Nephritic Syndrome	

Clinical Manifestations	• Hypertension
	• Hematuria
	• Fluid retention/edema
	• Sequelae of underlying disease
	  ▪ **SLE**: rash, arthritis, oral ulcers
	  ▪ **Vasculitides**: hemoptysis, skin ulcers
	  ▪ **Alport**: sensorineural hearing loss, vision changes
	• Ask about preceding sore throat (usually 2-3 weeks before onset of post strep GN) or current URI symptoms (which can be seen with IgAN)
	• Some patients may have rapid progression with development of acute renal failure over course of several days. Any of above etiologies can have a rapidly progressive course.

Exam	• Monitor BP • Assess volume status • Look for signs of lupus or other vasculitides such as rash, abdominal tenderness (HSP), joint swelling/tenderness
Diagnostic Studies	• **UA**: RBCs + proteinuria. Glomerular bleeding → dysmorphic RBCs and red cell casts • Chem 10 / CBC/diff/retic / serum albumin / ASLO + anti-DNase B / ANA + anti-dsDNA • **C3, C4**: low C3 seen with post-infectious GN and C3 glomerulopathy low C3/C4 in SLE; normal C3/C4 in IgAN, pauci-immune GNs (ANCA-associated vasculitis) and anti-GBM disease • **Urine protein to creatinine ratio**: typically will see proteinuria, sometimes in nephrotic range (nephrotic range protein is urine protein/Cr ratio >2) • If rapidly progressive course or significant renal insufficiency on admission, send anti-GBM Ab and ANCA (for Goodpasture disease and GPA/MPA). Patients with rapidly progressive course should have renal biopsy.

Treatment	• **Reasons for admission**: hypertension, acute renal failure, volume overload, or electrolyte abnormalities
	• Hypertension typically responsive to diuretics
	• Fluid and sodium restriction during acute phase
	• Patients with RPGN may be treated with pulse dose steroids
	  ▪ Patients with RPGN due to Goodpasture disease, SLE, or GPA/MPA may be treated with steroids, cyclophosphamide, and plasmapheresis
	• Post-infectious GN is typically self-resolving
	  ▪ Patients suspected to have post-infectious GN should have repeat complement studies sent in 8-12 weeks, at which time complement should return to normal. If still hypocomplementemic, consider other diagnosis such as C3 glomerulopathy or SLE

Nephrotic Syndrome	
Definition	Syndrome characterized by presence of heavy proteinuria (albuminuria >3 g/24 hours), hypoalbuminemia (<3.0 g/dL), edema, hyperlipidemia, and thrombotic disease
Etiology	• Minimal change disease (most common in children) • Focal segmental glomerulosclerosis • Membranous Nephropathy • Membranoproliferative GN (may be nephrotic + nephritic) • SLE (may be nephrotic + nephritic)
Pathophysiology	• Abnormalities in glomerular podocytes → increased filtration of proteins, esp **albumin**. Others include clotting inhibitors (Protein C, S, anti-thrombin III) → prothombotic state and immunoglobulins → susceptibility to serious infections. • Increased Na retention and hypoalbuminemia → edema • Decreased oncotic pressure → inc hepatic lipoprotein synthesis → hypercholesterolemia
Clinical Manifestations	• Edema, typically first appears in periorbital tissue/scrotum, then in dependent areas • HTN, HLD, increased risk of VTE • Can present with AKI

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 →