Interpreting Laboratory Results in an Older Adult Population

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Learning Objectives:
At the end of the lecture, participants should be able to:

1. Describe the pharmacist’s role in the use and interpretation of laboratory tests.
2. Use commonly ordered laboratory tests in chronic disease management to provide the best clinical care and consultation to older patients.
3. Understand the alternative strategies to monitor organ function, particularly renal function.
4. Use laboratory results to effectively guide therapeutic drug monitoring.

Suggested Resources:

- Converting to International Units: http://www.amamanualofstyle.com/page/si-conversion-calculator
I) Introduction
   A) General concepts for assessing laboratory tests
      1) Normal values vary from laboratory to laboratory
      2) Normal values may vary based on patient demographics (age, gender, etc.)
      3) Laboratory error uncommon (results can be affected by many factors)
      4) Remember to ‘treat the patient – not the numbers!’

B) Role of the pharmacist
   1) Assessment of need for therapy or to adjust existing therapy (not diagnosis)
   2) Identification of adverse outcomes
   3) Anticipate changes in condition based on existing therapy
   4) Recommending assessments: Think ‘Must’ – ‘Should’ – ‘Could’ – ‘Might’
      (a) Establish your ‘philosophy’ for standard assessments
         (i) Standing schedule
         (ii) When needed
      (b) Economical use of commonly used tests – ordering ‘target’ vs. ‘panel’
         (from 2015 CMS Maximum National Limits Table)

II) Typical laboratory tests
   A) Hematology
      1) CBC: WBC, RBC, Hemoglobin & Hematocrit, Red Cell Indices, Platelets, Platelet indices
         (a) White Blood Cells/WBC or leukocyte count, plus the leukocyte differential (% breakdown of neutrophils, lymphocytes, monocytes, eosinophils, basophils)
            (i) Leukocytosis = elevated number of WBCs generally due to infection, especially when accompanied with a ‘left shift’ indicating a higher number of less mature neutrophils (polymorphonucleocytes ‘polys’, banded neutrophils ‘bands’)
            (ii) Leukemia = elevated WBC generally due to hematologic cancer, usually in a specific cell line such as lymphocytes (lymphoma)
            (iii) Leukopenia = reduced number of WBCs
            (iv) Neutropenia = reduced number of neutrophils (infection fighting WBCs), absolute neutropenia = reduced levels below number to prevent infections
         (b) Red Blood Cells/RBC or erythrocyte count, plus hemoglobin, hematocrit, and erythrocyte indices (mean corpuscular volume/MCV, mean corpuscular hemoglobin/MCH, mean corpuscular hemoglobin concentration/MCHC, Red cell distribution width/RDW)
            (i) Anemia = reduced RBC, hemoglobin, hematocrit (influenced by both number of RBCs and fluid status)
            (ii) Microcytic Anemia = anemia with low MCV, common causes include iron deficiency and lead toxicity
            (iii) Macrocytic Anemia = anemia with high MCV, common causes include B12 deficiency (most common) or folate deficiency
(iv) Normocytic Anemia = anemia with normal MCV, common causes include acute blood loss, anemia of chronic disease, ‘mixed’ anemia of both large and small cells due to combined iron and B₁₂ deficiency (look for elevated RDW)

(v) Anemia of chronic disease - seen in chronic infection, chronic immune activation, and malignancy. Elevated Interleukin-6 stimulates hepcidin production and release from the liver reducing ferroportin (iron carrier protein) and access to circulating iron. Also caused by reduced erythropoiesis.

(vi) Mixed cause anemia indicated by increased Red Cell Distribution Width (RDW) – RDW is a measure of the range of variation of red blood cell (RBC) volume. (Ex. Increased RDW may be seen with combined iron deficiency plus B₁₂ deficiency.)

(c) Platelet count with or without platelet indices such as mean platelet volume (MPV)

(i) Thrombocytopenia = reduced platelet number

(ii) Thrombocytosis = increased platelet number

2) Iron Studies:

(a) Serum Iron - amount of circulating iron that is bound to transferrin

(b) Total Iron Binding Capacity (TIBC) - laboratory test that measures the blood’s capacity to bind iron with transferrin. TIBC is less expensive than a direct measurement of transferrin,

(c) Iron Saturation/ISAT - ratio of serum iron and total iron-binding capacity. Tells how much serum iron is actually bound to transferrin (ex. If ISAT = 15% then 15% of iron-binding sites of transferrin are occupied)

(d) Transferrin - iron-binding glycoproteins in plasma that control the level of free iron in the blood. Little of the body’s total iron is bound to transferrin but this source provides the most ‘available’ type of iron due to rapid turnover. About 30% of available sites on transferrin are normally bound with iron. When not bound to iron, transferrin is known as "apotransferrin".

(e) Ferritin - intracellular protein that stores iron and controls its release. Functions as an iron carrier in the blood. Plasma ferritin is used as an indirect marker of the total body stores of iron.

B) Serum electrolytes & blood chemistries

1) Basic Metabolic Panel:

<table>
<thead>
<tr>
<th>Na</th>
<th>Cl</th>
<th>BUN</th>
<th>Glucose</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>K</td>
<td>CO₂</td>
</tr>
</tbody>
</table>

2) Complete Metabolic Panel:

BMP + osmolality, total protein & albumin, hepatic transaminases (alkaline phosphatase(ALK Phos), alanine aminotransferase (ALT), aspartate aminotransferase (AST), bilirubin (total, direct, indirect), and calcium

3) Other electrolytes/metabolic chemistries

(a) Calcium

(b) Magnesium

(c) Phosphorous (inorganic)

(d) Uric Acid

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

5) Special calculations based on serum electrolytes and chemistries

(a) Anion Gap – indicates presence of unmeasured acids or bases in blood

\[ \text{Anion gap} = \left[ \text{Na}^+ - (\text{Cl}^- + \text{HCO}_3^-) \right] \]

(b) Serum Osmolality

\[ \text{Serum osmolality} = 1.86 \left[ \text{Na}^+ \right] + \text{glucose}/18 + \text{BUN}/2.8 \]
6) Electrolyte abnormalities –
   (a) Hyponatremia = low serum sodium (increased intravascular water or sodium depletion);
   Hypernatremia = elevated sodium (reduced intravascular water – dehydration, or sodium excess)
   (b) Hypochloremia (reduced chloride) or hyperchloremia (elevated chloride)
   (c) Hypokalemia (reduced potassium often resulting from diuretic use without supplementation); Hyperkalemia (elevated potassium often resulting from excess supplementation or renal insufficiency)
   (d) Bicarbonate values – elevation or depression often related to acid/base disorders
   (e) Hypoglycemia vs. Hyperglycemia
   (f) Renal Function Markers –
      (i) Uremia (elevated blood urea nitrogen)
      (ii) Elevated creatinine
      (iii) BUN/Creatinine Ratio –
         (a) < 10 suggests intrinsic renal disease
         (b) > 20 suggests ‘pre-renal’ causes including hypovolemia, dehydration, hypotension

C) Estimated Renal Function (Renal Clearance)
   1) THE CONTROVERSY – which method to 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)

   2) Modification of Diet in Renal Disease Study (MDRD) - GFR was measured using the renal clearance of $^{125}$I-iodohippurate and equations generated through multiple regression methods.
      (a) Modification of Diet in Renal Disease Study (MDRD6) equation
      (b) MDRD equation (MDRD4) - provides similar estimate of GFR results compared to the six-variable equation. Calculation based on: plasma creatinine, age, sex, and race
      (c) MDRD4–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$^2$).
      (d) CKD-EPI Equation –
         Recommended for patients with GFR >60 mL/min/1.73 m$^2$ (<0.58 mL/s/m$^2$).
         (i) MDRD4 equation consistently overestimated the CLcr, calculated by the Cockcroft-Gault method.
(ii) FDA conclusion: “For patients with advanced age, low weight, and modestly elevated serum creatinine concentration values, further work is needed before the MDRD equations can replace the Cockcroft-Gault equation for dose adjustment in approved product information labeling.”

3) Cockcroft Gault Formula
“The Cockcroft-Gault formula continues to provide a valid estimate of the CLcr of elderly patients.”

Cockcroft-Gault equation:
\[ \text{CrCl (mL/min)} = \frac{[(140 - \text{age}) \times \text{wt(kg)}]}{(\text{Scr} \times 72)} \times 0.85 \] [if female]
(Cockroft DW, Gault MH. Nephron 1976;16:31–41.)

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.”
(From: Dowling TC. 2014)

D) Hepatic and Gastrointestinal tests
1) Alanine Aminotransferase (ALT) – (prev. SGPT) – elevated in hepatocellular disease
3) Alkaline Phosphatase (Alk Phos) – found in bone and liver as well as intestine, kidneys, and placenta
4) γ-Glutamyl Transpeptidase (GGTP) – found in liver, kidney, and pancreas. Increased levels found in liver disease.
5) Lactate Dehydrogenase (LDH) – found in many tissues including heart, brain, liver, muscle, kidneys, lungs and RBCs. Fractionated into isoenzymes to determine source.
6) Ammonia (NH₃) – generated from protein metabolism in intestines and excreted as urea by kidneys. Used to diagnose and monitor hepatic encephalopathy.
7) Bilirubin – formed in liver. Reported as direct bilirubin (conjugated) or indirect bilirubin (unconjugated form) the form that is excreted as bile into intestines.
8) Amylase – excreted by pancreas and salivary glands to break down carbohydrates. Used to diagnose acute pancreatitis
9) Lipase – secreted by pancreas to digest fat. Used to diagnose acute pancreatitis.
10) Helicobacter pylori (H. pylori) immunoglobulin (IgG) – serologic test that detects antibodies to H. pylori. Positive result with presence of symptoms of peptic ulcer disease is used to substantiate need for antimicrobial and PPI or H₂RA antisecretory therapies.
11) Hemoccult – detects presence of occult (undetected) blood in the feces. Used as screening for follow-up with endoscopy or colonoscopy for intestinal/colonic problems.

E) Important vitamins and minerals
1) Vitamin D – essential for ‘bone health’, deficiencies linked to falls, increased cancer risk
2) Vitamin B₁₂ – essential for cellular function and development, nerve transmission; deficiencies linked with anemia (macrocytic or megaloblastic) and neuropathies
3) Folate – essential for cellular function and development; deficiencies linked with anemia (macrocytic or megaloblastic) and fetal abnormalities (neural tube disorders)

F) Endocrine Studies
1) Thyroid studies
(a) Thyrotropin Releasing Hormone (TSH) – increased in hypothyroidism as hypothalamus-pituitary axis is stimulated to produce increased levels of thyroid hormone. Requires at least 4-6 weeks between thyroxine dose changes and re-equilibration of the feedback mechanism.
Pharmacist’s Role in Laboratory Assessment
September 2017

(b) Total Thyroxin (T4) = Free Thyroxin (free-T4) + protein bound T4. Free T4 is better indicator of clinical thyroid status and should be used to confirm thyroid status when TSH value is slightly elevated without clinical symptoms of hypothyroidism. (c) Triiodothyronine (T3) – minor circulating thyroid hormone with little utility in diagnosis of hypothyroidism. More potent than T4. May be used in diagnosis of hyperthyroid states.

2) Glycosylated Hemoglobin or Hemoglobin A1C
(a) Formed by non-enzymatic uptake of glucose molecules onto proteins in hemoglobin.
(b) Indicates ‘average’ glucose loads experienced during lifespan of typical RBCs (generally 2-3 months).
(c) Average glucose concentration can be estimated based on HgA1C

G) Urine testing
1) Urine analysis (UA): appearance and color, WBCs and RBCs, pH, specific gravity, protein, glucose & ketones, bilirubin, leukocyte esterase & nitrites
2) Urine for culture and sensitivity

H) Cardiac testing
1) Creatine kinase – marker for muscle injury – reported as total CK, and subfractions: CK-MM (muscle), CK-BB (brain) & CK-MB (cardiac)
2) Troponin – sensitive markers for cardiac injury – Troponin 1 found solely in cardiac tissue, Troponin T found in both cardiac and skeletal muscle
3) Brain or B-type Naturetic Peptide (BNP) – hormone produced by heart to regulate sodium and water excretion by kidneys. Increases with heart failure, especially increased preload due to stretch of the atrium. Some labs now reporting as pre-BNP with varying normal values. ‘Normal’ values not established in the elderly – must be assessed in relation to the individual’s ‘baseline’
4) Prothrombin Time (PT) & International Normalized Ratio (INR) – used to monitor anticoagulation response to warfarin dosing

I) Infectious Diseases
1) General infections – nonspecific tests
(a) White Blood Cells (WBCs) and Differential – increased WBC number (leukocytosis) and increased percentage of infection fighting cells (neutrophils, PMNs, Bands, Segs) indicates active infection
(b) Lymphocytosis – increased number of lymphocytes found with Epstein Barr and Cytomegalovirus (CMV) viral infections
(c) Physical signs – fever, malaise, localized symptoms of rubor, pain, swelling
(d) Increased nuclear factor-κB (NF-κB) detected by transcription factor assay (TF-ELISA) indicates systemic inflammatory response syndrome (SIRS) in patients with septicemia.
(e) Erythrocyte Sedimentation Rate (ESR) and the C-reactive protein concentration (both are acute-phase reactants) - elevated during inflammatory process. Not confirmation of infection but may see large elevations in ESR with endocarditis, osteomyelitis, and intraabdominal infections.
(f) Procalcitonin (PCT) - an acute-phase reactant released in response to cytokines. More specific marker for bacterial infections and used to assess risk of mortality from infection and need for antibacterial therapy in respiratory tract infections.
(g) **Inflammatory cytokines** – interleukin 1 (IL-1), IL-6, and IL-8 and tumor necrosis factor-α (TNF-α) - may be useful in staging and monitoring the response to therapy in patients with serious infections, such as sepsis.

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

3) Sexually Transmitted Diseases
   (a) Rapid Plasma Reagin (RPR) – used to screen for presence of syphilis spirochete for diagnosis and response to therapy
   (b) Venereal Disease Research Laboratory Test (VDRL) - used to screen for presence of syphilis spirochete for diagnosis and response to therapy

4) Hepatitis
   (a) Hepatitis A –
      (i) Anti-HAV IgM – increases 4-6 weeks after exposure, usually coincides with onset of symptoms and jaundice
      (ii) Anti-HAV IgG – detected 2-3 months after exposure. Documents prior exposure/infection or immunization
   (b) Hepatitis B –
      (i) Hepatitis B Surface Antigen (HBsAg) – detected 1 to 3 months after infection. Indicates acute infection. Presence after 6 months after exposure/infection indicates chronic hepatitis B infection.
      (ii) Hepatitis B ‘e’ Antigen (HBeAg) – typically present for 2-6 weeks after acute infection. Used to assess severity of infection. Indicates active viral replication and degree of infectivity.
      (iii) Hepatitis B Core Antibody (anti-HBc) – IgM and IgG antibodies detected a few weeks after appearance of HBsAg. Presence indicates recovery and immunity to HepB.
   (c) Hepatitis C –
      (i) Hepatitis C Antibody (anti-HCV) – used as screening test for HepC virus. Indicates prior exposure or chronic infection. Does not indicate immunity to infection.
      (ii) Hepatitis C viral load – (HCV RNA by PCR) or radioimmunoblot assay (RIBA) – used to confirm active HepC infection

J) Immunologic Diseases
   1) Antinuclear Antibodies (ANA)
   2) Rheumatoid Factor (RF)
   3) Erythrocyte Sedimentation Rate (ESR)
   4) Others including specific mediators and proteins
Case Example 1:

A 66 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>Dose</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></td>
<td>Arthritis</td>
</tr>
<tr>
<td>Metformin 1000 mg</td>
<td>One twice daily with meals</td>
<td></td>
<td>Diabetes</td>
</tr>
<tr>
<td>Clozapine 100 mg</td>
<td>Three tablets (300 mg) twice daily</td>
<td></td>
<td>Schizophrenia</td>
</tr>
<tr>
<td>Sertraline 100 mg</td>
<td>One daily</td>
<td></td>
<td>Depression</td>
</tr>
<tr>
<td>Omeprazole 20 mg</td>
<td>One daily</td>
<td></td>
<td>GERD</td>
</tr>
<tr>
<td>Lisinopril 20 mg</td>
<td>One daily</td>
<td></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, Uric Acid, and Vitamin B₁₂
C. Iron Studies, Lipid profile and Basic Metabolic Profile

Case #1 Continued:
The physician ordered a CBC and BMP as part of the admission orders. The following laboratory results are now available:

<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 x 10³ cells/mm³</td>
<td>7.9 x 10⁹ 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 x 10⁶ cells/mm³</td>
<td>4.52 x 10¹² 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 x 10³/μL</td>
<td>333 x 10⁹/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. Megaloblastic Anemia
C. Microcytic Anemia

Question 4:
Which nutritional supplement is most likely needed in this situation?
A. Vitamin B12
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

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>

Question 6:
Which interventions are most needed as indicated by 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
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 may be implicated in the change in condition?
A. Hypoalbuminemia
B. Hyperkalemia
C. Hyponatremia

Physical Exam:
- Vital signs: HR 122 bpm (nl 65-105), RR 17 (nl 16-22), temp-within nl,
- Miscellaneous: ht = 182.9 cm ; wt = 70 kg

Laboratory and Diagnostic Studies:

<p>| CMP results: (conventional units) |</p>
<table>
<thead>
<tr>
<th>Na⁺</th>
<th>K⁺</th>
<th>Cl⁻</th>
<th>CO₂</th>
<th>BUN</th>
<th>Scr</th>
<th>Gluc</th>
</tr>
</thead>
<tbody>
<tr>
<td>122</td>
<td>4.1</td>
<td>101</td>
<td>24</td>
<td>7</td>
<td>0.5</td>
<td>110</td>
</tr>
<tr>
<td>122</td>
<td>4.1</td>
<td>101</td>
<td>38</td>
<td>2.5</td>
<td>44.2</td>
<td>6.1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<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>7.7</td>
<td>4.7</td>
<td>2.2</td>
<td>0.3</td>
<td>57</td>
<td>20</td>
<td>4.3</td>
<td>2.5</td>
</tr>
<tr>
<td>1.93</td>
<td>1.52</td>
<td>1.1</td>
<td>22.2</td>
<td>0.95</td>
<td>0.33</td>
<td>43</td>
<td>25</td>
</tr>
</tbody>
</table>

- CBC with differential:

<table>
<thead>
<tr>
<th>WBC</th>
<th>Segs/Band</th>
<th>Lymph</th>
<th>Hgb</th>
<th>Hct</th>
<th>Pts</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.2 k/mm³</td>
<td>55% / 3%</td>
<td>35%</td>
<td>9.2 g/dL</td>
<td>35%</td>
<td>130 k/mm³</td>
</tr>
<tr>
<td>7.2 x10⁹/L</td>
<td>0.55/0.03</td>
<td>3.35</td>
<td>92 g/L</td>
<td>0.35</td>
<td>130 x 10⁹/L</td>
</tr>
</tbody>
</table>

- Urinalysis: no WBCs, sp gravity is increased, no nitrites
- Chemistries: CrCl = > 100 ml/min/1.73 m²

Question 8:
Which current medication is most likely causing in the change in condition?
A. Citalopram
B. Lisinopril
C. Furosemide
Case #3

A 65 y/o female is seen in the 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.

PMH: Hypertension x 15 years
Congestive heart failure x 2 years; recent hospitalization 3 weeks ago
Diabetes type 2 x 1 years
Dyslipidemia x 8 years

Home Meds: Lisinopril 20 mg PO daily, cardvedilol 3.125 mg PO bid, furosemide 80 mg PO daily (recent increase from 40 mg daily), simvastatin 10 mg PO daily, glipizide XL 10 mg daily (recent increase from 5 mg daily)

Allergies: Codeine (dyspnea)

ROS:
- General: She appears ill.
- Cardiovascular: Crackles bilaterally, no expiratory wheezing
- Heart: RRR, no murmurs, rubs, or gallops
- Musculoskeletal/extremities: 3+ pitting edema bilaterally

Physical Exam:
- Vital signs: HR 101 bpm (nl 55-95), RR 15 (nl 16-22), BP 139/71 (nl 100-115/65-70), temp-WNL, O₂ Saturation- 95% (nl 92-100%)
- Miscellaneous: ht = 165 cm ; wt = 90 kg

Laboratory and Diagnostic Studies:

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Question 9:
Which laboratory abnormalities are present?
A. Hypoalbuminemia and hypoglycemia
B. Hyperglycemia and hyponatremia
C. Hypokalemia and hypochloremia

Question 10:
What medication is most likely causing the laboratory changes?
A. Carvedilol
B. Furosemide
C. Glipizide