What is the significance of chronic kidney disease in the community dwelling elderly?

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November 14, 2008
Regional Geriatrics Program City-Wide Rounds
Objectives

• At the end of this session you should be able to:
  – interpret the result of an eGFR (estimated Glomerular Filtration Rate)
  – describe the prevalence and significance of chronic kidney disease (CKD) in the elderly
  – initiate treatments to mitigate the effects of CKD on patient mortality and morbidity
  – differentiate CKD patients at risk of progressing to ESRD (end stage renal disease) and advise and possibly refer those patients
What is Chronic Kidney Disease

- The presence of Kidney Damage or an eGFR < 60 ml/min/1.73m² and
- Present for ≥ 3 months and
- Not treated with dialysis or transplant

The diagnosis of CKD is only present in patients with eGFR ≥60ml/min if other abnormalities (i.e. proteinuria, hematuria, anatomical) are also present.
<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
<th>Glomerular filtration rate in ml/min/1.73 m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Kidney damage with normal or high GFR</td>
<td>≥90</td>
</tr>
<tr>
<td>2</td>
<td>Kidney damage with slightly low GFR</td>
<td>60-89</td>
</tr>
<tr>
<td>3</td>
<td>Moderately low GFR</td>
<td>30-59</td>
</tr>
<tr>
<td>4</td>
<td>Severe low GFR</td>
<td>15-29</td>
</tr>
<tr>
<td>5</td>
<td>Kidney failure</td>
<td>&lt;15 or dialysis</td>
</tr>
</tbody>
</table>

GFR=glomerular filtration rate.
Chronic kidney disease is defined as either kidney damage or glomerular filtration rate <60 ml/min/1.73m² for ≥3 months. Kidney damage is defined as pathological abnormalities or markers of damage, including abnormalities in blood or urine tests or imaging studies.
Does this patient have CKD?

• 70 year old male with GFR 63 ml/min?

• 74 year old female with GFR 47 ml/min?

• 68 year old diabetic with GFR persistently 38 ml/min and microalbuminuria?
Glomerular filtration rate

- equal to the sum of the filtration rates in all of the functioning nephrons; thus, the GFR gives a rough measure of the number of functioning nephrons.

- normal value for GFR depends on age, sex, and body size, and is approximately 130 and 120 mL/min/1.73 m² for men and women, respectively, with considerable variation even among normal individuals.
Methods to assess GFR

• Serum urea
• Serum creatinine
• Serum cystatin C
• Timed urine collections
  – Creatinine clearance
  – Inulin clearance
• Nuclear medicine methods
Measuring GFR

- Freely filtered ✓
- Not secreted or reabsorbed
- Inexpensive to measure ✓
- Endogenous ✓

- Creatinine?
### Table 2. Factors Affecting Creatinine Generation.*

<table>
<thead>
<tr>
<th>Factor</th>
<th>Effect on Serum Creatinine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aging</td>
<td>Decreased</td>
</tr>
<tr>
<td>Female sex</td>
<td>Decreased</td>
</tr>
<tr>
<td>Race or ethnic group†</td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td>Increased</td>
</tr>
<tr>
<td>Hispanic</td>
<td>Decreased</td>
</tr>
<tr>
<td>Asian</td>
<td>Decreased</td>
</tr>
<tr>
<td>Body habitus</td>
<td></td>
</tr>
<tr>
<td>Muscular</td>
<td>Increased</td>
</tr>
<tr>
<td>Amputation</td>
<td>Decreased</td>
</tr>
<tr>
<td>Obesity</td>
<td>No change</td>
</tr>
<tr>
<td>Chronic illness</td>
<td></td>
</tr>
<tr>
<td>Malnutrition, inflammation, deconditioning (e.g., cancer, severe cardiovascular disease, hospitalized patients)</td>
<td>Decreased</td>
</tr>
<tr>
<td>Neuromuscular diseases</td>
<td>Decreased</td>
</tr>
<tr>
<td>Diet</td>
<td></td>
</tr>
<tr>
<td>Vegetarian diet</td>
<td>Decreased</td>
</tr>
<tr>
<td>Ingestion of cooked meat</td>
<td>Increased</td>
</tr>
</tbody>
</table>
Who has abnormal renal function?

a) 30 ♂ with Cr 130 umol/L

b) 75 ♀ with Cr 100 umol/L

c) 28 quadriplegic ♂ with Cr 50 umol/L

d) 80 ♂ with right hemiparesis and Cr 130 umol/L
Creatinine based approximations

1) **Cockcroft-Gault equation**

CrCl (ml/min) = (140-age) x actual weight (kg) x 1.2 (if male)

SCreat (µmol/L)

**Weight probably not available for lab to calculate**

2) **MDRD (Modification of Diet in Renal Disease)**

4 variable or abbreviated version

GFR(ml/min/1.73m2) = 186.3(PCR/88.4)^-1.154 x (Age)^-0.203 x (0.742 if female) x (1.21 if African American)

**Lab has patient age and gender – can do abbreviated version**
Where do these formulas come from?

- **Cockcroft-Gault**
  - 1976, 249 men ages 18-92
  - Used 24 hour urine collection as gold standard

- **MDRD**
  - 1999, 1628 men and women, mean age 50.6 ±12.7
  - enrolled in a trial of diet in kidney disease
  - Average GFR was 38 ml/min/1.73 m2 as measured with renal scan
Estimating the prevalence of renal insufficiency in seniors requiring long term care
Garg et al. KI 2004; 65:649-653
What’s the point?

• It’s improved the reliability of creatinine measurement

• It’s improved the detection of reduced renal function

• It has given us a common definition and vocabulary to use to study CKD
Variability in creatinine measurement

- Calibrations and random variation of the serum creatinine assay as critical elements of using equation to estimate glomerular filtration rate
  - Coresh et al, AJKD 2002; 39: 920-9

- Compared assays on the same blood samples
- Results were 0.23 mg/dl (~ 20 umol/L) higher in NHANES lab than in MDRD lab
- Overall data from College of American Pathologists is that average coefficient of variation of serum creatinine is ~8%
Local normal ranges - female

- Bio-test 35-97 umol/L
- MDS 35-88 umol/L
- Gamma Dynacare 50-100 umol/L
- CML 60-115 umol/L
- TOH 35-88 umol/L
Problems with creatinine

• Variability in measurement technique
  
  **Standardize creatinine measurement**

• Variability in creatinine generation depending on muscle mass
  
  **Express creatinine as eGFR: use formulae that adjust for differences in creatinine generation**

• Lags in situations with acute change in renal function
Improving accuracy of CKD detection

- Using standardized serum creatinine values in the MDRD study equation for estimating GFR

- Re-analyzed samples from 1628 patients in the MDRD study using an assay traceable to IDMS and expressed using mathematical formulae
Percentage of eGFR within 30% of measured GFR

“true” GFR value
A.

Measured GFR - Estimated GFR, mL/min per 1.73 m²

$R^2 = 0.882 \ (0.870 \text{ to } 0.893)$
What’s the point?

- Detection of CKD with laboratory reporting of eGFR and an educational program
  - Akbari et al, Arch Int Med 2004, 14:1788-1792

- Family Medicine clinic
- CG eGFR and CKD education to MD’s
- awareness of GFR < 60 ml/min improved from 22% to 85% of cases
Summary

• Chronic Kidney Disease is defined as the presence of kidney damage or GFR below 60 for at least 3 months

• Creatinine estimates GFR

• Creatinine based formulas are better but not perfect at estimating GFR
  – because they may take lab variation in measurement of creatinine as well as some surrogates of creatinine generation such as age, gender and race into account
What’s the effect of aging on kidney function?

• GFR falls 1 ml/min/year after the age of 40

• True

• False
Age changes in GFR, effective renal plasma flow and tubular excretory capacity in adult males Davies and Shock 1950, JCI 29: 496-507
Baltimore Longitudinal Study

The effect of age on creatinine clearance in men: a cross-sectional and longitudinal study

Rowe et al, J Gerontology 1976; 31:155-63

• 548 “normals”
• Cross-sectional analysis by 10 year age groups showed a progressive linear decline in 24 hour urine creatinine clearance from 140 at age 30 to 97 at age 80
Baltimore Longitudinal Study

Association between blood pressured and the rate of decline in renal function with age
Lindeman, Tobin and Shock, KI 1984; 26:861-868

- 446 participants, mostly white, middle and upper class, with at least 5 serial 24 hour urine creatinine clearances
- Classified into three categories
  - evidence suggesting potential renal disease (118)
  - hypertension or on diuretics (74)
  - normal (254)
24 hour urine creatinine clearance by age group over time
The higher the blood pressure the greater the rate of decline of renal function.

This effect is more pronounced in those with hypertension, but is present in all three groups.

<table>
<thead>
<tr>
<th>MBP limits mm Hg</th>
<th>All subjects</th>
<th>Category 1</th>
<th>Category 2</th>
<th>Category 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>MBP &lt; 120</td>
<td>430</td>
<td>-0.060 ± 0.011&lt;sup&gt;a&lt;/sup&gt;</td>
<td>113</td>
<td>-0.077 ± 0.024&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>MBP &lt; 114</td>
<td>400</td>
<td>-0.048 ± 0.013&lt;sup&gt;b&lt;/sup&gt;</td>
<td>104</td>
<td>-0.075 ± 0.028&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>MBP &lt; 107</td>
<td>356</td>
<td>-0.023 ± 0.016</td>
<td>88</td>
<td>-0.047 ± 0.036</td>
</tr>
</tbody>
</table>
Longitudinal studies on the rate of decline in renal function with age

- Mean decrease in creatinine clearance in “normal” group was 0.75 ml/min./year

- One third of all subjects had no change in renal function over time
Not just hypertension…

Renal function in the elderly: Impact of hypertension and cardiac function
Fliser et al, KI 1997;51:1196-1204

- 24 healthy young (age 26)
- 29 health elderly (age 68)
- 25 elderly treated and untreated hypertensives (age 73)
- 14 elderly heart failure (age 69)

- Inulin GFR
Fig. 1. Individual data on glomerular filtration rate (GFR) in young healthy normotensive subjects (N = 24; mean age 26 ± 3 years), elderly healthy normotensive subjects (N = 29; 68 ± 7 years), elderly hypertensive patients without heart failure (N = 25; 70 ± 6 years) and elderly patients with compensated mild to moderate (NYHA I/II) heart failure (N = 14; 69 ± 6 years). Symbols are: (○) men, (●) women; (►) mean value.
Summary ....

- Serum creatinine is affected by physiologic changes with age (due to changes in muscle mass)

- On average, renal function as determined by other methods of measuring GFR declines as we age
  - but not in everyone
  - and not at the same speed
    - worse in those with hypertension and heart disease
So what’s normal renal function for an 80 year old?

• conforming to the standard or the common type; usual

• free from any infection or other form of disease or malformation, or from experimental therapy or manipulation
Age and gender-specific reference values of estimated GFR in Caucasians: the Nijmegen Biomedical Study  Wetzels et al, KI 2007; 72:632-637

- Population based cross sectional study in the Netherlands
- 87% Caucasian

- 6097 responded to questionnaire and gave blood
- co-morbidities identified by questionnaire included hypertension, diabetes, MI, CVA, Kidney disease and use of diuretics, anti-hypertensives or antirheumatic drugs
Median GFR is 64 for a 80 year old woman with no co-morbidities normal range is 35-70

with a reported co-morbidity the median GFR drops to 56
Figure 3 | Prevalence of CKD stages 3-5 (GFR < 60 ml/min/1.73 m²) according to age in the non-diseased Caucasian Nijmegen Biomedical Study population. Black bars represent men and open bars women.
What’s the significance of that reduced GFR?

• Risk of developing end stage renal disease

• Other problems associated with reduced number of nephrons
  – Removal of medications/toxins
  – Anemia
  – Electrolyte abnormalities
  – Renal bone disease

• Other associated risks?
If you’re followed by a nephrologist…

- MDRD study
  - Annual decline in GFR ranged from 3-10 ml/min/1.73m²

- REIN study
  - Annual decline in GFR ranged from 6-10 ml/min/1.73m²
## Community based studies

<table>
<thead>
<tr>
<th>Location</th>
<th>Duration of followup</th>
<th>Incidence of ESRD</th>
<th>GFR change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Norway GFR &lt;60 prospective</td>
<td>10 yrs</td>
<td>4 % cumulative</td>
<td>73% had a stable GFR</td>
</tr>
<tr>
<td>Calgary &gt;65 yrs prospective</td>
<td>2 yrs</td>
<td>1 % cumulative</td>
<td>1 ml/min/yr nonDM</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2.5 ml/min/yr DM</td>
</tr>
<tr>
<td>KPNW GFR &lt;60 retrospective</td>
<td>5 yrs</td>
<td>1.6 /100 pt yrs</td>
<td></td>
</tr>
</tbody>
</table>

1. Eriksen and Ingebretsen, KI 2006; 69:375
2. Hemmelgarn et al, KI 2006; 69:2155
3. Johnson et al, AJKD 2007:50; 559
Who progresses to ESRD?

Those with worse renal function
KPNW study, Hazard ratios for ESRD, >45 as reference
Community based study from Japan
Iseki et al, AJKD 2004:44:806-814
Significance of reduced nephrons

What do the kidneys Do?
- remove endogenous and exogenous toxins
- produce EPO
- activate vit D (maintain iCa levels)
- maintain homeostasis
  - K+
- remove excess water
- maintain acid-base
Removal of drugs and toxins

Comparison of estimated glomerular filtration rate with estimated creatinine clearance in the dosing of drugs requiring adjustments in elderly patients with declining renal function

- Manufacturers have used Cockcroft Gault formula in their recommendations for dose adjustments (ml/min)
- Calculations comparing MDRD and CG
  - CG – use ideal Body Weight
  - MDRD – adjust for BSA
Table III. Calculation of creatinine clearance (CrCl) and conversion to glomerular filtration rate (GFR) equivalents. Sample patient was an 80-year-old female (total body weight [TBW], 120 kg; ideal body weight [IBW], 80 kg; adjusted body weight [AdjBW], 96 kg; and serum creatinine [Cr], 1.70 mg/dL).

<table>
<thead>
<tr>
<th>Formula</th>
<th>Equation</th>
<th>CrCl, mL/min</th>
<th>Body Size Adjustment for CrCl as mL/min</th>
<th>Conversion to GFR, mL/min/1.73 m²</th>
<th>GFR Value, mL/min/1.73 m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>CG using TBW, mL/min</td>
<td>TBW(140 - age)/(72 × Cr) × 0.85</td>
<td>50</td>
<td>None needed</td>
<td>1.73 m²/patient BSA</td>
<td>45</td>
</tr>
<tr>
<td>CG using IBW, mL/min</td>
<td>IBW(140 - age)/(72 × Cr) × 0.85</td>
<td>33</td>
<td>None needed</td>
<td>1.73 m²/patient BSA</td>
<td>30*</td>
</tr>
<tr>
<td>CG using AdjBW, mL/min†</td>
<td>AdjBW(140 - age)/(72 × Cr) × 0.85</td>
<td>40</td>
<td>None needed</td>
<td>1.73 m²/patient BSA</td>
<td>36*</td>
</tr>
<tr>
<td>Jelliffe equation, mL/min/1.73 m²</td>
<td>(98 - [0.8 (age -20)])/Cr) × 0.85</td>
<td>No value</td>
<td>None needed</td>
<td>1.73 m²/patient BSA</td>
<td>25</td>
</tr>
<tr>
<td>Original MDRD4, mL/min/1.73 m²</td>
<td>186(Cr⁻¹.¹⁵⁴ × age⁻⁰.²⁰³) × 0.742</td>
<td>31 mL/min/1.73 m²</td>
<td>No conversion</td>
<td>None needed</td>
<td>31</td>
</tr>
<tr>
<td>Revised MDRD4, mL/min/1.73 m²†</td>
<td>175(Cr⁻¹.¹⁵⁴ × age⁻⁰.²⁰³) × 0.742</td>
<td>29 mL/min/1.73 m²</td>
<td>No conversion</td>
<td>None needed</td>
<td>29</td>
</tr>
</tbody>
</table>
Drug dose adjustments

• Keep limitations of the formulas in mind especially if your patient is not the “usual” size

• Most of the time the dose adjustments are in big categories so it doesn't matter

• If it’s really important weigh the risk/benefit of over vs under dosing
  – or measure drug levels
Significance of reduced nephrons

What do the kidneys Do?

- remove endogenous and exogenous toxins
- produce EPO
- activate vit D (maintain iCa levels)
- maintain homeostasis
  - K+
- remove excess water
- maintain acid-base
Stevens L et al, NEJM 2006; 354:2473-2483
Other significance of CKD?
Age-Standardized Rate of Death from Any Cause (per 100 person-yr)

Estimated GFR (ml/min/1.73 m²)

- ≥60: 0.76
- 45–59: 1.08
- 30–44: 4.76
- 15–29: 11.36
- <15: 14.14

No. of Events: 25,803 11,569 7802 4408 1842

NEJM 2004, Go et al, Kaiser Permanente Northern California
Community based studies

<table>
<thead>
<tr>
<th>Location</th>
<th>Duration of followup</th>
<th>ESRD</th>
<th>Death</th>
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<tr>
<td>Norway GFR &lt;60 prospective</td>
<td>10 yrs</td>
<td>4 % cumulative</td>
<td>51 % cumulative</td>
</tr>
<tr>
<td>KPNW GFR &lt;60 retrospective</td>
<td>5 yrs</td>
<td>1.6 per 100 pt yrs</td>
<td>11.4 per 100 pt yrs</td>
</tr>
</tbody>
</table>

1. Eriksen and Ingebretsen, KI 2006; 69:375
2. Johnson et al, AJKD 2007:50; 559
Age affects outcomes in CKD. O’Hare et al, JASN 2007, 18:2758-2765

VA hospitals 2000-2001, 209,622 patients with two eGFR <60
**CV events**

B

Age-Standardized Rate of Cardiovascular Events (per 100 person-yr)

<table>
<thead>
<tr>
<th>Estimated GFR (ml/min/1.73 m²)</th>
<th>No. of Events</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥60</td>
<td>73,108</td>
</tr>
<tr>
<td>45–59</td>
<td>34,690</td>
</tr>
<tr>
<td>30–44</td>
<td>18,580</td>
</tr>
<tr>
<td>15–29</td>
<td>8809</td>
</tr>
<tr>
<td>&lt;15</td>
<td>3824</td>
</tr>
</tbody>
</table>
Fig. 2. Independent risk of renal insufficiency on cardiovascular events, adjusted for traditional cardiovascular risk factors. Longitudinal studies are from 1973 to 1999. Comparing cardiovascular event rates was problematic because different cardiovascular outcomes are reported in the studies. Here, cardiovascular events preferentially represented cardiovascular mortality or heart failure mortality when reported, or otherwise represented myocardial infarction, stroke, or some composite of cardiovascular disease. *Age adjusted rate.
## Other associations

<table>
<thead>
<tr>
<th>Disease</th>
<th>Study</th>
<th>GFR</th>
<th>HR</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHF</td>
<td>ARIC</td>
<td>GFR &lt;60</td>
<td>1.94</td>
</tr>
<tr>
<td>Peripheral artery disease</td>
<td>ARIC</td>
<td>GFR &lt;60</td>
<td>1.56</td>
</tr>
<tr>
<td>Stroke</td>
<td>Ohasama</td>
<td>GFR &lt;40</td>
<td>3.1</td>
</tr>
<tr>
<td>Hemorrhagic stroke</td>
<td>Rotterdam</td>
<td>GFR ~ &lt;50 quartiles</td>
<td>4.1</td>
</tr>
</tbody>
</table>

2. Wattanakit et al, JASN 2007; 18:629  
Hospitalization

![Bar chart showing age-standardized rate of hospitalization (per 100 person-yrs) for different Estimated GFR categories.](chart)

- **Estimated GFR (ml/min/1.73 m²)**
  - ≥60: 13.54
  - 45–59: 17.22
  - 30–44: 45.26
  - 15–29: 86.75
  - <15: 144.61

- **No. of Events**
  - 366,757
  - 106,543
  - 49,177
  - 20,581
  - 11,593
But..........................

- Patients with diabetes mellitus
- Patients with hypertension
- Patients with heart failure
- Patients with atherosclerotic coronary, cerebrovascular or peripheral vascular disease
- Patients with unexplained anemia
- Patients with a family history of ESRD
- First nations peoples
CVD and CKD

- Cardiovascular outcomes and all-cause mortality: exploring the interaction between CKD and cardiovascular disease. Weiner et al, AJKD 2006; 48:392
  - Pooled subject level data from 4 community based prospective studies (ARIC, CHS, Framingham and Offspring)

- Kidney disease, Framingham risk scores and cardiac and mortality outcomes. Weiner et al, AJM 120:552
  - ARIC and CHS, ages 45-74 without pre-existing cardiovascular disease
  - Calculated Framingham risk scores and examined discriminative ability
CKD is an independent risk factor, not synergistic
Magnitude of risk from CKD was comparable to that of diabetes and smoking.
Summary

• Reduced renal function is common in the elderly due to normal changes of ageing as well as the accumulation of co-morbidities

• Serum creatinine measurement is not an ideal assessment of GFR

• Formulas that estimate GFR improve our ability to detect abnormal renal function

• CKD defined by eGFR has been associated with patient outcomes like death, ESRD and cardiovascular disease
What should be done for patients with reduced eGFR?

- Identify those who have CKD

- Identify those at risk for progression to ESRD
  - Significant persistent proteinuria (ACR > 60)

- Implement risk reduction strategies
  - Bp control <130/80
  - ACE or ARB if proteinuria
  - Aim for HbA1c <0.07 if diabetic
  - LDL target as for those at highest risk (<2.0)
Identify patients in your practice at high risk for Chronic Kidney Disease

- Patients with hypertension
- Patients with diabetes mellitus
- Patients with atherosclerotic coronary, cerebral or peripheral vascular disease
- Patients with heart failure
- Patients with unexplained anemia
- Patients with a family history of end stage renal disease
- First nations peoples

eGFR <30

Consider reversible factors:
- Medication
- Volume depletion
- Intercurrent illness
- Obstruction

Repeat tests in 2 - 4 weeks

Nephrology referral recommended

eGFR < 30

or progressive decline in eGFR
or persistent significant proteinuria
or inability to attain treatment targets

eGFR 30-60

Follow eGFR at 3 months then serially
Assess for persistent significant proteinuria
Implement risk reduction

Stable eGFR 30-60
and
no significant proteinuria

eGFR >60

Individualized follow up
and treatment
CKD is diagnosed in this group only if
other renal abnormalities are present
(i.e. proteinuria, hematuria, anatomical)
Quick Tips on Referral and Management of Chronic Kidney Disease

- Most patients with non-progressive CKD can be managed without referral to a nephrologist. The goals of therapy are listed below:

  - Consider reversible factors, such as medications, intercurrent illness, volume depletion, or obstruction. An abdominal ultrasound may be indicated when eGFR < 60 ml/min/1.73m2.
  - Minimize further kidney injury by avoiding, if possible, nephrotoxins such as NSAID’s, aminoglycoside antibiotics, IV contrast, etc (if eGFR < 60 ml/min/1.73m2).
  - Remember to adjust dosages of renally excreted medications.

- Implement measures to slow the rate of progression of CKD:
  - Target BP is < 130/80 mmHg. Most patients will need 3 or more medications. Diuretics and salt restriction are very useful, and if needed, consider furosemide BID dosing when eGFR < 30 ml/min/1.73m2.
  - Target urine protein/creatinine ratio (mg/mmol) is < 60 (< ~ 500 mg/day) or target urine albumin/creatinine ratio (mg/mmol) is < 40. ACEI and/or ARB are first line therapies in patients with albuminuria or proteinuria.
  - Control blood sugar in diabetes, target HbA1C < 7%.
  - Implement measures to modify CV risk factors (NB: CV risk >> ESRD risk).
    - Follow the Canadian Hypertension Education Program, the Canadian Diabetes Association, and the Canadian Cardiovascular Society guidelines as per groups at highest risk for CV disease.

- Referral to a nephrologist is recommended for:
  - acute kidney failure
  - eGFR < 30 ml/min/1.73m2. (CKD stage 4 and 5)
  - progressive decline of eGFR
  - urine protein/creatinine ratio (PCR) > 100 mg/mmol (~900 mg/24 hours) or urine albumin to creatinine ratio (ACR) > 60 mg/mmol (~500 mg/24 hr)
  - inability to achieve treatment targets

- NOTE: detailed CSN CKD management guidelines are under development, these quick tips should be considered as an interim approach. Insert Quick Tips sheet from the CSN CKD document