Pearls of Pediatric Pee: Urinary Tract Infections

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Disclosures

- No relevant commercial relationships to disclose.

Learning Objectives

- At the end of this session, participants should be able to:
  - Recognize the symptoms of cystitis and pyelonephritis and identify the appropriate testing, work-up and treatment of UTI's
  - Identify anatomic and behavioral risk factors for UTIs in the pediatric patient
  - Describe medical and surgical treatment options for anatomic and behavioral risk factors for UTIs in the pediatric patient

Urinary Tract Infection

- Kidney (pyelonephritis)
- Bladder (cystitis)

- Pathogen is typically bacteria
- Rarely fungi or viruses

Origin of Pathogens

- Most common: **retrograde ascent**
- Catheterization
- Hematogenous

UTI's in Pediatric Patients

- Estimated to be 2.4-2.8% of children each year

Symptoms of UTI

- Varies by age
- Infants: fever, vomiting, feeding intolerance, diarrhea, lethargy
- Young children: fever is the most common symptom in pre-potty trained children

Symptoms of UTI

- Older children and adolescents
  - Able to verbalize and localize symptoms
  - Cystitis vs pyelonephritis symptoms

Cystitis: Symptoms

- Dysuria
- Frequency
- Urgency
- Malodorous urine
- Enuresis
- Suprapubic pain
- Gross hematuria
- Low grade temperature

Pyelonephritis: Symptoms

- Infants and Young Children:
  - High grade fever
  - Failure to thrive
  - Irritability
  - Vomiting
- Older children:
  - High grade fever
  - Flank pain and tenderness
  - Nausea/vomiting

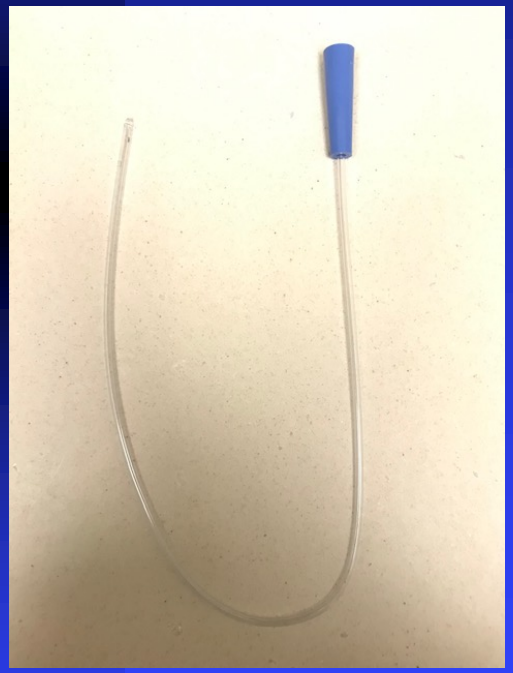
Physical Exam

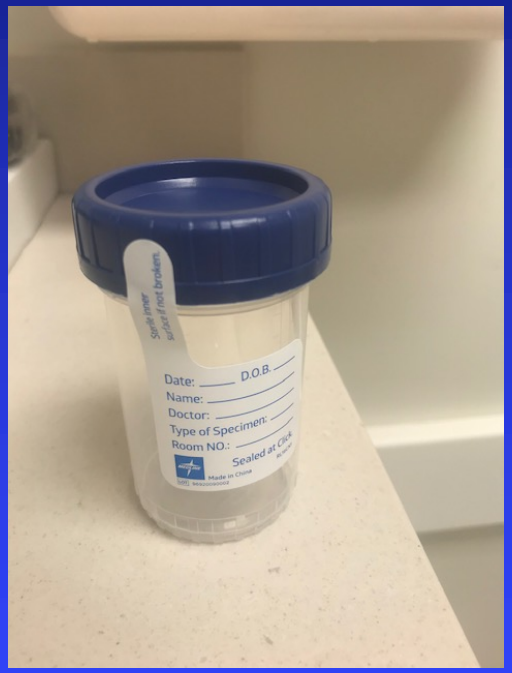
- Abdominal exam:
  - Palpable bladder/urinary retention
  - Palpable kidney
- Flank exam:
  - CVA tenderness
- Genitalia:
  - Phimosis, trauma, meatal stenosis, foreign body

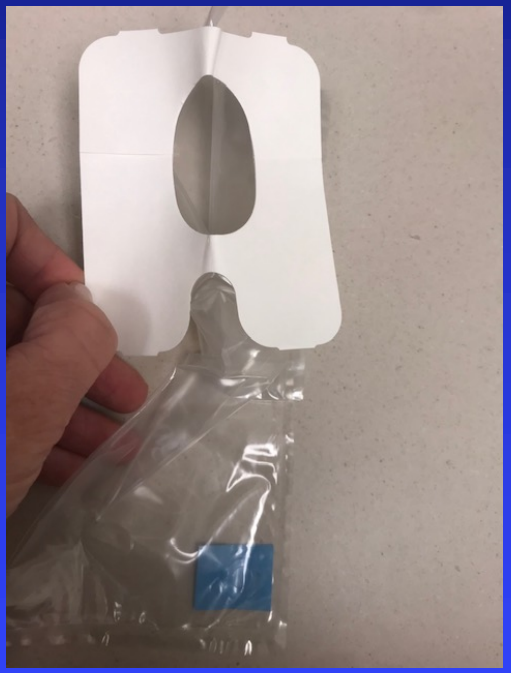
Diagnosis of a UTI: Proper Urine Collection is *Key*

- Infants and non toilet trained children
  - Catherized specimen preferred
  - Bagged specimen not suitable in a febrile infant
  - Supra pubic aspiration
- Toilet trained children
  - Clean catch **midstream** specimen
  - Caution:
    - Girls - contamination from skin and vagina
    - Boys – uncircumcised, retract foreskin

Collection Method

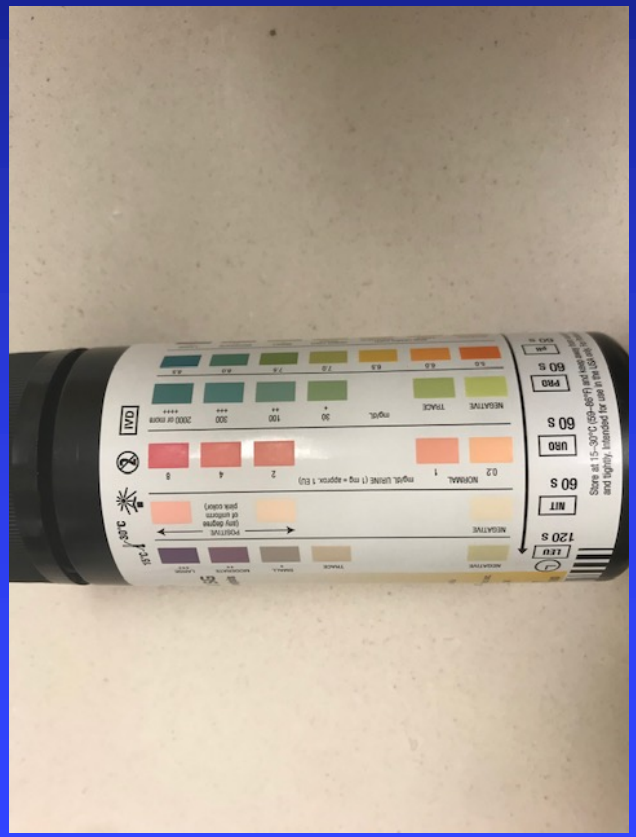






Urine Dip

- Easy, quick, in-office
  - False positive



Microscopic Urinalysis

- Recommended to look for blood, nitrites, leukocyte esterase, white blood cells
- Nitrite/LE suspicious
- Negative UA does not definitely mean no UTI
- Certain bacteria more likely to produce nitrites than others

Urine Culture

- The **GOLD STANDARD** to diagnose a UTI is
  - Urine Culture with sensitivities
- You can **NOT** diagnose a UTI based on:
  - Dipstick or a urinalysis
  - Presumptive based on symptoms

Urine Culture

- Need to collect urine before starting antibiotics
- Even one dose of antibiotic can affect culture results

Interpreting Urine Cultures Three Key Components:

- What organism is growing ?
- How much of the organism is growing?
- What antibiotics are bacteria
- sensitive to?

Colony Count

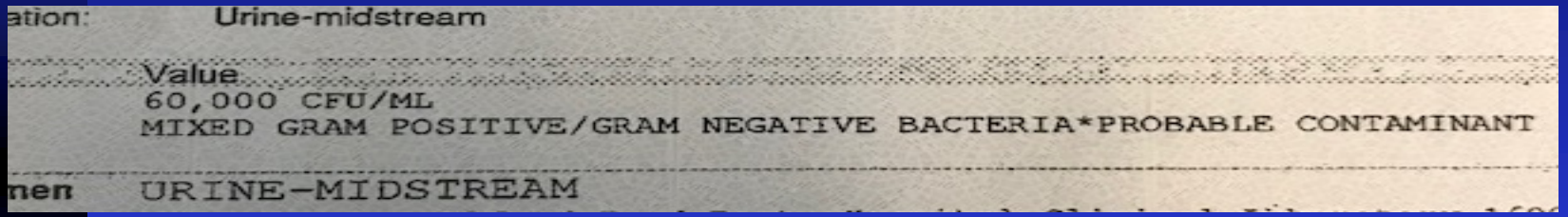
- Controversy over what CFU constitute a UTI
- Varies based on catheterized vs. bagged vs. clean catch

Colony Forming Units

- Suggested colony counts, not absolute
- Consider symptoms
- Can re-collect urine or treat in light of clinical scenario

Colony Forming Units

- Mixed organisms


ation: Urine-midstream

Value
60,000 CFU/ML
MIXED GRAM POSITIVE/GRAM NEGATIVE BACTERIA*PROBABLE CONTAMINANT

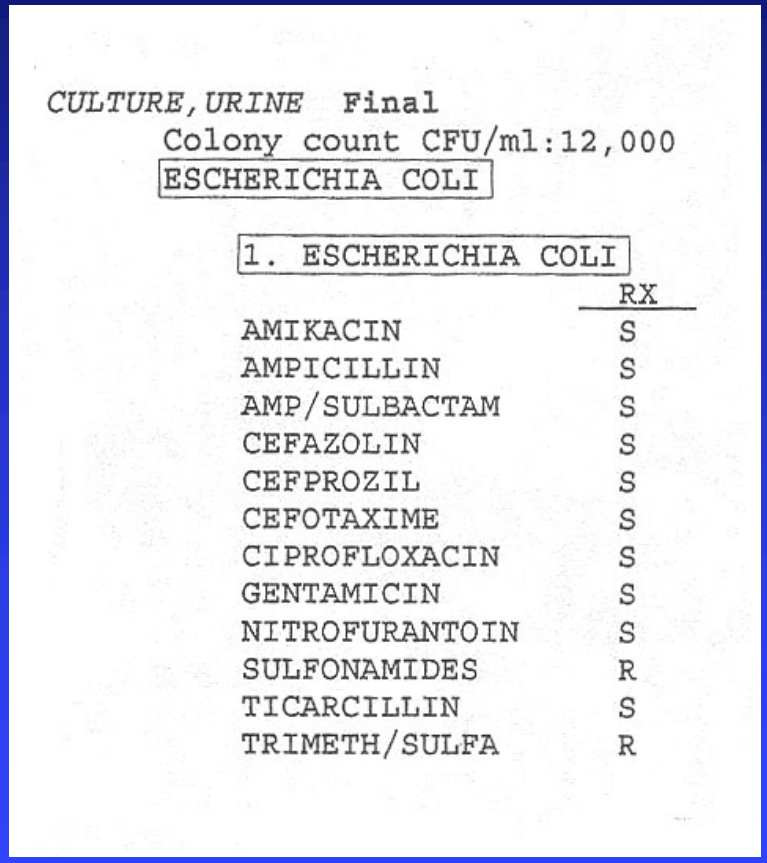
men URINE-MIDSTREAM

- Insignificant quantity

Urine culture Insignificant quantity of: Normal Urogenital Flora

No further workup will be performed.

How Many Colonies of that Organism Have Grown?



CULTURE, URINE **Final**

Colony count CFU/ml:12,000

ESCHERICHIA COLI

1. ESCHERICHIA COLI

	RX
AMIKACIN	S
AMPICILLIN	S
AMP/SULBACTAM	S
CEFAZOLIN	S
CEFPROZIL	S
CEFOTAXIME	S
CIPROFLOXACIN	S
GENTAMICIN	S
NITROFURANTOIN	S
SULFONAMIDES	R
TICARCILLIN	S
TRIMETH/SULFA	R

Pathogens in pediatric patients

- E.coli
- Klebsiella
- Proteus
- Enterobacter
- Citrobacter
- Enterococcus
- Serratia
- Pseudomonas

Pyelonephritis Treatment

- In infants under 2 months of age, IV antibiotics recommended
- For 2-24 months of age, length of treatment 7-14 days (oral and IV same efficacy unless too ill to tolerate PO treatment)
- Admission determined by ability to tolerate PO, systemic symptoms

Pyelonephritis Treatment

- Important for prompt treatment to help prevent urosepsis
- Pyelonephritis in setting of obstructing kidney stone is risk factor for urosepsis

Pyelonephritis Treatment

- If not responding to appropriate antibiotic treatment after 48-72 hours, consider imaging kidney to rule out abscess

Cystitis Treatment

- Simple Cystitis
  - 5 day treatment course
  - If dip is suspicious, start empiric treatment
    - Can base on prior cultures
    - Local antibiotic sensitivity patterns

First Line Oral Treatment

- Keflex
- Bactrim
- Augmentin

Asymptomatic Bacteriuria (ASB)

- Same rate of symptomatic infection if treated
- Consider age and underlying GU anomalies when considering treatment

Risk Factors (RF) for UTI in Pediatric Patients

- Age
- Sex of patient
- Genetics
- Circumcision status
- Immune system
- Anatomic abnormalities
- Habits/Behavioral/Functional

RF: Age and Sex

- Infants (<1 yo)
  - 2.7 % male
  - 0.7 female
- > 1 yo:
  - <1% male
  - 1-3 % female

RF: Race/Genetics

- Caucasian girls at increased risk of UTI's
- No specific genes localized
- May be a genetic component

RF: Circumcision Status

- Circumcision decreases risk of UTI in at least first 6 months of life 10 fold

RF: Immune System

- In first 6-12 months of life increased risk due to maturing immune system

RF: Anatomic Abnormalities

- Typically have UTI before 5 yrs of age if secondary to underlying GU anomaly

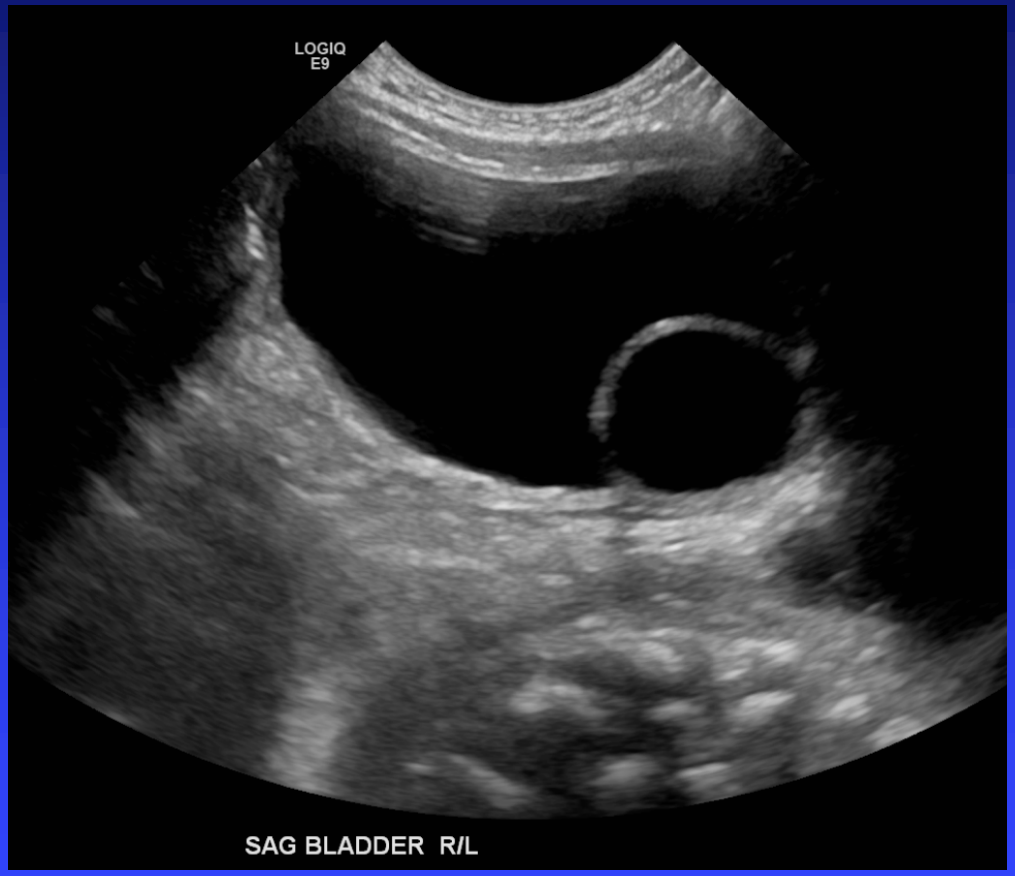
RF: Ureter

- Ureter
  - Vesicoureteral Reflux (VUR)
  - Ureterocele
  - Megaureter/UVJO
  - Ectopic ureter

VUR

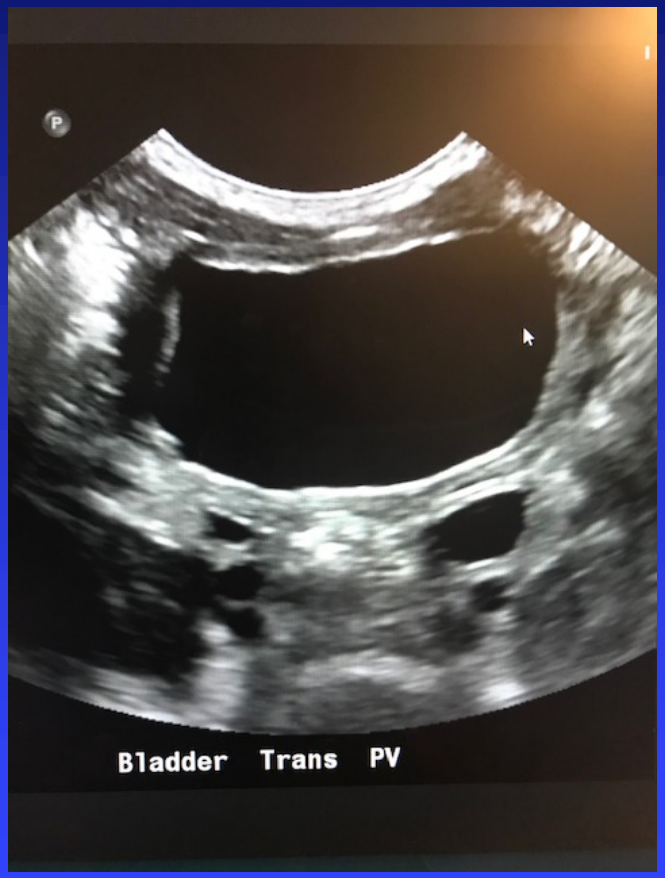
- Estimated in 1-2% of all newborns
- Present in 25-40% of children after first UTI
- Female > male
- Genetic component

Ureterocele



Megaureter

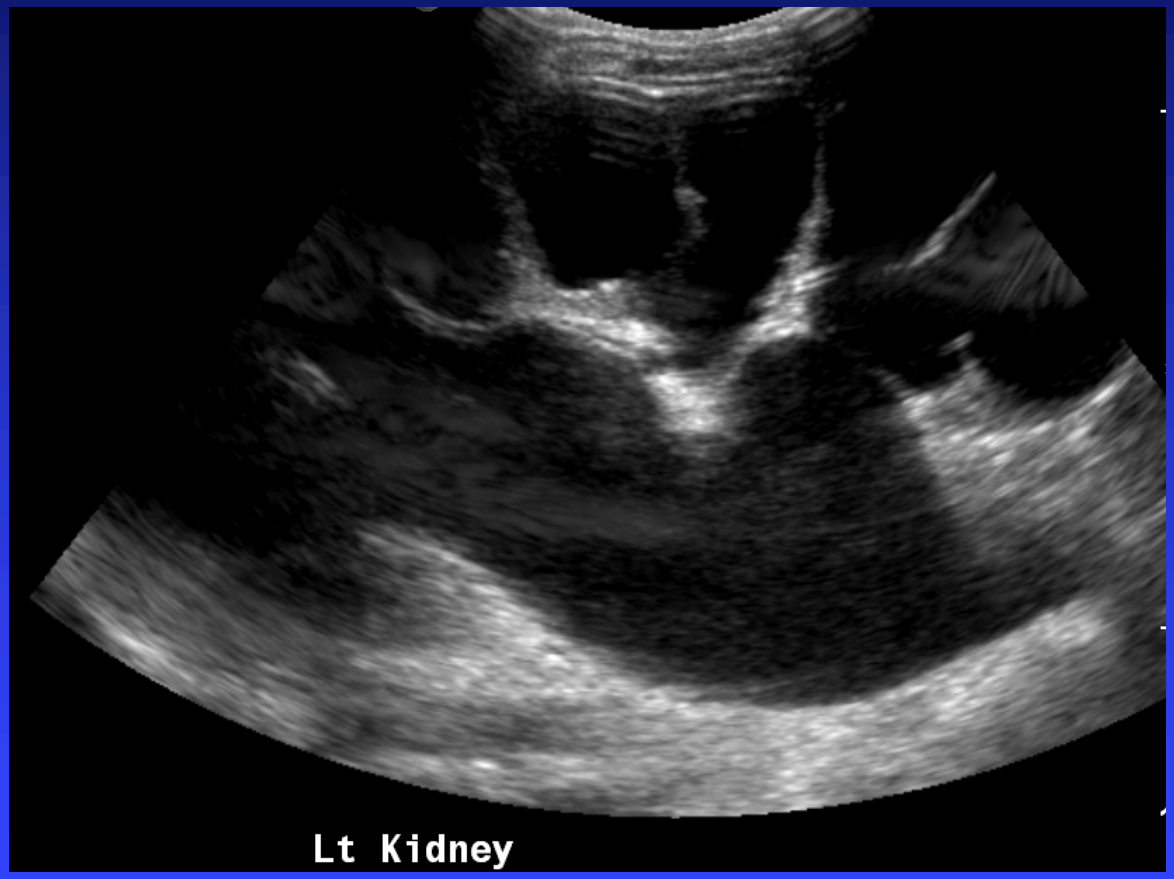
Ureterectasis



RF: Kidney

- Multicystic Dysplastic Kidney (MCDK)
- Ureteropelvic junction obstruction (UPJO)
- Horseshoe kidney
- Cross fused renal ectopia

UPJO



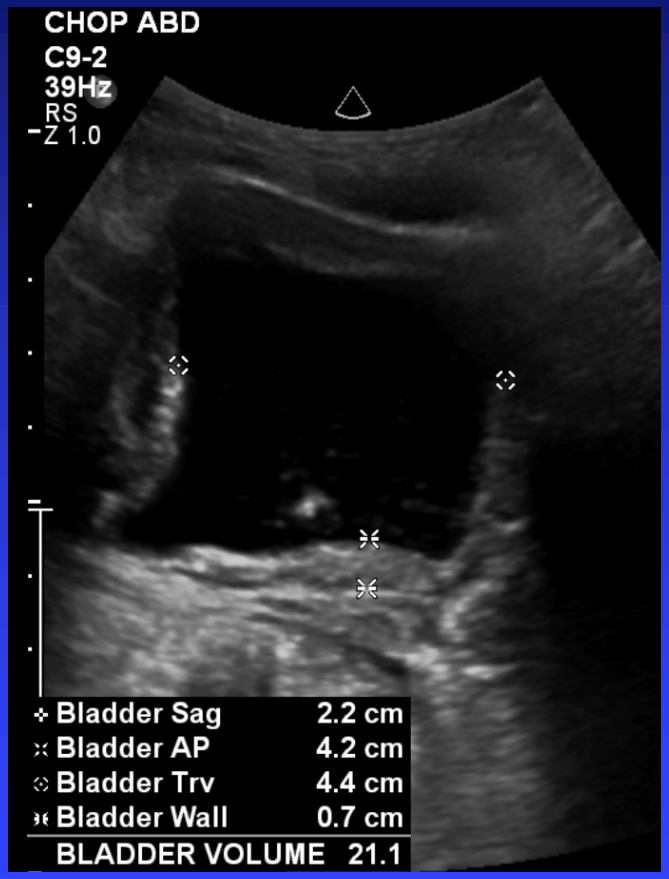
UPJO


C8-5
52Hz
RS
2D
47%
Dyn R 65
P Off
Gen
TIS0.2 MI 0.6
M5
X5
6.0cm
Coronal Lt Kidney POST/ANT

Risk Factors: Bladder/Urethra

- Posterior Urethral Valves
  - LUTO
  - VUR
  - Incomplete bladder emptying
- Neurogenic bladder
  - Incomplete bladder emptying
  - Catheterization

Bladder Thickening



Risk Factors: Bladder/Urethra

- Bladder diverticulum
- Bladder duplication
- Urogenital sinus
- Cloaca
- Bladder/cloacal exstrophy

RF: Bowel and Bladder Dysfunction (BBD)

- BBD known to contribute to UTI and to VUR

RF: Potty Training

- Potty training is a time of increased risk for UTI's

RF: Sexual Activity

- Sexual activity in females increases risk of UTI

Work-up of Febrile UTI

- Radiologic studies
  - Ultrasound
  - Voiding cystourethrogram (VCUG)
  - Renal scan

Radiology Studies

- Renal Bladder Ultrasound
  - Least invasive, no radiation, quick
    - Helps rule out major anatomic abnormalities
  - NOT sensitive enough to detect
    - VUR
    - Renal scarring

Renal Bladder Ultrasound

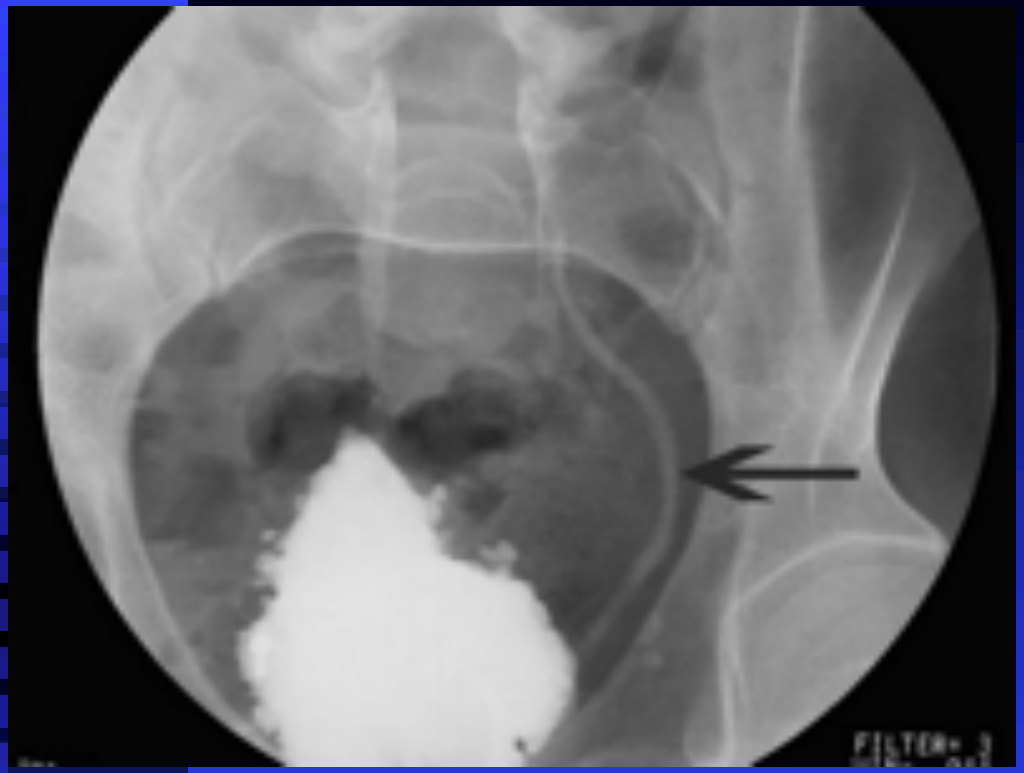
- Hydronephrosis from infection or obstruction
- Urothelial thickening
- Bladder wall thickening/irregularity
- Stones
- Post-void residual
- Pyelonephritis/renal abscess

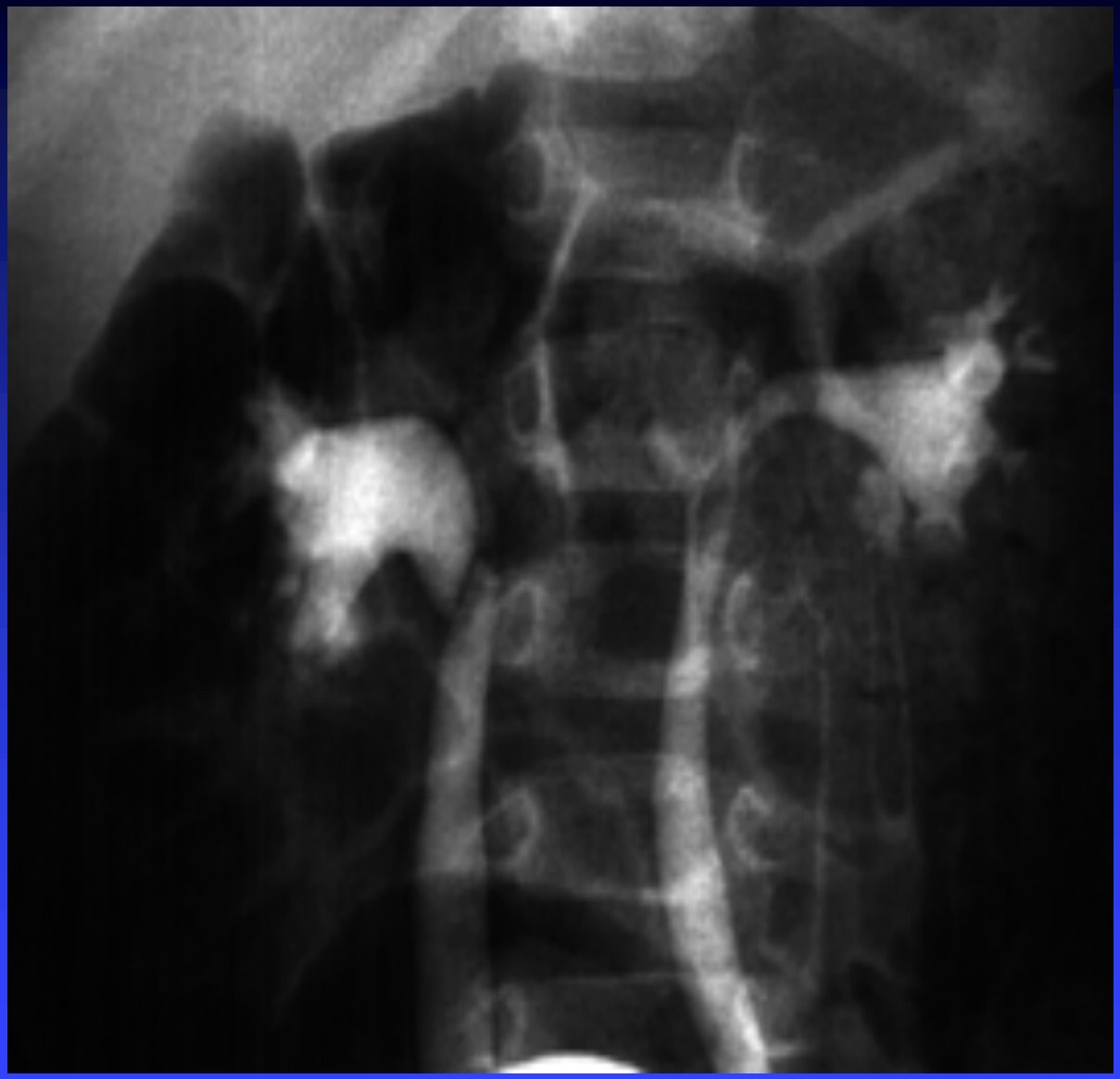
Hydronephrosis

VCUG

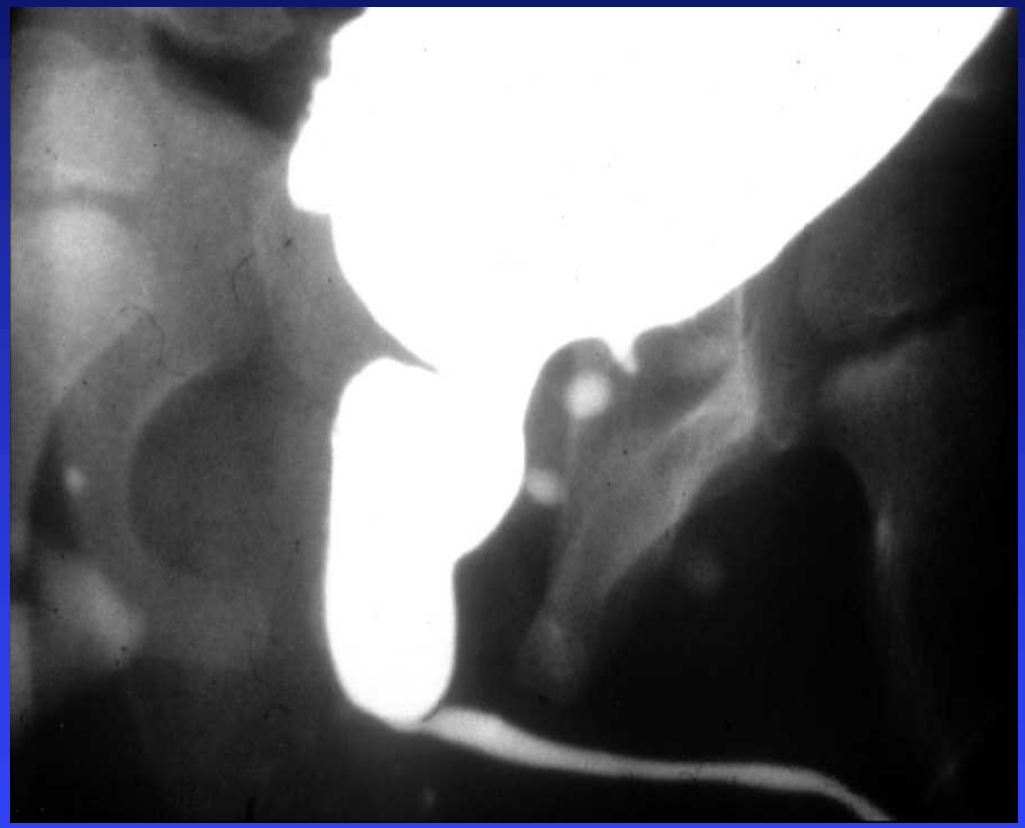
- Voiding Cystourethrogram (VCUG)
  - With a **FEBRILE** documented UTI
  - Rules out vesicoureteral reflux (VUR)
    - VUR is the retrograde flow of urine from the bladder to one or both kidneys

Fluoroscopic VCUG





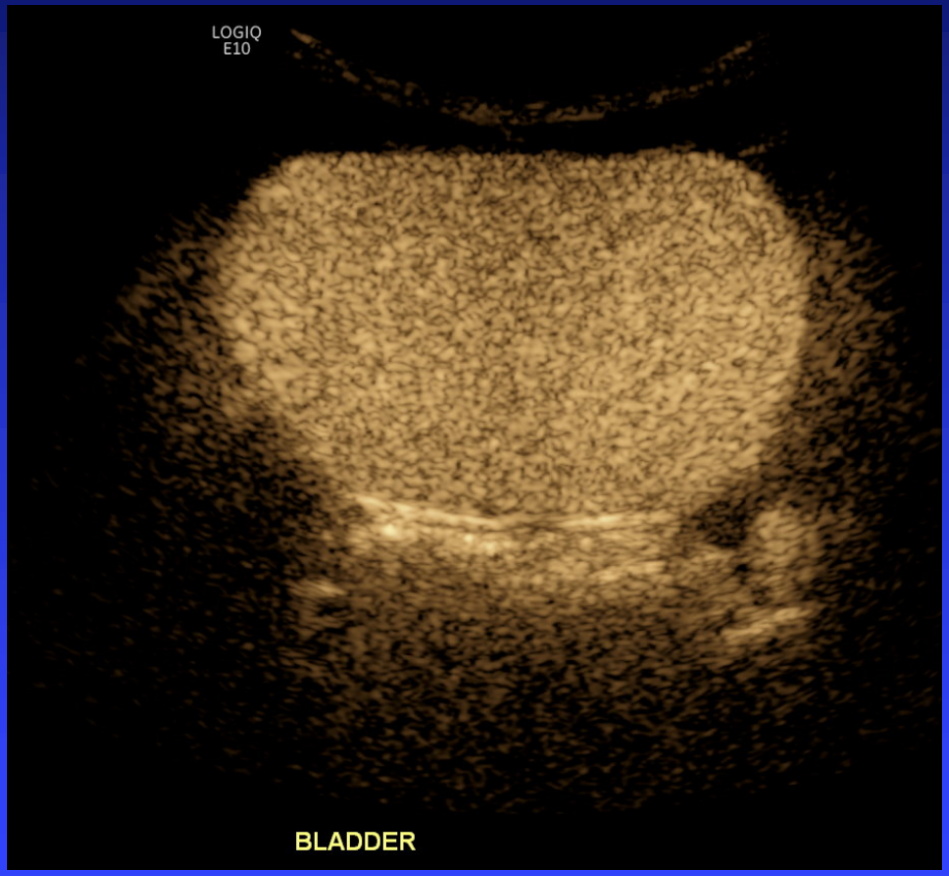
PUV



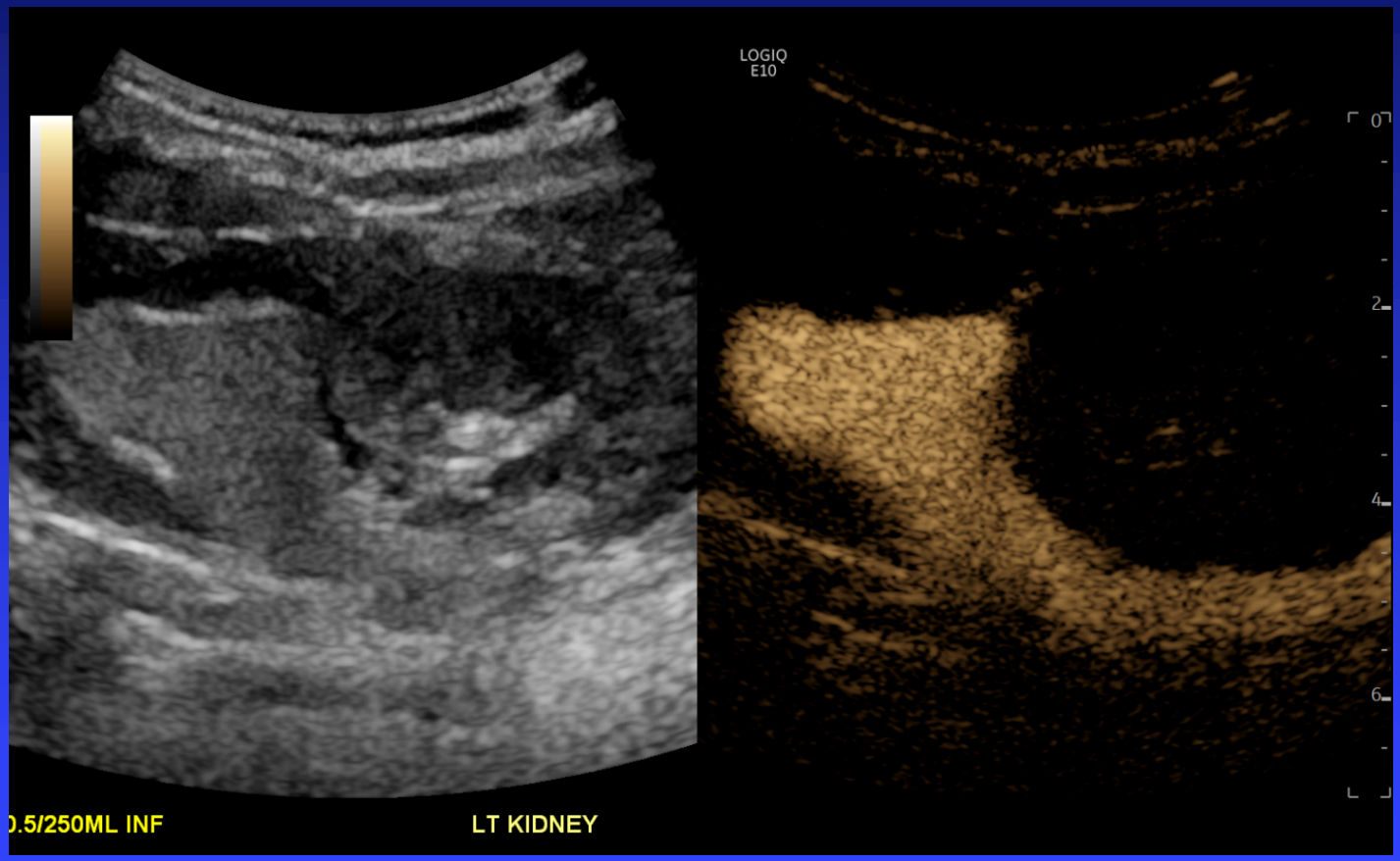
Sonicated VCUG (CeVUS)

- Microbubble contrast instilled
- No Radiation
- Does involve catheter

CeVUS



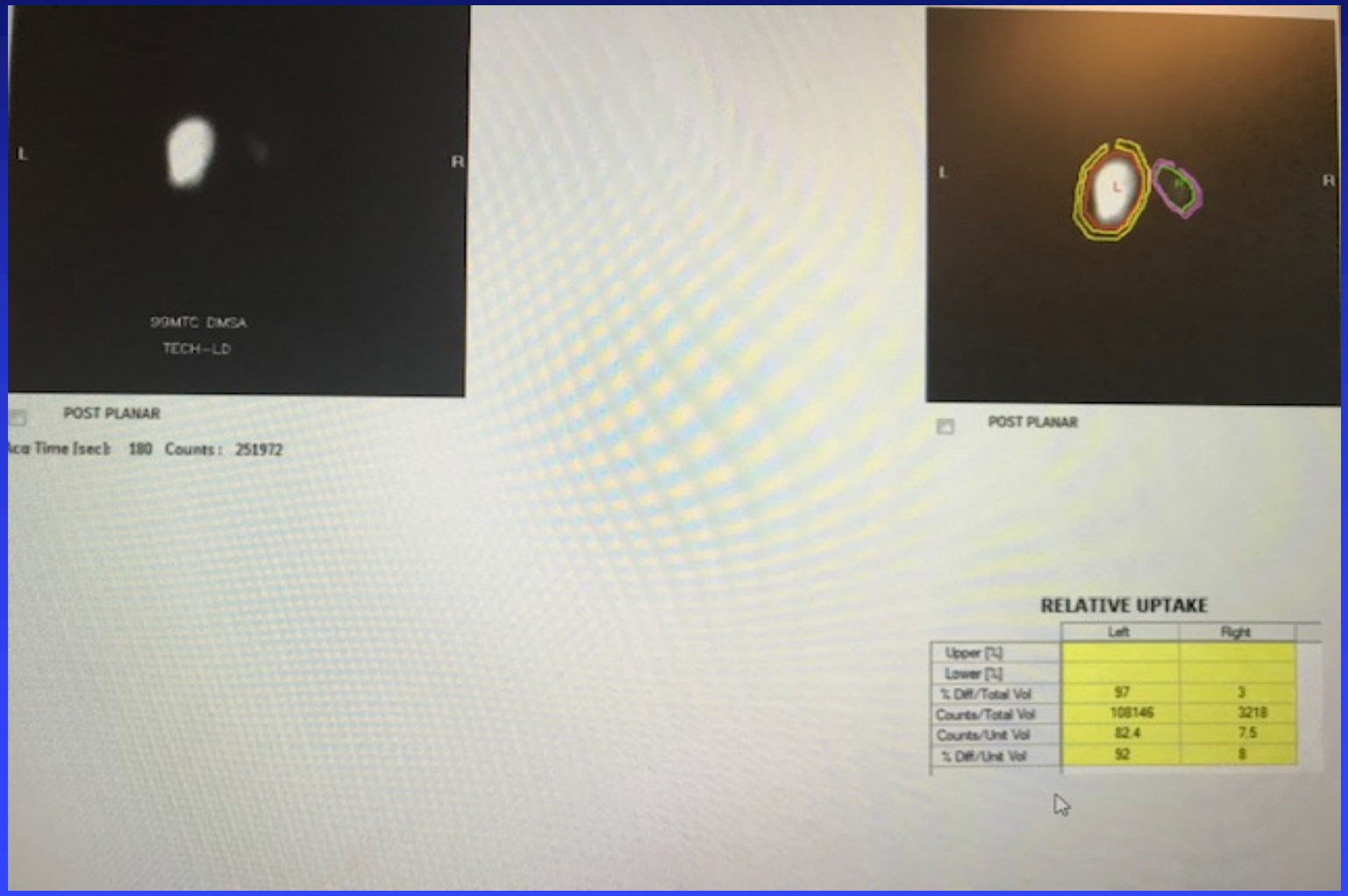
CeVUS

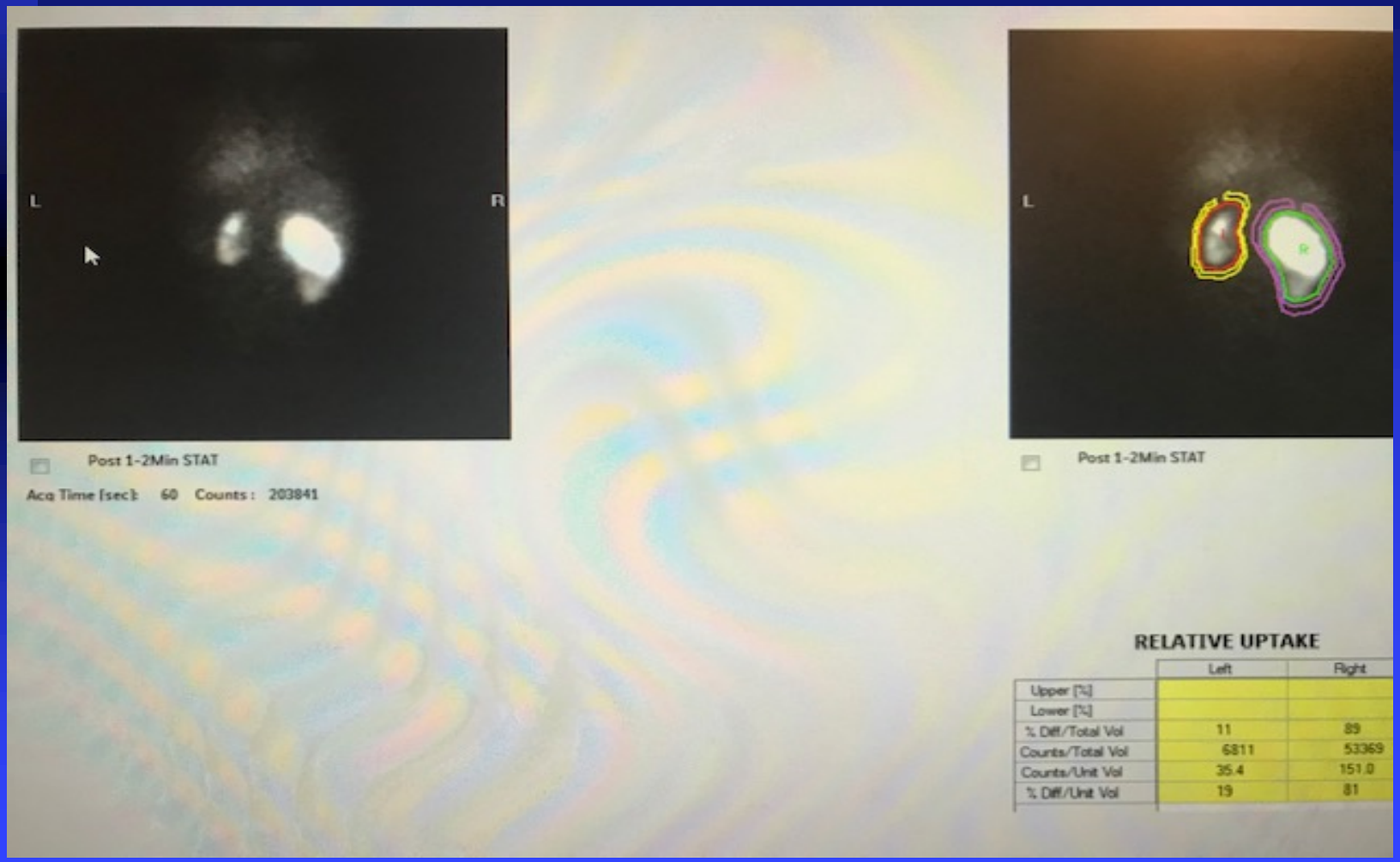


DMSA Renal Scan

- Assess for renal scarring
- Assess for functional split

DMSA

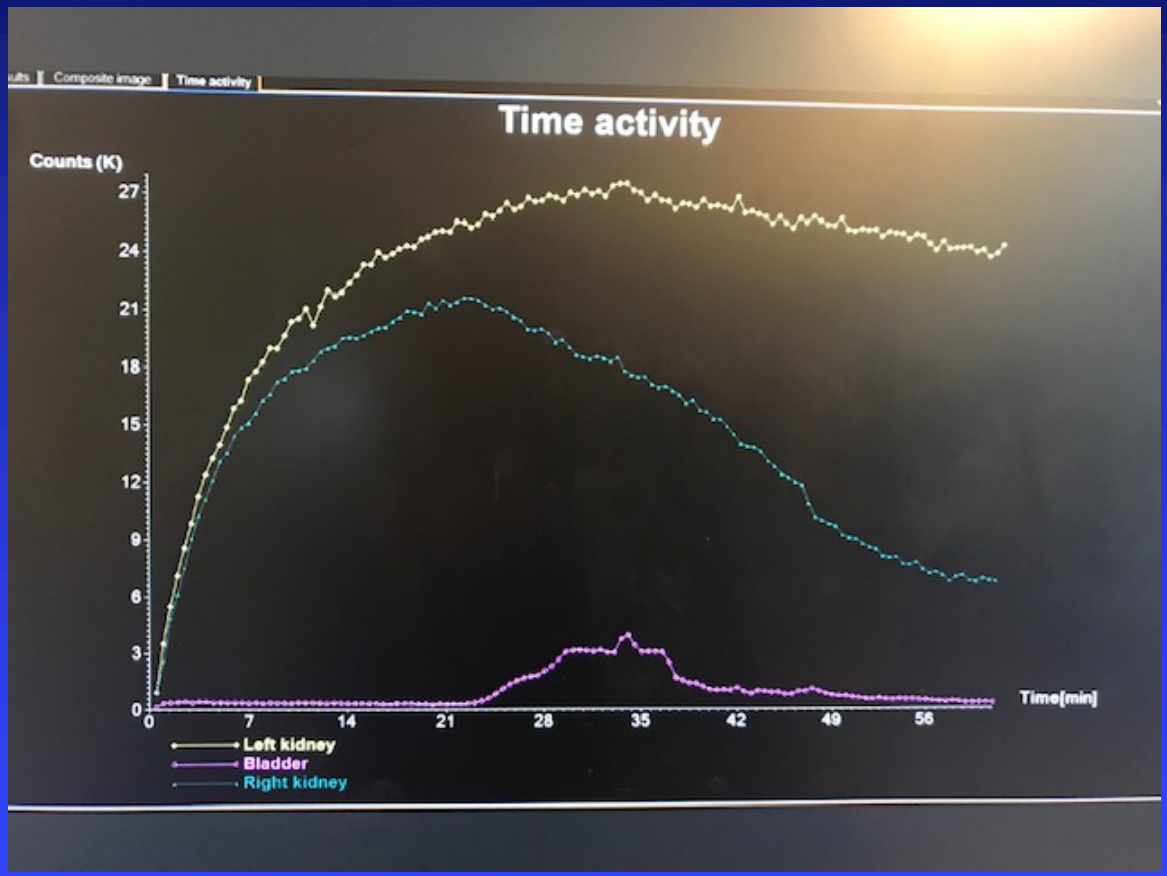

L
R
99MTC DMSA
TECH-LD
POST PLANAR
Time (sec) 180 Counts: 251972
L
R
L
POST PLANAR
RELATIVE UPTAKE
Left
Right
Upper [%]
Lower [%]
% Diff/Total Vol 97 3
Counts/Total Vol 108146 3218
Counts/Unit Vol 82.4 7.5
% Diff/Unit Vol 92 8

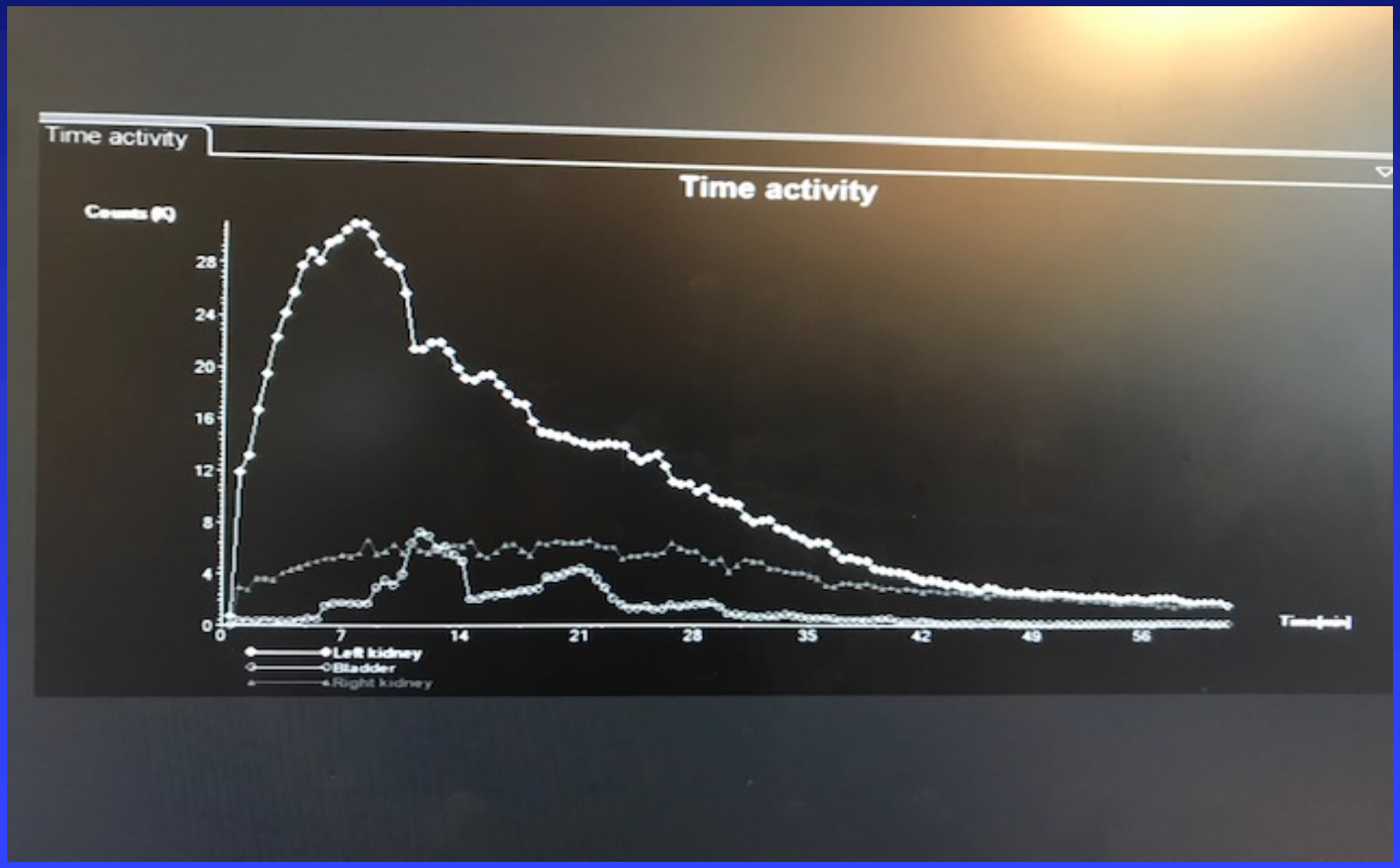

L
R
Post 1-2Min STAT
Acq Time [sec]: 60 Counts : 203841
L
Post 1-2Min STAT
RELATIVE UPTAKE
Left
Right
Upper [%]
Lower [%]
% Diff/Total Vol 11 89
Counts/Total Vol 6811 53369
Counts/Unit Vol 35.4 151.0
% Diff/Unit Vol 19 81

MAG 3 Renal Scan

- Lasix Renogram
- Obstruction/washout curves
- Functional split of kidneys/uptake of tracer

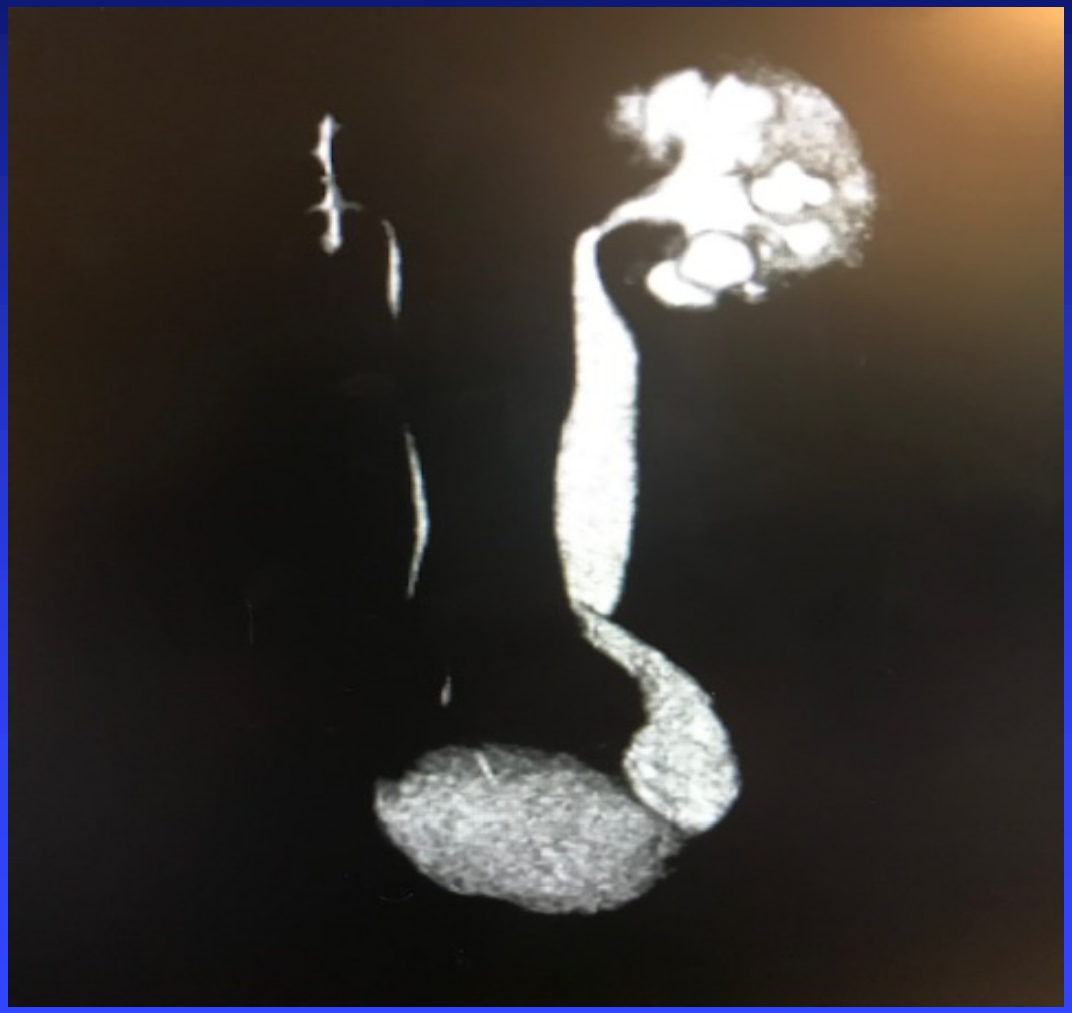
MAG 3 Renal Scan




Time activity
Time activity
28
24
20
16
12
8
4
0
0
7
14
21
28
35
42
49
56
Left kidney
Bladder
Right kidney

MRI Urogram

- Gfr based function
- Anatomic information, 3D reconstruction
- Evaluate for obstruction



	Right Kidney	Left Kidney
CTT [min, sec]	2m 19s	2m 19s
RTT [min, sec]	3m 29s	2m 29s
TTP [min, sec]	2m 19s	2m 39s
Volume [mL]	40.26	38.63
vDRF [%]	51.03	48.97
pDRF [%]	46.43	53.57
vpDRF [%]	47.46	52.54
Patlak [(mL/min)/mL]	0.50142	0.57846

MAG3scan... MRU3drec...

Top Down vs. Bottom Up Approach

- Bottom up
  - VCUG
  - US
- Top down
  - US
  - DMSA
  - Selective VCUG

Creatinine and Cystatin C

- Creatinine
  - If recurrent febrile UTI's
  - Renal scarring
- Cystatin C
- Procalcitonin
  - Indicator of active pyelonephritis, potential predictor of renal scarring

Nephrology

- If elevated creatinine or extensive renal scarring on DMSA, consider referral to nephrology for long term evaluation/management of CKD

Uroflow/PVR

- Contraction and relaxation of pelvic floor muscles
- Assess for bladder emptying

Flow Pattern

Treatment of RF

- Goal is to minimize risk of recurrence of UTI
- Treat underlying risk factors

Behavioral/Habit Risk Factors

- Bladder holding/infrequent voiding
  - Vincent's curtsy
  - Timed voiding
  - Vibrating watch
  - Stool under feet
  - Biofeedback

Water Intake

- Suboptimal water intake
- Concentrated urine
- Lack of bladder cycling
- Contributes to constipation

Constipation

- Incomplete bladder emptying
- Perineal colonization with fecal bacteria
- Increasing fiber intake, dietary or supplements/medication and consider GI referral if persists
- Gastrocolic reflex

Probiotics

- Theory that probiotics alter vaginal and intestinal flora to reduce uropathogens

Prevention of E.coli UTI's

- Cranberry extract
  - E.coli fimbriae
- D-mannose

Prevention of UTI's

- Antibiotic Prophylaxis
  - With or without vesicoureteral reflux
  - Sterile urine in bladder
  - RIVUR study
  - Amoxicillin, Bactrim, Nitrofurantoin, Keflex

Surgery for VUR

- If recurrent breakthrough UTI's
- Persistent high grade VUR
- Deflux
- Open or laparoscopic ureteral reimplant

Surgery for Anatomic Cause

- Consider circumcision if GU anomaly or recurrent UTI's
- Ureterocele incision
- Ureteral reimplant, ureterostomy, partial nephroureterectomy, ureteroureterostomy for ectopic ureter
- Ureteral reimplant or ureterostomy for megaureter

Vesicostomy and Ureterostomy

Surgery for Anatomic Cause

- Pyeloplasty for ureteropelvic junction obstruction
- Incision of posterior urethral valves or vesicostomy

Neurogenic Bladder UTI prevention

- CIC to empty bladder
- Vesicostomy for free drainage
- Bladder augmentation

Recurrent UTI's

- Afebrile: no known long-term damage or affect on kidneys
  - Repeat exposure to antibiotics
  - Cost of time away from school and work

Recurrent UTI's: Febrile

- Recurrent febrile UTI's is risk factor for renal damage and long term hypertension
- Screening with BP and UA
- Renal insufficiency
- Goal is prevent of pyelonephritis to prevent renal scarring, hypertension, renal insufficiency and ESRD

Take Home Points

- Prompt identification of UTIs
- Accurate diagnosis
- Identify children at risk for renal damage
- Avoid overuse of antibiotics and unnecessary testing
- Optimize habits to decrease UTI risk
- Surgically correct anatomic abnormalities when warranted

References

- **In Wein, A. J., In Kavoussi, L. R., Campbell, M. F., & Walsh, P. C**. (2012). *Campbell-Walsh urology*.
- **Subcommittee on Urinary Tract Infection, Steering Committee on Quality Improvement and Management, Roberts KB**: Urinary tract infection: clinical practice guideline for the diagnosis and management of the initial UTI in febrile infants and children 2 to 24 months. *Pediatrics.* 128:595-610 2011 21873693
- **GJ Williams, P Macaskill, SF Chan, et al.**: Absolute and relative accuracy of rapid urine tests for urinary tract infection in children: a meta-analysis. *Lancet Infect Dis.* 10:240-250 2010 20334847
- **MM Oh, JW Kim, MG Park, et al.**: The impact of therapeutic delay time on acute scintigraphic lesion and ultimate scar formation in children with first febrile UTI. *Eur J Pediatr.* 171:565-570 2012 22048628
- **LM Shortliffe, JD McCue**: Urinary tract infection at the age extremes: pediatrics and geriatrics. *Am J Med.* 113 (Suppl. 1A):55S-66S 2002 12113872
- **J Winberg, HJ Andersen, T Bergström, et al.**: Epidemiology of symptomatic urinary tract infection in childhood. *Acta Paediatr Scand Suppl.* 252:1-20 1974 4618418
- **EJ Schoen, CJ Colby, GT Ray**: Newborn circumcision decreases incidence and costs of urinary tract infections during the first year of life. *Pediatrics.* 105 (4 Pt. 1):789-793 2000 10742321
- **MY James-Ellison, R Roberts, K Verrier-Jones, et al.**: Mucosal immunity in the urinary tract: changes in sIgA, FSC and total IgA with age and in urinary tract infection. *Clin Nephrol.* 48 (2):69-78 1997 9285142

References

- **MC Yoder, RA Polin**: Immunotherapy of neonatal septicemia. *Pediatr Clin North Am.* 33 (3):481-501 1986 3520460
- **CM Kunin**: Emergence of bacteriuria, proteinuria, and symptomatic urinary tract infections among a population of school girls followed for 7 years. *Pediatrics.* 41 (5):968-976 1968 5654843
- **SA Koff, TT Wagner, VR Jayanthi**: The relationship among dysfunctional elimination syndromes, primary vesicoureteral reflux and urinary tract infections in children. *J Urol.* 160 (3 Pt. 2):1019-1022 1998 9719268
- **CK Yeung, B Sreedhar, JD Sihoe, et al.**: Renal and bladder functional status at diagnosis as predictive factors for the outcome of primary vesicoureteral reflux in children. *J Urol.* 176 (3):1152-1156 2006 discussion 1156–7 16890714
- **Chang SL, LD Shortliffe**: Pediatric urinary tract infections. *Pediatr Clin North Am.* 53 (3):379-400 2006 16716786
- **SP Greenfield, Wan J**: Vesicoureteral reflux: practical aspects of evaluation and management. *Pediatr Nephrol.* 10 (6):789-794 1996 8971908

Questions?

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