Reference Values for Neonates and Children for the UF-100 Urine Flow Cytometer

The UF-100 fully automated urine flow cytometer classifies urinary particles on the basis of their light scattering, fluorescence, and impedance properties. The UF-100 counts erythrocytes, leukocytes, bacteria, epithelial cells, and casts. The operating principles of the UF-100 and its precision, accuracy, and analytical sensitivity have been published previously (1–4). The high sensitivity of the flow cytometer leads to different reference values. In a recent report, Gyory et al. (5) presented reference values for children; for newborns, however, reference values have not as yet been published. In this report, we present preliminary reference values for neonates and children.

To establish these reference ranges, samples from two groups of children were analyzed. The pediatricians considered the infants in the first group to have no afflictions of the urinary tract after studying the case history, laboratory values (e.g., creatinine and urea), and the urine test strip results (n = 114). These infants were admitted to the neonatal clinic and remained there for >5 days. Admission automatically included urine examination in daily routine programs without additional consent of the parents. The long admission periods were attributable to other factors: maternal problems, such as cesarean section (n = 57); or neonatal problems, such as atresia of the esophagus (n = 3), inguinal hernia (n = 5), atrioventricular canal (n = 3), or preterm birth at more than 34 weeks of gestation without respiratory complications (n = 46). Urine was collected using perineal stick-on plastic containers that were inspected every hour.

Urine was also collected from preoperative children without evidence of hematuria, urinary tract infection (UTI), or renal disease (n = 141) as evaluated by the case history, laboratory values (e.g., creatinine and urea), and test strip results from the laboratory. In each case, a pediatrician was the person evaluating the child. The surgical procedures were adenotomy (n = 57), tonsillectomy (n = 54), otosclerosis (n = 7), and correction of various forms of chelo- gnatouranoschisis (n = 23). Three children were excluded because of UTI from unknown causes in the case history.

Both groups that constituted the reference population were regarded as free of any afflictions of the kidney and the urinary tract. Both groups of samples were analyzed using the test strip analyzer Clinitek Atlas (Bayer Diagnostics) and the UF-100 urine flow cytometer (Sysmex). Results for flow cytometry were given in cells per microliter of urine. Pathological values were rechecked using not only the above mentioned analyzers but also in several cases by examination of the urinary sediment after centrifugation. This result was reported as cells/HPF (high-power field). The children were again clinically examined, and those with previously undetected UTIs or other diseases affecting the urogenital system were not included in the reference set. Because the values did not exhibit a gaussian distribution, the 5th and 95th percentiles were used as reference limits.

The provisional reference values for healthy neonates (n = 114) are shown in the upper portion of Table 1. For comparison, the results for erythrocytes and leukocytes obtained after centrifugation and microscopic analysis of the urinary sediment (0–2 cells/HPF and 0–3 cells/HPF, respectively) are shown. The UF-100 measurements clearly gave higher cell counts for erythrocytes (~5 cells/μL) and leukocytes (~12 cells/μL). Epithelial cells were also counted by the UF-100, yielding a numerical value of ~4 cells/μL. When sediment microscopy was used, only the presence of epithelial cells was reported. Casts were not usually present. Practically all urine samples examined exhibited the presence of bacteria. Thus, a relatively high cell count (~83 cells/μL) was obtained. Preanalytical factors such as storage time before analysis certainly affect this result.

The reference values obtained for children (n = 141) are also shown in the lower portion of Table 1. Slightly higher values for erythrocytes and leukocytes were obtained with the UF-100 (~4 cells/μL for both erythrocytes and leukocytes, respectively).

### Table 1. Preliminary reference values for erythrocytes, leukocytes, casts, bacteria, and epithelial and small round cells, using the urine flow cytometer UF-100 for neonates and young children.

<table>
<thead>
<tr>
<th>Age</th>
<th>Infants (n = 114)</th>
<th>Children (n = 141)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cells/μL</td>
<td>Cells/HPF</td>
</tr>
<tr>
<td></td>
<td>RBCb, WBC, EC, Cast, Bact, SRC RBC, WBC</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>22 days</td>
<td>9.2 years</td>
</tr>
<tr>
<td>5th percentile</td>
<td>4 days</td>
<td>3.1 years</td>
</tr>
<tr>
<td>95th percentile</td>
<td>128 days</td>
<td>16.6 years</td>
</tr>
<tr>
<td>Infants (n = 114)</td>
<td>5.4 11.81 3.9 0 82.85 0.75 2 3</td>
<td></td>
</tr>
<tr>
<td>Children (n = 141)</td>
<td>0.9 3.1 0.6 0 24.1 0 0 0</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>128 days</td>
<td>36.3 56.8 124 0.94 471 4.57 8 12</td>
</tr>
<tr>
<td>5th percentile</td>
<td>16.6 years</td>
<td>25.9 17 30 0.77 197 1.9 3 3</td>
</tr>
<tr>
<td>95th percentile</td>
<td>16.6 years</td>
<td>25.9 17 30 0.77 197 1.9 3 3</td>
</tr>
</tbody>
</table>

a Values are compared with the reference values for erythrocytes and leukocytes obtained with microscopic examination of the urine specimens after centrifugation.

The reference values for urine sediment microscopy were taken from published literature (6, 7).

a RBC, red blood cells; WBC, white blood cells; EC, epithelial cells; Bact, bacteria.

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erythrocytes and leukocytes compared with 1 cell/HPF obtained with microscopy of the urinary sediment. Fewer epithelial cells and bacteria were seen in this population.

In both groups, however, the values for erythrocytes and leukocytes varied, with ranges of \( \sim 1-36 \) cells/\( \mu L \) and \( \sim 3-57 \) cells/\( \mu L \), respectively, when the results between the 5th and 95th percentile were examined. These values are obviously higher than those obtained with microscopic examination of the urinary sediment. Thus, the results should be interpreted with care because the units obtained with the UF-100 (cells/\( \mu L \)) are obviously different from those obtained after centrifugation and microscopy of the urinary sediment (cells/HPF). This may be a problem at the beginning when clinicians are not used to the units of the UF-100. Our experience with certain wards, however, shows that clinicians will adjust to changes relatively quickly.

The small round cells (SRCs) most probably originated from the tubular epithelium of the kidney or the transitional epithelium of the urinary tract. Very small quantities of these cells were seen in urine samples from both groups. Thus, the presence of up to 5 SRC/\( \mu L \) in neonates and up to 2 SRC/\( \mu L \) in children are within the 95th percentile and are not regarded as pathological.

We hope that these values are helpful to those colleagues already using the UF-100 in routine urinalysis.

This work is dedicated to Professor Eckart Köttgen on his 60th birthday.

References


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High Concentrations of Lithium Heparin Decrease Measured Serum Sodium in Some Analyzers

To the Editor:

While studying a handheld analyzer (i-STAT) in a neonatal intensive care unit (NICU), we found hyponatremia (<128 mmol/L sodium) in 25 of 137 newborn infants (postnatal age <6 days for 75% of the infants) with sodium values within the reference interval on a Vitros 750 analyzer (Johnson & Johnson). The difference in sodium values ranged from 5 to 19 mmol/L. Investigation into the clinical presentation and into the various treatments disclosed no common feature.

We tested the hypothesis that the heparinized capillary tubes used in the NICU for sample collection may explain the observed discrepancies in sodium values. We used the i-STAT analyzer and adult venous blood samples to compare capillary tubes supplied either by Chiron (from Ortho Diagnostics, with 130–200 kIU lithium heparin/L) or by Radiometer (50 kIU electrolyte-balanced heparin/L). The sodium results were lower (mean difference, \(-2.14\) mmol/L; range, 0 to \(-7\) mmol/L) with the Chiron capillary tubes (Fig. 1A). The same discrepancy was obtained when we tested the Chiron heparinized capillary tubes vs nonheparinized tubes (not shown). Moreover, incomplete capillary tube filling (a common situation in premature newborn infants) further increased the mean difference to \(-4.8\) mmol/L (range, \(-3\) to \(-8\) mmol/L). This difference was also present when tests were performed on an ABL500 blood gas-ion analyzer (Radiometer), using full Chiron capillary tubes (mean difference, \(-4.4\); range, \(-2\) to \(-8\) mmol/L). Decreased sodium values were thus observed exclusively when Chiron capillary tubes were used. We postulate that the effect reflects the high concentration of lithium heparin in the tubes.