Lab results and what they mean

SPH Health fair 2022

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Common Tests

- Comprehensive Metabolic Profile (CMP)
- Basic Metabolic Profile (BMP)
- Complete Blood Count (CBC)
- Thyroid Profile
- Urinalysis
- Hormone testing
Comprehensive Metabolic Profile

- Sodium - Na+
- Potassium - K+
- Chloride - Cl-
- Bicarbonate - HCO₃ (sometimes CO2)
- Blood Urea Nitrogen (BUN)
- Creatinine (Cr)
- Estimated Globular Filtration Rate (eGFR)
- Estimated Globular Filtration Rate (eGFR)
- Total Protein
- Albumen
- ALT
- AST
- Alkaline Phosphatase
 CMP - Electrolytes

- Na+ - sodium one of the most common electrolytes, generally tracts with hydration, can be abnormal due to pituitary disease, liver or kidney disease or a side effects of drugs - especially diuretics

- K+ - potassium required for normal muscle function, tightly controlled by kidney function. High or low causes muscles to not work right - often resulting in cramps or heart rhythm issues

- Cl- closely parired with Sodium,

- HCO3 - bicarbonate - controlled by kidneys and lungs - if it falls, it represents acid build-up
Kidney function (1)

- BUN - Blood urea nitrogen - a waste product of protein metabolism - sensitive to dehydration, results in Ammonia in urine
- Cr - Creatinine - waste product of skeletal muscle metabolism, only excreted by kidneys. Varies with body size and kidney function
- eGFR - a “correction” calculation of Cr, including age, height, weight, sex, (formerly included race) - normal > 90 = stage 1
  - 90-60 = stage 2 CKD (chronic kidney disease)
  - 60-45 = stage 3a CKD
  - 45-30 = stage 3b CKD
  - 30-15 = stage 4 CKD
  - < 15 = stage 5 CKD (End stage kidney disease)
Kidney function (2)

- Urine Protein / Albumin / Microalbumin
- UACR - Urine Albumin / Cr Ratio
  - < 30 = normal
  - 30-300 = microalbuminuria
  - > 300 = macroalbuminuria

- [https://www.youtube.com/watch?v=hvUoPfUY5ao&list=PLReQ4BxyIJa-k7TyskUuBCNg9LE60QJ2j&index=2](https://www.youtube.com/watch?v=hvUoPfUY5ao&list=PLReQ4BxyIJa-k7TyskUuBCNg9LE60QJ2j&index=2)
Liver function

- ALT
- AST
- Alk Phos (Liver or bone)
- Bilirubin
- Protein
- Albumin
<table>
<thead>
<tr>
<th></th>
<th>A1C</th>
<th>FASTING GLUC.</th>
<th>OGTT/NOT FASTING</th>
</tr>
</thead>
<tbody>
<tr>
<td>NORMAL</td>
<td>&lt; 5.7%</td>
<td>&lt;100</td>
<td>&lt; 140</td>
</tr>
<tr>
<td>PRE DIABETES</td>
<td>5.7-6.5%</td>
<td>100-125</td>
<td>140-200</td>
</tr>
<tr>
<td>DIABETES</td>
<td>&gt; 6.5%</td>
<td>&gt; 125</td>
<td>&gt; 200</td>
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Table 2.2—Criteria for the diagnosis of diabetes

<table>
<thead>
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<th>Criteria</th>
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<tbody>
<tr>
<td>FPG $\geq$ 126 mg/dL (7.0 mmol/L). Fasting is defined as no caloric intake for at least 8 h.*</td>
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<tr>
<td>OR</td>
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<tr>
<td>2-h PG $\geq$ 200 mg/dL (11.1 mmol/L) during OGTT. The test should be performed as described by WHO, using a glucose load containing the equivalent of 75 g anhydrous glucose dissolved in water.*</td>
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<td>OR</td>
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<tr>
<td>A1C $\geq$ 6.5% (48 mmol/mol). The test should be performed in a laboratory using a method that is NGSP certified and standardized to the DCCT assay.*</td>
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<tr>
<td>OR</td>
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<tr>
<td>In a patient with classic symptoms of hyperglycemia or hyperglycemic crisis, a random plasma glucose $\geq$ 200 mg/dL (11.1 mmol/L).</td>
</tr>
</tbody>
</table>

DCCT, Diabetes Control and Complications Trial; FPG, fasting plasma glucose; OGTT, oral glucose tolerance test; WHO, World Health Organization; 2-h PG, 2-h plasma glucose. *In the absence of unequivocal hyperglycemia, diagnosis requires two abnormal test results from the same sample or in two separate test samples.
Convert A1c to Glucose

Estimated Average Glucose

Table 6.1—Estimated average glucose (eAG)

<table>
<thead>
<tr>
<th>A1C (%)</th>
<th>mg/dL*</th>
<th>mmol/L</th>
</tr>
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<tbody>
<tr>
<td>5</td>
<td>97 (76–120)</td>
<td>5.4 (4.2–6.7)</td>
</tr>
<tr>
<td>6</td>
<td>126 (100–152)</td>
<td>7.0 (5.5–8.5)</td>
</tr>
<tr>
<td>7</td>
<td>154 (123–185)</td>
<td>8.6 (6.8–10.3)</td>
</tr>
<tr>
<td>8</td>
<td>183 (147–217)</td>
<td>10.2 (8.1–12.1)</td>
</tr>
<tr>
<td>9</td>
<td>212 (170–249)</td>
<td>11.8 (9.4–13.9)</td>
</tr>
<tr>
<td>10</td>
<td>240 (193–282)</td>
<td>13.4 (10.7–15.7)</td>
</tr>
<tr>
<td>11</td>
<td>269 (217–314)</td>
<td>14.9 (12.0–17.5)</td>
</tr>
<tr>
<td>12</td>
<td>298 (240–347)</td>
<td>16.5 (13.3–19.3)</td>
</tr>
</tbody>
</table>

Data in parentheses are 95% CI. A calculator for converting A1C results into eAG, in either mg/dL or mmol/L, is available at professional.diabetes.org/eAG. *These estimates are based on ADAG data of ~2,700 glucose measurements over 3 months per A1C measurement in 507 adults with type 1, type 2, or no diabetes. The correlation between A1C and average glucose was 0.92 (6.7). Adapted from Nathan et al. (6).
Thyroid

• TSH = Thyroid stimulating hormone
  • From the pituitary gland - reverse correlation - high is low, low is high
  • Normal 0.5 - 4.5 (pregnant 0.5 - 2.5)

• T4 - (4 iodine atoms) - made in the thyroid gland - duration = days

• T3 - (3 iodine atoms) - converted from T4 - duration = hours
Thyroid antibodies

• TPO - Thyroid peroxidase antibody - correlates with Hashimoto’s
• TSI - Thyroid stimulating immunoglobulin - correlates with Grave’s disease
• Thyroglobulin - correlates to mass of thyroid tissue - used after thyroid removal to assess return of thyroid cancer
CBC

• WBC - fight infection
  • Very high = leukemia, low = leukopenia
• Hb/HCT/RBC - measure red cell mass
  • Low = anemia, High = polycythemia
• Platelets - allow blood to clot
Urinalysis

- Specific gravity 1.000-1.030 - indicates hydration
- Glucose
- Protein/Albumen
- Blood
- Nitrite
Lipid Panel

- Total Cholesterol = HDL + Triglycerides/5 + LDL
- LDLc - “Bad cholesterol” - most closely linked to atherosclerosis
- Triglycerides (VLDLc) - unclear link to atherosclerosis.
  - If over 500, then risk of pancreatitis
- HDLc - “Good cholesterol” - brings cholesterol back to liver to be recycled
- Lp(a) - genetically abnormal cholesterol particle not on routine profile
Cholesterol goals

- **LDL** < 100 for otherwise healthy, < 70 if diabetes or prior events, < 50 if DM + cardiac event
- **HDL** > 50
- **Triglycerides** < 150
- **Lp(a) normal** < 75
- **Chol/HDL** < 3
- **Non-HDL cholesterol** - 30 points higher than LDL
Apolipoprotein B-containing LDL-Particles

Total LDL-apoB = non-apo(a)-LDL-apoB + Lp(a)-apoB

Heterogeneously sized & composed non-apo(a) containing LDLs

Non-apo(a)-LDL-apoB*

Non-apo(a)-LDL-C

Apo(a)-containing LDL

Lp(a)-apoB
Lp(a)-P*

Lp(a)-C

Total LDL-C

Normal LDL-P ~1000 nmo/L
Normal LDL-C < 70 mg/dL 1.8 mmol/L

Normal LP(a)-P = <50 nmo/L
Normal LP(a)-C = 11-20 mg/dL or .3-.5 mmol/L

Phospholipids  Cholesterol  Triglyceride

*NMR cannot differentiate non-apo(a)-LDLs from Lp(a)
Calculated **LDL cholesterol** (LDL-C) is the cholesterol trafficked within all of the low and intermediate density and Lp(a) lipoproteins in a deciliter of plasma.

Directly measured LDL-C is the cholesterol trafficked within all of the LDL and Lp(a) particles in a deciliter of plasma.

\[
\text{IDL-C} + \text{Actual LDL-C} + \text{Lp(a)-C}
\]

Lp(a), a potentially quite atherogenic particle make up a minority of LDL particles.

**Calculated or Direct LDL-Cholesterol**

**Friedewald Calculation:**

\[
LDL-C = TC - [HDL-C + VLDL-C]
\]

**VLDL-C = TG/5**
High Density Lipoproteins

- HDL particles are defined as a lipoprotein having a buoyant density between 1.063 and 1.21 g/mL in an ultracentrifuge.
- They range from large buoyant (HDL₂) to smaller, more dense (HDL₃).
- HDL diameter varies between 5-12 nm.
- ApoA-I is a single polypeptide of 243 amino acid residues with a molecular weight of 28,000 (28.3 KDa): HDL MW = 65-386 x 10³.
- ApoE is a peptide of 299 amino acids with a molecular weight of 34-38 KDa.