

NEPHROLOGY – Renal Failure

Creatinine: filtered and secreted – falsely low in severe muscle wasting, falsely elevated in rhabdomyolysis of any kind, drugs such as sulfonamides may interfere with secretion and will ketosis

BUN: filtered – falsely low in malnutrition, falsely elevated in upper GI bleeding, burns, tissue breakdown

BUN/CR ratio > 20:1 implies PRERENAL or occasionally AGN
< 10:1 suggests CKD, ATN

Useful Equations:

FE_{Na} = (UrineNa/ PlasmaNa) * (Plasma CR/Urine CR) * 100
< 1% implies intact tubular function in face of low GFR (sodium retention)
Suggests PRERENAL or AGN (Prerenal no cells/casts, AGN – RBCs/protein)
Correlates with ALDOSTERONE activity on tubules

Cockcroft-Gault

GFR = $\frac{(140 - \text{AGE}) * \text{Lean KG}}{72 * \text{Serum CR}}$ (multiple by 0.85 for female)

Implies stable renal fx, otherwise will OVERESTIMATE GFR

Chronic kidney disease classification

CKD1 – GFR > 90, but proteinuria, tubular defect, etc

CKD2 – GFR 60-90

CKD3 – GFR 30-60

CKD4 – GFR 15-30

CKD5 -- GFR < 15 or HD

INTERPRETING URINALYSIS

- 1) Specific gravity – concentrated (with low GFR) – think Prerenal or AGN, dilute think ATN – correlates with Urine OSM (measure of ADH activity)
- 2) Protein – ALBUMIN only – may not be reliable if very concentrated or very dilute
Check spot Urine Protein/spot Urine CR → the result will approximate the number of grams of protein in a 24hr urine > 1gram – very probably renal pathology --- < 1 gram may not be as significant -- > 1 gram implies some glomerular injury
If 4+ protein (> 3grams) and no cells think NEPHROTIC syndrome
If 1 to 4+ protein and RBC casts, WBCs think NEPHRITIC syndrome
microALB > 300mg is a sensitive indicator for nephropathy and CAD in Diabetics
- 3) Heme – look for RBCs, free HB (hemolysis) or myoglobin (CPK, rhabdo)
- 4) Bilirubin -- direct BR – implies liver pathology, IBR is not filtered
- 5) RBC casts – think NEPHRITIS

- RBCs/protein – think NEPHRITIS, RBCs/no protein – think renal CA, stones, lower tract bleeding
- 6) WBC casts – think PYELO (with ++bacteria, UTI s/s) ,, or AIN (no bacteria, URINE EOS) - WBC only/bacteria/dysuria -- cystitis
 - 7) Large GRANULAR casts (muddy) – think ATN
 - 8) Oxylate crystals – stone disease, acute ETHYLENE GLYCOL
 - 9) Urates – usually not significant, can imply gout or TUMOR LYSIS syndrome
 - 10) Nitrate POS -- usually COLIFORMS
 - 11) Nitrate NEG – ESBL (resistant coliforms), STAPH bacteremia, ENTEROCOCCUS
 - 12) LEUK ESTERASE – correlates with WBCs micro
 - 13) EPIs – usually squamous cells, more than a FEW implies contaminated sample from periurethrae – get minicath specimen – occasionally tubular epithelium implying ATN
 - 14) urine Eosinophils – think drug related AIN – Hansel stain
 - 15) Bacteria – if WBCs and symptoms, think UTI/pyelo, otherwise contaminant (esp if many EPIs)

Approach to renal disease/low GFR

0) Is the BUN and CR adequately reflecting low GFR – look for SULFA drug use, KETOSIS, Rhabdomyolysis (incr CR may NOT reflect worse GFR) – look for upper GI bleeding (incr BUN may not be reflective of worse GFR) – severe malnutrition (low BUN/CR may hide an impaired GFR) – estimate GFR with Cockcroft-Gault EQN

1) Is it PRERENAL?

- a. Look for clues about VOLUME DEPLETION: orthostatic, tachycardia, hx of bleeding, GI loss (diarrhea, vomiting), Renal (polyuria, diuretics) – usually respond to volume challenge fairly quickly – if it does not be suspicious of something else going on
- b. Look for clues of volume OVERLOAD – CARDIAC (JVD, rales, pleural effusions, S3, mitral murmur, orthopnea, PND, risk factors for dilated cardiomyopathy: IHD, valvular heart disease, HIV, alcohol, chemotherapy) --- CIRRHOSIS – edema, ascites w/o effusions or JVD, hepatosplenomegaly, ETOH, HEP C etc --- harder to fix, RX: is fixing heart or liver if possible
- c. BUN/CR ratio usual > 15 to 1, UA: usually concentrated – due to increased sympathetic tone, incr ALADOSTERONE/ANGIOTENSIN and incr ADH secretion (diuretics may mess this up), may be hyaline casts and trace protein, but usually very little in the way of ACTIVE sediment (WBCs, RBCs, tubular cells, other casts)
- d. Look for clues of RENOVASCULAR disease – renal failure develops acutely after taking DIURETICS, NSAIDs or excessive diuresis – look for ASVD risk factors, esp PERIUMBILICAL BRUIT with SYSTOLIC/DIASTOLIC component classical for RAS , secondary hypertension – HTN very young or very old
- e. Diagnosis: UA: concentrated w/o sediment, FENa < 1%, positive response to 1-2L NS, high BUN/CR ratio

2) Is it POSTRENAL?

- a) Sudden anuria, worse after taking anticholinergics, hematuria (w/o casts), suprapubic pain, history of urinary retention s/s (nocturia, hesitancy) .. history of urethral instrumentation, STDs (urethral strictures) ... pelvic symptoms , GI bleeding, hematuria (w/o RBC casts) (cervical CA, rectal CA, bladder/prostate CA) – foley difficult to pass, large amount of urine after placing cath (> 100 cc post void is abnormal .. usually will be more obvious though) ... US: shows hydronephrosis, ?bladder mass, distension
- b) Hx bulky lymphoma, retroperitoneal fibrosis – obstruction w/o abnormal bladder scan
- c) UA: FENa may be low or high, usually low acutely until back pressures leads to tubular damage, may show RBCs/WBCs from bladder/urethral pathology, but should not see casts
- d) Usually responds quickly to relief of obstruction if acute, not so well if chronic
- e) workup: Ultrasound for hyponephrosis, bladder scan, Postvoid residuals

3) Is it RENAL/ATN?

- a) look for history of shock, hypotension, rhabdomyolysis risk factors (found down, prolonged seizures, crush injuries, rarely STATIN use), aminoglycoside use for > 3 days, hx of contrast dye studies, may be oliguric
- b) UA: dilute urine, minimal protein, TUBULAR CELLS, TUBULAR CASTS diagnostic, if more chronic may be more GRANULAR CASTS than expected, if RHABDO look for PIGMENTED casts, should not be a lot of protein, WBCs or RBCS in most cases, no RBC/WBC casts – FeNa is characteristically > 3%
- c) Treatment: supportive, fix the underlying problem, remove offending medications
- d) workup: supportive history, tubular or coarse granular casts

4) Is it RENAL/ Interstitial?

- a) look for commonly offending drugs: beta lactams especially, NSAIDs, SULFA, Dilantin, Allopurinol, LASIX/HCTZ, UA: protein (not nephrotic, usually < 1gram, may be associated rash, eosinophiluria (HANSELS stain), or eosinophilia
- b) Look for SLE (rash, arthritis, ANA, etc)
- c) Treatment: remove offending drugs, steroids
- d) workup: WBC casts w/o bactiuria, urine EOS, rash, fever

5) Is it RENAL/Nephritic?

- a) Look for clues for autoimmune disease: arthritis, rash, mental status changes, serositis, high sed rates/CRP (SLE) , chronic sinus s/s (Wegener's), hemoptysis (Good pastures), hx HEP B, mental status changes, abd pain (PAN), hx HEP C, LE rash, neuritis (cryoglobulinemia), post infectious (Post STREP or IgA nephropathy)
- b) UA: FENa may be < 1% esp early, sediment: usually some protein (but NOT NEPHROTIC), some WBCs, RBC casts is DIAGNOSTIC
- c) Serologies/other testing: Wegener's (cANCA, necrotizing granulomas), Goodpastures (antiGBM, cannon ball hemorrhage on CXR), PAN (Hep B AG, CTA abd – mesenteric beading aneurysms), SLE (ANA, low complements, dsDNA, antiSMITH), post STREP (ASO titer) , cryoglobulins (+RF, Hep C, vasculitic rash extremities)
- d) Complement levels are helpful in diagnosis
- e) If no obvious systemic inflammatory disease (IgA, MPGN, PIGN, Alports)
- f) TREATMENT: high dose steroids, > 1mg/kg QD, many will use up to 1 gram/day
- g) DX: RBC casts, Hep BC serologies, ANA, ANCAs, antiGBM, complement levels

6) Is it RENAL/Nephrotic?

- a) Look for edema, anasarca, but no JVD, usually no pleural effusions (goes against cardiac causes)
- b) UA: predominant PROTEIN 4+ on dipstick, > 3 grams/day, oval fat bodies in urine, high lipids in serum – don't expect tubular cells, significant RBCs/WBCs or other casts (may see nonspecific hylaline, few granular casts depending on underlying CKD)
- c) Look for DM2, SLE, HIV, Multiple Myeloma/Amyloid kidney, may present as VTE (due to loss of ATIII)
- d) If no systemic etiology: young (NIL disease), adult (membranous, 10% solid tumor), young black male (FSGS)
- e) TREATMENT: control DM, HTN, ACE inhibitors, elevation, diuretics for symptoms
- f) Workup: ALB, serum lipids, Urine Spot Protein/Urine Spot Creatine, HBA1C, HIV, SPEP/UPEP, nephritic syndrome serologies /complement (looking for chronic nephritis) – if negative RENAL BX

7) Is it renal Metabolic/CRYSTALLINE?

- a) leukemia/lymphoma – TUMOR LYSIS syndrome, urates
- b) Oxaluria – ETHYLENE GLYCOL toxicity
- c) HIV/Indinivir/Acylovir related crystals

- d) HyperCalcemia: polyuria, dilute urine, 24hr urine CA > 400mg (r/o hyperPTH , sarcoid, MM, etc)
- e) DX: supportive hx and crystals in urine