

CLINICAL
VIDEOCONFERENCING
Network

Pediatric Assessment Series: Renal System and Skin

March 9, 2004
8 AM - Noon

Presented by:
Beatriz Kuizon, MD
Jeffrey Mallin, MD, F.A.A.P.

Pediatric Assessment Series: Renal System

March 9, 2004

Presented by: Beatriz Kuizon, MD

Learning Objectives:

Upon completion of this program, each participant will be able to:

1. Review the anatomy and physiology of the renal and urinary systems.
2. Discuss the subjective and objective data necessary to do a thorough assessment of the urinary and renal systems.
3. State the purpose, patient preparation and nursing implications for common renal and urinary diagnostic tests, including KUB, IVP, Ultrasound, Nephrotomogram, MRI, Renal scan
4. State purpose, patient preparation, nursing and clinical implications for the following renal and urinary function laboratory data
5. Identify common signs and symptoms of body fluid disturbances that are potential problems for patients with renal disease.
6. Assess patients for risk factors related to the development of urinary tract infections.

Content Outline:

I. Review Anatomy and Physiology

II. History

III. Physical assessment

IV. Diagnostic Tests

A. Evaluation of bladder function

1. Measurement of residual urine
2. Cystometrogram

B. Laboratory Evaluation of Renal Functions

1. Urinalysis
2. Serum & Urine Glucose
3. Creatinine Clearance
4. Urea Clearance
5. Serum Creatinine
6. Urine protein
7. Serum Uric Acid
8. Serum & Urine Osmolality
9. Serum Magnesium
10. Serum Calcium

C. Visualization of urinary tract

1. KUB
2. IVP
3. Ultrasound
4. Nephrotomogram
5. MRI
6. Renal scan

V. Fluid and Electrolytes Balance

A. Fluid and electrolytes

B. Potential problems for patients with renal disease

C. Risk factors for Infection

VI. Case study

Terminology:

Anemia

Anuria

Azotemia

Cystitis

Dialysis

dysuria

enuresis

fistula

glomerulus

hematuria

micturition

nephron

nocturia

obstruction

oliguria

osmolality

polyuria

proteinuria

renal colic

sedimentation rate

specific gravity

urethral stricture

urethritis

urinary frequency

urinary incontinence

urinary urgency

vesicoureteral reflux stasis

Pediatric Rashes: Recognizing the Common and the Serious

09 March 2004

Jeffrey Mallin, MD, FAAP

*Department of Pediatrics, Kaiser Permanente Bellflower Medical Center
Director of Medical Education, Kaiser Permanente Bellflower Medical Center*

Outline

- I. Taking the History
- II. Inspecting the Rash
- III. Non-Skin Sites that Shouldn't be Forgotten
- IV. Colored Skin Changes
- V. Vascular Rashes
- VI. Petechiae and Purpura
- VII. Viral Rashes
- VIII. Bacterial Rashes
- IX. Soft-tissue (Primary Skin) Infections
- X. Kawasaki Syndrome
- XI. Allergic Rashes
- XII. Common Rashes Difficult to Diagnose
- XIII. Fungal Rashes
- XIV. Newborn Skin
- XV. Nevomelanocytic Nevi and Melanoma
- XVI. Triaging Rashes
- XVII. Rashes Associated with Bioterrorism

I. Taking the History

- a. Tell me about the rash. (Open-ended question)
- b. When did it begin?
- c. Where on the body did it begin?
- d. To where on the body has it spread?
- e. How has it changed over time? What makes it worse or better?
- f. Any other symptoms (fever, itch, pain, URI sx's, etc.)?
- g. Is it affected by sunlight?
- h. Anyone else with rash?
- i. Ever had this before?
- j. Any environmental exposures (travel, food, detergents, contacts, etc.)?
- k. Tried any OTC or Rx treatment(s)? If so, how effective?
- l. Taking any medicines (OTC or Rx) for any other reason?
- m. Any health problems?
- n. What do you think is the cause? (Open-ended question)

II. Inspecting the Rash

- a. Exposure
 - i. Pts must be disrobed (at least, to their undergarments). Offer gowns.
 - ii. All of the skin must be inspected even if the rash is supposedly localized!
- b. Lighting
- c. Palpation
 - i. Petechiae can only be picked up by palpation and are important and ominous.
 - ii. Use universal infection control procedures (gloves and hand washing).
- d. Characteristics
 - i. Type of lesion (flat, raised, fluid-filled, etc.)
 1. Macule, Patch – Flat color change
 2. Papule, Plaque, Nodule, Tumor – Elevated solid mass
 3. Wheal – Elevated area of superficial edema
 4. Vesicle, Bulla – Elevated mass with serous fluid in it
 5. Pustule – Elevated mass with pus in it
 - ii. Secondary Skin Changes
 1. Erosion, Ulcer, Fissure – Loss of skin surface
 2. Crust, Scale – Material on skin surface
 3. Lichenification – Thickened, roughened skin with visible skin furrows
 4. Atrophy – Thinning of skin with absence of skin furrows
 5. Excoriation – Abrasion or scratch mark
 6. Scar – Fibrous tissue replacing normal skin
 7. Burrow – Small tunnel in skin (commonly from scabies)
 - iii. Shape, margins, size
 - iv. Distribution or anatomic location (generalized localized, intertriginous, flexural, sun-exposed surfaces, truncal, peripheral, etc.)
 - v. Arrangement or pattern (linear, clustered, annular, dermatomal, etc.)
 - vi. Color
 - vii. Temperature
 - viii. Response to blanching

III. Non-Skin Sites that Shouldn't be Forgotten

- a. Eyes (jaundice, conjunctivitis, tearing, discharge, allergic shiners)
- b. Nail beds (cyanosis, capillary refill time, peeling skin, nail pitting, nail growth arrest lines)
- c. Hair and scalp (hair color and distribution, scalp lesions)
- d. Mouth (cyanosis, pharyngitis, vesicles, strawberry tongue, fissuring of lips, Kopplitz spots, thrush)
- e. Lymph (node enlargement or tenderness, liver/spleen enlargement)
- f. Vital signs (BP for hypotension/shock, HR for tachycardia, Temp for fever or hypothermia, RR for work of breathing)

IV. Colored Skin Changes

- a. Cyanosis
 - i. Peripheral cyanosis – Observe the fingers and toes
 - ii. Central cyanosis – Observe the lips, face, and mucous membranes of mouth
- b. Jaundice (palpate the skin and examine the sclera under the eyelids)
- c. Carotonia (well-appearing, no scleral icterus, eating lots of orange/yellow foods)

- d. Café-Au-Lait Spots (consider neurofibromatosis if large & # >5, or axillary freckles)
- e. Post-Inflammatory Hyperpigmentation (darkening after a more acute rash)
- f. Vitiligo (depigmented macules)

V. Vascular Rashes

- a. Hemangioma (grow until 6 mo age, then 75% involution by age 5-6 yrs)
 - i. Superficial (“strawberry”)
 - ii. Cavernous (blue, doughy mass within dermis)
- b. Port Wine Stain (remain flat and stable; darken in adult years)
 - i. Klippel-Trenaunay-Weber Syndrome – hemihypertrophy of assoc. extremity
 - ii. Sturge-Weber Syndrome – trigeminal (eye) nerve w/ intracranial involvement
- c. Salmon Patch (Stork Bite)
 - i. Capillary malformations seen in 50% of newborns and fade in 1st year
 - ii. Pink patches on back of neck, upper eyelids, forehead, lower back
- d. Cherry Angioma (increase in size and numbers with age; benign)
- e. Pyogenic Granuloma (vascular overgrowth of granulation tissue; often needs excision)

VI. Petechiae and Purpura

- a. Take-Home Lessons When Petechiae or Purpura are Seen
 - i. Serious, life-threatening illnesses (LTI) must always be considered
 - ii. Immediate action must be taken to halt the progression of the LFI
 - iii. Some of the LTI are associated with well-appearing patients
 - iv. All of the benign causes are associated with well-appearing patients
- b. Size Classification
 - i. Petechiae (small, pinpoint capillary hemorrhages)
 - ii. Purpura (larger, superficial vascular hemorrhages)
 - iii. Ecchymoses (large vascular hemorrhages along planes of fascia)
- c. Physiologic Causes of Petechiae
 - i. Decrease in platelet function (von Willebrand disease)
 - ii. Decrease in platelet numbers (ITP, leukemia, HUS, DIC)
 - iii. Defect in blood vessels (sepsis, HSP, drugs, scurvy, trauma)
- d. Key Historical Factors
 - i. Rapidity of onset
 - ii. Associated signs of systemic illness
 - iii. Localization of petechiae and purpura
- e. Benign Conditions
 - i. Vascular rashes (above)
 - 1. Nonacute, localized, without systemic symptoms, well-appearing
 - ii. Factitious (cupping, coining, suction home remedies)
 - 1. Acute, localized, with known specific inciting event, well-appearing
 - iii. Valsalva maneuvers (forceful coughing, vomiting, or crying; weight lifting)
 - 1. Acute, localized to face/neck, known inciting event, well-appearing
- f. Concerning Conditions
 - i. Infection
 - 1. Bacterial (e.g., meningococcemia, endocarditis)
 - 2. Disseminated Intravascular Coagulation (DIC)
 - 3. Ricettisal (e.g. Rocky Mountain Spotted Fever [RMSF])

4. Viral (e.g., STORCH)
5. Hepatitis
- ii. Leukemia, lymphoma, neuroblastoma, and other cancers
 1. Fatigue; weight loss; bone pain; adenopathy; pallor; splenomegaly
- iii. Child abuse or trauma
 1. Bruises with clearly delineated borders or distinct configurations of a hand or implements; bruises over non-bony surfaces (neck, groin, axilla); circumferential marks; child may be well-appearing
 2. History is inconsistent w/ findings or not developmentally appropriate for age
- iv. Coagulation disorders (von Willebrand disease, hemophilia)
 1. Large bruise; clear mechanism of injury; consistent history; well-appearing (unless intracranial bleed); possible known history of disorder
- v. Idiopathic Thrombocytopenic Purpura (ITP)
 1. Viral illness 1-3 wks earlier; nosebleeds in 25%; age 1-9 yrs; normal spleen; well-appearing; normal exam otherwise; platelet count < 20,000
- vi. Henoch-Schonlein (Anaphylactoid) Purpura (HSP)
 1. Ankles, legs, buttocks, and distal arms often involved; red macules become petechiae that become purpura; 70% have URI 1-3 wks before; fatigue, low-grade fever before rash; arthritis (70%), abdominal symptoms (85%), and bloody stool (50%) can precede or be coincident with the rash; intussusception & renal disease are complications
- vii. Hemolytic Uremic Syndrome (HUS)
 1. Ill-appearing with pallor, petechiae and/or purpura; irritable or drowsy; elevated BP; distended, tender abdomen; preceding hx of bloody or watery diarrhea w/ crampy abdominal pain; typically associated w/ *E. coli* subtype 0157:H7 (produces a Shigella-like toxin); CBC shows anemia, thrombocytopenia, & fragmented RBCs; 10% have persistent renal insufficiency or hypertension

VII. Viral Rashes (Exanthems)

- a. Coxsackie (Hand-Foot-and-Mouth Disease)
 - i. Small, red, mildly painful vesicles and yellow ulcers on mucosal surfaces in mouth
 - ii. Small, red macules and vesicles on palms, soles, feet, fingers, buttocks
 - iii. When only oral lesions are present, disease is called herpangina
 - iv. Preceding low-grade fever, fatigue, sore mouth 1-2 days before the oral lesions
 - v. Cause: Coxsackievirus A16 in 90%; other enteroviruses in 10%
 - vi. Highly contagious, peak in summer to early fall, incubation 2-6 days, sx's last 2-7 days
- b. Roseola (Exanthem Subitum)
 - i. Preceding rapid-onset of high fever and irritability for few days without a source
 - ii. Non-toxic appearing child
 - iii. Fever abruptly subsides & erythematous maculopapular rash starting on the trunk
 - iv. Cause: Human herpesvirus 6
 - v. All year, but more in late fall & early spring; rash lasts 1-2 days, incubation 10-15 days
 - vi. Common in children 6 to 36 months; not very contagious
- c. Fifth Disease (Erythema Infectiosum)
 - i. Rash begins on face w/ both cheeks bright red cheeks without tenderness
 - ii. As face rash fades, lacy, slightly raised, red rash comes on extremities then spreads

- iii. Fever and other symptoms are rare
- iv. Cause: Parvovirus B19
- v. All year, but more in late winter & early spring; young children; resolves in 3-7 days
- vi. Mildly contagious; can be associated with RBC suppression (aplastic crisis)
- d. Varicella (Chickenpox)
 - i. Erythematous papules that become thin-walled vesicles with red halos; itchy rash
 - ii. Lesions appear in crops and evolve over hours and different stages seen at same time
 - iii. Rash preceded by low-grade fever, URI sx's, fatigue
 - iv. Cause: Varicella-zoster virus (a herpesvirus)
 - v. All year, but more in late fall and late winter to early spring; incubation 10-20 days
 - vi. Highly contagious from 1-2 days before the rash and continuing until all are crusted
- e. Herpes Zoster (Shingles)
 - i. Grouped, thin-walled vesicles on red base, distributed along a nerve root (dermatome)
 - ii. Pain or over-sensitivity may accompany, precede, or follow rash
 - iii. Fever and systemic symptoms are not common, but lymph node enlargement is
 - iv. Cause: Varicella-zoster virus (a herpesvirus)
 - v. Rash crusts in several days and is then no longer contagious
 - vi. Contagious to those who have not had varicella, but can be covered to reduce risk
- f. Infectious Mononucleosis
 - i. Usually erythematous maculopapular rash seen in 5-10% of pts with mononucleosis and in higher % of pts given ampicillin
 - ii. Rash is preceded by 3-5 days of fluctuating fever, pharyngitis (+/- exudates), fatigue, cervical lymph node enlargement, splenomegaly (late, 50%), hepatomegaly (in 10%)
 - iii. Cause: Epstein Barr virus (EBV)
 - iv. Contagious by intimate oral contact, sharing eating utensils; incubation 30-50 days
- g. Adenovirus
 - i. Nonspecific, generalized, maculopapular lesions occasionally accompany infection
 - ii. Classically rash is associated w/ conjunctivitis (w/o pus), pharyngitis, cervical or preauricular lymph node enlargement, rhinitis, and low-grade fever
 - iii. Peak in late winter to early summer; incubation 6-9 days; contagious in 1st few days
- h. Herpes simplex
 - i. Yellow ulcerations with red halo on mucosa, gingival, tongue, palate, tonsillar pillars
 - ii. High fever, irritability, drooling, mouth pain
 - iii. Can develop halitosis, bleeding gingival, white debris on tongue, cervical lymph node enlargement, dehydration (from anorexia); spread to fingers & eyes (risk of blindness)
 - iv. Cause: Herpes simplex virus 1 (HSV-1)
 - v. Only 10% of primary (first) infections with HSV-1 have symptoms
 - vi. Symptoms last 5-14 days, but virus sheds for weeks and remains contagious
 - vii. After primary infection, virus is latent in area nerve ganglia and can reactivate w/ stress
 - 1. Preceding the rash of reactivated HSV are burning and itching in the mouth
 - 2. Vesicles are smaller (than in primary) and systemic symptoms are uncommon

VIII. Bacterial Rashes

- a. Scarlet Fever (*Streptococcus pyogenes*)
 - i. Red skin with fine pinhead-sized papules (sandpaper texture on palpation), accentuated in skin folds, followed by linear petechiae along skin folds (Pastia lines)

- ii. Tonsils are large, red, and with exudates; palatal redness or petechiae; tongue with white coating with red papillae (“white strawberry tongue”) that then becomes red; tender cervical lymph nodes
 - iii. Rash preceded by fever, chills, headache, sore throat, vomiting, abdominal pain
 - iv. Desquamation occurs even with treatment as a late finding
 - v. Cause: toxin excreted by Group A beta-hemolytic streptococcus
 - vi. All year, but more common in winter and spring; incubation 0.5-7 days; very contagious
 - vii. Treatment shortens course, reduces contagion, prevents rheumatic fever and abscesses
- b. Staphylococcal Scalded Skin
- i. Diffuse redness (like a sunburn) that spreads from head to toe, then thin-walled bullous lesions appear that then rupture, then the skin dries and forms thick flakes
 - ii. Epidermis can be rubbed off leaving a raw, weeping surface (Nikolsky sign)
 - iii. In severe cases, may appear toxic and in severe pain
 - iv. Rash is preceded by fever, irritability, vomiting
 - v. Cause: exotoxin from phage group II coagulase-positive staphylococcus that has entered the body from impetigo, skin infections, or nasopharyngitis
- c. Toxic Shock Syndrome (Staphylococcus)
- i. Diffuse redness (like a sunburn) that becomes petechial or maculopapular, then desquamation occurs 1wk later with thick sheets of shedding on the palms and soles
 - ii. Rash is preceded by escalating symptoms of fever, fatigue, myalgias, vomit, weakness
 - iii. Associated w/ conjunctivitis, pharyngitis, strawberry tongue, watery diarrhea, hypotension, altered levels of consciousness, acute respiratory distress syndrome
- d. Meningococcal Infection (Sepsis)
- i. 90% get meningitis as the primary meningococcal infection (no rash)
 - ii. 10% get sepsis as the primary manifestation of infection (85% of these have rash which can be maculopapular or petechial or purpuric and prominent on extremities)
 - iii. Rash is preceded by URI sx's and fever & then an abrupt change w/ toxic appearance
 - iv. When course is rapid, mortality up to 40% (most in 24hrs) from DIC, shock, myocarditis
 - v. Clinically hard to distinguishable from other forms of bacterial sepsis, bacterial endocarditis, Rocky Mountain spotted fever, and leukemia
 - vi. Common under 5 yrs age (mostly 6-12 mo) and adolescence (dorms, military, daycare)
 - vii. All year, but common in late winter and early spring; incubation 1-10 days

IX. Soft-Tissue (Primary Skin) Infections

- a. Folliculitis
 - i. Red papules at base of hair shaft, then become pustules with thin red rim
 - ii. Cause: superficial infection of hair follicles commonly with *Staphylococcus aureus*
- b. Impetigo
 - i. Infection of epidermis commonly around the nose, mouth, face
 - ii. Group A streptococcus causes papule that becomes vesicular that ruptures and crusts
 - iii. *Staphylococcus aureus* causes larger bullae of bullous impetigo
 - iv. Occasionally assoc with itching, regional lymph node enlargement, or recent URI sx's
 - v. Very contagious to others and self (autoinoculation)
- c. Cellulitis
 - i. Painful, tender, hardened subcutaneous swelling with warm, red, shiny skin
 - ii. Indistinct borders and spreads by extension
 - iii. Assoc w/ fever, chills, malaise; can appear toxic when infection spreads to blood

- d. Abscess
 - i. Localized collections of pus buried within a tissue or confined space
 - ii. Usually start as an area of superficial infection (folliculitis, cellulitis, etc.)
 - iii. Paronychia (periungual abscess) – under the cuticle or along the finger/toe nail fold
 - iv. Furuncle – dermal abscess near the hair follicle
 - v. Requires incision and drainage procedure, oral antibiotics, and close observation
- e. Lymphangitiis
 - i. Bacterial infection of lymphatic vessels that migrate toward regional lymph nodes
 - ii. Red, irregular, linear streaks (+/- tenderness) extending toward draining nodes
 - iii. Occasionally assoc w/ fever, chills, malaise
 - iv. Without treatment, leads to cellulitis, necrosis, or ulceration
- f. Necrotizing Fasciitis
 - i. Severe, deep, necrotizing infection in subcutaneous tissue extending to muscle
 - ii. May look like cellulitis, but palpation reveals edema, unusual firmness, and tenderness
 - iii. Moderate or severe systemic symptoms, including fever and severe pain
 - iv. Suspect when cellulitis looks mild but the pain & systemic symptoms are more severe
 - v. Mortality: 8-70% depending on bacteria involved
 - vi. Treatment: wide excision, debridement, antibiotics

X. Kawasaki Syndrome

- a. Classic clinical diagnostic criteria
 - i. Fever for more than 5 days, and
 - ii. No other known disease process can explain the symptoms, and
 - iii. Four of the following:
 - 1. Bilateral conjunctival injection (without eye discharge or crusting)
 - 2. Mucous membrane changes (injected or dry lips, injected pharynx, or strawberry tongue)
 - 3. Extremity changes (edema, desquamation, or peripheral erythema)
 - 4. Rash (typically truncal and nonvesicular)
 - 5. Cervical lymphadenopathy (not a very common finding [approx 60%])
- b. Atypical KS can be diagnosed without all of the criteria, especially in children < 1 yr old
- c. Three phases of KS
 - i. Acute phase (first 7-14 days)
 - 1. High spiking fever (to >40°C) preceding other symptoms noted above
 - 2. Rash can take on different forms, be itchy, and involve the genital area
 - 3. Redness and edema of hands and feet with refusal to walk
 - 4. Subtle cardiac findings include tachycardia, irregular beats, & murmurs
 - 5. Arterial aneurysms can occur (most notably in coronary arteries in 20%)
 - ii. Subacute phase (days 10-25)
 - 1. Desquamation of feet more than hands
 - 2. Lip cracking and onset of arthralgias and cardiac disease
 - iii. Convalescent phase (days 21-60)
 - 1. No clinical symptoms, but ongoing inflammation
 - 2. Beau's lines seen on nails (deep grooves from arrested nail growth)
- d. Mortality: 1% die (85% of deaths are within the first 10-40 days of illness) from cardiac
- e. Treatment: Intravenous immunoglobulin (IVIG) and high-dose aspirin

XI. Allergic Rashes

a. Atopic Dermatitis (Eczema)

i. Clinical Presentation

1. Itchy, dry, scaling, erythematous patches (papular in Black children)
2. Poorly defined margins
3. Often spares moist, intertriginous areas (axilla, groin)
4. Associated w/ excoriations, exudate, lichenification, hyper-/hypo-pigmentation)
5. Young infants: widespread or localized on face
6. Older infants: extensor (back) of arms, wrist, legs
7. Children and Teens: flexor areas (folds) of elbows, knees, wrist, neck
8. Assoc findings: Dennie-Morgan folds (under lower eyelids), susceptibility to develop warts, herpes simplex, molluscum, and other atopic conditions (asthma, hayfever, food allergies)
9. Of childhood eczema, 75% improve by 10-14 yrs; 25% become chronic

ii. Treatment

1. Understanding chronicity
2. Lubricants immediately following short baths or showers
3. Humidifiers in dry months
4. Mild soaps (Dove®, Cetaphil®, Eurcerin®)
5. Topical steroids (ointment or emollient base)
 - a. Side effects: atrophy, telangiectasia, folliculitis, striae, hypertrichosis, acne, hypopigmentation, secondary infections
6. Nonsteroidal immunomodulators (Protopic®, Elidel®)
7. Oral antihistamines (diphenhydramine OTC, Atarax®)
8. Nails short and clean; avoid scratching
9. Short course of oral steroids (rarely needed)
10. Restrict eggs and milk (rarely needed)

iii. Secondary Infections

1. *Staphylococcus aureus*
2. Group A *beta-hemolytic streptococcus*
3. *Staphylococcus epidermidis* (bullous impetigo)
4. *Herpes simplex* (eczema herpeticum)

b. Contact Dermatitis

- i. Acute, localized erythema w/ crusting or blistering
- ii. Specific inciting direct contact w/ environmental irritant
- iii. Poison ivy, sumac, oak; nickel from metal belt buckles, snaps, necklaces
- iv. Treatment: may require oral steroids; antihistamines

c. Urticaria (Hives)

- i. Sudden appearance, transient, very itchy
- ii. Well-demarcated wheals that may coalesce with central clearing
- iii. Causes: food, drugs, insect bites, contact or inhaled agents, acute infections (streptococci and viruses)
- iv. Serum sickness-like reaction: hives, stocking-glove angioedema, & joint swelling
- v. Severe reaction can be associated w/ wheezing, facial swelling, airway edema
- vi. Treatment: antihistamines; local care; occasionally oral steroids

d. Erythema multiforme (EM)

- i. Acute allergic reaction from drugs, viruses, bacteria, foods, immunizations

- ii. Erythema multiforme Minor
 1. Dusky red macules or wheals that evolve into target-lesions
 2. Common on palms and soles
 3. Less itchy than hives; can become painful
 4. Associated w/ mild fever, fatigue, muscle aches
 5. Self-limited but crops last 1-3wks
- iii. Stevens-Johnson Syndrome (EM Major)
 1. Rare, life-threatening with vesicles, bulla, and tissue sloughing
 2. Common on head, neck, proximal extremities
 3. Ill-appearing w/ high fever, URI sx's, vomiting, diarrhea, arthralgias
 4. Mucous membranes involved (oral, conjunctival, urethral)
 5. Mortality: 5-25%; Treatment: IV Fluids, prevention of secondary infxn
- e. Drug Rash
 - i. Can present as many different kinds of rashes and to many different drugs
 - ii. Commonly (75%) are erythematous maculopapular (measles-like)
 1. Usually 5-14 days after starting a medicine
 2. Starts on face, trunk then spreads distally to extremities; resolve 1-2wks
- f. Itching
 - i. Common causes: excessive bathing, bubble bath, wool, cold, sweat, dryness, retained laundry detergent
 - ii. Instigating ingredients: lanolin, parabens, thimerosal (merthiolate), diphenhydramine, neomycin, lidocaine, xylocaine, ethylenediamine
- g. Allergic Reactions
 - i. Mild: rash and itch
 - ii. Moderate: hives, itching, mild local edema, mild dizziness, fatigue
 - iii. Severe: generalized hives or hives around mouth/neck, rapid onset or rapidly progressing rash or sx's, severe edema, syncope, blurry vision, disorientation, short of breath, wheezing, Stevens-Johnson Syndrome (mucous membrane involvement)

XII. Common Rashes Difficult to Diagnose

- a. Henoch-Schonlein Purpura versus Mongolian Spots versus Trauma (see above)
- b. Warts versus Molluscum Contagiosum
 - i. Warts (Human papillomavirus)
 1. Discrete, round papules w/ roughened surface & black dots (vessels)
 2. Plantar warts disrupt skin lines, unlike calluses (which are smooth)
 3. In children, common on fingers, hands, feet
 4. Usually self-limited and resolve within 5 yrs
 - ii. Molluscum contagiosum (Poxvirus)
 1. Sharply circumscribed, single or multiple, skin-colored, dome-shaped papule with waxy surface and umbilicated (depressed dot) center
 2. May have a white, curdlike core in center (molluscum body)
 3. Usually asymptomatic or minimally itchy
 4. Spontaneously resolve in 2-3yrs; curettage removal if desired
- c. Ringworm (Tinea Corporis) versus Pittyriasis Rosea
 - i. Tinea Corporis
 1. Itchy, annular lesion w/ central clearing and expands over weeks
 2. Border is distinct, vesicular, raised, or scaly

3. Spreads by autoinoculation or to close contacts
4. Acquired by human (*Trichophyton*) or animal (*Microsporum*) contact
- ii. **Pityriasis Rosea**
 1. Herald patch first
 2. Christmas tree pattern of small macules and raised ovals w/ scales
 3. Peaks in several weeks then fades over 2-3 months
 4. Peak incidence in late winter; low recurrence rate (prob viral etiology)
 5. Treatment: anti-itch measures, sunlight exposure
- d. **Insect Bites versus Scabies**
 - i. **Insect Bites**
 1. Exposed areas often involved; localized or generalized
 2. Common in warmer months (fleas from animals can bite year-round)
 3. Central punctum or papule at site of bite with erythematous surround
 - ii. **Scabies**
 1. Very itchy papules, pustules, vesicles, and burrows – 4-6wks after contact
 2. Fingers, toes, axillae, wrists, elbows, waistband area, buttocks, groin
 3. Cause: *Acarus scabiei* (8-legged mite; microscopic)
 4. Treatment: 5% permethrin (Elimite®) to all household members; thorough cleansing of clothes, bedding, etc.; anti-itch treatment
 5. Rash and itch can persist long after treatment
- e. **Dandruff (Seborrhea) versus Head Lice**
 - i. **Seborrheic Dermatitis**
 1. Scaling, greasy, non-itchy rash over hair-bearing & intertriginous areas (scalp, eyebrows, perinasal, presternal, neck, axilla, groin)
 2. Cradle cap (infants), dandruff (teens)
 3. Cause unknown: *Pityrosporum* or *Candida*
 4. Treatment: topical steroid, topical antifungal, dandruff shampoo
 5. Most resolve spontaneously
 - ii. **Head Lice**
 1. Scalp itching with secondary excoriations
 2. Nits (eggs): oval white 0.5mm dots glued to hair shaft 1-3cm from scalp and commonly above/behind ears; nits can not be moved along hair shaft
 3. Cause: *Pediculus humanus capitus* (6-legged insect visible to the eye)
 4. Treatment: pediculicide to all household members; thorough cleansing of clothing, bedding, etc.; fine-tooth combing to remove nits
 5. Dead nits do not need re-treatment or require exclusion from school
- f. **Pityriasis Alba versus Vitiligo versus Albinism**
 - i. **Pityriasis Alba (common)**
 1. Poorly defined, hypopigmented, scaly patches, commonly on face
 2. Can be associated with atopic dermatitis
 3. Treatment: observe; topical steroids; lubricants; sunscreen
 - ii. **Vitiligo (rare)**
 1. White macules around eyes, mouth, genitals, elbows, hands, feet
 2. Cause: autoimmune destruction of melanocytes in the areas involved
 - iii. **Albinism (rare)**
 1. Congenital hypopigmentation of skin, eyes, and hair

2. Inherited with several variants w/ high risk of developing skin cancer
- g. Phytophotodermatitis
 - i. Photosensitivity reaction to something accidentally applied to the skin (juice of lemon, lime, celery, carrots, clover, or buttercup plant)
 - ii. Patchy, linear, or irregular configuration (reflecting the splash, wipe, or contact area)
 - iii. Initially, erythematous, raised, or blistering, then becomes hyperpigmented

XIII. Fungal Rashes

- a. Tinea corporis (body) (see section above)
- b. Tinea capitis (scalp)
 - i. Mild cases cause scalp redness and scaling with areas of partial balding
 - ii. More severe cases have widespread hair breakage (black dots, salt-and-pepper)
 - iii. Kerion – raised, tender, boggy, oozing masses of pustules
 - iv. Causes: *Trichophyton tonsurans* (95%); *Microsporum canis* (10% -- dog/cat variety)
 - v. Very common among blacks
 - vi. Topical tx is ineffective; selenium sulfide shampoo 2.5% reduces contagiousness
- c. Tinea pedis (athlete's foot)
 - i. Scaling, fissuring, vesicles, and pustules especially between toes, on sides of toes and tops and bottoms of feet
 - ii. Associated with burning, itching, foul odor; made worse by retained moisture and sweat
- d. Tinea cruris (jock itch)
 - i. Peripherally advancing lesion w/ sharply demarcated, scaly border and central clearing
 - ii. Located in groin or gluteal cleft and spares the scrotum; itching is common
- e. Tinea unguium (onycomycosis)
 - i. Discoloration (often yellowing), thickening, crumbling of affected toenails or fingernails
 - ii. Difficult to eradicate and may recur
- f. Tinea versicolor
 - i. Multiple small, oval, minimally scaly, 1-3cm patches in raindrop pattern on upper chest, back, proximal arms
 - ii. Lesions can be light tan, reddish, or white in color; darker in non-sun-exposed areas
 - iii. Usually asymptomatic or with mild itching
 - iv. Cause: *Pityrosporum obiculare*
 - v. Treatment: selenium sulfide; can take months for lesions to clear; often recurs
- g. Topical treatment – first line treatment for tinea corporis, pedis, cruris, and versicolor
 - i. Often requires more than 1-2 weeks of treatment
 - ii. Nystatin (Rx) for candida only: thrush and candida diaper rash
 - iii. Imidazoles (Clotrimazole, Miconazole, Econazole), terbinafine (Lamisil®) (all OTC) for tinea and candida
 - iv. Selenium sulfide solution (Selsun Blue®, Sebulex®) for tinea versicolor (*Pityrosporum*) and as adjunctive (additional) treatment for tinea capitis
- h. Oral treatment – first line treatment for tinea capitis and unguium
 - i. Often requires more than 6-12 weeks of treatment
 - ii. Can be used for shorter durations as second-line treatment for other tinea
 - iii. Common agents: griseofulvin (Fulvicin®), terbinafine (Lamisil®)
- i. Recurrences are common for all types of fungus regardless of treatment

XIV. Newborn Skin

- a. Umbilical Cord Care
 - i. Triple Dye
 - ii. Isopropyl (rubbing) alcohol
 - 1. Studies do not indicate significant differences in cord separation
 - a. With alcohol, 10 days (range: 2-29 days)
 - b. Without using alcohol, 8 days (range: 1-24 days)
 - iii. Avoid iodine (Betadine®) products
- b. Bathing
 - i. Every other day is probably sufficient (especially in non-diaper areas)
 - ii. Hypo-allergenic and non-perfumed soaps when soap is used
 - iii. Rinse soap off thoroughly with clean water
- c. Moisturizers
 - i. Hypo-allergenic and non-perfumed products
 - ii. Useful in diaper area after cleaning stools
- d. Diapers and Diaper Care
 - i. Diaper rashes occur in babies who wear diapers
 - ii. Cloth vs. disposable: Currently available disposable diapers are better
 - 1. Launder cloth diapers without bleach/fabric softener and double rinse
 - 2. Avoid plastic underpants (retains moisture)
 - iii. Barrier creams to prevent rashes:
 - 1. Zinc oxide, Triple paste, Desitin®, A&D ointment®, etc.
 - 2. Pastes & ointments better protect from moisture than lotions do
 - iv. Avoid powders and talcs (risk of inhalation pneumonitis from breathing it in)
 - v. Change diaper immediately after soiling and let air out as much as possible
- e. Diaper Dermatitis
 - i. Candida diaper dermatitis
 - 1. Intensely red with sharp borders
 - 2. "Satellite" lesions are common
 - 3. Inguinal folds often involved
 - 4. Associated with oral thrush and/or antibiotic use
 - 5. Causes: *Candida albicans*
 - 6. Treatment: Imidazoles (OTC) or Nystatin (Rx)
 - ii. Irritant diaper dermatitis
 - 1. Pink and shiny
 - 2. Convex areas involved where the diaper touches
 - 3. Inguinal skin folds often spared (not involved)
 - 4. Causes: moisture, fecal enzymes, ammonia, frequent/loose stools
 - 5. Treatment: ordinary measures
- f. Newborn Rashes
 - i. Seborrhea (cradle cap or seborrheic dermatitis) (see Common Rashes, above)
 - ii. Salmon patches (nevus simplex lesions) (see Vascular Rashes, above)
 - iii. Mongolian spots (dermal melanocytosis)
 - 1. Flat, gray or blue-black, poorly demarcated macules present at birth
 - 2. Common in lower back and buttocks but can be anywhere
 - 3. Incidence: 90% Black infants, 80% Asian, 10% White
 - 4. Cause: accumulation of melanocytes within dermis; fade by age 7

- iv. Milia
 - 1. Firm, whitish-yellow 1-2mm papules that develop on the face
 - 2. Cause: epithelial-lined cysts from the hair follicles
 - 3. May resolve spontaneously over months to years
- v. Miliaria rubra (prickly heat rash)
 - 1. Face, neck skin folds, upper trunk
 - 2. Treatment: corn starch, avoid tight-fitting clothes and greasy lubricants
- vi. Erythema toxicum
 - 1. Erythematous (red) area with central papule or pustule (like flea bites)
 - 2. Common in full-term newborns at 1-2 days of age & fades within 5-7 days
 - 3. Cause unknown; benign
- vii. Neonatal acne
 - 1. Acne-like lesions on cheek, forehead, upper chest in first weeks of life
 - 2. From maternal hormonal stimulation; resolves over 4-6 wks
- viii. Sebaceous gland hyperplasia
 - 1. Over nose and cheeks at birth, 1-2 mm white papules
 - 2. From maternal hormonal stimulation; resolves by 4-6 months
- ix. Cutis Marmorata
 - 1. Transient net-like reddish mottling common in the first 6 months of life
 - 2. Chilling (being cold) causes vessel constriction and dilation
- x. Epidermolysis bullosa (EB)
 - 1. Some types can present at birth w/ generalized bulla, blisters, erosions
 - 2. Junctional EB: autosomal recessive; can be fatal in 1st year of life
 - 3. Skin biopsy distinguishes the different types
 - 4. Treatment: fluid management, infection prevention

XV. Nevomelanocytic Nevi and Melanoma

- a. Congenital Nevi
- b. Giant Congenital Nevi (>20cm, assoc w/ 2-5% lifetime risk of progression to melanoma)
- c. Acquired Nevi
- d. Melanomas
 - i. Changes in nevi that portend development of melanoma (The “**ABCDEs**”)
 - 1. **A**symmetry
 - 2. **B**order changes (irregular, scalloped)
 - 3. **C**olor changes (black; brown; mixture of red, white, or blue)
 - 4. **D**iameter (larger than 6mm)
 - 5. **E**levation changes (elevations, bleeding, scaling, ulcerations)
 - 6. **S**ensation (burning, itching, tenderness)
 - ii. Risk Factors
 - 1. Family history of melanoma
 - 2. Light skin
 - 3. Presence of atypical nevi or more than 50 nevi
 - 4. Immunosuppression
 - iii. Protective measures
 - 1. Avoid unnecessary sun exposure (especially at midday)
 - 2. Sunscreen
 - 3. Inspecting the skin (check non-exposed areas also)

- a. Monthly self-exams
- b. Clinician screen q3yrs (age 20-39), yearly (age 40+)
- e. Sunscreen Tips
 - i. Ultraviolet Rays
 - 1. UV-B – most common cause of skin cancer
 - 2. UV-A – photoaging effects
 - 3. UV-C – most carcinogenic ray but blocked by atmospheric ozone
 - ii. Sun Protection Factor (SPF)
 - 1. # of minutes for treated vs. untreated skin to redden w/ UV-B exposure
 - 2. SPF-15 is sufficient; higher SPF adds only a small, additional benefit
 - iii. Application
 - 1. Thirty to 60 minutes before sun exposure
 - 2. Reapply every couple hours and after swimming
 - iv. Active Components
 - 1. PABA: blocks UV-B rays best
 - 2. Benzophenones: block UV-A rays best
 - 3. Titanium dioxide: blocks both UV-A and UV-B rays

XVI. Triaging Rashes

- a. Associated symptoms that should prompt urgent evaluation
 - i. Acute onset or acute worsening
 - ii. Ill-appearance
 - iii. Fever
 - iv. Systemic symptoms
 - v. Petechiae (especially below the neck and not associated with Valsalva)
 - vi. Suspected abuse or trauma
 - vii. Severe itching
 - viii. Pain
 - ix. Peeling skin
 - x. Involvement of palms or soles (and not clearly tinea)
 - xi. History of environmental exposure
 - xii. Taking a medicine that could illicit an allergy
- b. Rashes that can be safely evaluated non-urgently
 - i. Rash that has been there for weeks or months without significant change and without a history of systemic symptoms, other than mild itching. (For example: tinea, atopic dermatitis, seborrhea, warts, molluscum contagiosum, benign nevi)
 - ii. Rash whose diagnosis is clear, certain, and benign

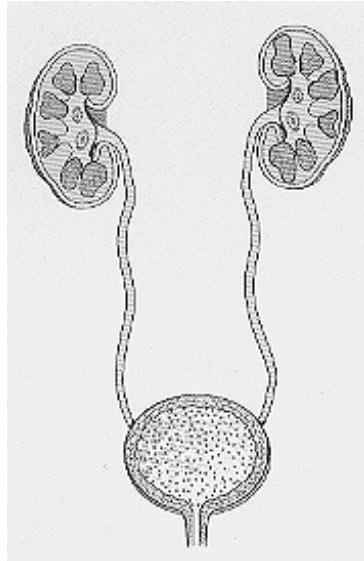
XVII. Rashes Associated with Bioterrorism

- a. Anthrax
 - i. Contagious: Not at all
 - ii. Incubation period: 1-5 days (with range up to 43 days)
 - iii. Diagnosis: Gram-positive rods w/ squared-off ends (safety pin appearance); PCR
 - iv. Treatment: Antibiotics and 3 doses of vaccine
 - v. Prophylaxis: Antibiotics until 3 doses of vaccine are given or until 60 days post-exposure
 - vi. Isolation: None

- vii. Cutaneous anthrax
 1. Single lesion that evolves: Small, painless, itchy papule → ring of vesicles coalesce into a larger vesicle → vesicles rupture to form a depressed ulcer → scab develops in center (7-10 days from onset) → scab falls off after 1-2 weeks → permanent scar remains
 2. Associated symptoms: Fever, headache, myalgias, regional lymph node enlargement, "malignant edema"
 3. Fatality: If untreated, up to 20%. If treated, less than 1%
- viii. Inhalation Anthrax
 1. Initial phase: Flu-like symptoms
 2. Acute phase: 2-5 days later come respiratory distress, stridor, cyanosis, high fever, edema of chest and neck, moist rales on lung exam
 3. Chest x-ray: Mediastinal widening
 4. Meningitis develops in up to 50%
 5. Clinical course: Shock and death in 24hrs in up to 90% despite antibiotic therapy
- ix. Gastrointestinal anthrax
 1. Intestinal presentation: Nausea, vomiting, anorexia, fever, progressing to bloody emesis and stools and acute abdomen
 2. Oropharyngeal presentation: Lesion on mucosa of mouth or pharynx, progressing to fever, trouble swallowing, lymphadenopathy, cervical edema, necrosis
 3. End-stage: Toxemia, shock, cyanosis; death in 25-60%
- x. Antibiotics
 1. Penicillin, Amoxicillin, Doxycycline, Ciprofloxacin
 2. Duration of treatment:
 - a. Cutaneous Anthrax: 14 days
 - b. Inhalation and GI Anthrax: Until 3 vaccine doses are given, or for 60 days if not vaccinated
- xi. Vaccine
 1. Schedule: q2wks x3, then q6months x3, then annual boosters
 2. Adverse reactions: Local tenderness and redness (30%), systemic reactions (2-3%)
- b. Smallpox
 - i. Clinical presentation
 1. High fever, malaise, abdominal pain, and back ache come before rash
 2. Macular red rash 2-3 days later, starting on face then spreading all over, but prominently on extremities
 3. Rash progresses to vesicles, then to pustules, then to crusty scabs
 - ii. Contagious: Highly, especially in the first week (when pt is typically the sickest)
 - iii. Incubation period: 12-14 days (range 7-17 days)
 - iv. Diagnosis: Vesicle fluid culture
 - v. Treatment: Supportive; antivirals (?)
 - vi. Prophylaxis: Vaccine within 3 days of exposure and quarantine for 17 days
 - vii. Isolation: Strict, until all scabs separate
 - viii. Features different from chickenpox (*Varicella*)
 1. More lesions on face and extremities

2. More common on palms and soles
 3. All lesions progress at the same rate and are at the same stage
 4. More deeply embedded in the skin (more scarring)
- ix. Vaccine
1. Application: 15 strokes of a needle until the site bleeds
 2. Contraindications: Eczema, immune suppression, pregnancy
 3. Adverse effects: Smallpox in 3 per 10,000; encephalitis in 3 per million recipients

Anatomy and Physiology



Unipapillary Kidney

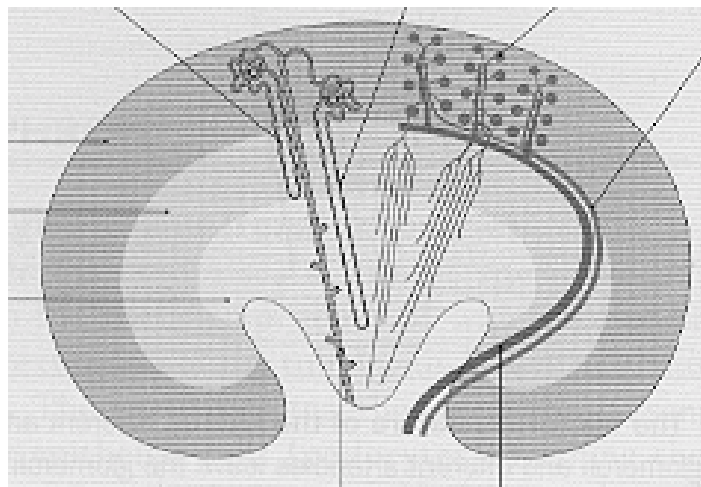
Short-looped Nephron

Long-looped Nephron

Glomeruli

Cortex
Outer
Medulla
Inner
Medulla

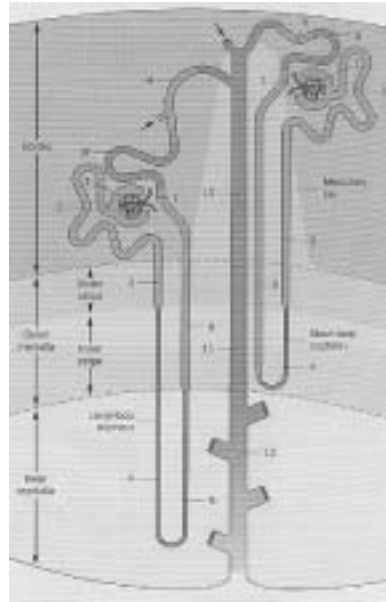
Renal
Artery



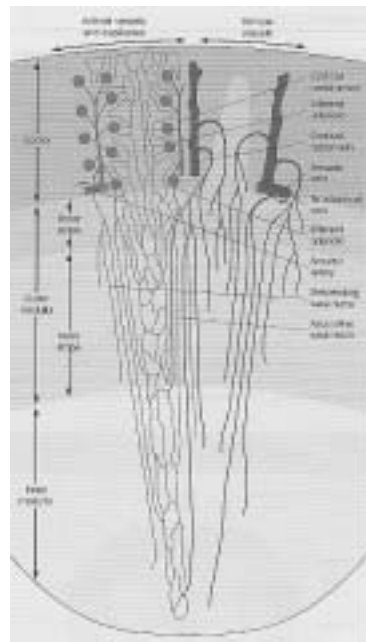
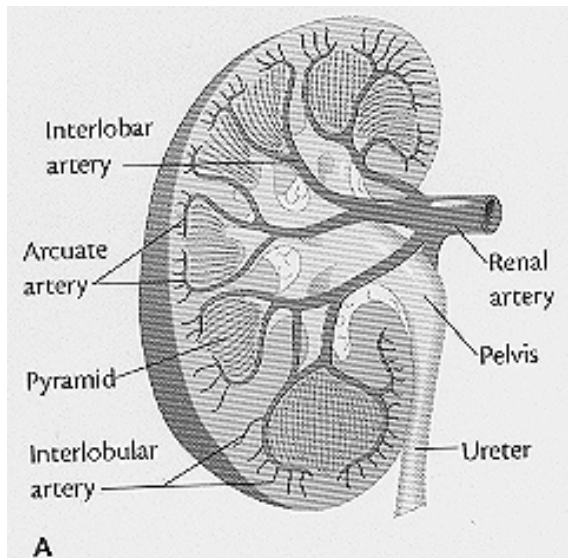
Collecting Duct

Renal Vein

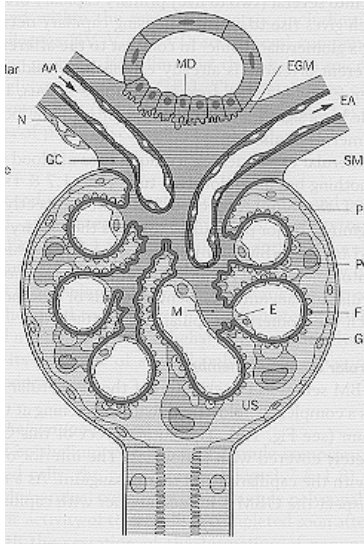
Nephron and Collecting Duct System



Microvasculature of the Kidney



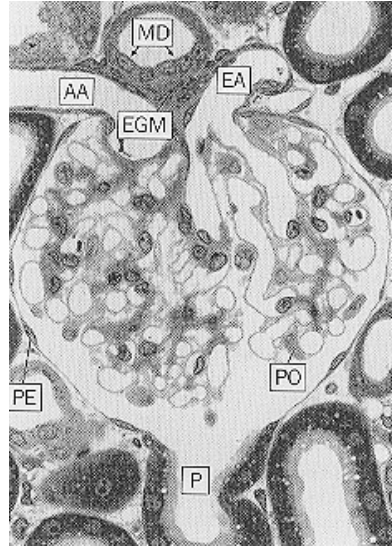
Glomerulus



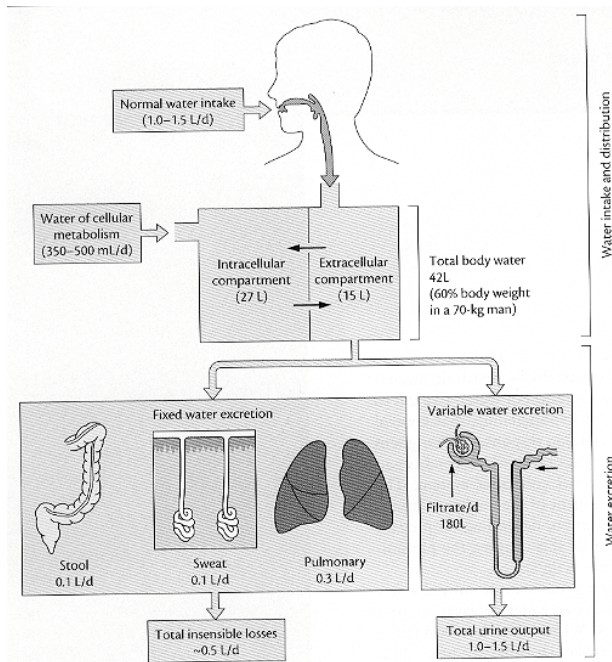
Vascular pole

Bowman's capsule

Urinary pole



Normal Water Balance



Functions of the Kidney

Function	Dysfunction
<ul style="list-style-type: none"> • Salt, water and acid-base balance <ul style="list-style-type: none"> – Water Balance – Sodium Balance – Potassium Balance – Bicarbonate Balance – Magnesium Balance – Phosphate Balance 	
	<ul style="list-style-type: none"> – Fluid retention and ↓Na – Edema, CHF, HTN – Hyperkalemia – Metabolic acidosis, Osteodystrophy – Hypermagnesemia – Hyperphosphatemia, Osteodystrophy

Functions of the Kidney

Function	Dysfunction
<ul style="list-style-type: none"> • Excretion of nitrogenous end products <ul style="list-style-type: none"> – Urea, creatinine, uric acid, amine, guanidine derivatives 	
	<ul style="list-style-type: none"> – Anorexia, nausea, pruritis, pericarditis, polyneuropathy, encephalopathy, thrombocytopeny
<ul style="list-style-type: none"> • Endocrine/Metabolic function <ul style="list-style-type: none"> – Synthesis of vitamin D – Production of erythropoietin – Renin 	
	<ul style="list-style-type: none"> – Osteomalacia, Osteodystrophy – Anemia – Hypertension

Assessment of Renal Function

- **Glomerular Filtration Rate (GFR)-**
 - represents renal excretory capacity which may correspond to the functioning mass of the kidney

Normal GFR (measured by inulin clearance)

Age	GFR
Newborn (<24h)	10.7 ± 0.12 ml/min/kg
(fairly constant between 27-43 wks AOG)	
5-7 days	50.6 ± 5.8 ml/min/1.73m ²
1-2 months	64.6 ± 5.8 ml/min/1.73m ²
3-4 months	85.8 ± 4.8 ml/min/1.73m ²
5-8 months	87.7 ± 11.9 ml/min/1.73m ²
9-12 months	86.9 ± 8.4 ml/min/1.73m ²

Normal GFR (measured by inulin clearance)

Age	GFR
1 ½ years to adolescence	
Male	124.0 ± 25.8 ml/min/1.73m²
Female	108.8 ± 13.5 ml/min/1.73m²
Adults	
Male	105.0 ± 13.9 ml/min/1.73m²
Female	95.4 ± 8.0 ml/min/1.73m²

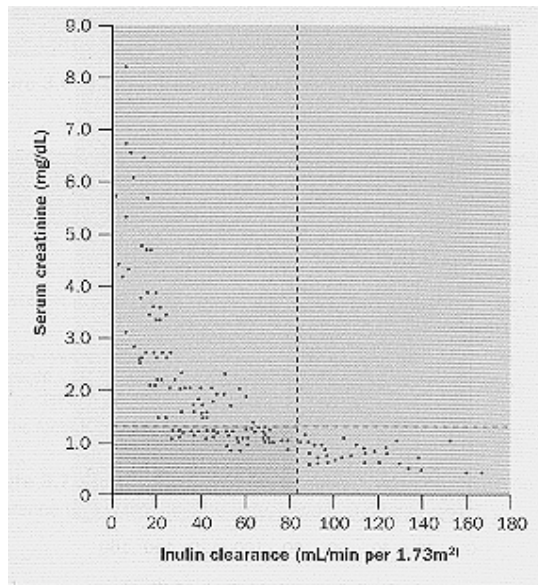
Measurement of GFR

- **Inulin Clearance**
 - **Inulin (5200Da uncharged polymer of fructose) is an ideal clearance substance**
 - **freely filtered by the glomerulus and is not absorbed, secreted, synthesized or metabolized by the tubules**
 - **Gold standard for GFR measurement**
 - **Method is cumbersome so it is not used in routine clinical practice**

Measurement of GFR

- **Alternative Filtration Markers**
 - ^{125}I -Iothalamate
 - ^{51}Cr -EDTA
 - $^{99\text{m}}\text{Tc}$ -DTPA

Estimation of GFR from Plasma Creatinine



Estimation of GFR from Plasma Creatinine

- **Schwartz Formula**

- $kL(cm)$

- $S_{Cr}(mg/dL)$

- **Urinary creatinine excretion rate ($U_{Cr}V$)- determined by the creatinine production rate which is a function of muscle mass**

$$C_{Cr} = \frac{k}{P_{Cr}}$$

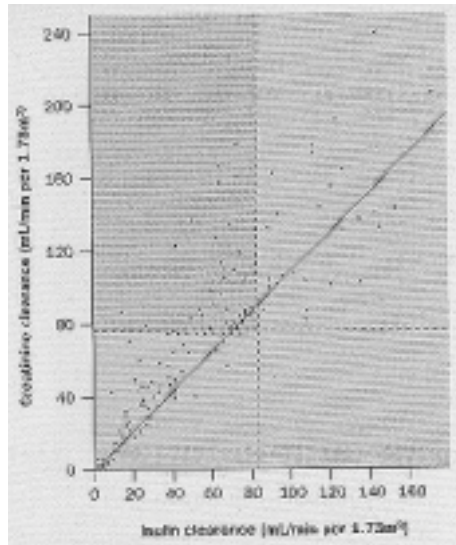
- **k values (proportionality constant)**

- **LBW during first year of life** **0.33**
 - **Term AGA during first year of life** **0.45**
 - **Children and adolescents** **0.55**
 - **Adolescent boys** **0.77**

Glomerular Filtration Rate (As Estimated by Plasma Creatinine)

- **An increase of Cr from 1 to 2 represents a decline in GFR of 50%**
 - *Say a decrease from 100 ml/min to 50 ml/min*
- **An Increase of Cr from 1 to 4 represents a decline in GFR of 75%**
 - *Say a decrease from 100 ml/min to 25 ml/min*

Estimation of GFR from Creatinine Clearance



Measurement of GFR-Creatinine Clearance

- 24 hour urine collection
 - Creatinine clearance (ml/min/1.73m²)
 - $\frac{U_{Cr} V}{P_{Cr}} \times \frac{1.73}{SA}$
 - U_{Cr} - urine creatinine level (mg/dl)
 - V - urine flow rate (ml/min); 24 hours=1440 min
 - P_{Cr} -plasma creatinine level (mg/dl)
 - SA - surface area (m²)

Creatinine Clearance

- overestimates GFR by an amount proportional to the secretion rate
 - normal renal function: 10-30%
 - renal failure: as much as 200%
- Cimetidine-blocked creatinine clearance
 - 20 mg/kg/day divided BID for 2 days before the test

Estimated Creatinine Clearance

- Cockcroft-Gault
 - $\frac{(140 - \text{age}) \times \text{Weight (kg)}}{72 \times \text{Serum creatinine}}$
 - reduced by 15% for women, 20% in paraplegics, and 40% for quadriplegics

Evaluation of Patient with Renal Disease

- **History**
 - **Abnormalities of urine color, turbidity, volume, passage of stone**
 - **Abnormalities of micturition-daytime incontinence, enuresis, urinary retention, poor urinary stream, frequency, dysuria**
 - **Medication- nephrotoxic agents- NSAIDs, contrast, aminoglycosides, Amphotericin B, cyclosporine, Prograf**
 - **Family History of renal disease**

Evaluation of Patient with Renal Disease

- **History- Asymptomatic Presentation**
 - **Abnormal prenatal U/S**
 - **Urine screening program**
 - **Family Studies**

Evaluation of Patient with Renal Disease

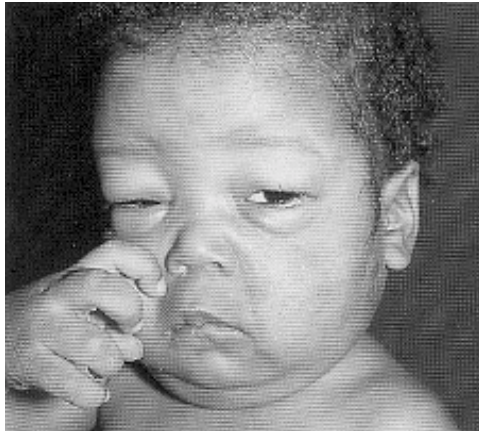
- Physical Exam
 - BP Measurement
 - Hypertension: Average systolic or average diastolic BP > 95th percentile for age, gender and height

Age (yr)	BP Percentile ^a	SBP by Percentile of Height (mm Hg) ^b							DBP by Percentile of Height (mm Hg) ^b						
		5%	10%	25%	50%	75%	90%	95%	5%	10%	25%	50%	75%	90%	95%
1	90th	97	98	99	100	102	103	104	53	53	53	54	55	56	56
	95th	101	102	103	104	105	107	107	57	57	57	58	59	60	60
2	90th	99	99	100	102	103	104	105	57	57	58	58	59	60	61
	95th	102	103	104	105	107	108	109	61	61	62	62	63	64	65
3	90th	100	100	102	103	104	105	106	61	61	61	62	63	63	64
	95th	104	104	105	107	108	109	110	65	65	65	66	67	67	68
4	90th	101	102	103	104	106	107	108	63	63	64	65	65	66	67
	95th	105	106	107	108	109	111	111	67	67	68	69	69	70	71
5	90th	103	103	104	106	107	108	109	65	66	66	67	68	68	69

Evaluation of Patient with Renal Disease

- Physical Exam
 - Height
 - poor growth is common in renal failure
 - Weight
 - nutritional status
 - fluid status

Marked edema in a boy with nephrotic syndrome



Evaluation of Patient with Renal Disease

- **Skin-rash**
- **Abdomen**
 - **Distension- ascites, hydronephrosis, tumor**
 - **Prune Belly**
- **Musculoskeletal**
 - **Skeletal deformities**

Henoch-Schonlein purpura



Boy with prune belly syndrome



Skeletal Deformities



Evaluation of Patient with Renal Disease

- **Measurement of Urine Output:**
 - **Oliguria: urine output less than**
 - 240 cc/m²/24 hrs**
 - 15 cc/100 kcal metab/24 hrs**
 - 0.5 cc/kg/hr**

Investigation of Renal Disease

- **Blood Tests: CBC, lytes, BUN, Cr, Ca, P, Mg**
- **Urinalysis**
- **Imaging**
- **Renal Biopsy**

Elevated BUN Levels

- **Acute and chronic RF**
- **High protein diet**
- **Hypercatabolism**
- **Corticosteroids**
- **GI Bleeding**
- **Volume depletion**
- **Renal hypoperfusion**

Elevated Serum Creatinine Levels

- **Reduction in GFR**
- **Creatinine load**
 - Meat-based formula**
 - Massive rhabdomyolysis**
- **Interference w/ laboratory assay**
 - Cephalosporins**
 - Ketones**
- **Drugs blocking tubular secretion of creatinine**
 - Bactrim**
 - H2 antagonists- Cimetidine, Ranitidine**

Investigation of Renal Disease

- **Blood Tests: CBC, lytes, BUN, Cr, Ca, P, Mg**
- **Urinalysis**
- **Imaging**
- **Renal Biopsy**

Urinalysis

- **Physical Characteristics**
- **Chemical Characteristics**
- **Urine Microscopy**

Urinalysis-Physical Characteristics Variations in Urine Color

Color	Endogenous causes	Exogenous causes	
		Food	Drug
Yellow			Nitrofurantion
Orange			Rifampin
Red	Hemoglobin Myoglobin	Beets	
Brown/	Blood		
Black	Porphyrin (porphyria) Homogentisic acid (alkaptonuria) Melanogen (melanoma)		

Urinalysis-Physical Characteristics

- **Turbidity**
 - **RBC**
 - **WBC and bacteria-suggest infection**
 - **Chylomicrons (Chyluria)-fistula between lymphatic system and bladder; most common cause worldwide is infestation with filarial worm *Wuchereria bancrofti***

Urinalysis-Physical Characteristics

- **Density**
 - **Specific gravity- measure of solute load in urine using hydrometer**
 - **SG > 1.02- volume depletion**
 - **Fixed SG of 1.01 (isosthenuria)- chronic kidney disease**
 - **Fixed SG 1.000-1.005- diabetes insipidus**

Urinalysis

- **Physical Characteristics**
- **Chemical Characteristics**
- **Urine Microscopy**

Urinalysis-Chemical Characteristics (Dipstick)

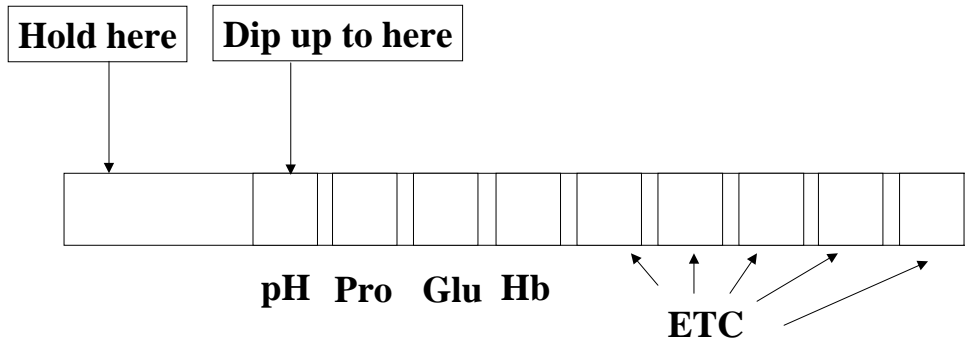
MORE IMPORTANT

- **Protein**
- **Glucose**
- **Hemoglobin**
- **Ketones**

LESS IMPORTANT

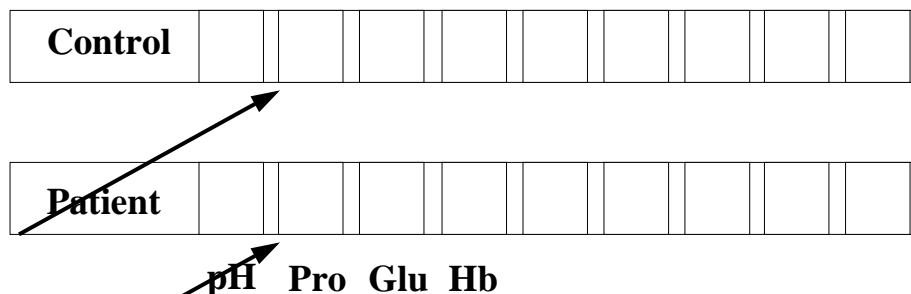
- **pH**
- **Bilirubin**
- **Urobilinogen**
- **Nitrite**
- **Leukocyte esterase**

Urinalysis-Chemical Characteristics (Dipstick)



The reactions are timed and the colors change if substances analyzed are present. Compare stick to colors on bottle and grade 0, 1+, 2+, 3+, 4+ (darker color means higher grade)

Urinalysis-Chemical Characteristics (Dipstick)



After appropriate time, protein has changed color: +4 protein

Urinalysis-Chemical Characteristics (Dipstick)

- **Urine pH**
 - normal range: 4.5-8
 - pH 5-6- initial morning specimen
 - may increase to 7 on a vegetarian diet
 - pH 8: renal tubular acidosis, infection with urea-splitting organism

Urinalysis-Chemical Characteristics (Dipstick)

- **Hemoglobin**
 - **Method:** ortholidine + peroxidase
 - **Positive:** intact RBC, free hemoglobin (hemolysis) and myoglobin (muscle damage due to trauma, convulsions, heat stroke, etc)
 - microscopic exam essential
 - **False Positive**
 - oxidizing contaminants (bacterial peroxidase from UTI)
 - interfering compounds (beets and aniline dyes)
 - **False negative**
 - reducing agent (ascorbic acid)

Urinalysis-Chemical Characteristics (Dipstick)

- **Protein (major manifestation of renal disease)**
 - **Method: tetrabromophenol blue + amino groups- color change, specific for albuminuria**
 - : tetrabromophenol blue-pH indicator; dipstick is buffered so color will not change at normal urine pH
 - **Positive: +1 (30 mg/dl) if specific gravity \leq 1.015**
 - +2 (100 mg/dl) if specific gravity $>$ 1.015
 - **False Positive: overlong immersion, placing reagent strip directly in urine stream, urine pH $>$ 7, pyuria, bacteriuria**
 - **Persistent proteinuria: positive dipstick in at least 2 of 3 random urine specimens collected 1 or more weeks apart**

Urinalysis-Chemical Characteristics (Dipstick)

- **Microalbuminuria**
 - **increased urine albumin excretion below the level of detected by dipstick**
 - **evaluation of patients with diabetes**

Urinalysis-Chemical Characteristics (Dipstick)

- **Glucose - Diabetes Mellitus**
- **Ketones - Diabetic Ketoacidosis**
- **Bilirubin- Biliary obstruction**
- **Urobilinogen - Liver injury, Hemolysis**
- **Nitrite - Bacteriuria**
- **Leukocyte esterase - WBC's**

Urinalysis

- **Physical Characteristics**
- **Chemical Characteristics**
- **Urine Microscopy**

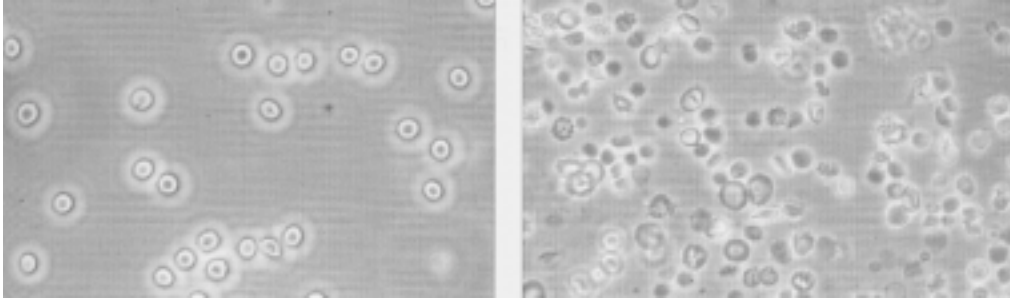
Urine Microscopy

- **Midstream specimen**
- **Centrifuged (10-15 ml of freshly voided urine centrifuged at 1500 rpm for 5-7 minutes, supernatant poured off, sediment examined under high power magnification) and uncentrifuged urine specimens are examined**
 - **Cells**
 - **Casts**
 - **Bacteria**
 - **Crystals**

Urine Microscopy

- **RBC: Abnormal if ≥ 5 RBC/hpf**
 - **Glomerular- Dysmorphic RBC, RBC casts, cellular casts, tubular cells, proteinuria $\geq +2$ by dipstick in absence of gross hematuria, brown/tea-colored/ cola-colored urine**
 - **Nonglomerular- Normal RBC morphology, blood clots, no proteinuria or $\leq +2$ by dipstick in absence of gross hematuria, red or pink urine**

Urine Microscopy



Isomorphic RBC

Dysmorphic RBC

Urine Microscopy

- **WBC: Abnormal if ≥ 5 WBC/hpf**
 - UTI
 - Acute interstitial nephritis
 - Prostatitis
- **Casts- cylindrical structures formed by aggregation of protein (Tamm-Horsfall) in distal tubules and collecting ducts**
 - normal urine- hyaline casts
 - abnormal urine- granular casts, RBC cast (glomerular disease), WBC cast (pyelonephritis), tubular cell cast (acute tubular necrosis)

RBC cast

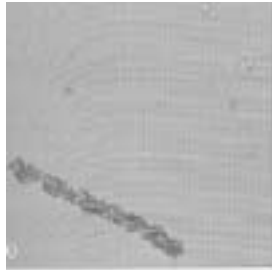


Urine Microscopy

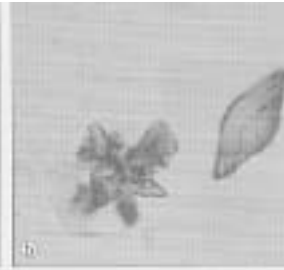
- **Urine Crystals**
 - **Calcium oxalate-** may be seen in normal urine; large numbers suggest hypercalciuria
 - **Urate-** may be seen in normal urine; large numbers reflect hyperuricosuria
 - **Cystine-** presence provides diagnosis of cystinuria
 - **Coffin lid crystals of magnesium ammonium phosphate (struvite)-** diagnostic of infection stones

Urine Microscopy- Crystals

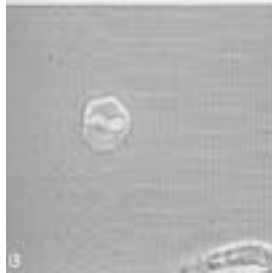
Ca oxalate



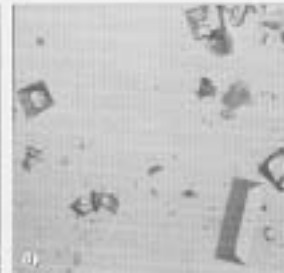
Urate



**Cystinuria
(hexagonal)**



**Struvite
(Coffin lid)**



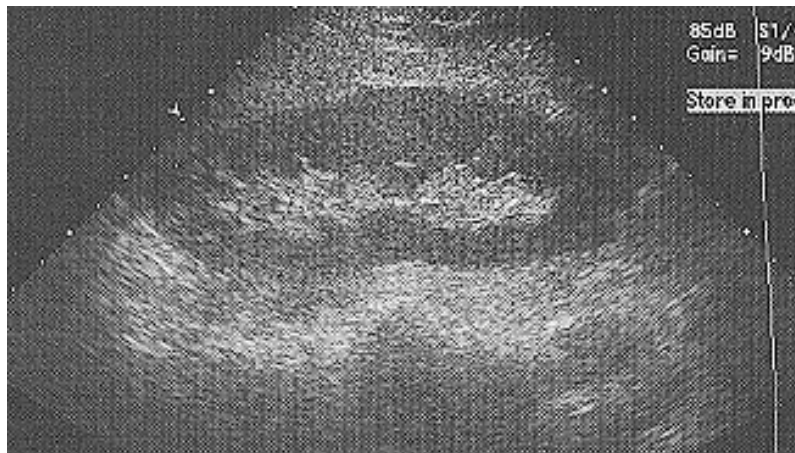
Investigation of Renal Disease

- **Urinalysis**
- **Imaging**
- **Renal Biopsy**

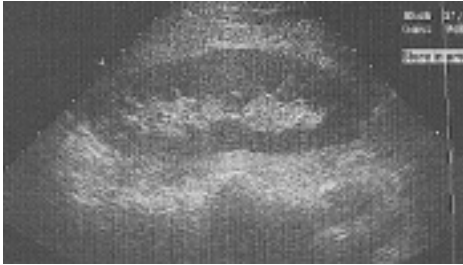
Renal Ultrasound

- **Assess renal size, contour, location, echogenicity**
- **Detect renal cysts, masses, hydronephrosis**
- **Assess renal blood flow by doppler**
- **Non-invasive and relatively inexpensive**
- **Operator-dependent**
- **NPO not required**

Renal Ultrasound



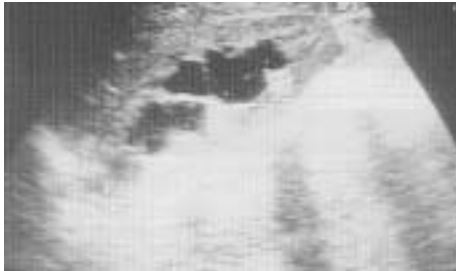
Renal Ultrasound



Normal

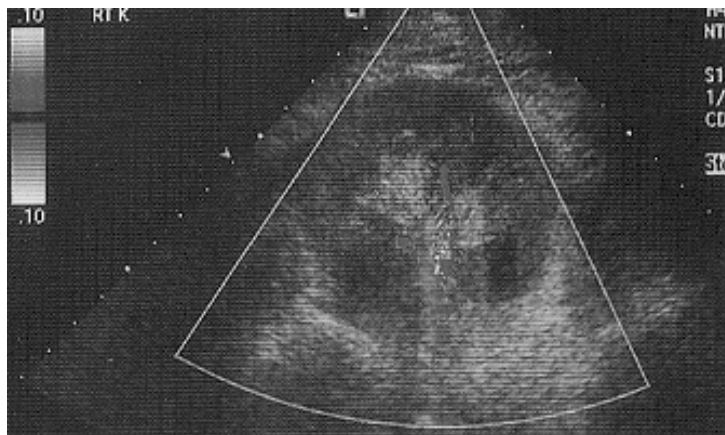


Increased echogenicity



**Hydronephrosis -
dilated urinary tract**

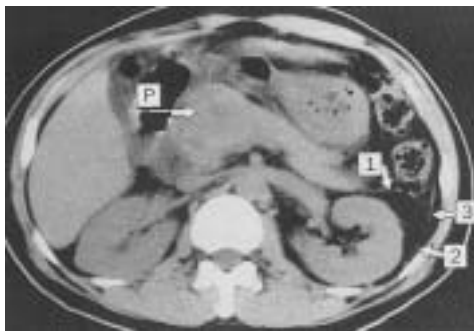
Doppler Ultrasound



Computed Tomography

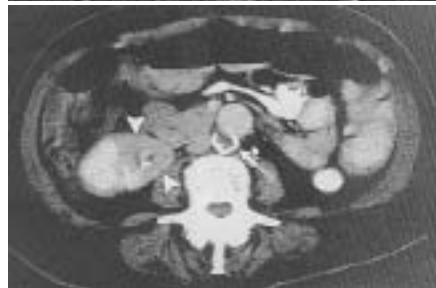
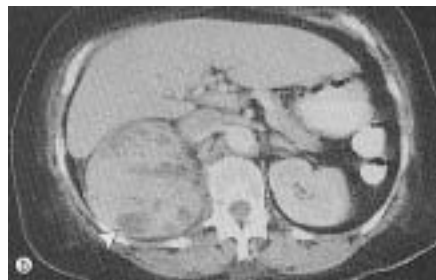
- Evaluate renal masses, locate ectopic kidneys, renal stones, renal function
- Can be performed with or without contrast
 - Noncontrast CT- stones, hemorrhage
 - Contrast CT (CT urogram)- evaluate anatomy, renal function
- Limitations
 - contrast nephropathy
 - low contrast dose (based on weight) because of small patient size may result in suboptimal scan

CT scan



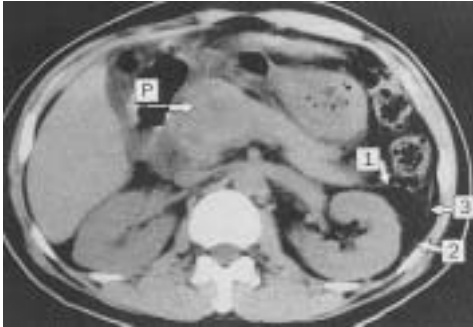
Normal

Renal abscesses



Renal infarct

CT scan

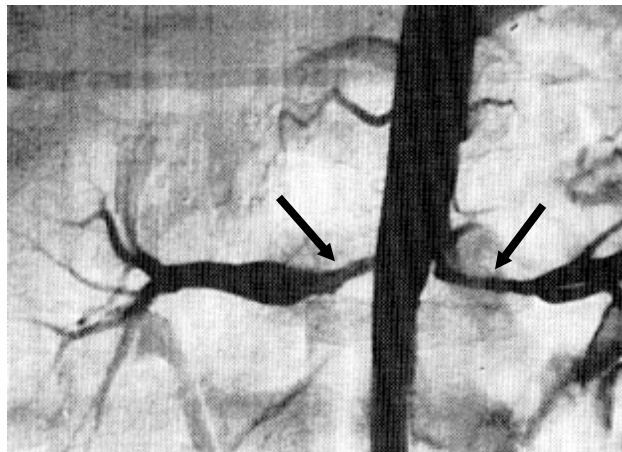
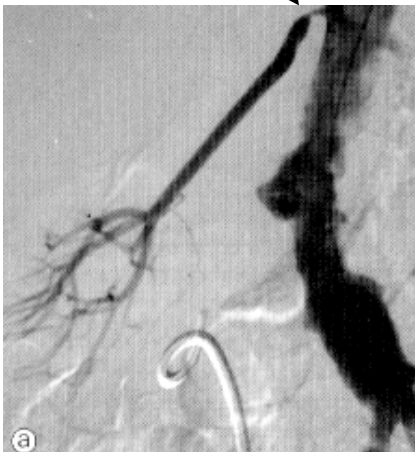


Normal



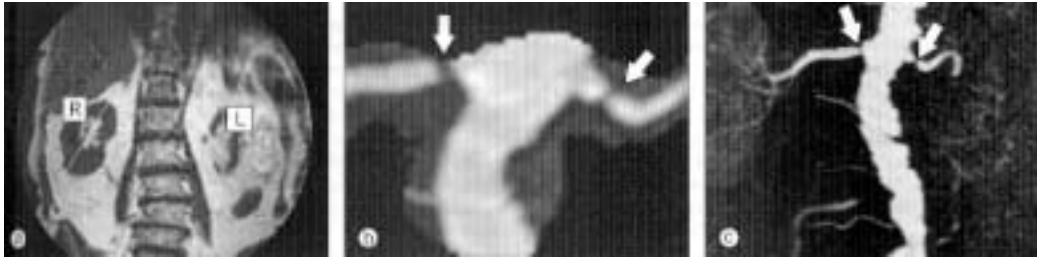
Dilated L renal pelvis with delayed excretion

CT Angiography- assess renal vessels



Renal Artery Stenosis

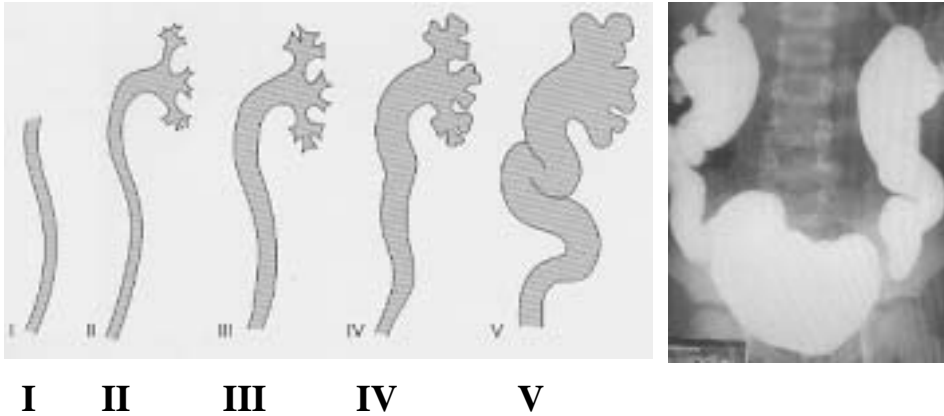
Magnetic Resonance Angiography



Voiding Cystourethrogram

- **Detect vesicoureteral reflux (gold standard)**
- **Assess bladder, posterior urethral valves**
- **Requires catheterization**
- **Bladder filled with contrast and observed for reflux during bladder filling or during voiding**

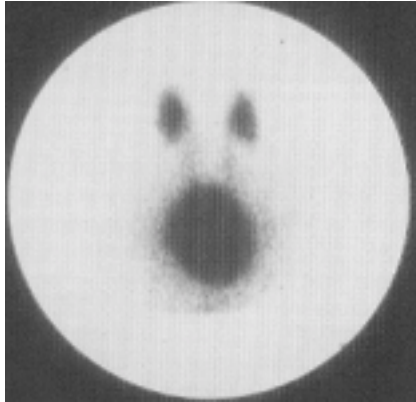
Voiding Cystourethrogram



Radionuclide Cystogram

- **Technetium pertechnetate**
- **Used for follow-up studies or as screening test in asymptomatic siblings of children with reflux**
 - cannot grade reflux
- **Exposes child to less radiation than standard VCUG**
- **Requires catheterization**

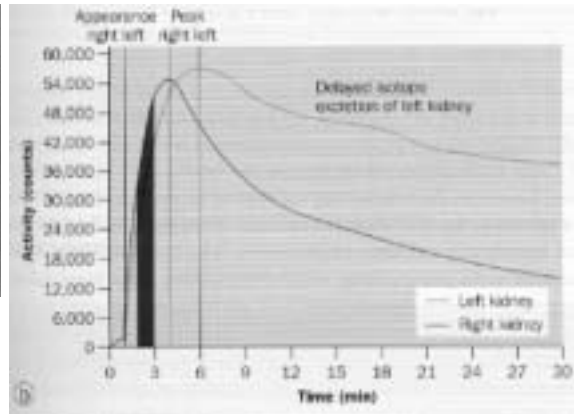
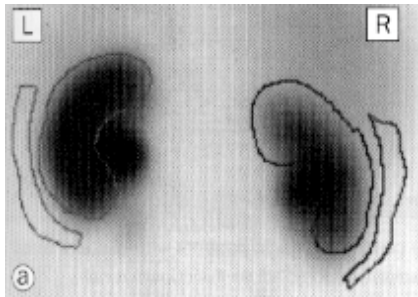
Radionuclide Cystogram



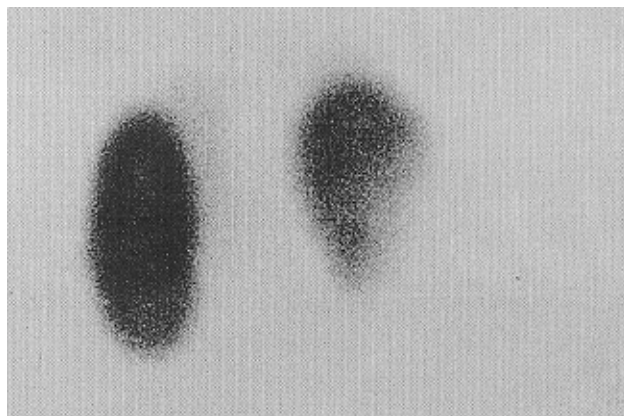
Radionuclide Evaluation of Kidneys

- **Assess renal blood flow, renal uptake and excretion**
- **Detect obstruction-⁹⁹Tc-labeled MAG3 or ⁹⁹Tc-labeled DTPA**
- **Evaluate for renal scarring- DMSA renal scan**

MAG-3 Renal Scan-R/O Obstruction



DMSA Renal Scan-R/O Scarring



Investigation of Renal Disease

- **Urinalysis**
- **Imaging**
- **Renal Biopsy**

Indications for Renal Biopsy

- **Unexplained renal failure**
- **Gross hematuria**
- **Microscopic hematuria with proteinuria, HTN, renal failure**
- **Systemic disease**
- **Nephrotic syndrome that fails to respond to steroids or associated with renal failure, HTN**
- **Persistent nonorthostatic proteinuria for more than 1-2 yrs**
- **Family history of chronic kidney disease, hearing deficit**
- **Renal transplant dysfunction**
- **Parental anxiety**

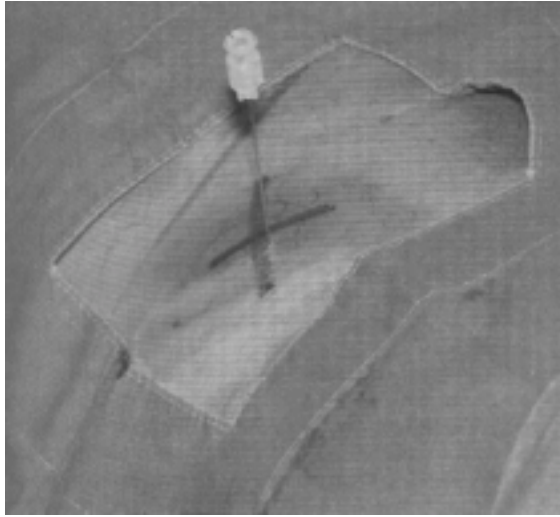
Contraindications to Renal Biopsy

- **Uncontrolled BP**
- **Bleeding problems**
- **Multiple cysts**
- **Solitary kidney**
- **Acute pyelonephritis/perinephric abscess**

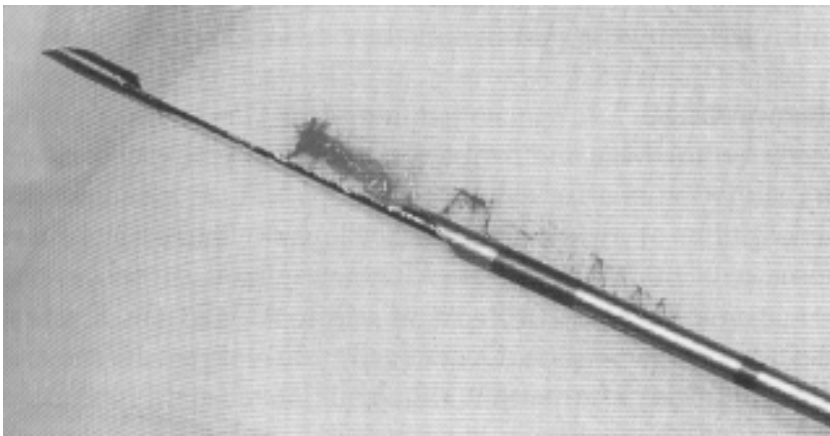
Percutaneous Renal Biopsy (Outpatient procedure)

- **Labs: CBC with platelet count, PT/PTT, urine C/S**
- **Anesthesia pre-op (normal BP)**
- **NPO after midnight except meds**
- **Stop aspirin and NSAIDs**
- **Ultrasound guided**
- **Operator- nephrologist, interventional radiologist**
- **Recovery room for about 6 hours**
- **No heavy lifting or strenuous activity for 2 weeks**
- **Results in approximately 2 weeks**

Percutaneous Renal Biopsy



Percutaneous Renal Biopsy



Open Renal Biopsy

- **High-risk patients**
 - **Single kidney**
 - **Abnormal anatomy**

Complications of Renal Biopsy

- **Bleeding- gross hematuria in 2%; requiring transfusion in 1%**
- **Arteriovenous fistula- 1%**
- **Infection- <1%**
- **Death-<1%**