Chronic Kidney Disease and End-Stage Renal Disease Diagnosis and Management

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Dr. Braun earned his medical degree at the Philadelphia College of Osteopathic Medicine, Pennsylvania, and completed his residency in family medicine at Womack Army Medical Center, Fort Bragg, North Carolina. At Madigan Army Medical Center, he has served as family medicine and internal medicine residency faculty for nine years. He has been a practicing hospitalist for seven years. He earned the Recognition of Focused Practice in Hospital Medicine (RFPHM) from the American Board of Family Medicine (ABFM) and the American Board of Internal Medicine (ABIM).

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**Learning Objectives**

1. Incorporate the major points of the National Kidney Foundation Quality Outcomes Initiative for chronic kidney disease (CKD) into practice.

2. Accurately identify, screen, evaluate and classify patients who are at risk or have the diagnosis of CKD.

3. Reduce the risk for progression of CKD to ESRD by applying appropriate, proven therapeutic interventions early in the disease process.

4. Devise management strategies for anemia, bone disease, malnutrition, and electrolyte abnormalities in the later stages of CKD.
Associated Sessions

- (PBL) Chronic Kidney Disease and End-Stage Renal Disease Diagnosis and Management

Audience Engagement System

**Step 1**

**Step 2**

**Step 3**

CME001 (PBL) Acute and Chronic Heart Failure

- Location: Room 113A
- Duration: 1 hour
- Credit hrs: 1
- Repeat: Friday at 7:10 AM
- Audience Engagement System

1. Through applying new knowledge and skills gained from acute and chronic heart failure sessions, through collaborative learning with peers and expert faculty, identify strategies that foster optimal management of acute and chronic heart failure within the context of
Outline

• Definition
• Causes
• Screening
• Initial work up
• Slowing the progression
• Complications
• Renal replacement therapy
• Nephrology referral

Importance

• Major public concern that affect 47 million Americans (14.8% of population)

• Costs $52 billion a year and cost Medicare 20% of its budget

• Increases the risk of CAD, hospitalization, and death

• Prevalence has been stabilizing since 2004

• Early detection is critical
Poll Question 1

Which of the following patients meets criteria for CKD?

A. 55 yo M with h/o HTN and urinary microalbumin excretion of ≥30 mg/day
B. 60 yo F with h/ CAD, HLD, and HTN with eGFR of 95 mL/min/1.73 m2
C. 52 yo M with creatinine of 1.3 and eGFR of 100 mL/min/1.73 m2
D. 40 yo F with h/o IDDM, HTN, and eGFR <60 mL/min/1.73 m2 x 1 month

Definition

• Presence of damage or decreased function
  • Structure or function
  • Decreased GFR <60mL/min
  • Urinary albumin excretion >30 mg/day

• Three months or more
### Staging Based on GFR and albuminuria

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<th>Terms</th>
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<tr>
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<td>Normal or high</td>
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<tr>
<td>G2</td>
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<td>Mildly decreased</td>
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<tr>
<td>G3a</td>
<td>45-59</td>
<td>Mild to moderate</td>
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<tr>
<td>G3b</td>
<td>30-44</td>
<td>Moderate to severe</td>
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<tr>
<td>G4</td>
<td>15-29</td>
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<tr>
<td>G5</td>
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<table>
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<th>ACR</th>
<th>Terms</th>
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<tr>
<td>A2</td>
<td>30-299</td>
<td>Moderately increased</td>
</tr>
<tr>
<td>A3</td>
<td>&gt;300</td>
<td>Severely increased</td>
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### Clinical Manifestations

- Usually asymptomatic unless more advance stages
- Physical manifestations include: edema or anasarca
- Symptoms: Fatigue, nausea, insomnia, confusion (Decreased concentration), pruritus, uremic frost
- Labs: Low vitamin D, anemia, Elevated BUN/Cr, secondary hyperparathyroidism
Screening

Who should be screened?

• Controversial

• U.S. Preventative Services Task Force (USPSTF) and American College of Physicians (ACP) recommend against screening in asymptomatic patients with or without risk factors

• American Society of Nephrology screening at risk patients
Who should be screened?

- Diabetes,
- Hypertension
- Cardiovascular disease
- HIV
- Hepatitis B/C virus infection
- Malignancy
- Autoimmune diseases
- Obesity?
- Indigenous origin (including Native Americans)
- FHX or childhood history of kidney disease
- Sickle cell trait
- h/o Nephrolithiasis
- Recurrent UTIs

Screening

- Serum BUN/creatinine with GFR calculation
  - 2009 CKD-EPI creatinine equation
- Urine testing
  - Spot albumin:creatinine ratio (Early morning sample)
  - Urinalysis (assess for infection, RBCs and protein)
  - 24 hour urine collection (Gold Standard)
- Abnormal → Repeat within 3 months
- Two abnormal >1-2 weeks apart → persistent
Poll Question 2

What is the most accurate equation to measure estimated glomerular filtration rate?

A. 48H creatinine clearance
B. Cockcroft-Gault equation
C. Modification of Diet in Renal Disease (MDRD)
D. CKD-EPI Creatinine equation

Diagnosis
Initial Work Up

- Estimate GFR from serum creatinine
  - CKD-EPI Creatinine equation
  - Cockcroft-Gault equation
  - Cystatin C
- Quantify urine protein
- Urinalysis with microscopy
- Hemoglobin A1C, lipid panel

Other labs and studies to consider

- Further work up varies
  - Reversible causes
    - Serum and urine protein electrophoresis, C3/C4, urinary casts, eosinophilia, antiglomerular basement membrane antibody, ANCA, ANA, cryoglobulin, hepatitis panel, HIV, RF
  - Renal US
  - Nephrology referral
  - Biopsy
Poll Question 3

58 yo M with h/o CKD Stage IV, IDDM, HTN, and CAD presents for routine clinic follow up. Medications include: insulin glargine, labetalol, sodium bicarbonate, and Lisinopril. Normal physical exam with arteriovenous fistula note in R arm. Labs show BUN of 50 mg/dL, bicarb 25, electrolytes normal, and an eGFR of 16 mL/min/1.73m2. What is the next step in management?

A. Follow up in 6 months
B. Fistulography of AVF to evaluate patency
C. Hemodialysis
D. Refer patient for kidney transplant

Treatment of CKD
Primary Care

• Slow the progression (All Stages)

• Treat the complications (Starting at Stage IIIa)

• Ensure vaccination

• Early referral
  • Kidney Failure Risk Equation (KFRE)

Hypertension Management (Non-dialysis)

• Blood pressure
  • Goal is <130/80
  • ACEI/ARBS recommended at first line in ≥ Stage 3 or stage 1-2 with albumin/creatinine ≥300 mg/g
  • Sodium restriction of <2G/day

• Proteinuria
  • Goal spot protein/creatinine ratio if <1.0
  • Check at each visit to trend
Hypertension Management (Dialysis)

- Do not use pre- and post dialysis BP measurements to make decisions
- Ambulatory Blood pressure monitoring is preferred
- BP target is <140/80
- Achieve target dry weight before start BP medications
- Beta blockers are preferred first line
- Dihydropyridine calcium blockers are second line (i.e. amlodipine)
- ACEI/ARBS may decrease risk of CV events – they do no confer the same mortality benefit as in non-dialysis patients

Proteinuria

- Persistent proteinuria is a defining marker of renal injury regardless of eGFR
- Independent risk factor for progressive renal structural damage
- Reducing proteinuria reduces rate of decline
- ACEI and ARBs for treatment
- The 2004 KDOQI Guidelines on HTN in CKD recommends a goal less than 500 to 1000 mg/g creatinine from the urine protein-to-creatinine ratio on a random urine specimen
Diabetics with CKD

- ACEI/ARBs for renal protection and protein reduction
- Weight reduction
- Goal hemoglobin A1C approximately 7.0%
  - Metformin
  - Sodium-glucose cotransporter 2 inhibitors (SGLT-2)
  - Glucagon-like peptide-1 (GLP-1) receptor agonist
  - Dipeptidyl peptidase-4 inhibitors (DPP-4)

Life Style Modifications

- Limiting protein intake – particularly when GFR reaches <20mL/min.
- Sodium should be limited to less than 2 grams per day
- Phosphate and potassium should also be restricted
- All patients should be referred to nutrition specialist
- Smoking cessation will slow the progression of disease
- Exercise 30-60 min of moderate intensity 5 days a week
Hyperlipidemia

- Statins have shown to decrease risk of CVD and mortality, but not in dialysis dependent CKD

- KDIGO recommends statin in all patients with non-dialysis CKD in all patients >50 years OR 18-49 year old with CVD, DM, stroke, or CVD risk >10%

- Statins are recommended in transplant patients

Coronary Artery Disease

- Increased risk for CVD in CKD

- CKD patients are less likely to undergo revascularization despite risks

- Patients may have chronically elevated serum biomarkers due to decrease renal clearance
Kidney Transplant

- Refer early when eGFR falls <30 mL/min/1.73 m²

- Contraindications to transplantation include current infection, active malignancy, chronic illness with shortened life expectancy, active substance abuse, tobacco usage (at least 6 months), obesity (BMI <30), and reversible renal failure

Kidney transplant work up

- Blood type, CBC, BUN, calcium, phosphorous, albumin, liver function tests, PT, PTT, PTH, HCG, RPR, UA/Ucx, UDS, and HbA1c
- Serologic testing for varicella, measles, mumps, CMV, EBV, and rubella viruses
- Serologic testing HIV, hepatitis B virus, anti-surface antibody [HBsAb], and anti-core antibody [HBcAb] and hepatitis C virus
- Human leukocyte antigen (HLA) typing and a panel reactive antibody assay
- PPD or CXR to r/o tuberculosis
- ECHO
- Cancer surveillance screenings UTD
- Iliac artery US
- Age >50 and diabetics >30 need stress test
Poll Question 4

66 yo M with h/o HTN, Stage III CKD, and migraines admitted for resection of sigmoid colon 3 weeks ago. Patient was noted to have an elevated K of 5.6 on round today. Baseline Cr is 1.5 and today is 1.8. Bicarb in 19. He is currently on amlodipine, topiramate, morphine, and heparin. What is the most likely cause of the patient’s hyperkalemia?

A. AKI
B. Topiramate
C. Metabolic acidosis
D. Heparin

Complications of CKD
Hyperkalemia

- Mild hyperkalemia should be treated
- Reversal of factors contributing
  - NSAIDS, spironolactone, hypovolemia
- Potassium binder
- Diuretic if tolerated
- Bicarbonate replacement if chronic metabolic acidosis present
- Not usually need to stop ACEi

Hyperkalemia continued

- Treat emergently as potassium will continue to increase
  - Dialysis-dependent CKD with potassium >5.5 mmol/L (If not stable)
  - Any stage CKD with symptoms
  - Potassium >6 mmol/L
  - EKG changes
  - Quickly rising potassium
Hyperkalemia Continued

- IV calcium
  - Antagonize potassium on membranes
  - Rapid onset but does not last long
- Insulin with glucose
  - Bolus versus infusion
- Albuterol
  - 10-20mg in 4mL saline by nebulization
  - Remove potassium from body
    - Diuretics
    - Hemodialysis or GI cation exchanger

Metabolic Acidosis

- Higher mortality rate
- Increased risk for progression of CKD
- Supplemental bicarbonate
  - Maintain normal range (23-29 mEq/L)
  - Generally 0.5-1.0 mEq/kg/day
  - Start when bicarb <22 mEq/L consistently
  - Dialysis
CKD Mineral and Bone disorder (CKD-MBD)

- Complex disease process
  - Phosphate, calcium, parathyroid hormone, vitamin D, FGF23

CKD-MBD

1. Hyperphosphatemia
   - Persistently above >4.5mg/dL
   - Dietary changes
     - Phosphate binders (Goal <4.5 in non-dialysis, 3.5-5.5 in dialysis)

2. Secondary hyperparathyroidism
   - Persistently above 150-200 pg/mL or 2-3x normal
   - Calcitriol 0.25mcg MWF to keep PTH level >30 but <150 pg/mL
   - No routine use of calcimimetics
CKD-MBD

3. Vitamin D deficiency
   - Only if PTH at goal, vitamin D <30ng/mL, and no hypercalcemia
   - 600-800IU daily oral supplementation
   - Benefit to utilizing Vit D2 to keep vit D2 levels >30 and Vit D3

4. Hypercalcemia
   - Decreased excretion & phosphate binders
   - Extraskeletal calcifications and vascular changes
   - Calcium phosphate product <55

CKD-MBD

5. Renal Osteodystrophy
   - Four subtypes
     - Osteitis Fibrosa Cystica
     - Adynamic Bone Disease
     - Osteomalacia
     - Osteoporosis
CKD-MBD

5. Renal osteodystrophy Cont:
   • Management
     • CKD Stage 3A-G5
       • Based on levels of Ca, Phos, and Vit D
       • Avoid hyperphosphatemia
       • Avoid hypercalcemia
       • Dialysis patients should have PTH lowered to target levels previous discussed
       • Mild and asymptomatic hypocalcemia does not usually need to be treated
         • Exposure to excess calcium increases vascular calcification and mortality

Clinical Evaluations Recommendations

• Stage 3a/b
  • Alk Phos check once
  • Calcium and Phos check q3-6 months
  • Vitamin D check once
  • PTH check once
  • CBC Yearly
• Stage 4-5
  • Alk Phos every 1-3 months
  • Calcium and Phos every 1-3 months
  • Vitamin D every 1-6 months
  • PTH check 1-6 months
  • CBC every 3-12 months (more for dialysis)
Anemia

• Do not assume cause is decreased erythropoietin
  • Work up includes CBC, transferrin, ferritin, iron studies, reticulocyte index, vit B12, folate
  • Check annually

• Treat iron deficiency before epo stimulating agents (ESA)

• Maintain Transferrin Sat levels >30% and ferritin levels >500 in all CKD patients

• Target Hb levels to 10-11 g/dL when utilizing ESA

Anemia continued

• Dialysis patients
  • Give iron infusion if TSAT <20% and ferritin <200 ng/dL
  • Consider iron if TSAT <30% and ferritin <500 ng/dL
  • Can give with ESA
  • No IV iron if ferritin >500 ng/dL

• Non-dialysis
  • Give iron infusion if TSAT <25% and ferritin <500 ng/dL
  • No iron if ferritin >500 ng/dL
Complications – Volume Overload

• Maintain low sodium diet

• No NSAIDS in anyone with CKD3 or greater
  • Can interfere with function of diuretics

• Bowel mucosal edema may reduce absorption

Volume Overload

• Loop diuretics
  • Maximum effective bolus doses:
    • 160 to 200mg furosemide
    • 8 to 10mg bumetanide
    • 50 to 100mg torsemide
  • Partial response ➔ Add thiazide diuretic
    • 30 minutes prior to loop diuretic
  • No response ➔ Continuous drip, albumin
    • Minimal evidence

• Dialysis or ultrafiltration
Preparation for Renal Replacement Therapy (RRT)

- Early planning is important

- 2015 KDOQI guidelines recommend that patients eGFR <30 mL/min/1.73 m² should be educated concerning these issues

- Transplantation is the treatment of choice for ESRD

- 2008 Society for Vascular Surgery guidelines recommend referral to surgeon when the patient has late stage 4 CKD

Preparation for Renal Replacement Therapy (RRT)

- AV fistulas are the preferred

- The 2006 KDOQI guidelines recommend that a fistula be placed at least six months prior to hemodialysis

- AV grafts can provide excellent vascular access in patients who cannot support an AV fistula.

- Tunneled hemodialysis catheters are primarily used as intermediate-duration vascular access
Renal Replacement Therapy (RRT)

• Intermittent
  • Shorter duration
  • Hemodialysis, ultrafiltration, sustained low efficiency, peritoneal

• Continuous
  • 18-24 hours in duration
  • Slower blood flow rates
  • Hemodynamically unstable

Renal Replacement Therapy (RRT)

• Renal transplantation
  • Preferred approach for long-term treatment of ESRD
Indications for Acute RRT

• A – Metabolic Acidosis
  • pH <7.2, refractory to medical management

• E – Electrolyte abnormalities
  • Hyperkalemia & Hypercalcemia most common

• I – Ingestions or Intoxications
  • Ethylene glycol, methanol, lithium, salicylates, etc.

• O – Volume Overload
  • Compromising cardiopulmonary status
  • Refractory hypertension

• U – Uremia
  • Pericarditis, bleeding, encephalopathy, malnutrition, etc.

Vaccination Recommendations

• Increased risk of infection
  • Pulmonary and GU

• All stages - annual flu vaccine

• Stages 4 & 5
  • Hepatitis B - confirm response with testing
  • Polyvalent pneumococcal - revaccinate after 5 years
Early Referral

- Late referral = poor outcomes

- Discuss and plan for replacement therapy
  - GFR<30mL/min
  - Rapidly declining GFR
  - Abrupt sustained decline in GFR
  - Creatinine >4
  - Consistent A3 proteinuria
  - Inability to meet treatment goals
End of Life Care

• Try dialysis for 3 months prior to comfort care

• Patient’s on dialysis meet hospice criteria as long as they stop dialysis

• Remember advanced care planning for all patients with end stage CKD

Recommended Practice Changes

• To prevent contrast-induced nephropathy, assess the risk by screening for preexisting kidney function impairment in all patients before procedures requiring iodinated contrast medium. Use volume expansion with crystalloid fluid administration and the lowest possible dose of iso-osmolar or low-osmolar contrast media. (SORT A)

• For adults with CKD with or without diabetes, use an angiotensin-converting enzyme inhibitor or an angiotensin II receptor blocker as first-line antihypertensive therapy to prevent CKD progression for patients with urine albumin excretion greater than 300 mg/24 hr. (SORT A)
Recommended Practice Changes

• For adults with CKD, use an intent-to-defer strategy for initiating dialysis, with a nephrology subspecialist monitoring patients whose estimated glomerular filtration rate (eGFR) is less than 15 mL/min/1.73 m² and dialysis initiated when clinical indications (e.g., uremic symptoms) emerge or the eGFR decreases to 6 mL/min/1.73 m² or less, whichever occurs first (SORT B)

• Use the following measurements for initial testing of proteinuria (in descending order of preference, in all cases an early morning urine sample is preferred) (2B SORT B):
  - 1) urine albumin-to-creatinine ratio (ACR);
  - 2) urine protein-to-creatinine ratio (PCR);
  - 3) reagent strip urinalysis for total protein with automated reading;
  - 4) reagent strip urinalysis for total protein with manual reading.

Recommend Practice Changes

• An early morning spot urine albumin/creatinine ratio is the preferred initial test to measure proteinuria in patients undergoing CKD evaluation. (SOR C)

• Patients with CKD should have serum hemoglobin measured at least annually, and more often depending on the severity of CKD. (SOR C)

• The evaluation of patients with stage 3a to 5 CKD (estimated GFR < 45 mL per minute per 1.73 m²) should include measurement of serum calcium, phosphorus, parathyroid hormone, alkaline phosphatase, and 25-hydroxyvitamin D levels. (SOR C)
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Questions
References


References


References


