CHAPTER TWO
LESSON THREE

Functional EHR Systems
Trend Analysis

• Changes in test results can indicate trend in patient's health.
• When health record is electronic, it is easier to compare data from different dates, tests, or events.
• When data is fielded and coded, it is possible to generate graphs and reports that support trend analysis.
Critical Thinking Exercise 7: Retrieving a Scanned Lab Report

• In this exercise you will use what you have learned in Guided Exercise 5.

• Step 1
  – Log into Document/Imaging simulation on Myhealthprofessionskit web site.

• Step 2
  – Select patient Raj Patel.
Critical Thinking Exercise 7: Retrieving a Scanned Lab Report

Step 3

- On February 8, 2012, the facility received results of lab test performed by Quest laboratories.
- Lab report was scanned and cataloged in Raj Patel's chart.
- Locate catalog entry for this lab report; click on it to display report.
Step 4

- When report is displayed in Image Viewer, locate results for test component “Triglycerides.”
- Write down value on a sheet of paper with your name and today's date.
- You may need to use Zoom In button to read value accurately.
Critical Thinking Exercise 7: Retrieving a Scanned Lab Report

- **Step 5**
  - Close browser window; give your paper to your instructor.
  - This is an example of data in format of digital image.
  - Lab data present in the EHR, but requires a human to locate and read data values.
Trend Analysis

• Lab Report as Text Data: File could be imported into the EHR, but data is not fielded or codified (Figure 2-18).
Trend Analysis

Raj Patel: M: 3/5/1932:

Doctor’s Laboratory
3/10/2012 11:30AM

<table>
<thead>
<tr>
<th>Tests</th>
<th>Value</th>
<th>Normal Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood Chemistry:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total plasma cholesterol level</td>
<td>215 mg/dl</td>
<td>140 - 200</td>
</tr>
<tr>
<td>Plasma HDL cholesterol level</td>
<td>40 mg/dl</td>
<td>30 - 70</td>
</tr>
<tr>
<td>Plasma LDL cholesterol level</td>
<td>98 mg/dl</td>
<td>80 - 130</td>
</tr>
<tr>
<td>Total cholesterol/HDL ratio</td>
<td>5.4</td>
<td>4 - 6</td>
</tr>
<tr>
<td>Hematology:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>INR</td>
<td>2.1</td>
<td>25 - 40</td>
</tr>
</tbody>
</table>

Figure 2-18: Text-based lab results.
Trend Analysis

- Coded Lab Data: Test result data fielded and coded; computer finds matching results in data and generates cumulative summary report or a graph (see Figure 2-19).
**Figure 2-19: Cumulative summary lab report.**

### Blood Gases

<table>
<thead>
<tr>
<th>DATE:</th>
<th>[----------]</th>
<th>03/26/2012</th>
<th>03/28/2012</th>
<th>NORMAL</th>
<th>UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH: Arterial</td>
<td>7.30 L</td>
<td>7.36 L</td>
<td>7.38 L</td>
<td>7.47 H</td>
<td>7.48 H</td>
</tr>
<tr>
<td>PCO2: Arterial</td>
<td>47.4 H</td>
<td>41.1</td>
<td>38.3</td>
<td>34.8 L</td>
<td>33.0 L</td>
</tr>
<tr>
<td>PO2: Arterial</td>
<td>90.3</td>
<td>189.0 H</td>
<td>187.0 H</td>
<td>188.0 H</td>
<td>227.0 H</td>
</tr>
<tr>
<td>HCO3: Arterial</td>
<td>22.8</td>
<td>22.8</td>
<td>22.0</td>
<td>24.9</td>
<td>24.4</td>
</tr>
<tr>
<td>Base Excess: A</td>
<td>3.2 H</td>
<td>3.1</td>
<td>2.5</td>
<td>1.7</td>
<td>1.6</td>
</tr>
<tr>
<td>Base Deficit: A</td>
<td>0.5</td>
<td>0.3 H</td>
<td>0.1 H</td>
<td>0.5</td>
<td>0.4</td>
</tr>
<tr>
<td>O2 Sat Dir: A</td>
<td>96.0</td>
<td>98.3 H</td>
<td>99.5 H</td>
<td>99.6 H</td>
<td>99.4 H</td>
</tr>
<tr>
<td>O2 Sat Content: A</td>
<td>15.9</td>
<td>15.3</td>
<td>14.6 L</td>
<td>10.3 L</td>
<td>14.4 L</td>
</tr>
<tr>
<td>HemoFiglobin: MG</td>
<td>12.0</td>
<td>10.8</td>
<td>10.9</td>
<td>9.7</td>
<td>10.1</td>
</tr>
<tr>
<td>CarboxyHb: A</td>
<td>1.1 H</td>
<td>1.0 H</td>
<td>1.7 H</td>
<td>0.8</td>
<td>1.6</td>
</tr>
<tr>
<td>MethB: A</td>
<td>0.9</td>
<td>0.4</td>
<td>0.7</td>
<td>0.4</td>
<td>0.8</td>
</tr>
<tr>
<td>PI03</td>
<td>0.55</td>
<td>0.56</td>
<td>0.54</td>
<td>0.65</td>
<td>%</td>
</tr>
</tbody>
</table>

### Whole Blood Chemistries

<table>
<thead>
<tr>
<th>DATE:</th>
<th>[----------]</th>
<th>03/26/2012</th>
<th>03/28/2012</th>
<th>NORMAL</th>
<th>UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium: WB</td>
<td>142</td>
<td>142</td>
<td>142</td>
<td>139</td>
<td>135-145 mEq/L</td>
</tr>
<tr>
<td>Potassium: WB</td>
<td>3.8</td>
<td>3.3</td>
<td>3.0 L</td>
<td>2.9 L</td>
<td>2.7 L</td>
</tr>
<tr>
<td>Calcium IONIZED</td>
<td>1.21</td>
<td>1.05</td>
<td>0.99 L</td>
<td>1.07</td>
<td>1.08</td>
</tr>
<tr>
<td>Lactic Acid-WB</td>
<td>1.3</td>
<td>0.8</td>
<td>1.1</td>
<td>0.8</td>
<td>0.5</td>
</tr>
<tr>
<td>Glucose-WB</td>
<td>170 H</td>
<td>156 H</td>
<td>165 H</td>
<td>118 H</td>
<td>90</td>
</tr>
<tr>
<td>Hematocrit-WB</td>
<td>37</td>
<td>34</td>
<td>32</td>
<td>28 L</td>
<td>31 L</td>
</tr>
</tbody>
</table>

### General Chemistry

<table>
<thead>
<tr>
<th>DATE:</th>
<th>[----------]</th>
<th>03/28/2012</th>
<th>03/28/2012</th>
<th>NORMAL</th>
<th>UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium</td>
<td>140</td>
<td>143</td>
<td>136-145 mmol/L</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Potassium</td>
<td>2.7 L</td>
<td>2.9 L</td>
<td>3.3-5.1 mmol/L</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chloride</td>
<td>101</td>
<td>100</td>
<td>98-107 mmol/L</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carbon Dioxide</td>
<td>32 H</td>
<td>36 H</td>
<td>22-30 mmol/L</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urea Nitrogen</td>
<td>10</td>
<td>7</td>
<td>5-20 mg/dL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Creatinine</td>
<td>0.94</td>
<td>0.69</td>
<td>0.40-0.90 mg/dL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glucose</td>
<td>115 H</td>
<td>96</td>
<td>55-99 mg/dL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calcium</td>
<td>8.4</td>
<td>8.0</td>
<td>8.0-10.6 mg/dL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Magnesium</td>
<td>1.9</td>
<td>2.3</td>
<td>1.8</td>
<td>1.5-2.8 mg/dL</td>
<td></td>
</tr>
<tr>
<td>Phosphorus Inorg</td>
<td>2.3 L</td>
<td>2.8</td>
<td>1.8 L</td>
<td>2.7-4.5 mg/dL</td>
<td></td>
</tr>
<tr>
<td>CK Total</td>
<td>165</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Abnormal High, Abnormal Low, Critical High, Critical Low, Medical Records Copy, Page*
Trend Analysis

• Figure 2-20: example of how data from multiple lab tests can be extracted and graphed for clinician.
Figure 2-20: Graph of total cholesterol from codified lab results.
Trend Analysis

• Computer able to generate this graph because data is fielded and tests and components have unique codes.
• Trend analysis is not limited to lab test results.
• One of the important reasons for widespread adoption of EHR is potential to reduce medical errors.

• Alert is term used in an EHR for message or reminder automatically generated by system.

• Alerts are based on programmed rules that cause the EHR to alert provider when two or more conditions are met.
Alerts

- Most prevalent alert systems are implemented with electronic prescription systems.
- Drug utilization review (DUR) program compares prescription to database of most known drugs.
- Database includes prescription drugs as well as over-the-counter drugs, and nutritional herb and vitamin supplements.
Figure 2-21: Electronic prescription DUR alert.
Alerts

• Formulary Alerts: Warns clinician if drug about to be prescribed is not covered by patient's pharmacy benefit insurance.
• Insurance plans provide formularies indicating preferred, nonpreferred, noncovered drugs.
Alerts

• Other types of alerts may include:
  – Lab order systems
  – Monitoring changes in values of certain blood tests
  – Generated by nonactions

• An alert system is programming a rule to watch for a certain event or detect a finding with a value above or below desired limit.
Health Maintenance

- Two important components:
  - Preventive Care
    - EHR software compares list of tests recommended for patients of certain age and sex to previous test results stored in the EHR.
    - Guidelines not limited to lab tests; include mammograms, hearing and vision screening, certain elements of physical examination.
Health Maintenance

• Two important components (cont.):
  – Immunizations
    ▪ Slows down or stops disease outbreaks.
    ▪ Must be acquired over time; vaccines cannot be given all at once.
    ▪ Using codified data in an EHR, computers compare patient's immunization history with CDC-recommended vaccines and intervals and identify immunizations patient needs.
Decision Support

• Decision support: ability of EHR systems to store or quickly locate materials relevant to findings of current case.
  – Not about “artificial intelligence” replacing physician with a computer; it is about providing help when clinician needs it.
  – Examples include prescriptions, medical references, protocols, medication dosing.
Meeting the IOM Definition of an EHR

• Each of the functional benefits—trend analysis, alerts, health maintenance, decision support—are products of EHR systems.

• It is only when these functional benefits are added to clinical practice that the EHR approaches vision of IOM and meets CMS “meaningful use” criteria.
Chapter Summary

• Three types of EHR data:
  – Digital image data
  – Text-based data
  – Discrete data, fielded and ideally codified

• Clinical nomenclature: Code set designed specifically to record medical observations.
• EHR nomenclatures pre-correlate individual terms into clinically relevant findings (codified observations).
• Findings are often linked to other findings.
• Differ from billing codes in that EHR nomenclatures have many more codes used to describe detail of exam.
Chapter Summary

• Reference terminologies designed for research may codify each medical term; nomenclatures are not easy to use at the point of care.
• Often include cross-references to other standard code sets.
Chapter Summary

- Prominent Coding Standards
  - SNOMED-CT
  - MEDCIN
  - LOINC
  - CCC
Chapter Summary

- EHR data captured in many ways:
  - Scanning paper records
  - Importing diagnostic images in digital format
  - Importing text or word processing files
  - Patients may enter their own history and symptoms
  - Providers record the EHR at point-of-care
Chapter Summary

• EHR data captured in many ways (cont.):
  – Receiving data electronically from other systems using
    ▪ HL7
    ▪ DICOM
    ▪ CDISK
    ▪ RHIO
    ▪ Biomedical devices
    ▪ Telemonitoring devices
Chapter Summary

• When EHR data is coded, it can be used for:
  – Trend analysis
  – Alerts
  – Health maintenance
  – Decision support