Interpreting Laboratory Values

Keith A. Swanson, PharmD, BCGP
University of Oklahoma
College of Pharmacy

DISCLOSURE

I have no relevant financial disclosures relative to the content of this presentation.
LEARNING OBJECTIVES

At the conclusion of this application-based activity, participants should be able to:

1. Describe the pharmacist’s role in the use and interpretation of laboratory tests.
2. Identify commonly ordered laboratory tests in chronic disease management to provide the best clinical care and consultation to older patients.
3. Use alternative strategies to monitor organ function, particularly renal function.
4. Apply principles to a geriatric patient case.

INTRODUCTION

• General concepts for assessing laboratory tests
  – Normal values vary from laboratory to laboratory
  – Normal values may vary based on patient demographics (age, gender, etc.)
  – Laboratory error uncommon (results can be affected by many factors)
  – Remember to ‘treat the patient – not the numbers!’
ROLE OF THE PHARMACIST

• Assessment of need for therapy or to adjust existing therapy (not diagnosis)
• Identification of outcomes to therapy
  – At target
  – Adverse events
• Anticipate changes in condition based on existing therapy
  – Recommending assessments:
    Think ‘Must’ – ‘Should’ – ‘Could’ – ‘Might’

ROLE OF THE PHARMACIST

• Establishing your ‘personal philosophy’ for standard assessments
  – Standing schedule
  – As needed schedule
• Laboratory Test “Stewardship”
  – Standing Orders vs. When Needed?
  – Laboratory Panels vs. Single Tests
### 2015 CMS Maximum National Limits

<table>
<thead>
<tr>
<th>Test</th>
<th>CMS National Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMP</td>
<td>$14.37</td>
</tr>
<tr>
<td>BMP with Ca</td>
<td>$11.51</td>
</tr>
<tr>
<td>Elyte Panel</td>
<td>$9.55</td>
</tr>
<tr>
<td>Hepatic Function</td>
<td>$11.11</td>
</tr>
<tr>
<td>Potassium</td>
<td>$6.26</td>
</tr>
<tr>
<td>Sodium (serum)</td>
<td>$6.55</td>
</tr>
<tr>
<td>Ca Total</td>
<td>$7.02</td>
</tr>
<tr>
<td>Ca Ionized</td>
<td>$18.60</td>
</tr>
<tr>
<td>Creatinine</td>
<td>$6.31</td>
</tr>
<tr>
<td>Protein Total</td>
<td>$7.04</td>
</tr>
<tr>
<td>Lipid Panel</td>
<td>$18.22</td>
</tr>
<tr>
<td>Cholesterol total</td>
<td>$5.92</td>
</tr>
<tr>
<td>Triglycerides</td>
<td>$7.82</td>
</tr>
<tr>
<td>Blood Culture</td>
<td>$14.05</td>
</tr>
<tr>
<td>Urine Culture</td>
<td>$10.99</td>
</tr>
<tr>
<td>Urosynthesis</td>
<td>$4.31</td>
</tr>
<tr>
<td>Blood Susceptibility(agar dil)</td>
<td>$6.46</td>
</tr>
<tr>
<td>Blood Susceptibility(disc)</td>
<td>$9.39</td>
</tr>
<tr>
<td>Vitamin D (25OH)</td>
<td>$40.29</td>
</tr>
<tr>
<td>Hgb A1C</td>
<td>$13.21</td>
</tr>
<tr>
<td>Hgb Glycosylated POC</td>
<td>$13.21</td>
</tr>
<tr>
<td>Prealbumin</td>
<td>$19.84</td>
</tr>
<tr>
<td>Thyroxine (total)</td>
<td>$9.35</td>
</tr>
<tr>
<td>Thyroxine (free T4)</td>
<td>$12.27</td>
</tr>
<tr>
<td>Uric Acid</td>
<td>$6.15</td>
</tr>
</tbody>
</table>

### Recommended Study Resources

  - 6th Edition soon to be released
HEMATOLOGY

• Complete Blood Count (CBC):
  – White Blood Cells/WBC or leukocyte count
  – Differential (% neutrophils, lymphocytes, monocytes, eosinophils, basophils)
  – Red Blood Cells/RBC or erythrocyte count
  – Hemoglobin, hematocrit
  – Erythrocyte indices (MCV, MCH, MCHC, RDW)
  – Platelet count (with or without MPV)

• Iron Studies:
  – Iron, Total Iron Binding Capacity/TIBC, Iron Saturation/ISAT %
  – Transferrin & Ferritin

HEMATOLOGY TERMINOLOGY & DISORDERS

• Leucocytosis (with left shift)
  – Neutrophils, PMNs, Polys, Bands
• Leukemia
  – Lymphocytes
• Neutropenia
• Platelet disorders
  – Thrombocytopenia
  – Thrombocytosis

• Anemias
  – Microcytic
  – Macrocytic
  – Normocytic
  – Anemia of Chronic Disease
  – Mixed Cause Anemias

• Iron Studies
  – Serum Iron, TIBC, % Sat
  – Transferrin
  – Ferritin
SERUM ELECTROLYTES & BLOOD CHEMISTRIES

• Basic Metabolic Panel:
  - Sodium (Na), Potassium (K), Chloride (Cl), Bicarbonate (CO₂), Blood Urea Nitrogen (BUN), Serum Creatinine (SCr), Glucose

• Complete Metabolic Panel:
  - BMP + osmolality, total protein & albumin, alkaline phosphatase, alanine aminotransferase (ALT), aspartate aminotransferase (AST), total bilirubin, and calcium

• Other commonly ordered panels (SMA-6, SMA-12, and Chem Profile-20 or Chem-20)

• Other electrolytes/metabolic chemistries
  - Calcium
  - Magnesium
  - Phosphorous (inorganic)
  - Uric Acid
  - Anion Gap – indicates presence of unmeasured acids or bases in blood
  - Serum Osmolality
COMMON ELECTROLYTE ABNORMALITIES

• Hyponatremia vs. Hypernatremia
• Hypochloremia vs. Hyperchloremia
• Hypokalemia vs. Hyperkalemia
• Bicarbonate elevation vs. Depression
• Hypoglycemia vs. Hyperglycemia
• Renal Function Markers
  – Uremia
  – Elevated creatinine
  – BUN/Creatinine Ratio

ESTIMATED RENAL FUNCTION
(RENAL CLEARANCE)

• THE CONTROVERSY – which method to choose and use?
  
  “A single GFR equation may not be best suited for all populations, and choice of equation has been shown to impact CKD prevalence estimates.”
  (Dowling TC. 2014)
MDRD$_4$–IDMS EQUATION

- Recommended by the NKF and the National Kidney Disease Education Program (NKDEP) for patients with CKD risk factors and a GFR <60 mL/min/1.73 m$^2$ (<0.58 mL/s/m$^2$).

MDRD4–IDMS equation:

\[
GFR = 175 \times (\text{Scr})^{-1.154} \times (\text{age})^{-0.203} \\
\times (0.742 \text{ if patient is female}) \\
\times (1.210 \text{ if patient is black})
\]


CKD-EPI EQUATION

- Recommended for patients with GFR >60 mL/min/1.73 m$^2$ (<0.58 mL/s/m$^2$).

CKD-EPI equation:

\[
GFR = 141 \times \min(S_{cr}/k, 1)^\alpha \times \max(S_{cr}/k, 1)^{-1.209} \times 0.993^{\text{age}} \\
\times 1.018 \times [\text{if female}] \\
\times 1.159 \times [\text{if black}]
\]

COCKCROFT GAULT FORMULA

• “The Cockcroft-Gault formula continues to provide a valid estimate of the CLcr of elderly patients.” (Dowling TC. 2014)

Cockcroft-Gault equation:
CrCl (mL/min) = [(140 – age) x wt (kg)]/(SCr x 72)
X 0.85 [if female]
(Cockroft DW, Gault MH. Nephron 1976;16:31–41.)

THE CONTROVERSY CONTINUES

(From: Dowling TC. 2014)
Sidebar: Clinical Controversy…

“Estimation of creatinine clearance in elderly with low serum creatinine values is controversial. Some clinicians advocate correction of serum creatinine to 1.0 mg/dL (88 μmol/L) to account for reduced muscle mass. This practice should be avoided, and the impact of this correction factor on glomerular filtration rate (GFR) estimates using the four-variable Modification of Diet in Renal Disease Study equation (MDRD4) or other equations has yet to be evaluated in this population.”
HEPATIC AND GASTROINTESTINAL TESTS

- Alanine Aminotransferase (ALT) – (prev. SGPT)
- Aspartate Aminotransferase (AST) – (prev. SGOT)
- Aspartate Aminotransferase (AST)
- Alkaline Phosphatase (Alk Phos)
- γ-Glutamyl Transpeptidase (GGTP)
- Lactate Dehydrogenase (LDH)

HEPATIC AND GASTROINTESTINAL TESTS

- Ammonia (NH₃) –
- Bilirubin –
  - Direct, Indirect, Urinary
- Amylase –
- Lipase –
HEPATIC AND GASTROINTESTINAL TESTS

• Helicobacter pylori (H. pylori) immunoglobulin (IgG) –
  – Detects antibodies to H. pylori.
  – Positive result + symptoms of peptic ulcer disease guides antimicrobial and PPI or H₂RA antisecretory therapies.
• Hemoccult® –
  – Detects presence of occult (undetected) blood in the feces.
  – Used as screening for follow-up with endoscopy or colonoscopy for intestinal/colonic problems.

IMPORTANT VITAMINS AND MINERALS

• Vitamin D
  (25-hydroxycholecalciferol or 25-OH Vitamin D)
• Vitamin B₁₂
• Folic Acid or Folate
ENDOCRINE STUDIES

• Thyroid studies
  – Thyrotropin Releasing Hormone (TSH) –
    • Requires at least 4-6 weeks between thyroxine dose changes and re-equilibration of the feedback mechanism.
  – Total Thyroxin (T4) = Free Thyroxin (free-T4) + protein bound T4.
    • Free T4 is better indicator of clinical thyroid status
  – Triiodothyronine (T3) –
    • More potent than T4. May be used in diagnosis of hyperthyroid states.

• Glycosylated Hemoglobin or Hemoglobin A1C
  – Indicates ‘average’ glucose during lifespan of typical RBCs (generally 2-3 months).
  – Average glucose concentration can be estimated based on HgA1C

AVERAGE GLUCOSE BASED ON HA1C

<table>
<thead>
<tr>
<th>A1c (%)</th>
<th>Glucose (mg/dL)</th>
<th>Glucose (mmol/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>126</td>
<td>6.99</td>
</tr>
<tr>
<td>7</td>
<td>154</td>
<td>8.55</td>
</tr>
<tr>
<td>8</td>
<td>183</td>
<td>10.16</td>
</tr>
<tr>
<td>9</td>
<td>212</td>
<td>11.77</td>
</tr>
<tr>
<td>10</td>
<td>240</td>
<td>13.32</td>
</tr>
<tr>
<td>11</td>
<td>269</td>
<td>14.93</td>
</tr>
<tr>
<td>12</td>
<td>298</td>
<td>16.54</td>
</tr>
</tbody>
</table>

Adapted from: Whalen & Botija-Hart (2009)
URINE TESTING

• Urine analysis (UA):
  – appearance and color, WBCs and RBCs, pH, specific gravity, protein, glucose & ketones, bilirubin, leukocyte esterase & nitrites
  – Differentiate between active infection (presence of WBCs and bacteria) and asymptomatic bacteriuria (bacteria without pyuria)
• Urine for culture and sensitivity (C & S)

CARDIAC TESTING

• Creatine kinase – marker for muscle injury –
  – subfractions: CK-MM (muscle), CK-BB (brain) & CK-MB (cardiac)
• Troponin – sensitive markers for cardiac injury –
  – Troponin 1 found solely in cardiac tissue,
  – Troponin T found in both cardiac and skeletal muscle
• Brain or B-type Naturetic Peptide (BNP) –
  – Increases with heart failure
  – Some labs now reporting as pre-BNP
• Prothrombin Time (PT) & International Normalized Ratio (INR) –
  – Anticoagulation response to warfarin dosing
INFECTIOUS DISEASES

• General infections – nonspecific tests
  – White Blood Cells (WBCs) and Differential – increased WBC number (leukocytosis) and increased percentage of infection fighting cells (neutrophils, PMNs, Bands, Segs) indicates active infection
  – Lymphocytosis – increased number of lymphocytes found with Epstein Barr and Cytomegalovirus (CMV) viral infections

• Physical signs – fever, malaise, localized symptoms of rubor, pain, swelling

INFECTIOUS DISEASES

• Nuclear Factor-κB (NF-κB) detected by transcription factor assay (TF-ELISA)
  – systemic inflammatory response syndrome (SIRS) in patients with septicemia.

• Erythrocyte Sedimentation Rate (ESR) and C-reactive
  – Elevated during inflammatory process
  – Elevated with endocarditis, osteomyelitis, and intraabdominal infections

• Procalcitonin (PCT) –
  – Specific marker for bacterial infections
  – Used to assess risk of mortality from infection
  – Indicates need for antibacterial therapy in respiratory tract infections

• Inflammatory cytokines –
  – Interleukin 1 (IL-1), IL-6, and IL-8 and tumor necrosis factor-α (TNF-α)
  – Useful in staging and monitoring the response to therapy in patients with serious infections
**HIV TESTING**

- ELISA or EIA for HIV – detects antibodies to HIV for screening
- Western Blot – detects specific antibodies to specific HIV proteins for confirming ELISA results
- CD4 T-Cell count (CD4 Count) – marker for patient’s immune status
- HIV Viral Load – marker for patient prognosis and level of active disease

**SEXUALLY TRANSMITTED DISEASES**

- Rapid Plasma Reagin (RPR) – used to screen for presence of syphilis spirochete for diagnosis and response to therapy
- Venereal Disease Research Laboratory Test (VDRL) - used to screen for presence of syphilis spirochete for diagnosis and response to therapy
**HEPATITIS**

- Hepatitis A –
  - Anti-HAV IgM –
  - Anti-HAV IgG –
- Hepatitis B –
  - Hepatitis B Surface Antigen (HBsAg) –
  - Hepatitis B ‘e’ Antigen (HBeAg) –
  - Hepatitis B Core Antibody (anti-HBc) –
- Hepatitis C –
  - Hepatitis C Antibody (anti-HCV) –
  - Hepatitis C viral load – (HCV RNA by PCR) or radioimmunoblot assay (RIBA) –

**IMMUNOLOGIC DISEASES**

- Antinuclear Antibodies (ANA)
- Rheumatoid Factor (RF)
- Erythrocyte Sedimentation Rate (ESR)
- Others including specific mediators and proteins
CASE EXAMPLE #1:

- A 72 y/o woman is admitted to a long term care facility.
- She is currently taking the following medications:

<table>
<thead>
<tr>
<th>Medication</th>
<th>Frequency</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxycodone/APAP 7.5/325</td>
<td>One three times daily</td>
<td>Arthritis</td>
</tr>
<tr>
<td>Metformin 1000 mg</td>
<td>One twice daily with meals</td>
<td>Diabetes</td>
</tr>
<tr>
<td>Clozapine 100 mg</td>
<td>Three tablets (300 mg) twice daily</td>
<td>Schizophrenia</td>
</tr>
<tr>
<td>Sertraline 100 mg</td>
<td>One daily</td>
<td>Depression</td>
</tr>
<tr>
<td>Omeprazole 20 mg</td>
<td>One daily</td>
<td>GERD</td>
</tr>
<tr>
<td>Lisinopril 20 mg</td>
<td>One daily</td>
<td>Hypertension</td>
</tr>
</tbody>
</table>
**QUESTION 1:**

Which laboratory assessment is necessary on a monthly basis based on the medications prescribed?

A. Basic metabolic panel
B. Complete blood count
C. Lipid profile

**QUESTION 2:**

Which best represents the laboratory assessments that should be recommended within six months to monitor for potential adverse drug events?

A. Basic metabolic profile, Hemoglobin A1c and Lipid profile
B. Hepatic transaminases, Hemoglobin A1c, and Vitamin B12
C. Iron Studies, Lipid profile and Basic Metabolic Profile
OPEN QUESTION

What are the potential common and/or severe adverse effects that can be identified with laboratory assessments?

<table>
<thead>
<tr>
<th>Drug</th>
<th>Adverse Effect</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrocodone/APAP</td>
<td>Constipation, CNS, Falls</td>
<td>Physical Exam</td>
</tr>
<tr>
<td>Metformin</td>
<td>Diarrhea, Glucose control, lactic acidosis, renal dosing</td>
<td>BMP/CMP, HA1c</td>
</tr>
<tr>
<td>Clozapine</td>
<td>Neutropenia, Metabolic syndrome, CNS effects</td>
<td>CBC, BMP/CMP, HA1c, Lipids, PE</td>
</tr>
<tr>
<td>Sertraline</td>
<td>CNS, Hyponatremia</td>
<td>BMP/CMP, PE</td>
</tr>
<tr>
<td>Omeprazole</td>
<td>Interferes with Ca++, Iron, B₁₂ absorption, Renal effects?</td>
<td>BMP/CBC, CMP, Iron</td>
</tr>
<tr>
<td>Lisinopril</td>
<td>Hyperkalemia, acute renal effects (w/NSAIDs &amp; diuretics)</td>
<td>BMP/CMP</td>
</tr>
</tbody>
</table>

CASE #1 (CONT’D)

The physician ordered a CBC and BMP as part of the admission orders. The following laboratory results are now available:
**LAB VALUES**

<table>
<thead>
<tr>
<th>Complete Blood Count</th>
<th>Conventional Units</th>
<th>International Units</th>
<th>Basic Metabolic Panel</th>
<th>Conventional Units</th>
<th>International Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>WBC</td>
<td>$7.9 \times 10^3$ cells/mm³</td>
<td>$7.9 \times 10^9$ cells/L</td>
<td>Blood urea nitrogen (BUN)</td>
<td>10 mg/dL</td>
<td>3.57 mmol/L</td>
</tr>
<tr>
<td>RBC</td>
<td>$4.52 \times 10^6$ cells/mm³</td>
<td>$4.52 \times 10^{12}$ cells/L</td>
<td>Creatinine</td>
<td>0.8 mg/dL</td>
<td>71 micromol/L</td>
</tr>
<tr>
<td>HGB</td>
<td>10.3 g/dL</td>
<td>6.4 mmol/L</td>
<td>Sodium</td>
<td>140 mEq/L</td>
<td>140 mmol/L</td>
</tr>
<tr>
<td>HCT</td>
<td>30.5 %</td>
<td>0.31</td>
<td>Potassium</td>
<td>3.7 mEq/L</td>
<td>3.7 mmol/L</td>
</tr>
<tr>
<td>MCV</td>
<td>72.3 μm³/cell</td>
<td>72.3 fl</td>
<td>Chloride</td>
<td>102 mEq/L</td>
<td>102 mmol/L</td>
</tr>
<tr>
<td>MCH</td>
<td>24.9 pg/cell</td>
<td>24.9 pg/cell</td>
<td>CO₂ (bicarbonate)</td>
<td>25 mEq/L</td>
<td>25 mEq/L</td>
</tr>
<tr>
<td>MCHC</td>
<td>30.2 g/dL</td>
<td>302 g/L</td>
<td>Glucose (fasting)</td>
<td>90 mg/dL</td>
<td>5.0 mmol/L</td>
</tr>
<tr>
<td>RDW</td>
<td>16.4</td>
<td>16.4</td>
<td>Calcium</td>
<td>8.5 mL/dL</td>
<td>2.1 mmol/L</td>
</tr>
<tr>
<td>PLT</td>
<td>$333 \times 10^3$/μL</td>
<td>$333 \times 10^9$/L</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NE%</td>
<td>59.4%</td>
<td>0.59</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LY%</td>
<td>27.3%</td>
<td>0.27</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**QUESTION 3:**

Which hematologic condition indicated by these results suggests the need for additional therapy?

A. Normocytic Anemia  
B. Macrocytic Anemia  
C. Microcytic Anemia
## Laboratory Assessment

### CGP Bootcamp 2017

**Swanson**

**April 2017**

<table>
<thead>
<tr>
<th>Lab Values</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Complete Blood Count</strong></td>
</tr>
<tr>
<td><strong>WBC</strong></td>
</tr>
<tr>
<td><strong>RBC</strong></td>
</tr>
<tr>
<td><strong>HGB</strong></td>
</tr>
<tr>
<td><strong>HCT</strong></td>
</tr>
<tr>
<td><strong>MCV</strong></td>
</tr>
<tr>
<td><strong>MCH</strong></td>
</tr>
<tr>
<td><strong>MCHC</strong></td>
</tr>
<tr>
<td><strong>RDW</strong></td>
</tr>
<tr>
<td><strong>PLT</strong></td>
</tr>
<tr>
<td><strong>NE%</strong></td>
</tr>
<tr>
<td><strong>LY%</strong></td>
</tr>
</tbody>
</table>

### QUESTION 4:

Which nutritional supplement is most likely needed in this situation?

A. Vitamin B$_{12}$

B. Iron

C. Folic Acid
**QUESTION 5:**

Which intervention is indicated by these results?

A. Increase metformin and decrease lisinopril
B. Increase lisinopril and discontinue sertraline
C. No change is necessary

---

**LAB VALUES**

<table>
<thead>
<tr>
<th>Complete Blood Count</th>
<th>Conventional Units</th>
<th>International Units</th>
<th>Basic Metabolic Panel</th>
<th>Conventional Units</th>
<th>International Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>WBC</td>
<td>$7.9 \times 10^3$ cells/mm$^3$</td>
<td>$7.9 \times 10^3$ cells/L</td>
<td>Blood urea nitrogen (BUN)</td>
<td>10 mg/dL</td>
<td>3.57 mmol/L</td>
</tr>
<tr>
<td>RBC</td>
<td>$4.52 \times 10^6$ cells/mm$^3$</td>
<td>$4.52 \times 10^{12}$ cells/L</td>
<td>Creatinine</td>
<td>0.8 mg/dL</td>
<td>71 micromol/L</td>
</tr>
<tr>
<td>HGB</td>
<td>10.3 g/dL</td>
<td>6.4 mmol/L</td>
<td>Sodium</td>
<td><strong>140 mEq/L</strong></td>
<td><strong>140 mmol/L</strong></td>
</tr>
<tr>
<td>HCT</td>
<td>30.5 %</td>
<td>0.31</td>
<td>Potassium</td>
<td><strong>3.7 mEq/L</strong></td>
<td><strong>3.7 mmol/L</strong></td>
</tr>
<tr>
<td>MCV</td>
<td>72.3 μm$^3$/cell</td>
<td>72.3 fl</td>
<td>Chloride</td>
<td>102 mEq/L</td>
<td>102 mmol/L</td>
</tr>
<tr>
<td>MCH</td>
<td>24.9 pg/cell</td>
<td>24.9 pg/cell</td>
<td>CO$_2$ (bicarbonate)</td>
<td>25 mEq/L</td>
<td>25 mEq/L</td>
</tr>
<tr>
<td>MCHC</td>
<td>30.2 g/dL</td>
<td>302 g/L</td>
<td>Glucose (fasting)</td>
<td><strong>90 mg/dL</strong></td>
<td><strong>5.0 mmol/L</strong></td>
</tr>
<tr>
<td>RDW</td>
<td>16.4</td>
<td>16.4</td>
<td>Calcium</td>
<td>8.5 mL/dL</td>
<td>2.1 mmol/L</td>
</tr>
<tr>
<td>PLT</td>
<td>$333 \times 10^3$/μL</td>
<td>$333 \times 10^3$/L</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NE%</td>
<td>59.4%</td>
<td>0.59</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LY%</td>
<td>27.3%</td>
<td>0.27</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**CASE #1 CONTINUED:**

The physician ordered additional laboratory tests on admission to assess for common conditions found in elderly patients. The following fasting laboratory results are now available (in addition to previous results):

<table>
<thead>
<tr>
<th>Lipid Profile</th>
<th>Conventional Units</th>
<th>International Units</th>
<th>Iron Studies</th>
<th>Conventional Units</th>
<th>International Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total cholesterol</td>
<td>223 mg/dL</td>
<td>5.76 mmol/L</td>
<td>Iron</td>
<td>34 mcg/dL</td>
<td>6 μmol/L</td>
</tr>
<tr>
<td>Triglycerides</td>
<td>167 mg/dL</td>
<td>1.89 mmol/L</td>
<td>TIBC</td>
<td>482 mcg/dL</td>
<td>90 μmol/L</td>
</tr>
<tr>
<td>HDL</td>
<td>58 mg/dL</td>
<td>1.49 mmol/L</td>
<td>ISAT</td>
<td>7 %</td>
<td>.07</td>
</tr>
<tr>
<td>LDL</td>
<td>132 mg/dL</td>
<td>3.40 mmol/L</td>
<td>Ferritin</td>
<td>10 ng/mL</td>
<td>10 μg/L</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hemoglobin A1C</td>
<td>7.1 %</td>
<td>0.07</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vitamin D (25 (OH) Vit D)</td>
<td>11.8 ng/mL</td>
<td>25 nmol/L</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**LAB VALUES**
**QUESTION 6:**

Which interventions are most needed based on these results?

A. Add lipid lowering agent, add vitamin D, add iron supplement

B. Add vitamin D, add another antidiabetic, add iron supplement

C. Add another antidiabetic, add vitamin D, add lipid lowering agent

---

**LAB VALUES**

<table>
<thead>
<tr>
<th>Lipid Profile</th>
<th>Conventional Units</th>
<th>International Units</th>
<th>Iron Studies</th>
<th>Conventional Units</th>
<th>International Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total cholesterol</td>
<td>223 mg/dL</td>
<td>5.76 mmol/L</td>
<td>Iron</td>
<td>34 mcg/dL</td>
<td>6 μmol/L</td>
</tr>
<tr>
<td>Triglycerides</td>
<td>167 mg/dL</td>
<td>1.89 mmol/L</td>
<td>TIBC</td>
<td>482 mcg/dL</td>
<td>90 μmol/L</td>
</tr>
<tr>
<td>HDL</td>
<td>58 mg/dL</td>
<td>1.49 mmol/L</td>
<td>ISAT</td>
<td>7 %</td>
<td>.07</td>
</tr>
<tr>
<td>LDL</td>
<td>132 mg/dL</td>
<td>3.40 mmol/L</td>
<td>Ferritin</td>
<td>10 ng/mL</td>
<td>10 μg/L</td>
</tr>
</tbody>
</table>

Other

- Hemoglobin A1C: 7.1 % | 0.07
- Vitamin D (25 (OH) Vit D): 11.8 ng/mL | 25 nmol/L
CASE #2

• A 71 YO Male has been living in the memory unit in your facility for the past 6 months. Up until yesterday, he has not exhibited any significant behaviors. Today he has been aggressive and resisting care and the nursing staff states that he has ‘not been himself’ the past couple days. He says, “There’s nothing wrong with me. Don’t touch me.”

• His medication list includes: Lisinopril 5 mg daily, furosemide 20 mg daily, potassium chloride 10 mEq daily, finasteride 5 mg daily, citalopram 10 mg daily, iron sulfate 325 mg daily, and PEG 17 gm daily.

QUESTION 7:

Which laboratory abnormality if present would most likely causing the change in condition?

A. Hypoalbuminemia
B. Hyperkalemia
C. Hyponatremia
**QUESTION 8:**

Which current medication is most likely causing the change in condition?

A. Citalopram  
B. Furosemide  
C. Lisinopril

**BONUS QUESTION:**

• What else could be causing the symptoms?
  – Acute infection – UTI
    • Typically unusual in males, but finasteride may hint at possible urinary retention
  – Urinary retention or constipation
  – Non-medical cause – change in staff, social change, recent family visit
**CASE #3 SUMMARY**

- A 75 y/o female is seen in Emergency Department for complaints of weakness, fatigue, myalgia, and polyuria over the past 2 days.
- She saw her physician 3 weeks ago following an admission to the hospital for heart failure. At discharge her “fluid pill” was increased.
- She states that “My doctor said my sugar was too high, and my heart was too big on that report”. She reports that she has had increased thirst along with her polyuria. She also reports that she vomited 4 times overnight.
- The following information is available.

**CASE #3 PHYSICAL EXAM**

- Vital signs: HR 101, RR 15, BP 139/71, temp-WNL, O2 Saturation- 95%
- Miscellaneous: ht = 165 cm; wt = 90 kg
CASE #3 LABS

<table>
<thead>
<tr>
<th></th>
<th>Na⁺</th>
<th>K⁺</th>
<th>Cl⁻</th>
<th>CO₂</th>
<th>BUN</th>
<th>SCr</th>
<th>Gluc</th>
<th>AG</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>136</td>
<td>2.8</td>
<td>84</td>
<td>38</td>
<td>24</td>
<td>2.21</td>
<td>154</td>
<td>14</td>
</tr>
<tr>
<td>2</td>
<td>136</td>
<td>2.8</td>
<td>84</td>
<td>38</td>
<td>8.8</td>
<td>195</td>
<td>8.6</td>
<td>14</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Ca²⁺</th>
<th>Phos</th>
<th>Mg²⁺</th>
<th>T. Bili</th>
<th>AST</th>
<th>ALT</th>
<th>T. Pro</th>
<th>Alb</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7.6</td>
<td>3.6</td>
<td>1.7</td>
<td>1.3</td>
<td>17</td>
<td>19</td>
<td>5.5</td>
<td>2.9</td>
</tr>
<tr>
<td>2</td>
<td>1.9</td>
<td>1.2</td>
<td>0.85</td>
<td>22</td>
<td>0.28</td>
<td>0.32</td>
<td>55</td>
<td>29</td>
</tr>
</tbody>
</table>

QUESTION 9:

Which laboratory abnormalities are present?

A. Hypoalbuminemia and hypoglycemia
B. Hyperglycemia and hyponatremia
C. Hypokalemia and hypochloremia
### Case #3 Labs

<table>
<thead>
<tr>
<th></th>
<th>Na⁺</th>
<th>K⁺</th>
<th>Cl⁻</th>
<th>CO₂</th>
<th>BUN</th>
<th>Scr</th>
<th>Gluc</th>
<th>AG</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>136</td>
<td>2.8</td>
<td>84</td>
<td>38</td>
<td>24</td>
<td>2.21</td>
<td>154</td>
<td>14</td>
</tr>
<tr>
<td>2nd</td>
<td>136</td>
<td>2.8</td>
<td>84</td>
<td>38</td>
<td>8.8</td>
<td>195</td>
<td>8.6</td>
<td>14</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Ca²⁺</th>
<th>Phos</th>
<th>Mg²⁺</th>
<th>T. Bili</th>
<th>AST</th>
<th>ALT</th>
<th>T. Pro</th>
<th>Alb</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>7.6</td>
<td>3.6</td>
<td>1.7</td>
<td>1.3</td>
<td>17</td>
<td>19</td>
<td>5.5</td>
<td>2.9</td>
</tr>
<tr>
<td>2nd</td>
<td>1.9</td>
<td>1.2</td>
<td>0.85</td>
<td>22</td>
<td>0.28</td>
<td>0.32</td>
<td>55</td>
<td>29</td>
</tr>
</tbody>
</table>

### Bonus Question:

What other laboratory test could be used to monitor therapy for heart failure on a longitudinal basis?

- B-type Naturetic Peptide
QUESTION 10:

What medication is most likely causing the laboratory changes?

A. Carvedilol
B. Furosemide
C. Glipizide

ROLE OF THE PHARMACIST

• Assessment of need for therapy or to adjust existing therapy (not diagnosis)
• Identification of outcomes to therapy
  – At target
  – Adverse events
• Anticipate changes in condition based on existing therapy
  – Recommending assessments:
    Think ‘Must’ – ‘Should’ – ‘Could’ – ‘Might’
QUESTIONS?