advice from friends and relatives
 - Advice from physicians unaware of Rx
 - Myth- Not to drink milk if stone is made of calcium
 - Kidney stone cleanser, herbals etc
-

Truth is:

“Treatment advice should be personalized to specific metabolic risk factors”

Before and During Medical Treatment



Data from Parks & Coe, 1996. University of Chicago

Urine volume:

Concentrated Urine

27 WM, obese. 2 visits to ER for renal colic. CT abd shows 2-3 mm Non-obstructing stones. Stone analysis not available. Has not needed any urology procedures. Significant family history of kidney stones.

Stone Risk Factors / Cystine Screening: Negative (07/12/2018)										
DATE	SAMPLE ID	Vol 24	SS CaOx	Ca 24	Ox 24	Clit 24	SS CaP	pH	SS UA	UA 24
07/10/18	S25620370	0.77	11.05	74	50	525	0.65	5.756	2.49	0.637
07/09/18	S25620369	0.81	8.19	93	33	404	0.41	5.385	3.49	0.542
REFERENCE RANGE		0.5 - 4L	6 - 10	male <250 female <200	20 - 40	male >450 female >550	0.5 - 2	5.8 - 6.2	0 - 1	male <0.800 female <0.750

Dietary Factors										
DATE	SAMPLE ID	Na 24	K 24	Mg 24	P 24	Nh4 24	Cl 24	Sul 24	UUN 24	PCR
07/10/18	S25620370	115	49	76	0.733	53	130	38	10.34	0.9
07/09/18	S25620369	114	48	84	0.822	58	137	43	10.25	0.8
REFERENCE RANGE		50 - 150	20 - 100	30 - 120	0.6 - 1.2	15 - 60	70 - 250	20 - 80	6 - 14	0.8 - 1.4

Normalized Values						
DATE	SAMPLE ID	WEIGHT	Cr 24	Cr 24/Kg	Ca 24/Kg	Ca 24/Cr 24
07/10/18	S25620370	97.5	1541	15.8	0.8	48
07/09/18	S25620369	97.5	1580	16.2	0.9	59
REFERENCE RANGE			male 11.9-24.4 female 8.7-20.3		<4	male 34-196 female 51-262

Low Urine Volume: Concentrated urine

- **Definition:** Urine output < 1 Lt per day
- **Goal:** Urine output > 2.5 Lt per day and decrease supersaturation of urine
- **Etiology:**
 - Chronic diarrhea, Colon resection
 - Excessive sweating, warm climate, foundry/factory work in high temperatures
 - Habitual low fluid intake. Decreased thirst.
 - Work limitations

Low Urine Volume: Concentrated urine

- **Recommendations:**

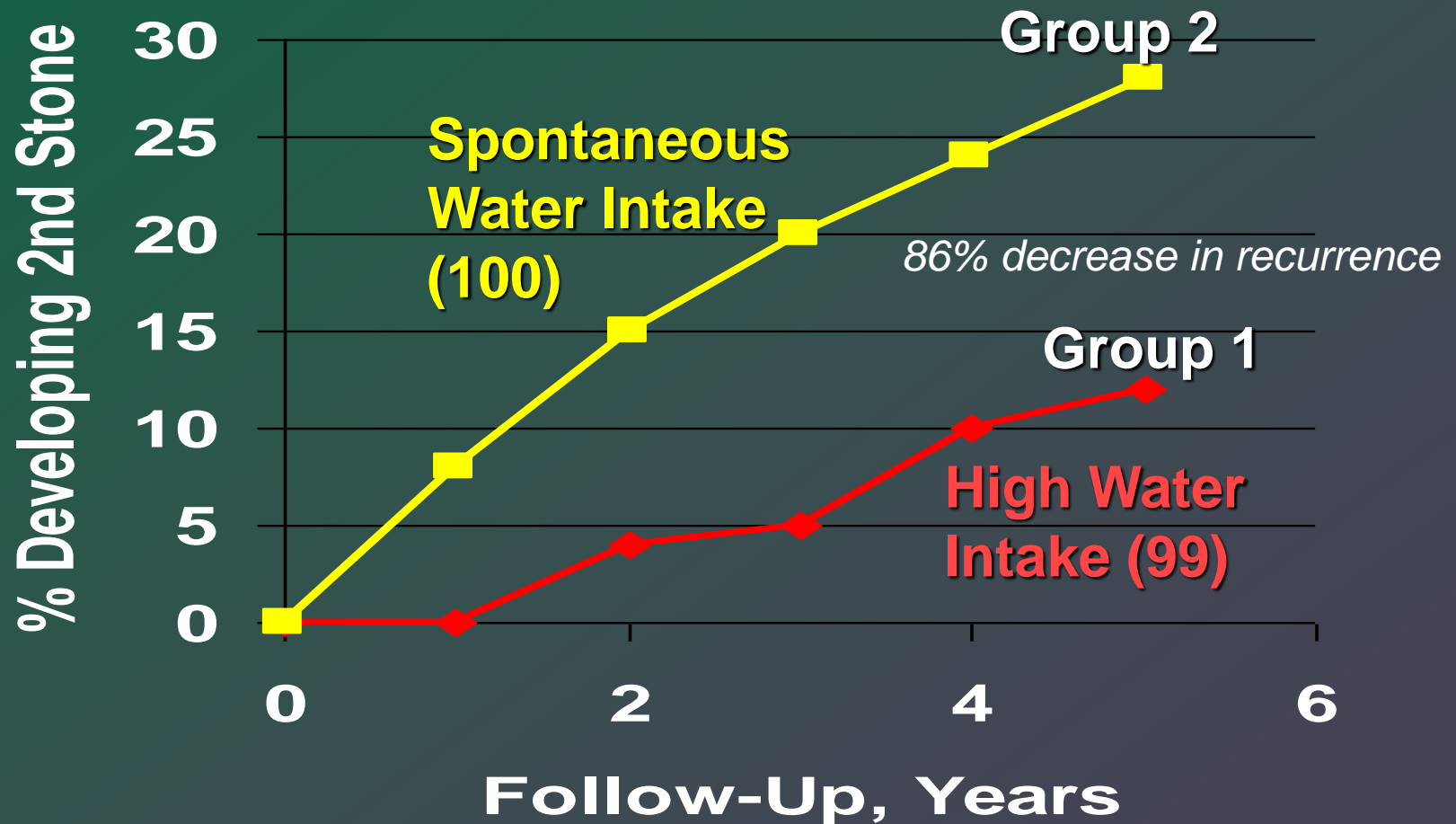
- Drink 16 Oz water every 2.5 to 3 hrs. Goal 100 Oz fluid/day.
- “Drink water Reminder” app
- Type of fluid: Best- water/flavored water.
- Avoid sugar containing beverages/juices.
- Coffee, Tea, Alcohol in moderation. Too much caffeine can cause HyperCalciuria
- Cranberry juice- no studies to support its use in stone prevention

Urine Volumes in Kidney Stone Patients



(Borghi, L. et al, J Urology 1996)

Effect of Increased Water on Stone Recurrence



(Borghi, L. et al, J Urology 1996)

Urine Calcium: **HyperCalciuria**

34 yrs WM. H/O kidney stones since 2006. Recently presented with obstructing left ureteral stone, L hydronephrosis and needed Left Ureteroscopy and laser Lithotripsy.

Stone analysis: CaOx 80%, CaP 20%.

Stone Risk Factors / Cystine Screening: Negative (04/26/2018)

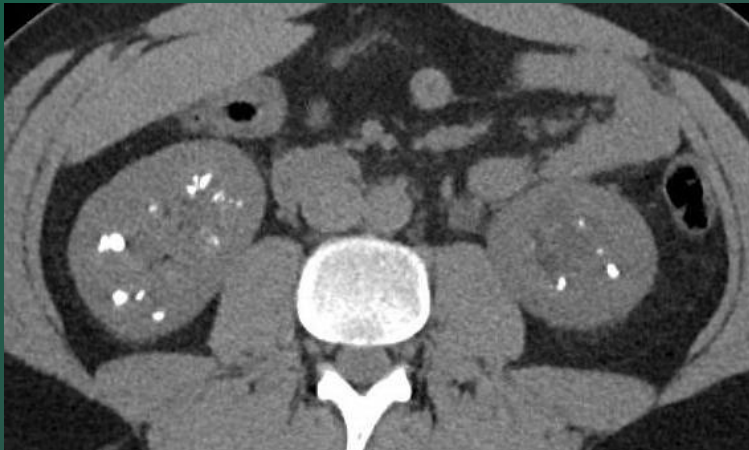
DATE	SAMPLE ID	Vol 24	SS CaOx	Ca 24	Ox 24	Cit 24	SS CaP	pH	SS UA	UA 24
07/06/18	S25597671	2.62	5.56	394	41	520	2.05	6.240	0.43	0.904
07/05/18	S25597670	2.69	3.79	316	28	658	1.68	6.459	0.23	0.786
04/24/18	S25542353	2.34	4.51	286	27	316	1.62	6.313	0.40	0.843
REFERENCE RANGE		0.5 - 4L	6 - 10	male <250 female <200	20 - 40	male >450 female >550	0.5 - 2	5.8 - 6.2	0 - 1	male <0.800 female <0.750

Dietary Factors

DATE	SAMPLE ID	Na 24	K 24	Mg 24	P 24	Nh4 24	Cl 24	Sul 24	UUN 24	PCR
07/06/18	S25597671	176	88	274	1.581	61	180	74	15.07	1.1
07/05/18	S25597670	179	71	206	1.013	37	192	34	12.81	0.9
04/24/18	S25542353	112	47	163	0.976	50	119	43	11.94	0.9
REFERENCE RANGE		50 - 150	20 - 100	30 - 120	0.6 - 1.2	15 - 60	70 - 250	20 - 80	6 - 14	0.8 - 1.4

Normalized Values

DATE	SAMPLE ID	WEIGHT	Cr 24	Cr 24/Kg	Ca 24/Kg	Ca 24/Cr 24
07/06/18	S25597671	106.6	3456 *	32.4	3.7	114
07/05/18	S25597670	106.6	2036	19.1	3.0	155
04/24/18	S25542353	106.6	2196	20.6	2.7	130



HyperCalciuria

- **Definition:** 200 mg/day (risk is continuous)
- **Goal:** U Calcium < 150 mg/day
- **Risk Factor:** seen in 40-75% cases
- **Etiology:**

A. With hypercalcemia

Hyperparathyroidism

Granulomatous diseases

Hyperthyroidism

Malignancies, Immobilization

B. Without Hypercalcemia

High salt intake, High protein intake,

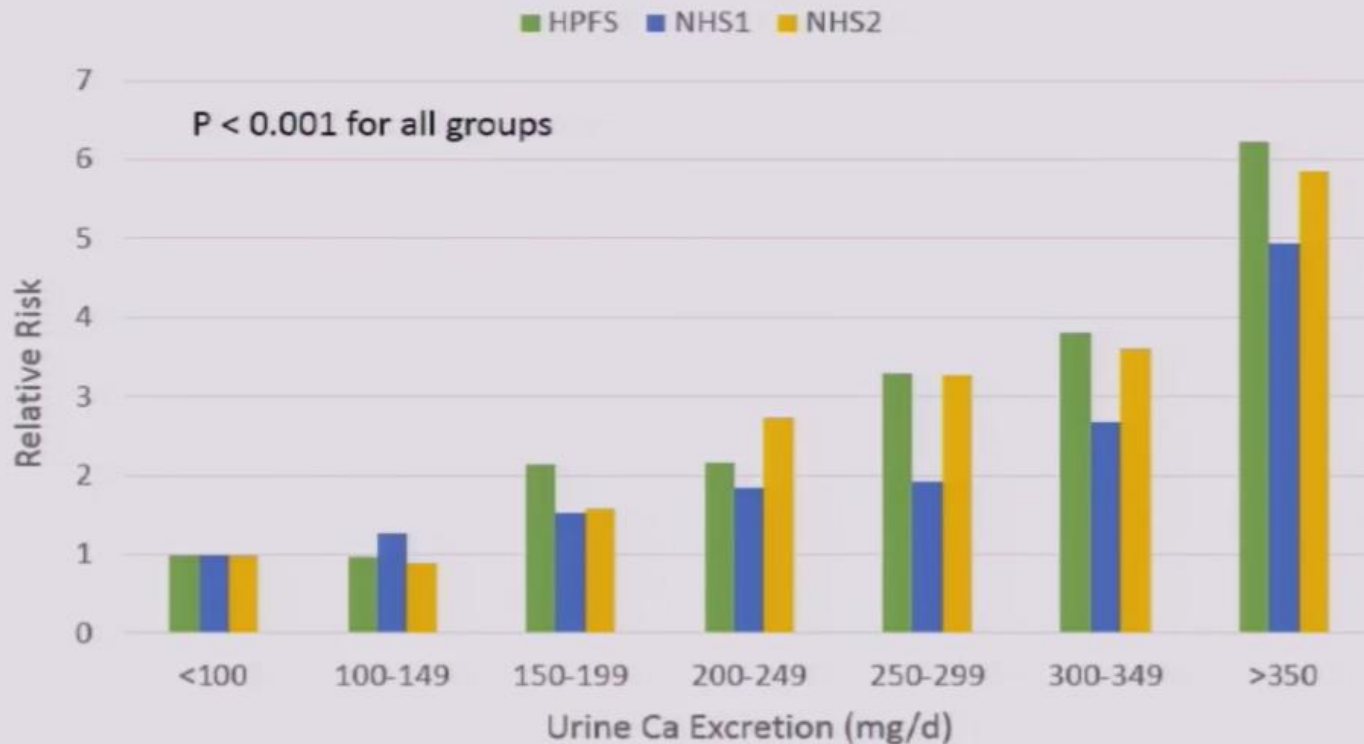
Excess Refined sugar, Caffeine in excess

Type 1 RTA

Idiopathic Hypercalciuria (most common)

U Calcium and Risk for Ca Kidney stones

Incident Stone Risk in Relation to Urine Ca



Curhan GC and Taylor EN *Kidney Int* 73:489, 2008

Refined sugars and U Calcium

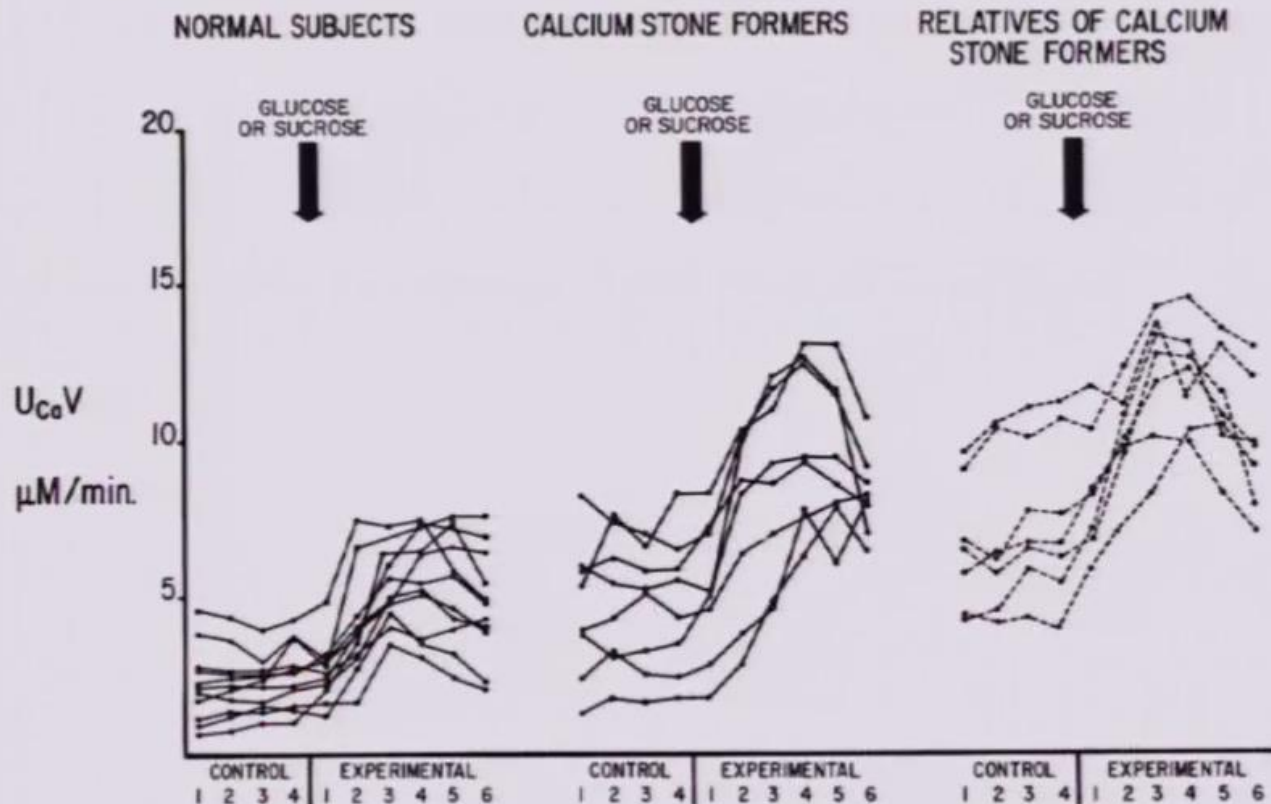


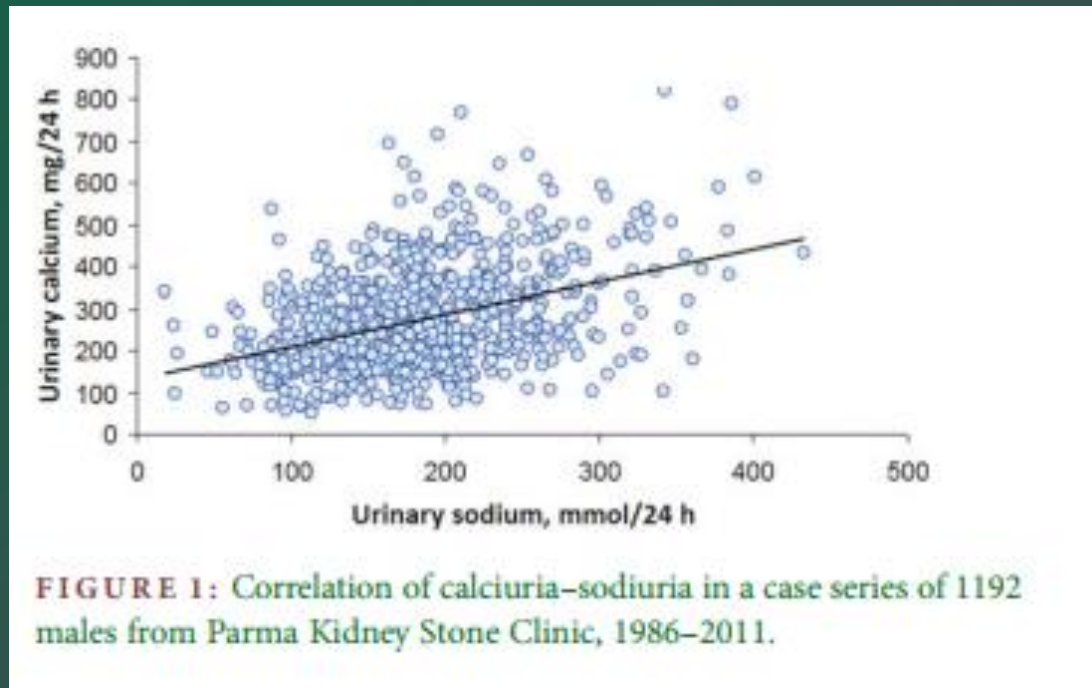
FIGURE 2. Urinary Calcium Excretion Rates during Control Clearance Periods and during Periods after Ingestion of 100 Gm of Glucose or Sucrose in Normal Subjects, Patients and Relatives of Patients. Each clearance period (numbered on the abscissa) was of 20 minutes' duration.

Sucrose intake and Risk of stone formation

Median sucrose intake gm/d	31	40	47	54	66
No. of stones	210	209	263	223	318
RR	1.00	1.01	1.25	1.0	1.31

Curhan GC et al. Arch Int Med 2004;164:885-891

Urine Sodium and Urine Calcium



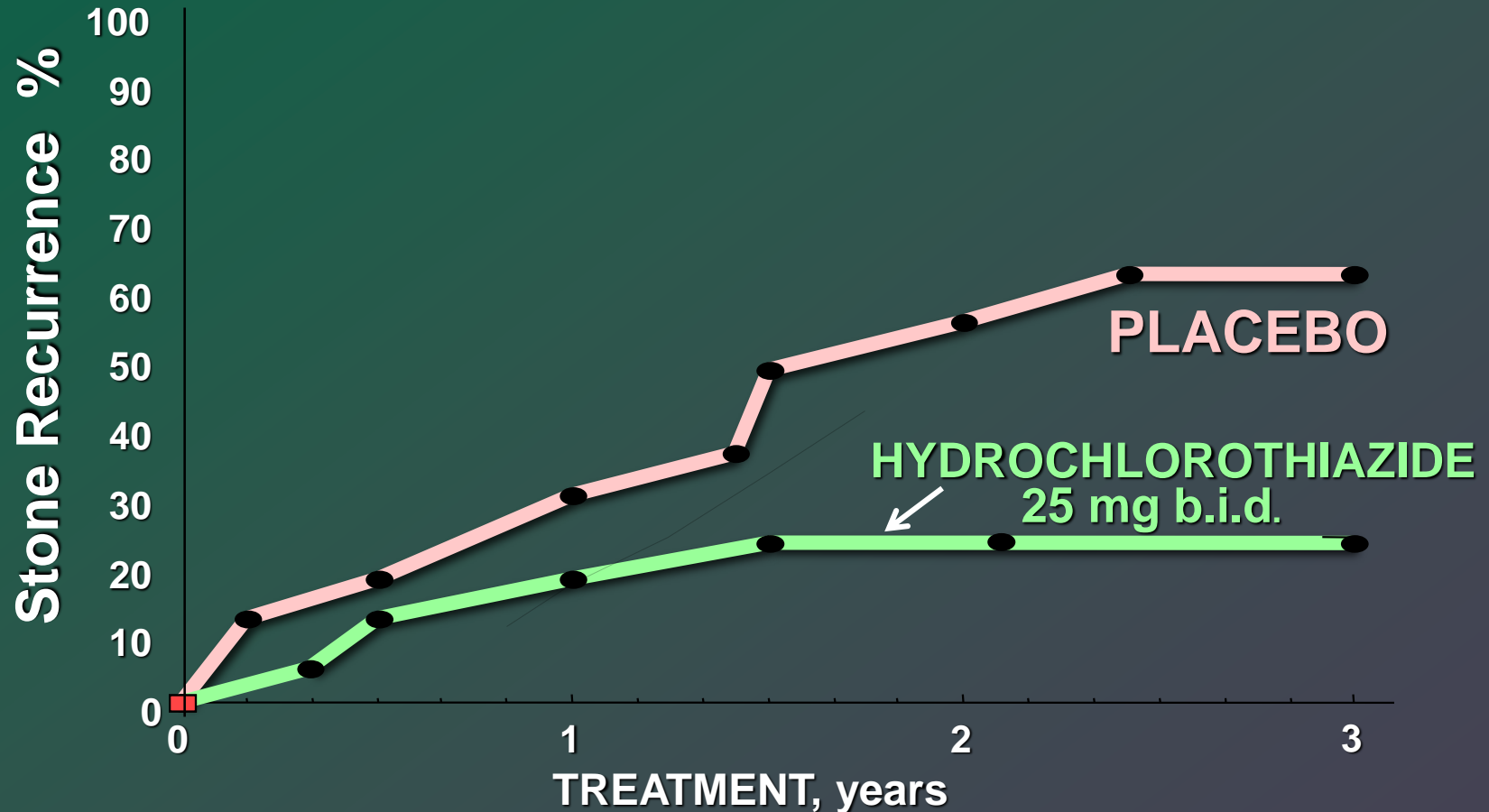
For every additional 100 mmol Na,
U Ca increases by 140 mg in Idiopathic
Hypercalciuria

Salt and Nephrolithiasis.
Nephrol Dial Trans, 2016,
31: 39-45

Hypercalciuria: Treatment

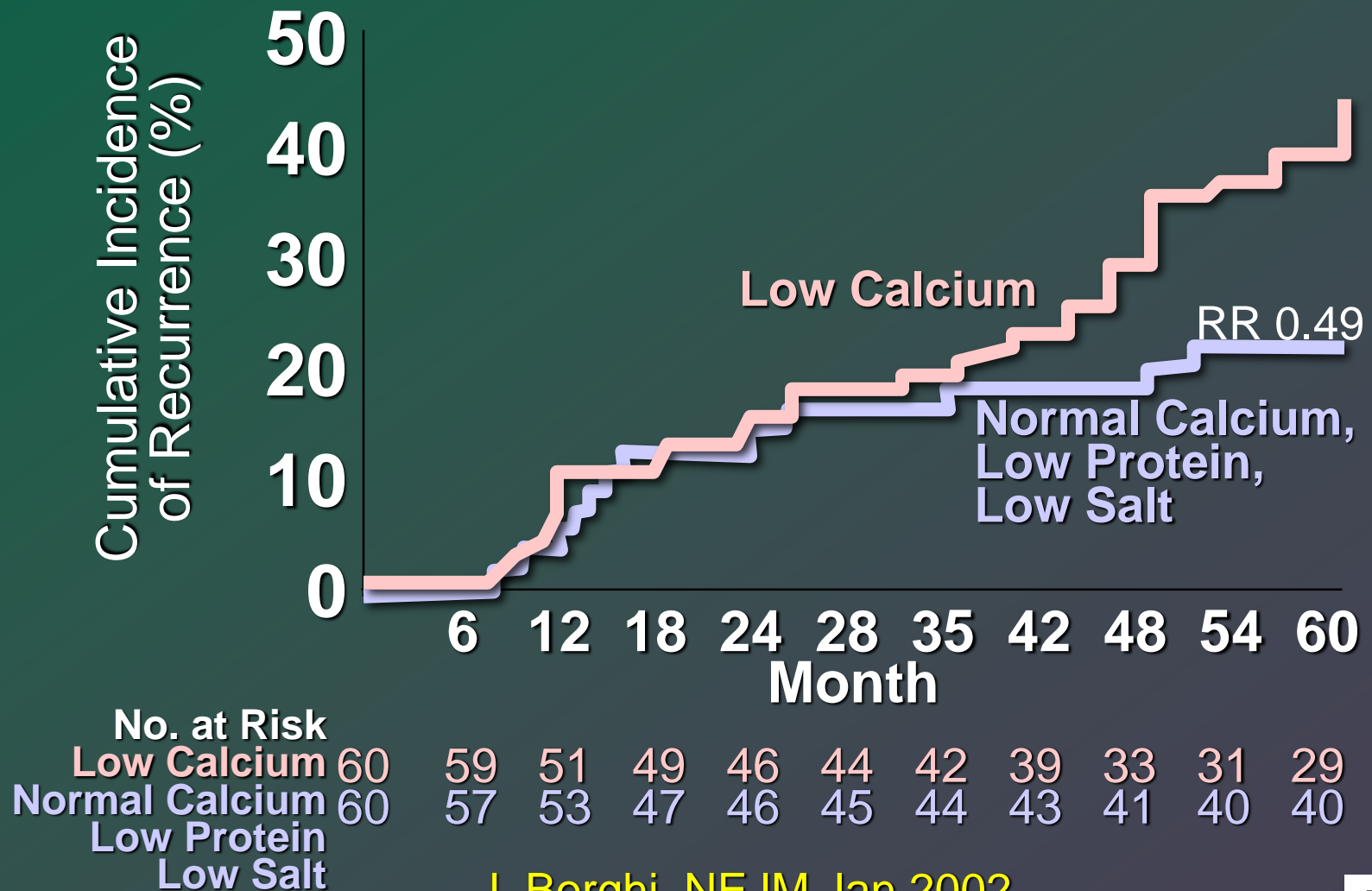
1. Urine output >2.5 L/day
2. Low salt diet 2 gm Sodium \sim (24 hr U Na <100 mmol)
3. Chlorthalidone 25-50 mg qd or HCTZ 25 mg bid or Indapamide (\downarrow Urine Ca by 40-60%)
4. Avoid Hypokalemia
(causes Hypocitraturia and Hypercalciuria)
5. Maintain normal Ca diet
6. Avoid refined sugars
7. Dietary protein 1 gm/kg/day

Hypercalciuria: Thiazides & Stone Recurrence



Laerum & Larsen, Acta Med Scand 1984

Hypercalciuria: Recurrent Stones According to Diet



L Borghi, NEJM Jan 2002

Urine Oxalate: **HyperOxaluria**

HyperOxaluria

- **Definition:** U Oxalate > 40 mg/d (> 20% of U Ca) –Risk is continuous
- **Goal:** < 40 mg (Ideally < 25 mg/d)
- **Risk Factor:** seen in < 5% cases
- **Etiology:**
 - Enteric hyperoxaluria (Malabsorption, Bariatric surgery principally Roux-en-Y, Crohn's, small bowel resection, Irritable bowel, Celiac, lactose intolerance)
 - Low dietary Ca
 - Oxalate rich food- chocolate, cocoa, spinach, nuts, starfish fruit
 - Ascorbic acid (6-13 mg U Oxalate for every 1 g Vit C above 500 mg)
 - Alteration in GI flora- abx, Cystic fibrosis – loss of Oxalobacter formigenes which degrades oxalates
 - Primary HyperOxaluria –enzyme def – overproduction of oxalates

HyperOxaluria

Treatment:

1. Urine Output > 2.5 L
2. Low oxalate diet: 100-200 mg Oxalate/day
3. Avoid ascorbic acid or (upto 90 mg)
4. Dietary Calcium(1000-1200 mg)
5. Low sodium diet
6. Probiotics with antibiotics
7. Rx of Malabsorption- Cholestyramine, Tums with food
8. Treatment of Crohn's, Celiac, short gut.

Urine Citrate:
Inhibitor of Kidney stones

HypoCitraturia

19 yr old OSU sophomore student, seen after 1 st kidney stone episode needing URS with HLL. He missed 4-5 weeks of college. He did not want to suffer more. He has h/o Pseudotumor Cerebri and was on Topamax.

Stone Risk Factors / Cystine Screening: Negative (06/10/2016)										
DATE	SAMPLE ID	Vol 24	SS CaOx	Ca 24	Ox 24	Cit 24	SS CaP	pH	SS UA	UA 24
11/23/18	S25617788	3.31	1.85	114	31	436	0.43	6.389	0.22	0.768
10/15/17	S25387470	2.86	3.11	215	30	303	0.50	5.838	0.92	0.958
04/18/17	S25214666	2.79	3.43	215	30	301	0.46	5.846	0.90	0.922
11/25/16	S22111720	2.40	4.57	235	36	387	0.56	5.764	1.19	0.938
08/12/16	S20451874	4.03	3.67	222	43	279	0.62	6.438	0.13	0.617
06/08/16	S19188124	4.70	2.43	293	33	<70	1.18	6.727	0.10	1.025
06/07/16	S19188123	2.76	5.94	398	37	<41	2.72	6.903	0.12	1.125
REFERENCE RANGE		0.5 - 4L	6 - 10	male <250 female <200	20 - 40	male >450 female >550	0.5 - 2	5.8 - 6.2	0 - 1	male <0.800 female <0.750
Dietary Factors										
DATE	SAMPLE ID	Na 24	K 24	Mg 24	P 24	Nh4 24	Cl 24	Sul 24	UUN 24	PCR
11/23/18	S25617788	174	81	58	1.013	52	182	48	13.74	1.1
10/15/17	S25387470	198	60	104	1.385	68	198	55	16.59	
04/18/17	S25214666	169	46	113	1.145	55	150	59	14.24	1.2
11/25/16	S22111720	231	61	106	1.348	68	242	68	16.98	1.4
08/12/16	S20451874	174	25	102	0.853	61	155	39	13.29	1.1

Hypocitraturia

- **Definition:** U Citrate < 350 mg (Risk is continuous)
- **Goal:** U Citrate > 600-800 mg
- **Risk factor:** in 10-50% cases
- **Etiology:**
 - Diarrhea
 - Hypokalemia
 - Metabolic acidosis
 - Medications-(Carbonic anhydrase Inhibitor) Topamax, Diamox, Zonisamide, HIV meds (PI)
 - High protein diet
 - Type 1 RTA (Distal)- complete/incomplete

Hypocitraturia

- **Treatment:**

- U Vol > 2.5 L/day
- Discontinue offending agent
- Alkali supplement promotes tubular excretion of Citrate
- Normal protein diet
- Normalize Serum Bicarb
- Treat Hypokalemia

Hypocitraturia

- **Treatment:**

- Will need 60-80 meq of alkali:

- Pot Citrate 20 meq PO TID with food
 - Crystal light 1 pack = 10 meq alkali
 - Litholyte 1 pack = 10 meq citrate
 - 1 lt of Diet 7 UP = 10 meq citrate
 - Sod Bicarb 650 mg Tab = 7.7 meq Alkali
 - (Caution about Na -Can lead to high U Ca)
 - Baking soda 1 Teaspoon = 53 meq Alkali



potassium citrate (5 mEq),
sodium bicarbonate (2.5 mEq)
magnesium citrate (2.5 mEq)



High U Sodium
Leads to High U Ca

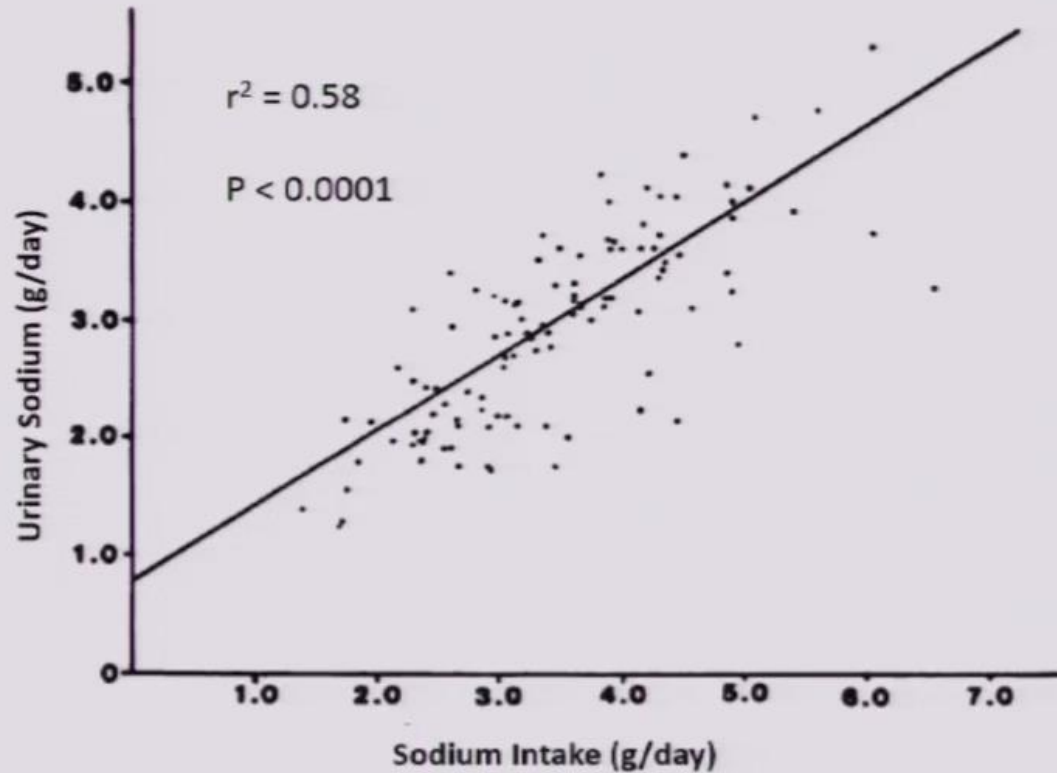
46 yrs old WM, H/O Kidney stones since 2014, needing 3 urology procedures. CaOx stones.

Stone Risk Factors / Cystine Screening: Negative (06/08/2018)										
DATE	SAMPLE ID	Vol 24	SS CaOx	Ca 24	Ox 24	Cit 24	SS CaP	pH	SS UA	UA 24
06/06/18	S25544504	1.74	9.02	351	41	801	0.42	5.301	1.26	0.382
06/05/18	S25544503	1.77	10.47	257	56	786	0.58	5.627	1.32	0.624
REFERENCE RANGE		0.5 - 4L	6 - 10	male <250 female <200	20 - 40	male >450 female >550	0.5 - 2	5.8 - 6.2	0 - 1	male <0.800 female <0.750

Dietary Factors										
DATE	SAMPLE ID	Na 24	K 24	Mg 24	P 24	Nh4 24	Cl 24	Sul 24	UUN 24	PCR
06/06/18	S25544504	310	81	112	1.067	50	346	59	13.80	1.0
06/05/18	S25544503	249	85	94	1.046	45	263	64	16.50	1.2
REFERENCE RANGE		50 - 150	20 - 100	30 - 120	0.6 - 1.2	15 - 60	70 - 250	20 - 80	6 - 14	0.8 - 1.4

Normalized Values										
DATE	SAMPLE ID	WEIGHT	Cr 24	Cr 24/Kg	Ca 24/Kg	Ca 24/Cr 24				
06/06/18	S25544504	104.3	1941	18.6	3.4	181				
06/05/18	S25544503	104.3	1877	18.0	2.5	137				
REFERENCE RANGE				male 11.9-24.4 female 8.7-20.3	<4	male 34-196 female 51-262				

U Na as a marker of Dietary Na



Holbrook JT Am J Clin Nutr 40:786, 1984

High U Sodium

- **Definition:** U Na > 100 meq (2300 mg)/day
- **Goal:** U Na < 100
- **Etiology:** In steady state 24 hr urine sodium represents dietary sodium intake
- **Risk:** High U Na increases U Calcium
- **Treatment:**
 - Low salt diet ~ 2 gm sodium per day
 - Check Nutrition labels
 - Check online sodium content of food
 - Avoid processed food, Canned food, lunch meats etc

High Protein Intake:

High U Ca
Low U Citrate
High U Uric acid

Case 3

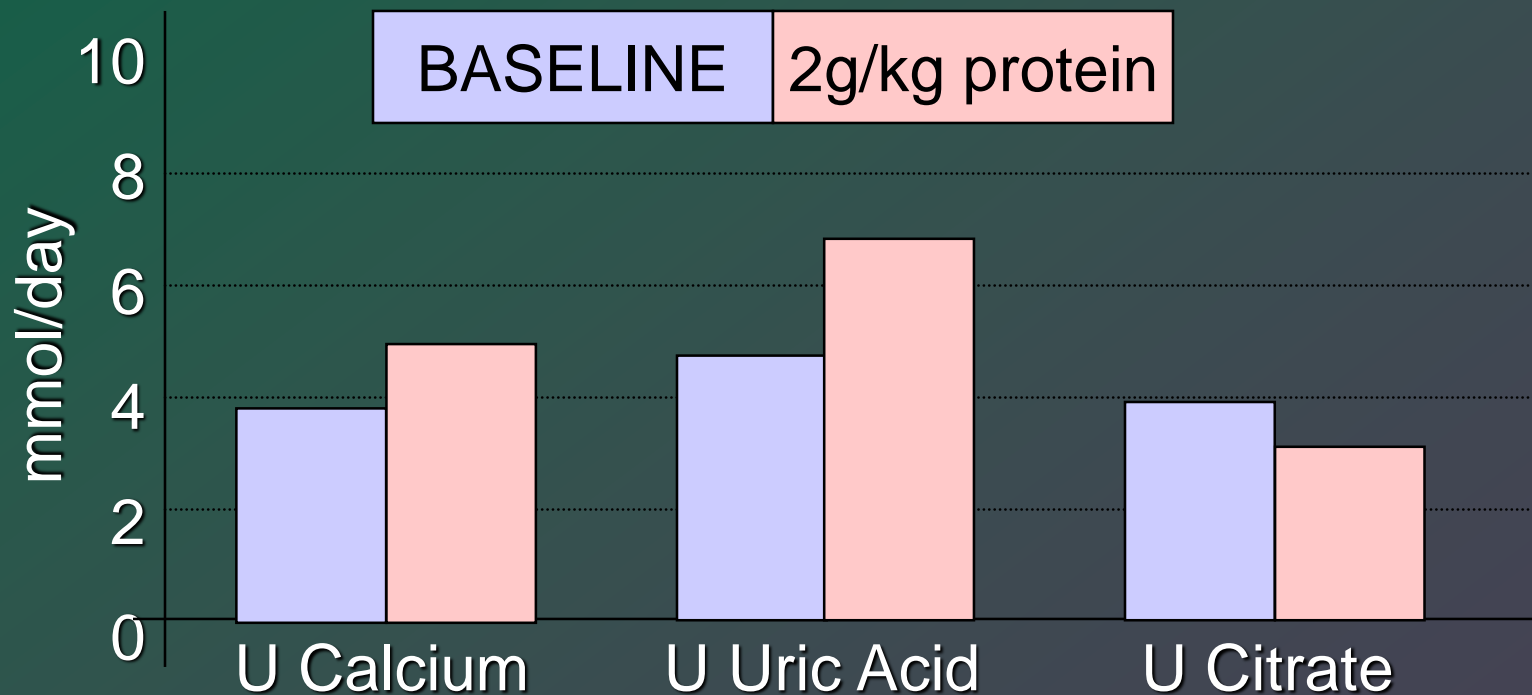
44 yo man with recurrent kidney stones

Stone Risk Factors / Cystine Screening: Negative (09/07/2007)

DATE	SAMPLE ID	Vol 24	SS CaOx	Ca 24	Ox 24	Cit 24	SS CaP	pH	SS UA	UA 24
10/31/07		4.21	4.21	409	53	542	0.54	5.748	1.48	1.976
09/05/07		4.49	4.39	545	55	774	1.42	6.206	0.54	1.806

DATE	SAMPLE IC	Na 24	K 24	Mg 24	P 24	Nh4 24	Cl 24	Sul 24	UUN 24	PCR
10/31/07		353	142	112	2.294	107	337	126	35.13	1.9
09/05/07		342	229	177	2.449	92	387	140	29.73	1.7

Protein Load Increases Urine Stone Forming Tendency



J Clin Endocrinol Metab 1990;71:861

High protein intake

- **Definition:** Protein intake > 1.3 gm/kg/day, Sulfate > 70
- **Goal:** Protein intake < 1 gm/kg/d and Sulfates < 70
- **Risk:** HyperCalciuria, HypoCitraturia, HyperUricosuria
- **Recommendations:**
 - Decrease animal protein and substitute with plant protein
 - Protein intake ~ 1 gm/kg/day
- **Monitor:** U Sulfates, U PCR, U Ammonia

Non Calcium stones

Uric Acid

Cystine

Infection – Triple phosphate - Carbonate

Non Calcium kidney stones

Uric Acid Stones

36 yrs WF, diagnosed with Staghorn kidney stone
needing PNCL.
Stone Analysis: Uric acid 90%, CaOx 10%

Stone Risk Factors / Cystine Screening: Negative (07/06/2018)										
DATE	SAMPLE ID	Vol 24	SS CaOx	Ca 24	Ox 24	Cit 24	SS CaP	pH	SS UA	UA 24
07/03/18	S25614026	0.95	12.55	424*	26	1332	0.99	5.001	3.00	0.376
07/02/18	S25614025	1.00	10.78	251*	26	686	0.68	5.146	4.51	0.665
REFERENCE RANGE		0.5 - 4L	6 - 10	male <250 female <200	20 - 40	male >450 female >550	0.5 - 2	5.8 - 6.2	0 - 1	male <0.800 female <0.750

Dietary Factors										
DATE	SAMPLE ID	Na 24	K 24	Mg 24	P 24	Nh4 24	Cl 24	Sul 24	UUN 24	PCR
07/03/18	S25614026	97	43	183	1.605	72	84	65	16.48	0.8
07/02/18	S25614025	41	48	129	1.277	53	45	55	13.00	0.7
REFERENCE RANGE		50 - 150	20 - 100	30 - 120	0.6 - 1.2	15 - 60	70 - 250	20 - 80	6 - 14	0.8 - 1.4

Uric acid stones

Account for 10-15% of stones. 60% of Uric acid stones in diabetics

Risk factors-

Uric acid overproduction	Gout, myeloproliferative disorder
Hyperuricosuria >800 mg/day	High protein intake
Persistent acid urine < pH 5.5	Diarrhea, DM, Obesity
Concentrated urine < 1 L	Diarrhea, hot climate

Solubility of uric acid-

Acidic urine - 100 mg/L
At pH 7 – 1600 mg/L

Uric acid stones

Treatment -

Purine rich food restricted

Drink water to make > 2.5 L of urine

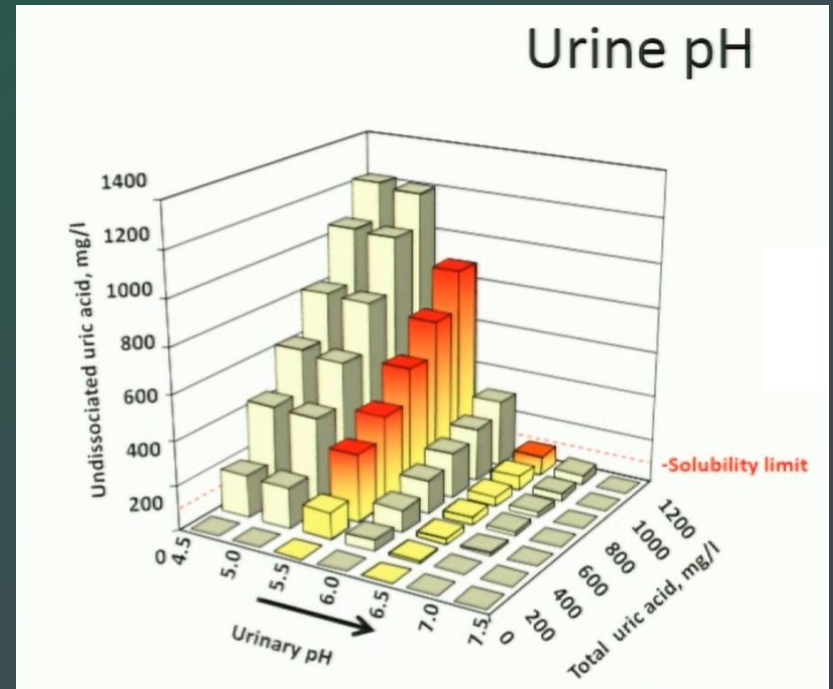
Maintain alkaline urine pH ~ 6.5

K citrate 30-60 meq/d

If urine uric acid > 800 mg/day

Allopurinol

Normalize S Bicarbonate



Vitamin D Intake and Kidney stones

P Ferraro, G Curhan J: Urology: Vol. 197, 405-410, February 2017

Participants: 193,551; Kidney stone incident events: 6,576

Table 3. Supplemental vitamin D intake and risk of kidney stones

	None	Less than 400 IU/Day	400–599 IU/Day	600–999 IU/Day	1,000 or Greater IU/Day	p Value for Trend
HPFS:						
No. cases	1,068	343	426	98	28	
Person-time	333,293	127,922	159,707	38,509	10,057	
Age adjusted HR	1.00 (Ref)	0.87 (0.77, 0.99)	0.91 (0.81, 1.02)	0.85 (0.69, 1.05)	1.12 (0.75, 1.66)	0.66
MV adjusted HR	1.00 (Ref)	0.90 (0.78, 1.04)	1.00 (0.86, 1.15)	0.93 (0.74, 1.18)	1.23 (0.81, 1.86)	0.34
NHS I:						
No. cases	671	250	340	62	8	
Person-time	480,572	214,937	252,492	53,291	9,150	
Age adjusted HR	1.00 (Ref)	0.83 (0.72, 0.96)	0.98 (0.87, 1.12)	0.90 (0.73, 1.12)	0.88 (0.61, 1.26)	0.70
MV adjusted HR	1.00 (Ref)	0.89 (0.76, 1.04)	1.09 (0.94, 1.27)	1.05 (0.83, 1.33)	1.03 (0.71, 1.51)	0.26
NHS II:						
No. cases	1,357	770	635	196	56	
Person-time	624,460	393,051	304,519	86,544	19,761	
Age adjusted HR	1.00 (Ref)	0.85 (0.78, 0.93)	0.92 (0.84, 1.02)	0.96 (0.82, 1.13)	1.18 (0.90, 1.56)	0.76
MV adjusted HR	1.00 (Ref)	0.94 (0.84, 1.04)	1.00 (0.89, 1.13)	1.10 (0.92, 1.32)	1.38 (1.03, 1.85)	0.02

Vitamin D intake in typical amounts was not statistically associated with risk of kidney stone formation.

However, higher risk with higher doses cannot be excluded

Take Home Messages -1

- Common disease causing fair amount of morbidity & large economic burden
- Systemic disease associated with HTN, Obesity, DM, CAD, Metabolic syndrome and bone disease
- Identifying risk factors is important
- Simple treatments –dietary & fluid modifications can slow or prevent stone development
- Increased fluid intake is first line of treatment for stone preventions

Take Home Messages -2

- Considerable variability in urine solute excretion, collection at home and work
- Stone risk increases even when chemistries are in “normal range”
- U chemistry can give insight in patients diet
- U pH is critical in management of Uric acid CaP, Cystine and Infection stones
- SS helps to identify type of stone and provide guidance for treatment

Questions?



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