Nephrotic Syndrome

Exam	Edema, hypertension, assess for extra-renal findings that may suggest a secondary cause for nephrotic syndrome (e.g. infection)
Diagnostic Studies	• Chem 10; C3; see also section on proteinuria • UA + 24 hour urine collection >3 grams/day OR spot Ur prot:Cr ratio > 2 (normal <0.2) • Consider renal biopsy for diagnosis (see below)
Treatment	• Empiric steroids for presumed minimal change disease (if persistent past 1-2 wk) ▪ Prednisone 60 mg/m2/day (max 60 mg/day) for 4 weeks ▪ Then prednisone 40 mg/m2/day QOD for 4 weeks w/ gradual taper, generally for minimum total 2 -3 months • Consider biopsy if steroid resistant, steroid-dependent, or evidence of steroid toxicity ▪ In minimal change, see normal light microscopy but on EM there is diffuse foot process effacement • ACE inhibitors or ARBs are preferred for BP control (decrease glomerular pressure, → decreased protein filtration) ▪ e.g., **enalapril** 0.08 mg/kg per day (maximum of 5 mg/day), titrate to maximum dose of 0.6 mg/kg per day (maximum of 40 mg/day) re: BP response ▪ Use with caution for GFR <60 mL/min/1.73 m2 ▪ Re-check serum Cr, K 3-5 days after starting ACEI/ARB • Edema - **salt restriction** (< 2 mEq/kg/day) and **diuretics**: ▪ if intravascular volume normal (FeNa >2%) - furosemide 1-2 mg/kg/dose x2 doses ▪ If intravascular volume low (FeNa <2%) and edema is **severe** (anasarca, pleural effusions, ascites): • Albumin 25% 1 gram/kg IV over 4 hours • Give 1 mg/kg IV lasix at the 2 hour point • Give 1 mg/kg IV lasix after albumin infusion • Consider prophylactic anticoagulation if high-risk (age >12, albumin <2, fibrinogen >6) • Treat VTE if present with LMWH • Consider statin for HLD, especially if other ASCVD risk factors are present

Acute Kidney Injury

Definition	Acute decrease in GFR per KDIGO criteria: **Table 2 | Staging of AKI** Stage 1: Serum creatinine: 1.5–1.9 times baseline OR ≥0.3 mg/dl (≥26.5 µmol/l) increase; Urine output: <0.5 ml/kg/h for 6–12 hours Stage 2: Serum creatinine: 2.0–2.9 times baseline; Urine output: <0.5 ml/kg/h for ≥12 hours Stage 3: Serum creatinine: 3.0 times baseline OR Increase in serum creatinine to ≥4.0 mg/dl (≥353.6 µmol/l) OR Initiation of renal replacement therapy OR, In patients <18 years, decrease in eGFR to <35 ml/min per 1.73 m²; Urine output: <0.3 ml/kg/h for ≥24 hours OR Anuria for ≥12 hours
Etiology	**Pre-Renal**: decreased renal perfusion • Decreased intravascular volume: dehydration, blood loss • Decreased effective circulating volume: shock, heart failure, cirrhosis **Renal**: intrinsic renal parenchymal disease • Glomerular disease: glomerulonephritis, nephrotic disorders • Vascular: vasculitis • Tubulointerstitial: ATN (ischemia/progression of pre-renal AKI, aminoglycosides, myoglobin, uric acid in tumor lysis syndrome), interstitial nephritis (NSAIDs, penicillins) **Post-Renal**: obstructive uropathy (posterior urethral valves, tumor, large stones, etc). Needs to be bilateral compression to develop renal failure in a patient with otherwise normal kidneys.
Clinical Manifestations	• Fluid retention: edema, decreased urine output • Hematuria with intrinsic kidney injury (glomerulonephritis, ATN) • Uremia: nausea/vomiting, GI bleeding, pericarditis, pruritus, mental status change

Acute Kidney Injury continued on next page →

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