Unit 3

Chemical Examination of Urine
Part 1 - Overview of Procedure & pH

Unit Outline

- Introduction to reagent strip testing
- pH
- Glucose & Carbohydrates
- Ketones
- Protein
- Bilirubin
- Urobilinogen
- Blood
- Leukocyte esterase
- Nitrite
- Miscellaneous

Chemical Exam of Urine

- Reagent strip manufactures
  - Siemens Multistix 10 SG
  - Roche Chemstrip
Illustration of Multistix 10 SG

Sources of Error

<table>
<thead>
<tr>
<th>Source of Error</th>
<th>What is going on?</th>
<th>How to prevent it</th>
</tr>
</thead>
<tbody>
<tr>
<td>Testing cold samples</td>
<td>Chemical reactions slowed</td>
<td>Test fresh / RT samples</td>
</tr>
<tr>
<td>Specimen not mixed</td>
<td>Blood cells have settled to bottom and not in contact</td>
<td>Test well mixed sample.</td>
</tr>
<tr>
<td>Over-dipping strip</td>
<td>Reagents get leached out</td>
<td>Dip completely, but briefly</td>
</tr>
<tr>
<td>Inadequate blotting / fail to keep strip level</td>
<td>Over-run or mixing of chemicals</td>
<td>Blot away excess urine and keep strip horizontal</td>
</tr>
<tr>
<td>Improper timing</td>
<td>Over / under development of reagent pad colors</td>
<td>Follow manufacturer’s recommendations</td>
</tr>
<tr>
<td>Inadequate lighting</td>
<td>Poor lighting results in mis-interpretation of results</td>
<td>Work in well lighted area</td>
</tr>
<tr>
<td>Mis-using color chart</td>
<td>Mis-interpretation of results</td>
<td>Align reagent pad with proper part of color chart.</td>
</tr>
</tbody>
</table>
Chemical Exam of Urine

• Handling and Storage of Strips
  • Keep strips in original container
  • Store in cool (below 30°C, but not refrigerated, not frozen)
  • Protect from moisture and volatile fumes
    • Keep bottle tightly closed
    • Keep desiccant in bottle
  • Remove strips immediately prior to use
  • Do not touch reagent pad areas
  • Use before expiration date
    • Do not use if pads are discolored

Quality Control

• Use commercially prepared positive and negative controls.
  • at least once per 24 hours,
  • and anytime a new bottle is opened,
  • or question of validity of results.
• Readings should agree with published results ± one color block.
• Be aware of manufacturer's stated limitations

Chemical Exam of Urine - pH

• pH definition: Negative log of the hydrogen ion concentration
• Kidneys have major role in regulation of acid/base balance
  • Kidneys & Lungs are major players in body acid/base balance.
• ** The over-all goal is blood pH 7.40 ± .005.
Chemical Exam of Urine - pH

- No normal values
  - urine pH is a reflection of blood pH
- Kidneys capable of 4.5-8.0
- In this hemisphere, first morning urine samples usually have an acid pH (@ 6.0)
- Dipstick range is 4.5 - 9.0.
  - Kidneys are not able to produce urine with pH of 9 (either normally or abnormally)
  - pH of 9 associated with old sample / UTI

Fluctuations in Urine pH

<table>
<thead>
<tr>
<th>Situation</th>
<th>Reason / effects</th>
<th>Urine pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>During sleep</td>
<td>Metabolism continues; but respiration decreased</td>
<td>pH decrease (more acid)</td>
</tr>
<tr>
<td>Following meals</td>
<td>Stomach acids being absorbed into foods</td>
<td>pH increases (more alkaline)</td>
</tr>
<tr>
<td>General diet</td>
<td>Western diets of high meat = Acid urines, Eastern diets of vegetables = Alkaline urines</td>
<td></td>
</tr>
<tr>
<td>Specific foods</td>
<td>Example: metabolism of cranberries produces quinalic acid</td>
<td>pH decrease (more acid)</td>
</tr>
<tr>
<td>Metabolic disorders</td>
<td>Example: diabetes mellitus, patient produces keto-acids</td>
<td>pH decrease (more acid)</td>
</tr>
<tr>
<td>Drugs</td>
<td>In-adventent affects of medication, drugs designed to control pH, as to limit kidney stone formation</td>
<td>depends</td>
</tr>
</tbody>
</table>

Urine pH: Significance

<table>
<thead>
<tr>
<th>Persistent Acidity</th>
<th>Persistent Alkalinity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acidifying drugs</td>
<td>Alkaline drugs</td>
</tr>
<tr>
<td>Dehydration</td>
<td>Acute and Chronic renal failure</td>
</tr>
<tr>
<td>Diabetes</td>
<td>Diuretics</td>
</tr>
<tr>
<td>Diarrhea</td>
<td>Renal tubular acidosis</td>
</tr>
<tr>
<td>Fever</td>
<td>Urinary tract infections</td>
</tr>
<tr>
<td>Gout</td>
<td></td>
</tr>
<tr>
<td>High protein diets</td>
<td></td>
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<tr>
<td>Pulmonary emphysema</td>
<td></td>
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</table>
Chemical Exam of Urine - pH

- **Urine pH Measurement**
  - **Purpose / reasons**
    - Although rarely diagnostic, measurement of urine pH can be used to indicate overall body acid/base status.
    - Medical management of pH
      - Crystals and renal calculi may form depending on urinary pH.
    - Identify crystals by the urine’s pH.
      - Use the pH to assist in the identification of urine crystals.
  - **Methods**
    - pH meter
      - Overkill of technology, so rarely required.
    - pH papers
      - Litmus paper
      - Nitrazine paper
    - Reagent dipsticks

Chemical Exam of Urine - pH

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**pH color chart**

- Acid indicator - methyl red
- Alkaline indicator - bromthymol blue
- Read 60 seconds after dipping
- pH ranges from 5.0 to 8.5 in half units
Chemical Exam of Urine - pH

- Glucose
- Bilirubin
- Ketones
- Specific Gravity
- Blood
- pH
- Protein
- Urobilinogen
- Nitrite
- Leukocyte Esterase

pH Over-Run Phenomenon
Buffers from the protein area of the strip (with pH of 3.0) spill over to the pH area of the strip and make the pH of the sample appear more acidic than it really is.

In - Summary

- Store reagent strips in their bottle with lid closed at room temperature.
- Do not expose strips to:
  - Sunlight
  - Heat
  - Cold
  - Volatile substances
  - Moisture (each bottle contains a desiccant)
- Only remove the number of strips you need for immediate testing.
- Do not use strips that have discolored pads.
- Do not use expired reagent strips.
- Test urine which is brought to room temperature.
- Run appropriate QC and only release patient results if controls perform as expected.
- Kidneys are capable of producing urine with pH 4.5 - 8.0
- Strips capable of providing results from @ 4.5 - 9.0
- pH indicators methyl red and - bromthymol blue provide results
- Be aware of ‘run-over’ and work to prevent it.

Reference Listing

- Please credit those whose work and pictures I have used throughout these presentations.
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- Susan Strassinger & Marjorie Di Lorenzo, Urinalysis and Body Fluids, 5th Ed.
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