The Hospitalized Dialysis Patient

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Objectives

• Describe the clinical and metabolic derangements of end stage renal disease
• Evaluate common complications of the hospitalized dialysis patient
• Distinguish the truths from the myths for the care of the dialysis patient
End stage renal disease (ESRD)

- Defined as GFR<15ml/min
- Marks the beginning of the end (time to start dialysis)
  - Varies between patients (typically GFR<8 ml/min)
- Associated with progressive metabolic and clinical complications of renal failure
EPO production

Vitamin D activation

Fluid balance: aquaporins

Sodium excretion

HTN, edema

Phosphorus excretion

Vascular calcification

Potassium excretion

Hyperkalemia

Acid excretion

Acidemia, bone disease, inflammation

Vitamin D deficiency

Anemia

Hyponatremia
<table>
<thead>
<tr>
<th>Blood Cell Count</th>
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<tbody>
<tr>
<td>Hgb</td>
<td>9.9 (L)</td>
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<tr>
<td>Hct</td>
<td>30.7 (L)</td>
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<tr>
<td>RBC</td>
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<tr>
<td>MCV</td>
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<td>RDW CV</td>
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<td>WBC</td>
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<table>
<thead>
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<tr>
<td>Abs Neut</td>
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<td>Abs Lymph</td>
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<td>Abs Mono</td>
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<td>Abs Eos</td>
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<tr>
<td>Abs Baso</td>
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<tr>
<td>Nuc RBC</td>
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<table>
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<tr>
<td>Iron</td>
<td>71</td>
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<td>TIBC</td>
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<td>Iron % Sat</td>
<td>35</td>
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<tr>
<td>Ferritin</td>
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<td>Glucometer POC</td>
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<table>
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<td>142</td>
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<tr>
<td>K</td>
<td>5.7 (H)</td>
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<tr>
<td>Cl</td>
<td>108 (H)</td>
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<tr>
<td>TCO2</td>
<td>17 (L)</td>
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<tr>
<td>Anion Gap</td>
<td>17 (H)</td>
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<tr>
<td>Ca</td>
<td>9.7</td>
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<tr>
<td>Phos</td>
<td>4.9 (H)</td>
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<tr>
<td>TP</td>
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<tr>
<td>Albumin</td>
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<tr>
<td>Glucose</td>
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<tr>
<td>Bili Total</td>
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<tr>
<td>Uric Acid</td>
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</tr>
<tr>
<td>Creat</td>
<td>9.0 (H)</td>
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<tr>
<td>Estimated GFR</td>
<td>7.2 * (L)</td>
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<tr>
<td>BUN</td>
<td>75.7 (H)</td>
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All of the following are associated with ESRD except?

1. Hypertension
2. Dementia
3. Peripheral vascular disease
4. Sexual dysfunction
5. Gastrointestinal bleeding
6. Hyperglycemia
Signs/symptoms of the dialysis patient

- Hypertension (>95%)
- Insomnia (20-70%)
- Pruritus (25-44%)
- Restless leg syndrome (12-25%)
- Peripheral and pulmonary edema
Co-morbidities

- Cardiovascular (CV)
  - Arrhythmia, heart failure, myocardial infarction, peripheral vascular disease
- Infections
- Malignancies
  - Renal cell carcinoma
- Dementia/cognitive impairment
- Bleeding diathesis
Graded association between low eGFR and cardiovascular events (CVE)

![Graph showing the relationship between estimated GFR and age-standardized rate of cardiovascular events. The x-axis represents estimated GFR (ml/min/1.73 m²) with categories from ≥60 to <15. The y-axis represents the age-standardized rate of cardiovascular events (per 100 person-y). The graph shows a increase in event rate as GFR decreases, with higher event rates in the <15 category.]

Go. NEJM 351:1296-1305, 2004
CV related mortality increases with declining eGFR

Causes of death in incident dialysis patients, 2009-2011, first 180 days

- Arrhythmia/cardiac arrest: 24.3%
- Infection: 9.6%
- All others: 35.8%
- AMI: 3.6%
- CHF: 5.7%
- Other cardiac: 1.5%
- CVA: 2.2%
- Other vascular: 0.6%
- Pulmonary embolus: 0.2%
- Hyperkalemia: 0.2%
- Malignancy: 4.9%
- Withdrawal: 11.4%
Key points

• ESRD is the CKD stage of dialysis initiation
• ESRD patients die most commonly due
  • CV events
  • Infections
  • Malignancies
• ESRD affects EVERY ORGAN SYSTEM
Objectives

• Describe the clinical and metabolic derangements of end stage renal disease (ESRD)

• Evaluate common complications of the dialysis patient: infections

• Distinguish the truths from the myths for the care of the dialysis patient
Case 1

- Mr. DD is a 59 year old man with ESRD due to DM2 on hemodialysis since 2013
- Other co-morbidities include CAD s/p CABGx3, HLD, HTN
- Presented to the hospital on Sunday morning for fatigue, malaise, nausea, vomiting x 3 days
- Last dialysis was a week ago
- He was dismissed from his dialysis unit due to behavioral dyscontrol
- He does not make any urine
Case 1

- Home meds include: amlodipine, aspirin, metoprolol, atorvastatin, sevelamer, sertraline, clonidine patch, hydralazine, lanthanum
- Exam: BP 187/76, HR 68bpm, saturating 83% on room air
- Bibasilar inspiratory crackles, 3+ pitting edema
<table>
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<tr>
<th>Parameter</th>
<th>Value</th>
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<tbody>
<tr>
<td>Na</td>
<td>144</td>
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<tr>
<td>K</td>
<td>7.1 (!)</td>
</tr>
<tr>
<td>Cl</td>
<td>100</td>
</tr>
<tr>
<td>TCO2</td>
<td>14 (L)</td>
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<tr>
<td>Anion Gap</td>
<td>30 (H)</td>
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<tr>
<td>Ca</td>
<td>8.9</td>
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<tr>
<td>Ionized Ca</td>
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</tr>
<tr>
<td>Phos</td>
<td>11.3 (H)</td>
</tr>
<tr>
<td>TP</td>
<td></td>
</tr>
<tr>
<td>Albumin</td>
<td></td>
</tr>
<tr>
<td>Glucose</td>
<td>125 (H)</td>
</tr>
<tr>
<td>Bili Total</td>
<td></td>
</tr>
<tr>
<td>Bili Direct</td>
<td></td>
</tr>
<tr>
<td>Creat</td>
<td>13.8 (!)</td>
</tr>
<tr>
<td>Estimated GFR</td>
<td>3.6 *(L)</td>
</tr>
<tr>
<td>BUN</td>
<td>129.6 (H)</td>
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<tr>
<td>Creat-CT, IVP, MRI, Hem</td>
<td></td>
</tr>
<tr>
<td>Mg</td>
<td>2.9 (H)</td>
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</tbody>
</table>
Normal sinus rhythm

Peaked T waves consistent with hyperkalemia

Vent. rate: 64 BPM
PR interval: 188 ms
QRS duration: 112 ms
QT/QTc: 438/451 ms
P-R-T axes: 51 39 71
In addition to administering calcium gluconate or chloride, what is the most important step in the treatment of this patient?

1. Furosemide 100mg IV x1
2. Kayexalate
3. Insulin+ D50
4. Call the dialysis nurse
## Treatment of hyperkalemia while waiting for hemodialysis

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Dose</th>
<th>Onset of action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium gluconate</td>
<td>10cc of 10% soln (1g)</td>
<td>3-5 min, last up to 1 hr</td>
</tr>
<tr>
<td>Insulin + D5W</td>
<td>20U IV with 50cc of 50% D5W</td>
<td>10 min, peak 1hr, last for 6 hr</td>
</tr>
<tr>
<td>Albuterol</td>
<td>10-20mg in 4ml saline nebulized</td>
<td>30 min, up to 90-120 min</td>
</tr>
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</table>

Avoid using sodium bicarbonate therapy. Ineffective. Can lead to calcium precipitation if also giving calcium.
Pearl #1

- Hyperkalemia is common in dialysis patients
- Associated with significant arrhythmia
- Treatment of choice is URGENT HEMODIALYSIS
- Sodium bicarbonate therapy is not effective
- Do not rely on hyperkalemia care set alone
Case 2

- Ms. DC is a 50 year old with type 1 DM s/p pancreas and kidney transplant both of which failed in 2013 now with ESRD on hemodialysis on Tues/Thurs/Sat schedule
- Presented to the ED after missing three dialysis sessions due to nausea and weakness
- On exam: BP 154/87, HR 83 bpm, afebrile, 10kg above usual dry weight
  - Distant heart sounds, decreased BS at lung bases
  - 3+ pitting edema
Patient is diagnosed with DKA. What is the best treatment approach for this patient?

1. Insulin drip + dialysis
2. Insulin drip + dialysis + 1L of normal saline
3. Insulin drip + dialysis + 1L of 0.45% normal saline
4. Insulin drip + dialysis + 1L of normal saline + K replacement
Unique aspects of DKA in dialysis patient

- DKA in dialysis is very rare
  - Reduced insulin clearance (renal)
  - Improved insulin sensitivity with dialysis
  - Decreased renal gluconeogenesis

- Volume depletion is uncommon
  - No osmotic diuresis
  - Extracellular volume expansion more common

- High potassium balance
  - No GFR + low insulin state + hypertonicity
Pearl #2

- Management of DKA in a dialysis patient is different than non-dialysis patient
- Insulin is the only treatment required
- Fluids and potassium replacement not necessary and can be harmful
- Do not rely on DKA care set
Case 3

• Ms. NC is a 29 year old female with DM1 complicated by retinopathy, neuropathy and ESRD on home hemodialysis (5x/week) for last 5 months via tunneled dialysis catheter who was called to the hospital to receive a combined kidney-pancreas transplant

• ROS: tired with chills last two dialysis sessions, new onset left shoulder pain x 2 weeks, chronic dry cough x 4 weeks

• On exam temp 38.6, BP 183/99, HR 98bpm, saturating 83% on RA
  • Significant left shoulder pain with passive movement
Labs

Ca  8.5  
Phos 9.7  
Alb  3.2  

ESR  94  
CRP  >300

19.7  9.6  321  
135  88  55  222  
3.4  23  5.4  

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How would you work up this patient’s febrile illness?

1. Peripheral blood cultures
2. Peripheral blood cultures + chest x-ray
3. Peripheral blood cultures + chest x-ray + shoulder x-ray
4. Peripheral blood cultures + culture from each port of the dialysis line + chest x-ray + shoulder x-ray
What is the most likely cause of this patient’s fever?

1. Pneumonia
2. Tunneled dialysis catheter infection
3. Septic arthritis
4. Bacteremia
5. Endocarditis
6. Any of the above
Tunneled dialysis catheter

- Easiest & fastest access
- 80% of patients starting dialysis use catheter
- Associated with highest risk of infection (10x) and mortality compared to AV fistula or graft
- Two main complications:
  - Catheter malfunction
  - Catheter infection
    - Exit site
    - Systemic bacteremia
Tunneled dialysis catheter related infection

- 35-54% rate of catheter associated bacteremia within 3-6 months of insertion
- 5-10% rate of metastatic infectious complications
  - Staph aureus → up to 40%
- Skin flora: staph and Strep are most common organisms
Back to our patient

- Transplant was cancelled and she was transitioned to general medicine service for further workup
- CXR → pulmonary edema/ no pneumonia
- Shoulder x-ray → normal
- Peripheral and dialysis catheter blood cultures:
  - Coag negative staphylococcus
  - staph Lugdunensis
- Left shoulder synovial fluid aspirate
  - staph Lugdunensis
- Persistent bacteremia despite 3 days of vancomycin

  → Echocardiogram
Back to our patient

• Right atrial ‘thrombus’ enlarged despite adequate anticoagulation and antibiotic therapy

• Operative removal of the mass
  • ‘a multi-lobed gelatinous collection with the bulk of the tumor being the consistency of an egg yolk with a thin layer of film of outer consolidation and a near-liquid cavity’
Pearl #3

• Must obtain blood cultures from each lumen of dialysis catheter AND peripheral in all dialysis patients with suspicion for infection

• Low threshold to check echocardiogram to rule out endocarditis

• Do not let the SUN SET on a dialysis patient presenting with fever!
Case 4

- Ms. CA is a 41 year old female with ESRD due to lupus nephritis on hemodialysis for 9 months via a tunneled dialysis catheter
- Admitted for MRSA dialysis catheter associated bacteremia
- She is about to be discharged from the hospital and requires 2 weeks of intravenous vancomycin with vancomycin trough level monitoring to maintain level between 15-20
What is the best approach for administering intravenous vancomycin in this patient?

1. Place peripherally inserted central catheter (PICC line) and coordinate with home health administration of vancomycin

2. Coordinate with patient’s outpatient dialysis unit to administer vancomycin after dialysis using patient’s tunneled dialysis catheter

3. Coordinate with home health administration of vancomycin via small bore cuffed tunneled central catheters (TSB-CVC)
PICC line in dialysis patients

- Associated with delay in establishing a working vascular access (fistula or graft)
- Associated with high likelihood of failed fistula
- Associated with shorter survival on dialysis

Why are PICC lines evil?

- Create venous injury
- Promote venous thrombosis (as high as 38%)
  - Cephalic and basilic sites
    - Golden veins for fistula creation
- Increase risk of vascular sclerosis → stenosis
What are the alternatives?

• Explore options of antibiotic administration after dialysis using the patient’s dialysis access (fistula or catheter)

• Consider small-bore tunneled internal jugular catheter
  • Less risk of venous thrombosis or stenosis
  • Avoid cannulation of cephalic and basilic veins
Pearl #4

- Think twice before ordering PICC on your dialysis patient
- National Kidney Foundation Kidney Disease Outcomes Quality Initiative (NKF-KDOQI) recommends AGAINST the use of PICCs in patients with CKD
- Talk with your nephrologist and dialysis center first
- Explore use of small-bore tunneled internal jugular catheter if available at your hospital
- Preserve the veins of your dialysis patient!
Case 5

- Ms. NS is a 63 year old female with ESRD due to DM & HTN admitted for leg pain
- Found to have severe anemia due to bilateral iliopsoas hematoma
- Oxycodone was not adequate for pain control
- Morphine 2mg IV pushes q4hr given
- 12 hours later patient became confused and disoriented
What of the following is the best treatment approach for her pain?

1. Tramadol (extended release)
2. _____
3. Codeine
4. Hydromorphone
5. High doses of morphine
Pain management in ESRD: WHAT NOT TO USE

- Morphine
  - Active metabolite, morphine-6-glucuronide, accumulates in decreased kidney function with concentrations in the cerebral spinal fluid of dialysis patients 15 times that of patients with normal kidney function
  - Case reports of patients with decreased kidney function describe ranges of adverse effects from respiratory and CNS depression to myoclonus and death

- Codeine
  - Reduced clearance and prolonged half-life in decreased kidney function
  - Adverse effects reported in patients with decreased kidney function include nausea, vomiting, hypotension, CNS depression, and respiratory arrest

- Hydrocodone
  - Limited information available
  - Reduced clearance of parent compound and metabolites

- Tramadol (extended release)
  - Formulation has not been studied in decreased kidney function
### Medications to use in ESRD

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<tr>
<th>Medication</th>
<th>Pain severity</th>
<th>Dose</th>
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<tbody>
<tr>
<td>Acetaminophen</td>
<td>Mild</td>
<td>650mg q6hr as needed</td>
</tr>
<tr>
<td>Oxycodone</td>
<td>Moderate</td>
<td>5mg q4-6hr as needed</td>
</tr>
<tr>
<td>Tramadol (short acting)</td>
<td>Moderate</td>
<td>50mg q12hr dose after dialysis</td>
</tr>
<tr>
<td>Hydromorphone</td>
<td>Severe</td>
<td>1mg q6hr as needed</td>
</tr>
<tr>
<td>Fentanyl</td>
<td>Severe</td>
<td>12.5-25μg patch *only use in patients who have been on opioids prior</td>
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</table>

*Koncicki HM et al. Am J Kid Dis Nov 20, 2016*
Pearl #5

- Avoid MORPHINE and codeine in patients with ESRD
- Remember to check drug-dosing adjustment for your dialysis patient
- Start low and go slow
True or False

Patients on dialysis should avoid the use of NSAIDS and contrast exposure.

1. True
2. False
True or False

Tunneled dialysis catheter in a dialysis patient can be used for maintenance IV fluids and blood draws.

1. True
2. False
True or False

- Dialysis patients fasting for surgery or procedure should receive maintenance IV fluids to avoid dehydration.

1. True
2. False
Summary Points

- Hyperkalemia is common → Urgent Dialysis
- DKA uncommon → treat with insulin drip only
- Always get blood cultures from dialysis catheter
- Avoid PICC lines in dialysis patients
- Avoid morphine and codeine in dialysis patients
- Preserve residual renal function in patients who still make urine
- Avoid the use of dialysis catheter outside the dialysis session
- Avoid maintenance IVF in fasting dialysis patients