

What do kidneys do? (REVIEW)

- Maintain composition and volume of body fluids
- Secrete ESH and Renin
- Blood, waste and water enter through the Renal Artery
- Blood without waste or excess water leaves via the Renal Vein
- Excess water and toxic waste in the form of urine leaves via the Ureter
- Secretion = substances added to urine (secreted out of body into urine)
- Reabsorption = substances returned to the blood
- Excretion = urine and wastes leaving the body

Renal function: Endocrine (REVIEW)

- Erythropoietin Stimulating Factor
- Renin: Responds to Low BP and Low Blood Volume
- Renal activation of Vitamin D

Renin Angiotensin System (REVIEW)

- Decreased blood pressure, low sodium, decreased blood volume or increased catecholamines
- Renin released
- Angiotensin 1 converted to Angiotensin 2
- Increased vascular resistance, increased sodium reabsorption

A & P Review: Renal Function

- Unimpaired Renal Blood Flow
- Adequate Glomerular Filtration
- Normal Tubular Function
- Unobstructed Urine Flow

Renal Blood Flow: Pedi Issues

- $[CO = HR \times SV]$
- Higher proportion of water content...as child gets older, this decreases
- Child starts out with more ECF than ICF...a lot of the total body weight is in the ECF.
- Babies have more BSA proportionate to their size
- Ex: Clear Lake (lots of shoreline but shallow)
- Kids have an increased RR...leading to higher insensible fluid loss
- Kids have increased BMR...lots of byproducts for the kidneys to get rid of.
- See table to the right for changes in total body water

Age	TBW	ECF	ICF
Newborn	70-80%	40%	30%
1 year old	64%	34%	30%
3 year old	60%	24%	36%
Puberty	60%	20%	40%

Glomerular Filtration/Tubular Function

- Kidneys less protected: larger, compliant ribs, less fat pads
- Growth X 5 years: primarily tubular system
- At birth GFR<adults: ability to concentrate urine decreased
- Efficiency regulating acid-base, 'lytes, drug elimination decreased X 2 years

Unobstructed Urine Flow

- Bladder of young child more anterior...easier to palpate than an adult.
- Hard to cath a child...and is very traumatic for the kids. Doc can go in and do a suprapubic tap to get into the bladder...uses a small needle.
- Structural alterations may cause back up or stasis of urine...leading to damage to the kidney (especially in male babies...happens more in males)
- Urethra anatomically shorter...in a child it's about 3/4 an inch. UTIs are very common in little girls.

- Bladder capacity increases with age:
 - Ounces = 2 + age (years)
 - If infant that's 1 month old, then capacity is 2 oz.
 - Implications for bladder retention issues
- Minimum Urine output = 1 ml/kg/hr...anything less than this is oliguria...can pee more than this!

Renal Function: Assessment (3 main areas)

- Perfusion: Assessment of Cardiac Output
- GFR/Tubular Function
- Urine Flow

Renal Function Assessment: Perfusion

- Perfusion: Assessment of Cardiac Output
 - Decreased CO is = decreased renal blood flow
- VS with decreases in CO
 - HR is going to go up
 - RR is going to go up
 - BP is going to stay same, unless crashing (with a renal pt, look at BP trends over time)
- Systemic perfusion
 - Cap refill
 - Cold skin...if extremities are cold and the closer it gets to the center of the body, then the worse the condition is getting...they are shunting toward the vital organs
 - Mottling, also looks "marbled" or "lacy"...sometimes pink and blue.
- Peripheral Perfusion...look at O2 sats
- Urine Output will be decreased

Renal Function Assessment: GFR/Tubular Function

- I & O...dont want it to be "equal" b/c child has larger insensible fluid loss. You want to see higher intake...if intake is less than output, they are heading toward dehydration (ditto if equal).
 - Sometimes O is greater in chemo kid...they are mega-hydrated before chemo (the day before often). Their I&O may show a huge output, but look back and see what the intake was the prior day or earlier that day.
- Daily Wt: significant change, accuracy
 - Muy importante: THE MOST SIGNIFICANT indicator of fluid balance in anyone's body!
 - A significant change is > 20 g in infant...in child > 0.5 kg change
 - Ex: child in NICU has gained 60 g in one day...check to see how long it's been since they had a BM before you call the doc. If they've lost 60 g in one day...check to see if they had a big poo-poo that day.
 - Use same scale, same time, same clothes (or no clothes).
- Labs: UA, BUN, Cr (p. 954 of text)
 - UA = use a bag (not pleasant experience...really difficult. easy to lose the sample or cause skin problems). If you are going to use a bag, cut a hole in the diaper and put the bag through. Can also put cotton balls in the diaper and wring them out...good if you just need to do a dipstick and don't need a sterile sample. Sample needs to go to lab for UA within 15 minutes. If not going to make that time goal, put it in the fridge.
 - Re: BUN/Cr...they increase for a child as they get older. Values for child are not the same...pay attention to what you are comparing it to (use values in back of book pg. 954)...sometimes hospital will have the adult values as reference. Yay...don't need to memorize these...but just know basics like K, Na, etc... What you will typically see in peds is low BUN b/c child is hydrated (IV fluids) and low hematocrit d/t hemodilution.
- Edema is very hard to assess, especially with babies. Children tend to have generalized edema rather than any dependent or peripheral edema. There are different techniques...but you don't see pitting edema in kids...you see a "boggy edema" in kids...kind of like a water balloon.

Renal Function Assessment: Urine Flow

- Urine flow should be at least 1mg/kg/hour
- Urine Output...kids in hospital often have lots of drains...urostomy, nephrostomy tubes. These tubes are very small (think angel hair spaghetti)...if you have tubes this size, you have concerns r/t clogging or kinking. **Check patency of the tube every time you assess child.**
- Bladder distention is very easy to see and palpate
- Pain Assessment
 - If UTI, pain is on urination...looking for grimacing, crying. Pull diaper back every 15 mins-30 mins (be careful of boys!)...you are hoping to catch the child mid-stream so you can watch their reaction to pain. May have to check little girls more often...don't pee as reliably when diaper is removed like boys do.
- Bacteria

Need to stay on top of RR and HR...these are the main compensatory mechanisms. If BP gets affected then child is in bad bad shape.

UTI: Pathophysiology REVIEW

- Urinary tract is usually sterile above urethrovesical junction.
- If bladder not emptied, bacteria can multiply
- Can lead to scarring and atrophy

UTI: Urinary Tract Infection REVIEW

- An infection of one or more structures of the urinary tract
 - Cystitis
 - Urethritis
 - Pyelonephritis
- Incidence and etiology (she didn't really go into this)

UTI: Predisposing Factors

- Urine stasis
- Urine reflux
- Poor perineal hygiene
- Constipation
- Pregnancy
- Uncircumcised males
- Urinary catheter
- Antimicrobial agents
- Tight Clothes
- Diapers
- Bubble bath
- Shampoo in bath
- TP: perfumes/dyes...can cause inflammatory response and set baby up for bacterial infection
- Retention...when kids get to school age tend to hold urine, which sets them up for more UTI opportunities.
- Vaginitis
- Sexual intercourse
- Sexual abuse
- Injury to kidney

Recognition of UTI ...see table

- The symptoms in general are very vague..could be lots of problems.
- When baby comes in to hospital, there will be a septic workup. Babies do not localize infection...they will get septic fast.
- So, FYI...you don't document "no redness at IV site" b/c they wouldn't show that anyway.

Infants	Preschool	School-Age
Non-specific symptoms Fever Failure to thrive Poor feeding V/D ? Foul-smelling urine Irritability then lethargy	Classic symptoms Fever Frequency Dysuria Abdominal pain Malaise Hematuria	Classic symptoms + Avoidance of urination

UTI Treatment Pearls

- Treat the infection: main abx is amoxicillin...if hospitalized use gentamycin and cephalosporins...these are nephrotoxic!
- Do UAs every 42-72 hours to follow-up
- Lower – oral antibiotics
- Upper – IV antibiotics
- Treat co-existing conditions
- Long term follow up/ patient & family education depends on cause
- GOAL of treatment: PREVENTION
- If repeated UTIs...may have structural abnormalities...need to follow up.

NCLEX tip: Key signs for toddlers and infants...feeding problems

Enuresis

- Involuntary voiding of urine beyond the expected age at which voluntary control should be achieved (5 years of age)
 - If child is 4 and having this problem, assure mom that it's OK.
- Primary (no test question on this). They have never been dry for 3 month period.
- Secondary (no test question on this). Have been dry for a 3 month period, and now having problems.

Enuresis

- Etiology (See p 537-538 of Text)
 - Organic causes...first thing you always want to look for is to r/o any physical or organic causes.
 - #1 problem is constipation...constipation causes enuresis b/c it puts pressure on bladder
 - CRF...may not be able to control when urine comes out
 - Sickle cell anemia
 - UTI
 - Diabetes Insipidus & Diabetes Mellitus
 - Neuro problem
 - Structural disorders of urinary tract
 - Possible allergies
 - Nonorganic causes
 - Stress, psychological, child-abuse (particularly sexual), sleep disorders that are not related to organic causes
- Clinical manifestations
 - Looks like UTI ?? more here?

Enuresis

- Treatment of enuresis
- R/O organic factors first
- Medications (Symptom relief, not a cure)
 - Ditropan (oxybutynin)...urinary antispasmodic...anticholinergic...decreases bladder contractions
 - DDAVP (Desmopressin)...analog of vasopressin...which is an ADH...stops diuresis to decrease urine output
 - Tofranil (Imipramine)...TCA...not giving for mental health reason...it actually decreases depth of sleep.

Enuresis

- Nonpharmacological treatment
 - Alarms (moisture sensor)...teach families that this won't electrocute their kid (no electrical current). Wakes up child, stops urine stream and child goes to bathroom to void. Trains neural pathways to sense the urine fullness.
 - Motivational...rewards. Wouldn't do this with a child with a physical defect.
 - Elimination diets
 - no carbonated beverages
 - no artificial coloring...can be irritating and cause an inflammatory process

(Enuresis treatment, cont'd)

- decrease sugar intake
- no caffeine
- no dairy products...cow's milk is not intended for human consumption...the allergy or insensitivity to this can cause the enuresis.
- Bowel programs: bowel training to relieve constipation
- Retention control training: half them drink a lot of water and hold it as long as they can...this expands bladder capacity

Nursing Management of Enuresis

- Assessment (p. 537 of text)
- Nursing diagnoses
 - Impaired urinary elimination
 - Impaired skin integrity
 - Disturbance in sleep pattern
 - Low self-esteem
 - Impaired social interactions
- Outcome identification
- Evaluation
- Family teaching...do not diaper these kids...does not build self esteem! Change sheets...don't diaper, restrict fluids at bedtime, try earlier bedtimes if using sensors so they still get good sleep, provide emotional support.

Vesicoureteral Reflux

- Retrograde flow of bladder urine into the ureters during voiding, then flows back into the empty bladder- reservoir for bacteria.
 - The ureter is in an abnormal position → backflow of urine during voiding → reflux → reflux enlarges ureters and urine goes into kidney → infection & scarring = renal damage
 - Can be r/t spina bifida, but if you have it, this does **not** mean you have spina bifida.

VCUG

- Voiding cystourethrogram
- Dye should not back up into kidneys...if it does, then there's a problem!

Vesicoureteral Reflux (do not memorize, just get the concept)

- Grade I: ureter only...want to be #1! This is the best dx result.
- Grade II: high without dilation
- Grade III: dilation
 - 1-3 can be treated in outpatient setting
 - Can resolve itself as the ureter lengthens (as child grows)
- Grade IV: dilated calyces
- Grade V: may result in persistent VUR
 - If IV-V, then surgical intervention is necessary

Treatment and Management of VCUG

- Goal: prevent infection and further damage of the kidney
- Treatment: low-dose prophylactic abx
- Nursing management

Post-operative care GU surgery

- Tubes:
 - Nephrostomy tube
 - Ureteral stent
 - Foley to take pressure of surgical site

- Medication orders post-op GU surgery
 - Morphine to relieve pain...then take them down to Tylenol with Codeine...then just Tylenol
 - Morphine lasts 1-2 hours...want to get them on a more steady pain management that lasts longer
 - Do not give Ibuprofen post op b/c risk of bleeding
 - Ditropan (urinary antispasmodic)?
 - Antibiotics
 - Antiemetics
 - Zofran
 - Reglan
 - Do not give Fineren (sp?) to kids under 18 month
 - No Compazine with kids...it produces neural problems, tachycardia, altered mental status
 - No Anapsine
- Surgical site
 - Clean tube insertion q 4 hours
 - Irrigate foley w/ NS...use NS that is at room temp.

Hypospadias & Epispadias

- Hypo = ventral (Jim)
- Epi = dorsal

Hypospadias & Epispadias

- Surgical repair
 - Need to do before 18 months of age b/c potty training. If child is not fixed...they can't urinate standing up most likely...the urine is going all over the place.
 - Reconstruct urethra
 - Urinary & sexual function
- Pre-op
 - No circumcision b/c they are going to us the foreskin for the reconstructive surgery
 - Testosterone cream...makes penis bigger to make it easier to work on.
- Post-op
 - Urethral stent is put in...will have the D drug
 - side effects of D drug is dry mouth, facial flushing
 - Concerns: urethral fistula, stricture at anastomosis site, retrusion of meatus going back to original position
 - Encourage fluid intake to flush

Cryptorchidism: Undescended testes

- Usually just one side
- Incidents
 - 3-5% Full term
 - 33% Preterm
- DX

Cryptorchidism

- Medical treatment: HCG Why give this? It stimulates testosterone to help induce decent of the testicles. Not extremely successful so not used a lot.
- Surgical treatment: orchiopexy, conducted by 1-2 years of age b/c the testicle can have fertility issues if it stays in the body and there is a chance for it developing malignant tumors.
- Post-op care:
 - Pain and infection
 - Need for monthly exams

Structural Defect: Inguinal Hernia and Hydrocele

- Inguinal hernia: a scrotal or inguinal swelling, or both, that includes a protrusion of a section of the bowel into the inguinal canal
- Hydrocele: collection of peritoneal fluid in the scrotal sac

Inguinal Hernia

- Assessment
 - no light illumination
- Treatment: can “reduce” by pressing it back up into place (usually in premies...maybe in full-term infants, depends on how much is coming through); in older infant, you are concerned about strangulation of the bowel...definitely want this done by 2 months.
 - Parents need to watch for severe, unconsolable pain...they will pull their legs up, won't eat, won't want to play. The hernia area can turn a darker red during this time, abd distention can also occur...TachyC, TachyP...these are signs of strangulation. Tell parents to call ambulance
- Nursing management
- Family teaching

Hydrocele

- Assessment
 - Will get light illumination behind the scrotum
- Treatment
 - Usually resolves spontaneously...if it does not resolve within 1 year time, then you have to go in and do surgical removal of the fluid.
 - Not painful, no activity restriction
- Nursing Management
- Family Teaching

PRE OP CARE

- Assess caregivers/child (depending on age of child) understanding of problem & surgical procedure
 - Child may be seen by Child Life Specialist
- Assess past experience with surgery, especially with a child
- Anticipatory guidance regarding appearance after surgery and care (bruises, swelling, wrinkled, etc...)

Circumcision

- Factors involved in parents decision: religion, culture, social
- Stats: 2000-2005 it has stayed the same at 57%...dip around 1980...American Pediatrics put out statement stating that they don't recommend as a standard procedure. They are now neutral on the issue.
- Nursing:
 - Give all facts prior to decision...(risks & benefits p. 226 of text)
- Very controversial
- Pain management
 - 24% sucrose used as a pain med or as an adjunctive
 - Sucrose lasts up to 9 minutes with no side effects
 - give 2mL Sucrose 2 mins prior to procedure
 - Localized meds (EMLA) may also be used.
- Remain non biased
- Post-op teaching
 - About 2nd day, will be yellow-ish, white-ish exudate...this is not a sign of infection!

Acute Glomerulonephritis

- School aged children 6-7 most affected
- Males 2x greater than females
- Autoimmune response
- Usually is post infection: most often secondary to strep 5-12 days after acute infection

- Antibody-antigen complex are deposited in glomerular capillaries
- Sudden inflammation of the glomerulus

AGN: Pathophysiology

- Cell proliferation and edema of capillary lumen of glomeruli
- Protein and RBCs leak through damaged glomeruli
- Decreased GFR causes increased fluids and sodium retention (edema)
 - Intravascular and tissue fluid overload
- Increased blood pressure

AGN: Diagnosis

- UA
 - High specific gravity b/c retaining fluid and urine output is down.
 - Hematuria
 - Proteinuria
 - Not usually bacteria in the urine
- Renal Panel
 - 50% will have increased BUN and creatinine (but most kids who are hospitalized with this will have increased BUN/Cr)

AGN: Clinical Manifestations

- Urine Output (** are classic signs)
 - Decreased **
 - Cola colored ** (d/t RBCs in urine)
 - Hematuria **/ proteinuria
- Fluid Volume
 - Edema ** periorbital – worse in AM
 - Hypertension
 - Elevated Na and K+
 - H & H d/t hemodilution

AGN: Clinical Manifestations

- Loss of appetite ** d/t fluid all over the body, including in GI tract (intestinal edema)
- Increase BUN/CR b/c of decreased GFR
- Low grade fever (may or may not have)
- Irritability leading to lethargy

AGN

- ID source of inflammation
- Management
 - If still an infection, will be on Abx
 - Manage S&S
 - Key Assessments: lungs, I & O, daily weights
 - Fluid restriction (as low as 1/3 fluid maintenance)
 - Restrict high Na and K foods
 - Low to moderate protein
 - Maintain skin integrity
 - Prevent infection...kid is very susceptible to infection.
 - Let kid monitor their own bedrest/activity
 - Try to conserve activities, allow for rest
- Prognosis
 - Usually spontaneous recovery over weeks to months (80-90% have full recovery)
 - Small percentage may go into ARF

Nephrotic Syndrome

- Clinical entity characterized by “**MASSIVE**” proteinuria and hypoalbuminemia leading to generalized edema and hyperlipidemia
- See page 959 of text for patho map
- same thing as “nephrosis”

Nephrotic Syndrome

- Glomerular membrane becomes permeable to protein
- Hypoalbuminemia leads to fluid moving to interstitial space (3rd spacing)
 - Intravascular is going to have decreased hydration (hypovolemia)...going to trigger Renin-Ang pathway so the body will try to hang on to fluid...it's going to bring this fluid in which is just going to be third-spaced...more and more edema.
 - Interstitial space is going to have overhydration (edema)
- Hypercholesterol thought to be related to low serum protein

Nephrotic Syndrome (don't memorize)

- 80% minimal change nephrotic syndrome (MCNS)
- 2-7 y/o; boys>girls
- Immune system role suspected...we know this b/c there is abnormal T-cell functioning. Complexes do not form!
- Inflammatory response...take care of the inflammation and you take care of everything else!
- Key symptoms:
 - Massive edema
 - Weight gain with decreased appetite
 - Decreased urinary output
 - High specific gravity
 - Pallor & fatigue

Nephrotic Syndrome: Symptoms

- Generalized edema r/t hypoalbuminemia
- Frothy urine b/c of protein
- Serum Protein will go down b/c you are losing it
- BP-- remains normal, and may go down b/c of the hypovolemia in the vascular space.
- Anorexia and diarrhea b/c edema in GI tract
- HCT will be up d/t dehydration of vascular space
- Respiratory distress b/c of fluid overload

Pedi GU Case

- A 3 y/o is admitted with a history of gradual onset of irritability, fatigue, generalized edema, and decreased appetite.
- Labs: Serum albumin 18 gm/L (low); Urine +++ protein.
- Physical exam reveals massive edema
- *What do you believe is happening?* Nephrotic syndrome
- *What treatments do you expect?* Steroid therapy to reduce inflammation
 - Corticosteroids (Prednisone)
 - Works within 7-21 days (see response by this time)
 - Have to be free of protein in the urine (occurs between 4-8 weeks)
 - Low sodium diet
 - No fluid restriction b/c vascular space is dehydrated...would only put on fluid restriction if severe pulmonary problems.
 - May give albumin + lasix in severe cases
- Key assessment: Abdominal girths (as well as lungs)
- If prednisone doesn't work...have to go to other immune-suppressant drugs

HEMOLYTIC UREMIC SYNDROME

- INCIDENTS : Usually 6 mo → 5 yr old
- ETIOLOGY E. coli or Shigella (improperly cooked hamburgers have caused this!)

Hemolytic Uremic Syndrome

- PATHO : glomerular arterioles occluded, damages lining of blood vessels, destruction of RBC, toxins destroy platelets and you get platelet aggregation...can end up with DIC
- Anemia, Thrombocytopenia, ARF

Hemolytic Uremic Syndrome

- S/S: vomiting, diarrhea, HTN, oliguria, bruising, weakness, neuro abnormal, proteinuria, hematuria, casts,
- BUN & Cr will be elevated b/c of filtration problems
- H & H will usually be low b/c of destruction of the RBCs
- TX : dialysis, RBC transfusion, BP meds, fluid bal, plasmapheresis
- Nursing Care
 - Same as for ARF

Renal Failure in Children

- Infants
 - NICU (b/c of contrast dyes used)
 - Obstructive uropathy
 - Dehydration
 - HUS
- Toddler
 - Poisoning (Tylenol, mushrooms)
- School age/adolescent
 - Trauma
- Nephrotoxic drugs:
 - Antimicrobials, aminoglycosides, cephalosporins, tetracycline, sulfonamides
 - Radiological contrast with iodine
 - Heavy metals
 - NSAIDS

Renal Failure in Children (don't memorize)...the main this is to know basically what is happening in ARF.

- Acute:
 - Sudden onset
 - Pre/Intra/Post renal causes
 - Uncommon in peds
 - S/S similar to adults
 - Dialysis for severe
 - hypertension, BUN >120; **Hyperkalemia**; acidosis
 - Worried about dehydration in kids
 - Can be secondary to UTI, hypovolemic shock, nephrotic disease, nephrotoxic drugs, etc...
- Chronic:
 - Progressive: 50% or < renal function
 - Irreversible = ESRD
 - Uremia
 - Treatment:
 - Fluid management
 - Electrolyte replacement – CA
 - Tx: hypertension
 - Diet: Protein, phosphorus
 - Erythropoietin

Peritoneal Dialysis (REVIEW)

- Use of peritoneal membrane
- Solutes move through diffusion
- Water through ultrafiltration
- Determinants of solute clearance

Complication	Cause
Peritonitis: cloudy dialysate, leukosytosis, fever, constipation	Staph aureus, Staph epidemidis, fungus, gram negative rods Risk: r/t duration of dialysis, age
Pain: during inflow and/or outflow	Too rapid rate, too large volume, migration of catheter, temperature of dialysate
Leakge: fluid around catheter, SC edema, pleural effusions	Overfilling of abdomen, catheter migration
Respiratory: SOB, decreased BS, decreased chest expansion	Overfill = compromise Diaphragm movement, leak into pleural space

Peritoneal dialysis: Nursing Care (REVIEW)

- Dwell time/drain time
 - Decrease dwell time
- B/P & weight
- Fluid shifts:
 - Increase concentration
 - Additives

Management Infants ESRD

- CAPD..continuous ambulatory peritoneal dialysis
 - Kids can go about their daily life
 - Often do it at night while child is sleeping
- Controlled Enteral Nutrition
- Recombinant Growth Hormone
- Erythropoietin
 - Helps to combat anemia
- Transplant