End Stage Renal Disease (ESRD)

- ESRD = dialysis dependent
- Over 500,000 American have ESRD (2007)
- Medicare spent $23.9 billion on ESRD (2007)
The Uremic Man

- Uremia
  - Accumulation of nitrogenous waste products (urea)
  - Constellation of symptoms associated with ESRD

All-cause Mortality Rates, 2007

![Graph showing all-cause mortality rates for ESRD and general population by age group.](USRDS 2009)
CKD Definition
National Kidney Foundation
Kidney Disease Outcomes Quality Initiative (KDOQI)

1. **Kidney damage (proteinuria/albuminuria)** for ≥3 mo ± ↓ GFR.

   OR

2. **GFR <60 mL/min/1.73 m²** for ≥3 mo ± kidney damage.

Glomerular Filtration Rate (GFR)

- Index of kidney function
- Creatinine clearance can be used to approximate GFR
  - Various prediction formulas based on SCr
    - SCr alone should not be used to assess kidney function
  - Cockcroft-Gault commonly used in patients with stable kidney function
    - Developed in healthy subjects
Modification of Diet in Renal Disease (MDRD) Equation

- Developed in patients with CKD
- Used to estimate GFR

\[
eGFR (mL/min/1.73m^2) = 186 \times (SCr)^{-1.154} \times (Age)^{-0.203} \\
\times (0.742 \text{ if female}) \times (1.210 \text{ if African American})
\]

Modification of Diet in Renal Disease (MDRD) Equation

- More accurate estimate of renal function at lower levels
- Used to classify CKD into different stages
- eGFR reported automatically by some labs
  - Calculators available at [www.kidney.org](http://www.kidney.org) or [www.nephron.com](http://www.nephron.com)
  - SCr measurement traceable to isotope dilution mass spectrometry (IDMS)?
### Stages of CKD

<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
<th>GFR (mL/min/1.73 m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Kidney damage with normal or ↑ GFR</td>
<td>≥ 90</td>
</tr>
<tr>
<td>2</td>
<td>Kidney damage with mild ↓ GFR</td>
<td>60-89</td>
</tr>
<tr>
<td>3</td>
<td>Moderate ↓ GFR</td>
<td>30-59</td>
</tr>
<tr>
<td>4</td>
<td>Severe ↓ GFR</td>
<td>15-29</td>
</tr>
<tr>
<td>5</td>
<td>Kidney Failure (ESRD)</td>
<td>&lt; 15 or dialysis dependent</td>
</tr>
</tbody>
</table>


### Estimate of Chronic Kidney Disease (CKD) in the US

NHANES 1999-2004 Data

- **CKD Stage 4 & 5**: CKD effects
- **24 to 28 million Americans**

Whaley-Connell et al. AJKD 2008; 4: S13-S20
Kidney Disease Initiation Risk Factors

• Directly initiate kidney damage
  – Diabetes* 51%
  – Hypertension* 23%
  – Glomerulonephritis 10%
  – Polycystic kidney disease 3%
  – Autoimmune diseases
  – Systemic infections, UTI
  – Lower urinary tract obstruction
  – Drug toxicity

Kidney Disease Progression Risk Factors

• Associated with further kidney damage, faster decline in function after kidney damage
  – Poor glycemic control*
  – Proteinuria*
  – Hypertension*
  – Smoking

4 most common etiologies of CKD
Glycemic Control

• Diabetic nephropathy = microvascular complication of DM
• Studied in many large randomized trials
  – DCCT, UKPDS 33, Kumamoto, ADVANCE
• Strict glycemic control in Type 1 & Type 2 DM
  – ↓ incidence of nephropathy (1° prevention)
  – Delayed progression of nephropathy (2° prevention)

Test | Glycemic Goal
--- | ---
Hgb A1C | < 7%
Preprandial plasma glucose | 70-130 mg/dL
Peak postprandial (1-2 h) plasma glucose | < 180 mg/dL
Special Consideration for Glycemic Control in CKD

- CKD patients - ↑ risk of hypoglycemia
  1) Impaired renal gluconeogenesis
  2) Decreased clearance of insulin
  3) Decreased clearance of some oral agents
- Insulin is appropriate for all CKD stages

### Oral Hypoglycemic Agents & CKD

<table>
<thead>
<tr>
<th>Class</th>
<th>Drug</th>
<th>Dose Recommendation CKD Stage 3 &amp; 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>2nd Generation Sulfonylureas</td>
<td>Glipizide (Glucotrol)</td>
<td>Preferred sulfonylurea</td>
</tr>
<tr>
<td></td>
<td>Glyburide (Diabeta)</td>
<td>Avoid</td>
</tr>
<tr>
<td></td>
<td>Glimepiride (Amaryl)</td>
<td>Initiate low dose</td>
</tr>
<tr>
<td>Alpha-glucosidase inhibitors</td>
<td>Acarbose (Prandase)</td>
<td>Not recommended in patients with SCr &gt; 2 mg/dL</td>
</tr>
<tr>
<td></td>
<td>Miglitol (Glyset)</td>
<td></td>
</tr>
<tr>
<td>Biguanide</td>
<td>Metformin (Glucophage)</td>
<td>Contraindicated with SCr ≥1.5 mg/dL in men</td>
</tr>
<tr>
<td></td>
<td></td>
<td>≥1.4 mg/dL in women</td>
</tr>
</tbody>
</table>

KDOQI. Am J Kidney Dis 2007; 49 (Suppl 2)
### Oral Hypoglycemic Agents & CKD

<table>
<thead>
<tr>
<th>Class</th>
<th>Drug</th>
<th>Dose Recommendation CKD Stage 3 &amp; 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meglitinides</td>
<td>Repaglinide (Prandin)</td>
<td>No dose adjustment</td>
</tr>
<tr>
<td></td>
<td>Nateglinide (Starlix)</td>
<td>Initiate low dose</td>
</tr>
<tr>
<td>Thiazolidinediones (TZDs)</td>
<td>Pioglitazone (Actos)</td>
<td>No dose adjustment, caution fluid retention</td>
</tr>
<tr>
<td></td>
<td>Rosiglitazone (Avandia)</td>
<td></td>
</tr>
<tr>
<td>Incretin mimetic</td>
<td>Exenatide (Byetta)</td>
<td>No dose adjustment**</td>
</tr>
<tr>
<td>Amylin analog</td>
<td>Pramlintide (Symlin)</td>
<td>No dose adjustment for GFR 25-50</td>
</tr>
<tr>
<td>DPP-4 inhibitor</td>
<td>Sitagliptin (Januvia)</td>
<td>Dose adjustment required</td>
</tr>
</tbody>
</table>

**KDOQI. Am J Kidney Dis 2007; 49 (Suppl 2)**

### 2nd Generation Sulfonylureas (SU)

- **Mechanism:** stimulates pancreatic insulin secretion
- **Glipizide (Glucotrol)**
  - Preferred sulfonylurea
  - Hepatic metabolism (10% excreted unchanged in urine)
  - Starting dose: 2.5-5 mg po once daily
- **Glimepiride (Amaryl)**
  - Initiate low dose
  - Hepatic metabolism (**CKD - ↓ metabolite clearance**)
  - Start low: 1 mg po once daily
- **Glyburide (Diabeta)**
  - Up to 50% renally excreted
  - CrCl <50 mL/min → AVOID
Alpha-glucoSIDase inhibitors

- Mechanism: delays digestion and absorption of starches and disaccharides
- Acarbose (Prandase), miglitol (Glyset)
- Renally excreted unchanged
- AVOID SCr >2 mg/dL (CrCl <25 mL/min) – no clinical studies in this population

Biguanide

- Mechanism: ↓ hepatic glucose production
- Metformin (Glucophage)
- Excreted by kidneys as active compound
- Metformin accumulation with ↓ renal function → ↑ risk lactic acidosis (50% fatality rate)
  - Lactic acidosis risk factors: DM, significant hypoperfusion and hypoxemia
- Contraindicated in patients with ↑ SCr
  - ≥1.5 mg/dL (males); ≥1.4 mg/dL (females)
Meglitinides

- Mechanism: glucose-dependent stimulation of insulin secretion
- Repaglinide (Prandin)
  - Hepatic metabolism
  - Starting dose 0.5 mg TID-AC
  - No dose adjustments with CrCl >20 mL/min
- Nateglinide (Starlix)
  - Hepatic metabolism, renal elimination
  - Accumulation of metabolite with CKD → start low dose
  - Starting dose 60 mg TID-AC

Thiazolidinediones (TZDs)

- Mechanism: decreases insulin resistance
- Hepatically metabolized
- No dosage adjustments in renal insufficiency
- Pioglitazone (Actos)
  - Starting dose: 15-30 mg po once daily
- Rosiglitazone (Avandia)
  - Starting dose: 4 mg po divided once or twice daily
- Dose-related edema
Incretins

- Glucagon-like peptide-1 (GLP-1)
- Glucose-dependent insulinotropic polypeptide (GIP)

Incretin mimetic

- Mechanism
  - Enhance glucose-dependent insulin secretion
  - ↓ glucagon production
  - Slows gastric emptying
- Exenatide (Byetta) = GLP-1 receptor agonist
- Indicated in T2DM only
- Monotherapy or combine with metformin, SU, or TZD
- Renally eliminated
- No dose adjustment with CrCl > 30 mL/min
- Should not be used in patients with CrCl <30 mL/min
- Post-marketing reports of altered renal function
- Starting dose: 5 μg sc BID AC two main meals (≥6 h apart)
Amylin Analog

- Mechanism
  - Prevents post prandial glucagon rise
  - Slows rate of gastric emptying
  - ↑ Satiety → ↓ caloric intake
- Pramlintide (Symlin)
- Metabolized by kidneys
- No dose adjustment with CrCl > 20 mL/min
  - ***no studies in patients with CrCl < 20 mL/min
- Starting dose:
  - Administered with insulin, ↓ prandial insulin dose 50%
  - T1DM: 15 μg sc prior to major meals
  - T2DM: 60 μg sc prior to major meals
  - Major meal = ≥250 kcal or ≥30 g carbohydrate

DPP-4 Inhibitor
DPP-4 Inhibitor

- Mechanism: ↓ GLP-1 & GIP degradation
  - Glucose-dependent ↑ insulin production
  - ↓ glucagon production

- Sitagliptin (Januvia)

- Indicated for T2DM only

- Monotherapy or combination therapy
  - ↓ SU/insulin dose

- Renally eliminated → adjust dose for ↓ renal function
  - CrCl 30-50 mL/min: 50 mg po OD
  - CrCl <30 mL/min & ESRD: 25 mg po OD

Blood Glucose Optimization

- Tight glycemic control → delays onset/progression of diabetic nephropathy

- Consider how oral agents are eliminated

- Insulin appropriate at all levels of CKD

- Patients with CKD at ↑ risk of hypoglycemia
  - Ensure patients are aware of signs & symptoms & how to treat

- Encourage self blood glucose monitoring where appropriate
Kidney Disease Progression Risk Factors

• Associated with further kidney damage, faster decline in function after kidney damage
  – Poor glycemic control*
  – Proteinuria*
  – Hypertension*
  – Smoking

First Principles of HTN and Proteinuria in CKD

• HTN associated with faster rate of GFR decline
• Proteinuria associated with faster rate of GFR decline
• Agents used to decrease proteinuria are also anti-hypertensive agents
• BP lowering will decrease protein excretion
Why do we use proteinuria as a therapeutic target?

- Marker of kidney damage
- Risk factor for adverse outcomes (associated with faster ↓ GFR)
- Surrogate outcome - ↓ proteinuria should slow CKD progression
- Effect modifier for interventions (monitoring tool)

Am J Kid Dis. 2004;43(5 suppl 1):S1-230

Screening for Proteinuria

- Qualitative Measure: Dipstick
  - Results affected by hydration status
  - Potential for false (+) & (-)
  - (+) dipstick test needs to be confirmed by a quantitative test within 3 mo
Screening for Proteinuria

• Quantitative Measures
  – 24-h urine collection
    • Inconvenient
    • May be inaccurate due to improper collection techniques
  – Spot urine protein:creatinine ratio
    • Includes urinary albumin
  – Spot urine albumin:creatinine ratio
    • Ability to screen for microalbuminuria
  – ≥2 (+) quantitative tests spaced 1-2 weeks apart = persistent proteinuria/albuminuria

Definitions of Proteinuria and Albuminuria

<table>
<thead>
<tr>
<th></th>
<th>Method</th>
<th>Normal</th>
<th>Microalbuminuria</th>
<th>Albuminuria/ Clinical Proteinuria</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Protein</strong></td>
<td>Spot urine dipstick</td>
<td>&lt; 30 mg/dL</td>
<td>N/A</td>
<td>&gt; 30 mg/dL</td>
</tr>
<tr>
<td></td>
<td>24 hr excretion</td>
<td>&lt; 300 mg/day</td>
<td>N/A</td>
<td>&gt; 300 mg/day</td>
</tr>
<tr>
<td></td>
<td>Spot protein:creatinine ratio</td>
<td>&lt; 200 mg/g</td>
<td>N/A</td>
<td>&gt;200 mg/g</td>
</tr>
<tr>
<td><strong>Albumin</strong></td>
<td>Spot urine albumin dipstick</td>
<td>&lt;3 mg/dL</td>
<td>&gt;3 mg/dL</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>24 hr excretion</td>
<td>&lt; 30 mg/day</td>
<td>30-300 mg/day</td>
<td>&gt; 300 mg/day</td>
</tr>
<tr>
<td></td>
<td>Spot urine albumin:creatinine ratio (ACR)</td>
<td>&lt;30 mg/g</td>
<td>30-299 mg/g</td>
<td>≥ 300 mg/g</td>
</tr>
</tbody>
</table>
KDOQI Hypertension Guidelines

• Pts with CKD considered “highest risk” group for cardiovascular disease
• Target BP <130/80 mmHg
• Variation in guideline for Diabetics vs Non-Diabetic CKD
  – Preferred agents for CKD should be used 1st
  – Diuretics should be prescribed for most patients
  – Additional agents chosen based on cardiovascular disease indications
  – Multiple agents usually required to achieve target BP

HTN Management: Nondiabetic CKD

• Target BP < 130/80 mmHg
• < 125/75 mmHg in select patients with proteinuria >1g/day
  – Controversial
  – Weak evidence but will see in some guidelines

<table>
<thead>
<tr>
<th>NON-diabetic CKD</th>
<th>Preferred Agent for CKD</th>
<th>Additional agents to ↓ CVD risk and reach target BP</th>
</tr>
</thead>
<tbody>
<tr>
<td>HTN + Proteinuria/albuminuria</td>
<td>ACEI or ARB</td>
<td>Diuretic preferred BB or CCB</td>
</tr>
<tr>
<td>HTN (no proteinuria/albuminuria)</td>
<td>None preferred</td>
<td>Diuretic preferred ACEI, ARB, BB, or CCB</td>
</tr>
<tr>
<td>No HTN + Proteinuria/albuminuria</td>
<td>ACEI or ARB</td>
<td></td>
</tr>
<tr>
<td>No HTN + microalbuminuria</td>
<td>None preferred</td>
<td></td>
</tr>
</tbody>
</table>
HTN Management: DM + CKD

- Target BP <130/80 mmHg
- ACEI and ARBs delay progression from microalbuminuria to macroalbuminuria (regardless of whether HTN is present)

<table>
<thead>
<tr>
<th>Diabetic CKD</th>
<th>Preferred Agent for CKD</th>
<th>Additional agents to ↓CVD risk and reach target BP</th>
</tr>
</thead>
<tbody>
<tr>
<td>HTN</td>
<td>ACEI or ARB</td>
<td>Diuretic preferred BB or CCB</td>
</tr>
<tr>
<td>No HTN + microalbuminuria or proteinuria/macroalbuminuria</td>
<td>ACEI or ARB</td>
<td></td>
</tr>
</tbody>
</table>

Antihypertensives That Decrease Proteinuria

- **ACEI and ARBs most effective in decreasing proteinuria (1st line)
- Non-dihydropyridine (diltazem, verapamil) CCB can also reduce proteinuria
- Antiproteinuric effects of antihypertensives appear to be additive
  - ACEI + ARB
  - ACEI or ARB + NDHP CCB
Why ACE inhibitor/ARB?

- ↓ Systemic BP
- ↓ Glomerular capillary pressure
- ↓ Protein filtration
- Shown in clinical trials to:
  - ↓ Albuminuria
  - Preserve renal function
  - Delay time to dialysis

↑ Intra-Glomerular pressure can cause protein to leak from glomerulus into urine

Diagram showing:
- ↑ Intra-Glomerular pressure
- Angiotensin II = vasoconstrictor
  - Afferent Arteriole
  - Efferent Arteriole

Effect of ACEIs / ARBs

Diagram showing:
- ↓ Intra-Glomerular pressure
  - ↓ Angiotensin II → vasodilation
  - Afferent Arteriole
  - Efferent Arteriole
ACE inhibitors and ARBs in CKD

• No upper limit of SCr for initiation of ACE inhibitor or ARB
• BUT drug clearance from body reduced in CKD
• If CrCl < 30 mL/min
  – Agents should be started with care
  – Start with lower dose

Use and Monitoring of ACE-I/ARB Therapy in CKD

• Use moderate to high doses
  – Titrate every 4-8 weeks as tolerated
• Dose-related adverse effects
  – Hypotension
  – Hyperkalemia
    • Aldosterone secretion inhibited
  – Elevations in SCr
    • ↓ GCP = ↓ GFR = ↑ SCr
Monitoring of ACE-I/ARB

- Monitor K⁺ & SCr within 2 wk initiation/dose ↑
- If GFR ↓ <50%, D/C ACE-I/ARB
- If GFR ↓ >30% baseline or K⁺ >5 mEq/L, ↓ ACE-I/ARB dose 50% and recheck
- In most patients, ACE-I or ARB can be continued if:
  - GFR ↓ over 4 mo is <30% from baseline value
  - K⁺ is ≤5.5 mEq/L

ACE-I + ARB Combination

- Numerous small studies, most of short duration
- Additive BP lowering
- Additive antiproteinuric effect
- More effective in slowing GFR decline
  - COOPERATE (Lancet 2003; 361:117-24)
- Limited data to support
- ONTARGET most recent study
ONTARGET

– Main study: NEJM 2008;358:1547-89

• Multicenter, double-blind RCT
• N=25 620; median follow-up=56 mo
• Telmisartan 80 mg vs. ramipril 10 mg vs. telmisartan 80 mg + ramipril 10 mg
• Included pts with atherosclerotic vascular disease or diabetes with end organ damage

ONTARGET Results

• 1° renal outcome: composite of dialysis, renal transplant, doubling of SCr, or death
  – Similar between telmisartan & ramipril but ↑ with combination (HR 1.09, p=0.037)
• 2° renal outcome: composite of dialysis or doubling of SCr
  – Similar between telmisartan & ramipril but ↑ with combination (HR 1.24, p=0.038)
ONTARGET Results

- Risk developing new microalbuminuria or macroalbuminuria
  - Similar between telmisartan & ramipril but ↓ with combination (HR 0.88, p=0.003)
- Risk of progression from microalbuminuria to macroalbuminuria
  - Similar between telmisartan & ramipril but ↓ with combination (HR 0.76, p=0.019)

Criticisms of ONTARGET

- Renal outcome were substudy of main trial, therefore trial was not powered to detect differences in major renal outcomes
- Death was most common component of composite primary outcome
- Know from previous studies that the greater the proteinuria, the bigger the effect of ACE-I
  - Most subjects did not have proteinuria
  - Subgroup of subjects with DM+macroalbuminuria demonstrated a trend towards ↓ 1° with combination
Considerations with Alternate BP Lowering Agents

| Diuretics          | • Thiazides – CrCl > 30 mL/min  
                  | *Metolazone if CrCl < 30 mL/min |
|                   | • Loop diuretics – CrCl < 30 mL/min |
|                   | • K⁺ sparing – use with caution |
| B-blockers        | • Mask signs & symptoms of hypoglycemia |
|                   | • Initiate renally eliminated B-blocker |
| Calcium Channel Blocker | • Nondihydropyridine CCB (Verapamil, diltiazem) ↓ proteinuria |

BP Optimization

• Slows CKD progression
• Reduces urinary albumin & protein excretion  
  – Certain agents more effective
• Ideal to lower BP to target goal  
  – Any reduction in BP would be beneficial
• All classes of antihypertensive drugs are effective
• Most cases, multiple antihypertensive drugs will be needed  
  – Use of ACE-I + ARB combination controversial
Monitoring Progression of CKD

- GFR decline
- Proteinuria
  - Surrogate marker for CKD progression
  - Quantitative measurements should be used to monitor progression

1/SCr predicts need for Dialysis

![Diagram showing the relationship between 1/SCr and time leading to dialysis intervention.](image)
Additional Points Regarding Prescribing to Patients with CKD

Analgesics

GI Products

Analgesics

• Avoid NSAIDs if possible
  – ASA 80-325 mg daily okay
• Mechanism of NSAID nephrotoxicity

Effect of NSAIDs

• Analgesic of choice = acetaminophen (alone)
GI Products

- Avoid products with Mg$^{2+}$, Al$^{3+}$, Phosphate
  - Renally eliminated → Can accumulate in CKD

<table>
<thead>
<tr>
<th>Products to Avoid</th>
<th>Consider using:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antacids</td>
<td>Tums (*watch serum Ca)</td>
</tr>
<tr>
<td></td>
<td>H2-antagonist (*dose adjustment required)</td>
</tr>
<tr>
<td></td>
<td>Proton Pump Inhibitors</td>
</tr>
<tr>
<td>Amphogel, Alternagel</td>
<td></td>
</tr>
<tr>
<td>Gaviscon</td>
<td></td>
</tr>
<tr>
<td>Maalox</td>
<td></td>
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<tr>
<td>Milk of Magnesia</td>
<td></td>
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<tr>
<td>Mylanta</td>
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<tr>
<td>Rolaid</td>
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<tr>
<td>Laxative Stool Softeners</td>
<td>Fleet Phospha Soda</td>
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<td></td>
<td>Citro Mag</td>
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<td></td>
<td>Docusate</td>
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<td></td>
<td>Glycerin</td>
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<tr>
<td></td>
<td>Lactulose</td>
</tr>
<tr>
<td></td>
<td>Sennosides</td>
</tr>
<tr>
<td></td>
<td>Bisacodyl</td>
</tr>
</tbody>
</table>

CKD Case
AL 68 y/o white male

- PMH: Type 2 diabetes x 5 years
- Labs: Na=140; Cl=110; K=4.0; HCO3=20
  - SCR 1.8; BUN=22; Hg=12
  - Glucose (fasting)=170; HgA1C=9.4%
  - Urine albumin:creatinine ratio=100
- Vitals: BP=155/94; Pulse=70
- Medications:
  - Metformin 1000 mg po BID

**What signs are suggestive of CKD?**

**What stage of CKD does AL have?**

---

**What signs are suggestive of CKD?**

- Albumin: creatinine ratio (ACR) = 100
  - ACR consistent with “microalbuminuria”
  - Protein/albumin in urine is a sign of kidney damage
  - Proteinuria associated with faster rate of GFR decline
- Elevated SCR
  - Need to determine GFR
What stage of CKD does AL have?

• Stage of CKD based on eGFR using MDRD equation
  – Assume SCR not measured by method traceable to IDMS

\[
eGFR \, (\text{mL/min/1.73m}^2) = 186 \times (\text{SCR})^{-1.154} \times (\text{Age})^{-0.203} \\
x (0.742 \text{ if female}) \times (1.210 \text{ if African American})
\]

\[
eGFR \, (\text{mL/min/1.73m}^2) = 186 \times (1.8)^{-1.154} \times (68)^{-0.203} = 40
\]

<table>
<thead>
<tr>
<th>Stage</th>
<th>eGFR (mL/min/1.73m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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<td>&lt;15 (or dialysis dependent)</td>
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  – Urine albumin:creatinine ratio=100
• Vitals: BP=155/94; Pulse=70
• Medications:
  – Metformin 1000 mg po BID

What factors will contribute to the progression of CKD?
What factors will contribute to the progression of CKD?

• Poor glycemic control; HgA1C=9.4% and fasting glucose=170 mg/dL
  – Target HgA1C <7%, pre-prandial (fasting) blood glucose 70-130 mg/dL
  – AL has diabetic nephropathy, therefore optimal glycemic control will slow the progression of CKD (2° prevention)

• Hypertension; BP 155/94
  – Goal BP <130/80
  – Blood pressure control will slow progression of CKD

• Microalbuminuria
  – Goal = ↓ to normal range, prevent progression to macroalbuminuria

AL 68 y/o white male

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• Labs: Na=140; Cl=110; K=4.0; HCO3=20
  – SCR 1.8; BUN=22; Hg=12
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  – Urine albumin:creatinine ratio=100
• Vitals: BP=155/94; Pulse=70
• Medications:
  – Metformin 1000 mg po BID

How can we help AL to achieve better glycemic control?

Which antihypertensive agent should be started?
How can we help AL to achieve better glycemic control?

- Discontinue metformin
  - Contraindicated with SCr >1.5 mg/dL (males) due to increased risk of lactic acidosis
- Prescribe another oral agent appropriate for renal function
  - Combination therapy may be required
- Consider insulin?
- Review diet and activity level
- Monitor HgA1C

Which antihypertensive agent should be started?

- ACE-I or ARB = 1st line in patients with DM + CKD

<table>
<thead>
<tr>
<th>Diabetic CKD</th>
<th>Preferred Agent for CKD</th>
<th>Additional agents to ↓ CVD risk and reach target BP</th>
</tr>
</thead>
<tbody>
<tr>
<td>HTN</td>
<td>ACEI or ARB</td>
<td>Diuretic preferred BB or CCB</td>
</tr>
<tr>
<td>No HTN + microalbuminuria or proteinuria/mac</td>
<td>ACEI or ARB</td>
<td></td>
</tr>
</tbody>
</table>

- ACE-I or ARB will delay progression of microalbuminuria to macroalbuminuria
- Start low dose and titrate to moderate to high doses
- Monitor BP, K⁺, SCr (GFR)
  - GFR ↓ over 4 mo is <30% from baseline value
  - K⁺ is ≤5.5 mEq/L