Preanalytical factors in basic urine examinations

Timo Kouri,
Associate Chief Physician
Oulu University Hospital
e mail: timo.kouri@ppshp.fi
Preanalytical steps

- Test requisition: Medical need
  - Essential measurands
  - Different patient populations
- Patient preparation
- Specimen collection
- Preservation
Essential Measurands: Analytes and Particles

**UTI**: Bacteria, WBC (usually granulocytes)
- other microbes, e.g., chlamydiae, fungi, *M. tuberculosis*

**Renal disease**: Proteins (albumin, alfa\textsubscript{1}-microglobulin), RBC, WBC, casts, renal epithelial cells (?), osmolality
- *urine particles are more specific, but less sensitive than proteinuria (significance of the differences?)*
- *also measured: plasma creatinine and cystatin C (GFR)*

**Post-renal disease**: RBC, WBC, stone composition, tumour cells and antigens

**Reference analytes** to assess water excretion: creatinine, osmolality, density, or conductivity
Different Patient Populations

- **General screening of symptomatic patients**
  - Any one attending health care services

- **Specific suspicion for UTI or renal disease**
  - Subgroups of UTI patients: background
  - KDIGO: Kidney Diseases, Improving Global Outcomes (by NKF) by early detection of kidney disease

*Important background information:*

- Age groups (children, elderly), pregnancy
- Increased probability of disease due to pre-existing conditions (e.g., diabetes, hypertension, malignancy, ureteral reflux)
- Ambulatory vs. hospital-acquired infections
PATIENT PREPARATION

Possibilities and impossibilities
Inform the Patient

- Why urine collection is needed
- How to collect
- How to be prepared to obtain reliable results
- How to report difficulties in obtaining adequate specimen

Classify even the mid-stream specimens into “qualified” or “non-standard” specimens whenever known / report it in the laboratory report

→ to be used in the assessment of the analysis
Detail of a Proper Urine Specimen

- **Concentration** (reduced water excretion rate)
- **Contamination** (avoid commensal bacteria, vaginal secretions)
- **Exercise**, also postural and dietary changes
- **Bladder incubation time** > 4 hours if possible (sensitivity of bacterial culture; 2-4 hours ideal for particles and chemistry only)
SPECIMEN COLLECTION
Timing of Urine Specimens

*Second Morning Urine* - single specimen voided 2-4 hours after the first morning urine.
- Practical compromise for *ambulatory* patients
- Composition may be affected by prior ingestion of food and fluids
- Postural proteinuria may occur
- Quality improvement: Ingestion of only one glass of water (200 mL) after 22:00 on the previous evening. A recommended bladder time > 4 hours
Urine Collection Methods

- **Mid-Stream Urine** (or clean-catch urine) = the middle portion of a voided specimen.
- **First-void Urine** = the first portion of urine voided at the beginning of micturition (*Chlamydia trachomatis*).
- **SupraPubic Aspiration Urine** = sterile aspiration of urine through the abdominal wall from a distended bladder.
- **Single Catheter Urine** = a sterile catheter into the bladder through the urethra (straight or “in-and-out” catheterisation).
- **Indwelling Catheter Urine** is collected at replacement or by sterile puncture of an indwelling catheter.
- **Bag Urine** is widely collected from small infants
- **Pad Urine** is equivalent to bag, more convenient

- Diapers or Nappies are not recommended
Recogida de orina de la mitad del chorro, en mujeres

1. Lávese las manos
2. Separe los labios
3. Lávese los genitales externos con agua
4. Sequelos con una toalla de papel
5. Orine la primera parte del chorro en el inodoro (water)
6. Continúe orinando el resto en el inodoro (water)
7. Deje el vaso con la orina en el mostrador.
8. Recoja unos 50 centímetros cúbicos de la mitad del chorro de orina en el vaso, sin dejar de orinar. Evite tocar el interior del vaso.

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Recogida de orina de la mitad del chorro, en hombres

1. Lávese las manos
2. Tire del prepucio o capuchón hacia atrás
3. Lávese el glande
4. Sequelo con una toalla de papel
5. Orine la primera parte del chorro en el inodoro (water)
6. Continúe orinando el resto en el inodoro (water)
7. Deje el vaso con la orina en el mostrador.
8. Recoja unos 50 centímetros cúbicos de la mitad del chorro de orina en el vaso, sin dejar de orinar. Evite tocar el interior del vaso.

TAUH Department of Clinical Chemistry / T. Heittola
Urine specimen by suprapubic needle aspiration is widely used in many European countries, both by paediatricians and general practitioners.
PRESERVATION
Specimens can be *transported* in their primary containers or divided into aliquots that may range from 1 – 100 mL for chemical and morphological investigations.

For microbiological analysis, 1-3 mL of urine in a *clean* container is sufficient.

A standardized container with a volume of 3-10 mL is essential for automated analytical systems.

*Preservatives* should be evaluated with the analytical procedure for which they are intended to be used.
MONITORING (precision is important):
\[ \text{TE}_{\text{Mon}} \leq \frac{1}{2} s_i \], where \( \text{TE}_{\text{Mon}} \) = total error in monitoring, and
\[ s_i = \text{within-subject biological standard deviation} \]

DIAGNOSTIC TESTING (trueness/total accuracy is important):
\[ \text{TE}_{\text{DT}} \leq \frac{1}{4} s_c \], where \( \text{TE}_{\text{DT}} \) = total error in diagnostic testing, and
\[ s_c = \sqrt{(s_i^2 + s_g^2)} = \text{composite biological standard deviation} \]
\[ s_g = \text{between-subject biological standard deviation} \]

Maximum allowable total error for any clinical chemistry test:
\[ \text{TE}_{\text{Max}} = \text{TE}_{\text{Mon}} + 1.65 \times \text{TE}_{\text{DT}} \]
Analytical quality specifications for urine preservation: maximum allowable error

- Difference between healthy and diseased values $D$ is about 10-fold

- Total technical preanalytical and analytical variation can be maximally 3 (-5) fold to reach $D = 2.8 \times T_{EMax}$ ($p < 0.05$)
  - $T_{EMon}$: $s_i$ of excretion rates $\approx 50$-$100\%$ (1 SD)
    - dispersion of particle counts (Poisson distribution) $SD = \sqrt{n}$
  - $T_{EDT}$: relative deviation $< 2$-fold $\Leftrightarrow -50\% - +100\%$
    - compare to test strip categories with 5 x class widths

- Estimate for a maximally allowable total error could be a two-fold change during storage or transport

Maximum allowable total error ($TE$) for any clinical chemistry test:

$T_{EMax} = T_{EMon} + 1.65 \times T_{EDT}$
Commercial preservative tubes

**BD Diagnostics Preanalytical Systems**

- Urine C&S (glass, +20°C)
- Urine C&S Plus (plastic, +20°C)
  - acetate/borate, sorbitol/mannitol, formiate
- Bacterial culture, particles

- Conical Plus (+4°C)
  - no preservatives
- UAP Plus Conical (+20°C)
  - preservative: chlorhexidine
- Test strip reading

**Greiner (Mekalasi in Finland)**

- Vacuette, Stabilur-tube (plastic, +20°C)
  - mercury chloride → new formula (Stabilur, Cargille Laboratories/Roche, USA)
- Test strips, particles

- Vacuette, boric acid tube (plastic, +20°C)
- Bacterial culture

**Sarstedt Urin-Monovette**

- (no preservatives, +4°C)
Preservation of Urine for Flow Cytometric and Visual Microscopic Testing

Timo Kouri,¹* Lotta Vuotari,² Simo Pohjavaara,² and Pekka Laippala³
Preservation experiment
(Kouri et al, 2002)

- 106 consecutive adult urine specimens
- Divided into 6 different storage procedures for 3 days
  - no preservatives, +4 °C
  - BD Urine C&S –tube, +20 °C
  - (nerbe plus –tube, excluded from the final report)
  - formaldehyde + NaCl
  - ethanol + polyethylene glycol
  - no preservatives, +20 °C
## STORAGE RESULTS IN VISUAL MICROSCOPY (CHAMBER COUNTING OF STAINED CELLS)

<table>
<thead>
<tr>
<th>START</th>
<th>GranO</th>
<th>EryO</th>
<th>SECO</th>
<th>TECO</th>
<th>RTCO</th>
<th>CastHyaO</th>
<th>BactO</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOTAL</td>
<td>96</td>
<td>96</td>
<td>96</td>
<td>96</td>
<td>96</td>
<td>96</td>
<td>96</td>
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<tr>
<td>Positive</td>
<td>62</td>
<td>49</td>
<td>37</td>
<td>25</td>
<td>11</td>
<td>8</td>
<td>18</td>
</tr>
</tbody>
</table>

### AFTER 3 DAYS

<table>
<thead>
<tr>
<th>AFTER 3 DAYS</th>
<th>Class A or B</th>
<th>Gran3</th>
<th>Ery3</th>
<th>SECO</th>
<th>TEC3</th>
<th>RTC3</th>
<th>CastHya3</th>
<th>Bact3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refrigerated</td>
<td>Success%</td>
<td>79%</td>
<td>65%</td>
<td>92%</td>
<td>76%</td>
<td>64%</td>
<td>63%</td>
<td>2%</td>
</tr>
<tr>
<td>BD Vacutainer</td>
<td>Success%</td>
<td>82%</td>
<td>71%</td>
<td>95%</td>
<td>84%</td>
<td>55%</td>
<td>63%</td>
<td>4%</td>
</tr>
<tr>
<td>nherbe plus</td>
<td>Success%</td>
<td>69%</td>
<td>61%</td>
<td>92%</td>
<td>80%</td>
<td>55%</td>
<td>63%</td>
<td>3%</td>
</tr>
<tr>
<td>Form + NaCl</td>
<td>Success%</td>
<td>81%</td>
<td>63%</td>
<td>92%</td>
<td>72%</td>
<td>73%</td>
<td>63%</td>
<td>2%</td>
</tr>
<tr>
<td>EtOH + PEG</td>
<td>Success%</td>
<td>60%</td>
<td>53%</td>
<td>92%</td>
<td>64%</td>
<td>45%</td>
<td>63%</td>
<td>7%</td>
</tr>
</tbody>
</table>

| None        | A  | 3  | 2  | 25 | 9  | 0  | 5  | 4  | few |
| None        | B  | 9  | 16 | 8  | 6  | 3  | 0  | 3  | moderate |
| None        | C  | 28 | 12 | 0  | 4  | 2  | 0  | 39 | abundant |
| None        | D  | 21 | 16 | 2  | 4  | 7  | 1  | N/A |
| None        | none | 35 | 50 | 81 | 73 | 84 | 90 | 50 | negat |
| None        | Success% | 19% | 37% | 89% | 60% | 27% | 63% | 48% | Bact% |
Small Round Cell Channel, Sysmex UF-100

- Refrigerated
- BD Vacutainer
- nerbe plus
- formaldehyde+NaCl
- EtOH + PEG
- NONE

PARTICLES (median) * E6/L

DAY OF EVALUATION

day0am  day0pm  day1  day3

84-88  79-88
BACT Channel, Sysmex UF-100

n = 84-88

- Refrigerated
- BD Vacutainer
- nerbe plus
- formaldehyde + NaCl
- EtOH + PEG
- NONE

PARTICLES (median) * E6/L

DAY OF EVALUATION

day0am  day0pm  day1  day3
Reciprocal changes?
Poisson-distribution

Effect of small counts on statistical variation $SD = \sqrt{n}$
### White Blood Cells

#### Refrigeration + 4 °C

<table>
<thead>
<tr>
<th>UF-100, WBC (cells x 10^6/L)</th>
<th>&lt; 16</th>
<th>16 - 24</th>
<th>&gt; 24</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 0, AM: Original values</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Below 16</td>
<td>39</td>
<td>1</td>
<td>24</td>
<td>93</td>
</tr>
<tr>
<td>16-24</td>
<td>1</td>
<td>13</td>
<td>1</td>
<td>15</td>
</tr>
<tr>
<td>25 or more</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grand Total</td>
<td>39</td>
<td>16</td>
<td>38</td>
<td>93</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>BD Vacutainer tube</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 0, AM: Original values</td>
</tr>
<tr>
<td>Below 16</td>
</tr>
<tr>
<td>16-24</td>
</tr>
<tr>
<td>25 or more</td>
</tr>
<tr>
<td>Grand Total</td>
</tr>
</tbody>
</table>

#### Agreement

- FN rate Day 1: 0 %
- FP rate Day 1: 0 %
- Agreement: 95 %

### Refrigeration + 4 °C

<table>
<thead>
<tr>
<th>UF-100, WBC (cells x 10^6/L)</th>
<th>&lt; 16</th>
<th>16 - 24</th>
<th>&gt; 24</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 3, AM: Original values</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Below 16</td>
<td>36</td>
<td>1</td>
<td>1</td>
<td>38</td>
</tr>
<tr>
<td>16-24</td>
<td>3</td>
<td>14</td>
<td>1</td>
<td>18</td>
</tr>
<tr>
<td>25 or more</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Grand Total</td>
<td>39</td>
<td>16</td>
<td>38</td>
<td>93</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>BD Vacutainer tube</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 3, AM: Original values</td>
</tr>
<tr>
<td>Below 16</td>
</tr>
<tr>
<td>16-24</td>
</tr>
<tr>
<td>25 or more</td>
</tr>
<tr>
<td>Grand Total</td>
</tr>
</tbody>
</table>

#### Agreement

- FN rate Day 3: 3 %
- FP rate Day 3: 0 %
- Agreement: 92 %
### Red Blood Cells, UF-100

#### Refrigeration + 4 °C

<table>
<thead>
<tr>
<th>UF-100, RBC (cells x 10^6/L)</th>
<th>Day 0, AM: Original values</th>
<th>Day 0, AM: Original values</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt; 8</td>
<td>8 - 11</td>
</tr>
<tr>
<td><strong>Day 1</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Below 8</td>
<td>36</td>
<td>4</td>
</tr>
<tr>
<td>8 - 11</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>12 or more</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Grand Total</td>
<td>42</td>
<td>8</td>
</tr>
</tbody>
</table>

- **FN rate Day 1:** 12 %
- **FP rate Day 1:** 0 %
- **Agreement:** 75 %

#### BD Vacutainer tube

<table>
<thead>
<tr>
<th>UF-100, RBC (cells x 10^6/L)</th>
<th>Day 0, AM: Original values</th>
<th>Day 0, AM: Original values</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>&lt; 8</td>
<td>8 - 11</td>
</tr>
<tr>
<td><strong>Day 3</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Below 8</td>
<td>31</td>
<td>5</td>
</tr>
<tr>
<td>8 - 11</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>12 or more</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Grand Total</td>
<td>42</td>
<td>8</td>
</tr>
</tbody>
</table>

- **FN rate Day 3:** 9 %
- **FP rate Day 3:** 12 %
- **Agreement:** 71 %
Leukocyte comparison against chamber counts

MIDITRON, LEUKOCYTES

"1+" range equals 20 - 50 Leuk *E6 /L in the average

REMSSION %

CHAMBER COUNT (cells *E6/L)

Neg 25 1+ 100 500
### AVERAGE OF POSITIVE TEST STRIP RESULTS

<table>
<thead>
<tr>
<th>Storage</th>
<th>Point</th>
<th>EryRed</th>
<th>EryGreen</th>
<th>UBG</th>
<th>Glu1</th>
<th>Pro</th>
<th>Nit</th>
<th>Leu</th>
<th>pH0ra</th>
<th>pHGre</th>
<th>SG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refrigerated</td>
<td>AM</td>
<td>43.9</td>
<td>32.4</td>
<td>49.6</td>
<td>21.7</td>
<td>56.0</td>
<td>45.4</td>
<td>17.4</td>
<td>37.1</td>
<td>33.9</td>
<td>18.5</td>
</tr>
<tr>
<td>BD Vacutainer</td>
<td>AM</td>
<td>46.4</td>
<td>39.0</td>
<td>51.7</td>
<td>24.5</td>
<td>56.5</td>
<td>47.7</td>
<td>18.2</td>
<td>47.6</td>
<td>39.2</td>
<td>28.9</td>
</tr>
<tr>
<td>nerbe plus</td>
<td>AM</td>
<td>46.9</td>
<td>43.2</td>
<td>50.0</td>
<td>21.6</td>
<td>56.5</td>
<td>46.3</td>
<td>19.0</td>
<td>40.1</td>
<td>34.1</td>
<td>22.3</td>
</tr>
<tr>
<td>Form + NaCl</td>
<td>AM</td>
<td>59.8</td>
<td>55.8</td>
<td>61.4</td>
<td>36.4</td>
<td>59.7</td>
<td>55.1</td>
<td>19.8</td>
<td>54.0</td>
<td>27.8</td>
<td>26.1</td>
</tr>
<tr>
<td>EtOH + PEG</td>
<td>AM</td>
<td>50.0</td>
<td>50.8</td>
<td>52.7</td>
<td>25.1</td>
<td>55.5</td>
<td>49.5</td>
<td>23.1</td>
<td>34.0</td>
<td>34.5</td>
<td>16.4</td>
</tr>
<tr>
<td>None</td>
<td>AM</td>
<td>46.7</td>
<td>40.1</td>
<td>51.1</td>
<td>22.9</td>
<td>56.4</td>
<td>47.1</td>
<td>16.6</td>
<td>36.2</td>
<td>33.2</td>
<td>18.9</td>
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<table>
<thead>
<tr>
<th>Storage</th>
<th>Day3</th>
<th>EryRed</th>
<th>EryGreen</th>
<th>UBG</th>
<th>Glu1</th>
<th>Pro</th>
<th>Nit</th>
<th>Leu</th>
<th>pH0ra</th>
<th>pHGre</th>
<th>SG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refrigerated</td>
<td>Day3</td>
<td>47.4</td>
<td>41.5</td>
<td>54.3</td>
<td>22.0</td>
<td>55.9</td>
<td>46.4</td>
<td>19.2</td>
<td>34.7</td>
<td>35.2</td>
<td>18.6</td>
</tr>
<tr>
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<td>Day3</td>
<td>49.2</td>
<td>48.1</td>
<td>62.7</td>
<td>24.7</td>
<td>54.5</td>
<td>48.2</td>
<td>18.0</td>
<td>47.7</td>
<td>39.8</td>
<td>29.2</td>
</tr>
<tr>
<td>nerbe plus</td>
<td>Day3</td>
<td>48.3</td>
<td>55.5</td>
<td>59.8</td>
<td>23.9</td>
<td>56.2</td>
<td>45.5</td>
<td>17.9</td>
<td>39.2</td>
<td>34.6</td>
<td>21.7</td>
</tr>
<tr>
<td>Form + NaCl</td>
<td>Day3</td>
<td>55.4</td>
<td>57.4</td>
<td>62.5</td>
<td>33.5</td>
<td>60.0</td>
<td>67.5</td>
<td>23.1</td>
<td>52.5</td>
<td>29.0</td>
<td>25.0</td>
</tr>
<tr>
<td>EtOH + PEG</td>
<td>Day3</td>
<td>50.9</td>
<td>57.3</td>
<td>59.2</td>
<td>26.1</td>
<td>54.8</td>
<td>48.5</td>
<td>21.4</td>
<td>31.7</td>
<td>35.1</td>
<td>15.7</td>
</tr>
<tr>
<td>None</td>
<td>Day3</td>
<td>47.0</td>
<td>51.0</td>
<td>40.7</td>
<td>24.0</td>
<td>55.5</td>
<td>28.9</td>
<td>16.9</td>
<td>32.8</td>
<td>34.3</td>
<td>19.2</td>
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<table>
<thead>
<tr>
<th>RANGES</th>
<th>1+</th>
<th>57 - 24</th>
<th>52 - 36</th>
<th>56 - 47</th>
<th>63 - 56</th>
<th>&lt; 68</th>
<th>59 - 60</th>
<th>56.49 = 6.5</th>
<th>&lt; 35 = 5</th>
<th>&gt; 49 = 1.030</th>
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<tbody>
<tr>
<td></td>
<td>2+</td>
<td>&lt; 24</td>
<td>&gt; 33</td>
<td>38 - 28</td>
<td>47 - 32</td>
<td>55 - 47</td>
<td>50 - 33</td>
<td>49.28 = 7</td>
<td>&gt; 35 = 6</td>
<td>49 - 39 = 1.025</td>
</tr>
<tr>
<td></td>
<td>3+</td>
<td>&lt; 24</td>
<td>&lt; 33</td>
<td>&lt; 28</td>
<td>&lt; 32</td>
<td>&lt; 47</td>
<td>&lt; 38</td>
<td>28.15 = 8</td>
<td>&lt; 15 = 9</td>
<td>39.28 = 1.020</td>
</tr>
</tbody>
</table>

Labquality Days 2005
De Haene H, Penders J, Delanghe J:
Clinical performance evaluation of new urine preservative tubes.
BVKB Annual symposium, 9.10.2004 Belgium

Materials and methods:
Five tubes (see table) were drawn from each of 92 randomly collected urine samples within 1 hour of collection, analyzed immediately and after 24 and 48 hours. Particle counting was performed on UF-100 (Sysmex) and chemical test strip analysis on Urysis 2400 (Roche). Kruskal-Wallis and Wilcoxon tests were used to determine significant differences between tubes and time of analysis.

<table>
<thead>
<tr>
<th>Tube</th>
<th>Preservative</th>
<th>Performed analysis</th>
<th>Storage</th>
</tr>
</thead>
<tbody>
<tr>
<td>BD C&amp;S Plus</td>
<td>Yes</td>
<td>Automated particle counting</td>
<td>Room</td>
</tr>
<tr>
<td>BD C&amp;S Glass*</td>
<td>Yes</td>
<td>Automated particle counting</td>
<td>Room</td>
</tr>
<tr>
<td>BD UAP Plus Conical</td>
<td>Yes</td>
<td>Chemical analysis</td>
<td>Room</td>
</tr>
<tr>
<td>BD Conical Plus*</td>
<td>No</td>
<td>Chemical analysis</td>
<td>4°C</td>
</tr>
<tr>
<td>Sarstedt Urin-Monovette</td>
<td>No</td>
<td>Both (laboratory reference tube)</td>
<td>4°C</td>
</tr>
</tbody>
</table>

*previously validated reference tube

Results:
No significant influence (cut-off p=0.05) of time or type of tube was seen in the measurement of white and red blood cells, epithelial cells, casts and bacteria by automated particle counting or for hemoglobin, leucocyte esterase, protein, nitrite and glucose by test strip analysis.
De Haene et al. Urisys2400 test strip results (Rem%), preliminary data; TUBE 4: chlorhexidine preservative at +20°C

Samples shown n=95 (<100 RBC/µL) of 112 samples, ranging up to 3900 RBC/µL

Samples shown n= 90 (<1500 WBC/µL) of 112 samples, ranging up to 14 300 WBC/µL
Comparison of Greiner’s and BD’s urine preservative tubes
(Kaija Leisma et al., P-KKS, Joensuu)

- 34 patient specimens
- Analysers: Clinitek 500/Multisix 8SG and UF-50
- Tubes:
  - empty (+4°C and +20°C)
  - BD C&S -tube
  - Greiner (Mekalasi) Vacuette-Stabilur-tube
- Follow-up for 3 days
- Immediate measurement: no effect by the tube on particle counts ($r > 0.97$; for bacteria $r > 0.92$)
Leukocytes: Automated counts with UF-50

Upper limit of healthy reference interval

Maximum detectable deterioration: storage at +20°C
Preanalytics are critical in urinalysis results, but documentation is still lacking in most laboratory information systems.

Preservation of urine allows regional organisation of urine investigations. Tradition in bacterial culture, but criteria and more data on acceptable preservation are still needed for particle and chemical analysis.

Outcomes depend on the analytical procedure:
- particle counting: automated instruments vs. visual microscopy
- in test strip measurements, reflectance readings should be used instead of wide ordinal scale categories