Acute Kidney Injury	
Exam	Look for hypertension and edema (periorbital and peripheral)
Diagnostic Studies	• UA: ▪ Hematuria, proteinuria, red cell casts suggests glomerulonephritis ▪ Muddy brown casts suggests ATN ▪ Urine eosinophils suggests acute interstitial nephritis (not a great test, may be positive even if only 1 eosinophil) • Urine electrolytes to calculate fractional excretion sodium (FENa) ▪ FENa = (UNa x PCr)/(PNa x UCr) ▪ FENa <1% suggests prerenal; FENa >2% suggests intrarenal • Chem 10 • CBC/diff • Consider CK if history suggestive of rhabdomyolysis • Renal US to look for hydronephrosis, obstructive uropathy, renal scarring
Treatment	• Correct associated electrolyte issues (hyperkalemia, hyponatremia, hypocalcemia, acidosis) • Manage hypertension (see section below) • Fluid management ▪ Small NS bolus (5-10 cc/kg) if hypovolemic or in pre-renal failure ▪ Reassess volume status and continue to give small boluses until patient is euvolemic ▪ Replace insensible losses plus 1:1 urine/stool output ▪ Insensible losses = 300 cc/m2/day ▪ *BSA = square root of [(ht cm x wt kg)/3600]* • Indications for dialysis: AEIOU ▪ **A**cidosis ▪ **E**lectrolyte anomalies refractory to medical management (hyperK/Phos) ▪ **I**ngestions (Li, ASA) ▪ **O**verload ▪ **U**remia (pericarditis, encephalopathy)

Chronic Kidney Disease	
Definition	• Irreversible kidney damage and reduction in kidney function; may be progressive • Requires 1 of 2 of the following (2012 KDIGO Clinical Practice Guideline); **ages 2+:** ▪ GFR < 60 mL/1.73 m2 for > 3 mo ▪ GFR > 60 mL/1.73 m2 alongside evidence of structural kidney damage or other marker of abnormal renal function (proteinuria, albuminuria, renal tubular d/o) ▪ For kids <2 → GFR <1 std dev below mean = mod dysfunction, <2 std dev = severe • Severity stratified by GFR from G1 (normal, ≥90) → G2 (60-89) → G3a (45-59) → G3b (30-44) → G4 (15-29) → G5 (<15) = ESRD / dialysis-dependence
Etiology	• Congenital causes (renal aplasia, reflux, PKD, obstructive uropathy) in ~60% • Glomerular disease (FSGS, membranous nephropathy, MPGN, SLE nephritis, etc.) • Other: HUS, Alport syndrome, cystinosis, interstitial nephritis, tumors
Pathophysiology	Multiple possible insults leading to intraglomerular HTN and glomerular hypertrophy → nephron loss → hyperfiltration in remaining nephrons → further glomerular damage → glomerulosclerosis, proteinuria, fibrosis
Clinical Manifestations	• Edema + HTN • Proteinuria / hypoalbuminemia • Anemia (due to EPO deficiency) • Dyslipidemia / accelerated ASCVD • Vitamin D deficiency with secondary hyperparathyroidism • Electrolyte derangements: hyperkalemia, hyperphosphatemia, hypocalcemia, metabolic acidosis • Growth failure, delayed puberty, and intellectual disability • Complications of uremia: pericarditis, platelet dysfunction, encephalopathy

Chronic Kidney Disease

Diagnostic Studies	• Chem 10 • UA w/ urine protein:Cr ratio • CBC/diff/retic + iron studies • 25-OH Vitamin D, PTH • Fasting lipid panel • If etiology uncertain: see sections on proteinuria/hematuria, consider renal U/S and bx
Management	Stage G1/G2 → • Monitor kidney function closely • Educate about nephrotoxin avoidance (NSAIDs, contrast, smoking, obesity, dehydration) • BP control w/ ACEI/ARB ▪ ESCAPE trial - N Engl J Med. 2009;361(17):1639. Using ramipril (starting at 6 mg/m2/d and inc dose / adding other agents as needed), targeting 50th %ile BP for age, sex, and weight vs 90th %ile slowed rate of progression to ESRD Stages G3 and above, add the following → • Prepare for possibility of transplant, ideally prior to dialysis (HD vs peritoneal) • Na-restricted diet (2-3g/d) +/- diuretics (furosemide 0.5-2 mg/kg/d, HCTZ 1-3 mg/kg/d) • Management of hyperkalemia (low K diet, diuretics), acidosis (Na bicarb), hypocalcemia/ hyperphosphatemia (Vitamin D, calcimimetics, phos binders) • Rx anemia to goal Hgb 10-12 g/dL w/ EPO-stimulating agents (erythropoietin alfa, darbepoetin alfa) • In pts with significant uremia, consider preoperative DDAVP to prevent bleeding

Hemolytic-Uremic Syndrome

Definition	• **Hemolytic Uremic Syndrome**: microangiopathic hemolytic anemia + AKI + thrombocytopenia • **Thrombotic Thrombocytopenic Purpura**: triad of HUS + fever + neurologic changes
Etiology	• Principally affects children under the age of five years. • 90% due to shiga toxin; of those 70% due to *enterohemorrhagic* E. Coli • Occurs in 6-9% of EHEC infections; usually begins 5-10 days after diarrhea onset • Non-diarrheal (atypical) HUS associated can be due to *S. pneumo* infection or due to defects in the complement system (e.g., mutations in complement regulatory proteins)
Pathophysiology	• **HUS**: Shiga toxin binds to receptors in glomerular, colonic, and cerebral cells → promotes adhesion and aggregation of platelets onto endothelial cells → thrombocytopenia and RBC shearing (microangiopathic anemia); in kidney, glomerular damage • **TTP**: due to deficiency or immune-mediated inhibition of ADAMTS13, a metalloproteinase responsible for breakdown of vWF. No vWF cleavage → coagulation occurs at a higher rate, particularly in microvasculature → platelet consumption → thrombocytopenia and microthrombi → microangiopathic hemolytic anemia.
Clinical Manifestations	• **Microangiopathic hemolytic anemia**: jaundice, pallor, dark urine • **Thrombocytopenia**: petechiae, bleeding • **Acute renal failure**: HTN, edema • **Central nervous system**: seizures, coma, stroke • **Cardiac**: dysfunction due to ischemia, uremia, fluid overload. • **Pancreas**: transient DM • **Liver**: Hepatomegaly, increased serum transaminases • **Heme**: In addition to anemia and thrombocytopenia, leukocytosis is common in diarrhea-induced HUS; the prognosis is worse with increased white blood cell counts

Hemolytic-Uremic Syndrome continued on next page →