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Reliable laboratory urinalysis results using a new standardised urine collection device

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ABSTRACT

Objectives: While urine sampling is necessary in the diagnosis of urinary tract infection and electrolyte disturbances, the collection of urine in neonates and non-toilet-trained children is often difficult. A universal urine collection method providing representative urinalyses results is needed. The objective of this study is to evaluate the applicability of the currently used urine collection pads (gauze compresses) and a new urine collection device (Peespot).

Design and methods: We tested the reliability of routine (semi-)quantitative urinalysis results with these two different kinds of urine collection methods in a laboratory model. Although important in clinical diagnosis, we did not evaluate the effects on cellular and other components such as casts in the urinary sediment.

Results: Most semi-quantitative variables determined by urine stick (pH, blood, protein, leukocytes, nitrite, glucose, ketones, bilirubin and urobilinogen) gave concordant results for both methods compared with native urine. Using the Peespot urine collection device, reliable quantitative results were obtained for calcium, chloride, glucose, magnesium, phosphate, potassium, sodium, osmolality, urea nitrogen and urate compared with native urine. Data were concordant only for chloride, phosphate, glucose, sodium and urea nitrogen by use of gauze compresses.

Conclusions: Urine collection pads are non-invasive methods useful in the collection of urine in non-toilet-trained children. Because of better practical standardisation and more reliable (semi-) quantitative urinalysis results, the Peespot urine collection device is preferred for the collection of urine.

Introduction

In the screening, diagnosis and follow-up of urinary tract infections [1] and electrolyte disturbances, the collection of a urine sample is essential. Several urine collection methods exist to sample urine in non-toilet-trained infants including neonates; however, each method has its own limitations [2,3].

In the diagnosis of (suspected) urinary tract infections, it is necessary to obtain non-contaminated urine. Because of low contamination rates, both transurethral catheterization and supra-pubic bladder aspiration are considered to be the most reliable urine collection methods. Both methods are invasive and painful, and have to be performed by a paediatrician or trained nephrologist [4]. For screening of urinary tract infections, clean catch of mid-stream urine is preferred as it is non-invasive. In non-toilet-trained children, this method remains practically difficult. In this patient population, sterile urine bags are widely used but these give high contamination rates by skin and faecal flora and may cause dermatological problems (i.e. when they have to be removed from the skin of neonates).

More recently, several methods using a kind of pads have been proposed to collect urine in non-toilet-trained children especially neonates. Their practical applicability and the reliability of obtained urinalysis results still have to be proven. Some studies [5–7] assessed the application of urine collection pads in first-line screening of urinary tract infections by urine culture. Less is known about the effects of urine collection pads on urine stick and quantitative urine biochemistry variables in neonates and young children.

In clinical practice, different urine collection methods are used interchangeably and are not always fully standardised. Therefore, the objective of this study is to evaluate the applicability of the currently used urine collection pads (gauze compresses) and a new urine collection device (Peespot, see Fig. 1). The effects on frequently ordered and clinically important semi-quantitative (pH, blood, protein, leukocytes, nitrite, glucose, ketones, bilirubin and urobilinogen) and quantitative (calcium, chloride, creatinine, glucose, magnesium, phosphate, potassium, protein, sodium, urea nitrogen, urate and osmolality) urinalysis variables were investigated.

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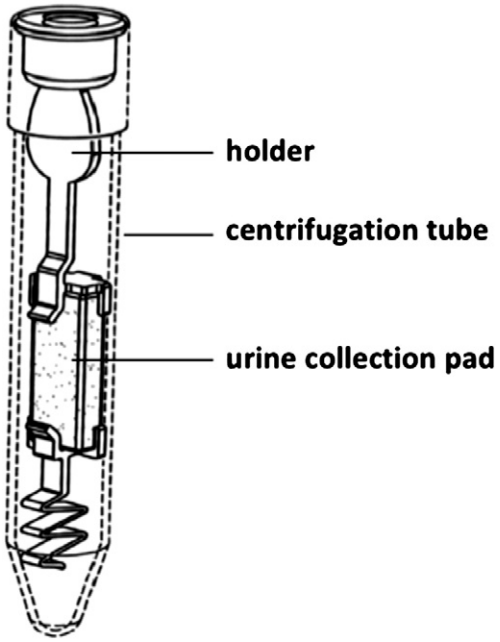

Fig. 1. The Peespot urine collection device consisting of a conical centrifugation tube containing a urine collection pad clamped in a holder.

Patients and methods

Urine samples

Urine samples ($n = 45$) were selected from routine samples delivered to the laboratory for urinalysis, and leftover urine was used in an anonymous way. Twenty-three urine samples were selected for urine stick analyses to reflect the different types of semi-quantitative laboratory results (positive (+ or 2+), trace (+/−) or negative (−)) of each variable. Five urine samples obtained from catheterized neonates, 5 urines from catheterized children, and 12 samples from hospitalised or outpatient adults, and these samples were selected to cover a broad range of quantitative urine biochemistry results.

Urine collection methods

Two different types of urine collection pads, i.e. the new urine collection device (Peespot) and the gauze compresses method, were tested in a laboratory model. This model was developed to evaluate simultaneously the collection of urine by different methods and to simulate the in vivo situation in neonates. The urine collection pad of the Peespot urine collection device, as shown in Fig. 1, is an absorption felt containing a dried hygroscopic polymer (Peespot urine collection device, Hessels & Grob, Deventer, The Netherlands). After removal of the adhesive the pad was attached to a diaper (Pampers New Baby Micro 0.5–1.5 kg, Procter & Gamble, The Netherlands). Two different types of Peespot urine collection pads were used for its specific applications, one developed for semi-quantitative urinalysis and one for quantitative urine biochemistry analysis. For the gauze compresses method, 5 sterile gauze compresses (Medicomp 5 × 5 cm, Hartmann bv, Nijmegen, The Netherlands) were placed in a diaper. Next, a 10 mL aliquot of each urine sample was pipetted on the gauze compresses, 3 mL on the pad and 3 mL in a 5 mL plastic tube as native urine sample. Subsequently a plastic ball was placed on the gauze compresses or pad and the diaper was closed over this ball. Then the diapers and the plastic tube without lid were incubated for 3 hours at 37 °C in an incubator (ULM400, Memmert Universal Ovens, Jakarta, Indonesia). After incubation, the Peespot pad was picked up from the diaper and simultaneously clamped into the holder, and transferred into the centrifugation tube (Peespot urine collection device, Hessels & Grob, Deventer, The Netherlands). Subsequently, the urine collection device was centrifuged (Rotina 38 centrifuge, Hettich Benelux bv, Geldermalsen, The Netherlands) at 1800 ×*g* for 5 minutes to yield approximately 1.2 mL of urine at the bottom of the tube. The gauze compresses were transferred with a pincette from the diaper into a syringe (BD Plastipak 20 mL syringe, Becton Dickinson International, Erembodegem, Belgium) with which urine was aspirated from the gauze compresses.

Analytical methods

Semi-quantitative urinalysis results were obtained using urine sticks (Uriflet S 9UB, Arkray, Tokyo, Japan) containing test fields for pH, blood, leukocytes, protein, nitrite, glucose, ketones, bilirubin, and urobilinogen, and were measured on Aution Eleven AE-4200 urine chemistry analyser (Arkray, Kyoto, Japan) according to the manufacturer's instructions. Results are expressed qualitatively as negative (−), trace (+/−) and positive (+ or 2+) as well as semi-quantitatively as reflection percentages (%) based on the reflected light from the different reaction fields. These percentages are used in statistical analyses.

The following quantitative urine biochemistry variables were measured on an Architect c16000 chemistry analyser (Abbott Laboratories, Illinois, United States of America) according to manufacturer's instructions: sodium, potassium and chloride (ion-selective electrodes), calcium (arsenazo-III dye), phosphate (molybdenum blue), magnesium (xylidyl blue, Roche Modular MG reagent), glucose (hexokinase), creatinine (enzymatic), protein (trichloroacetic acid), urea nitrogen (urease), and urate (uricase). Osmolality was measured by the freezing point depression principle of analysis on an Osmostation OM-6050 (Vitech scientific, Sussex, United Kingdom). To adjust for dilution of urine samples, results are expressed as analyte/creatinine ratios.

Statistical analysis

Passing–Bablok regression and paired *T* tests were used to compare (semi-) quantitative results of both urine collection methods pair-wise to the incubated native urine sample. Statistical calculations were performed using EP Evaluator release 9 software, version 9.0.0.366. A probability level (*P*-value) of less than 0.05 was considered statistically significant.

Results

Semi-quantitative urinalysis

Urine samples were selected to represent all kinds of urine stick results as shown in Fig. 2. For all semi-quantitative variables tested by urine stick, no false negative (−) results were obtained while the result in native urine was positive (+) with either the Peespot urine collection device or the gauze compresses method. With each of the methods, one trace (+/−) urine sample was tested negative (−) for leukocytes. Using gauze compresses, two trace (+/−) samples tested negative (−) for blood. With both urine collection methods, pH values did not differ more than 0.5 from the native urine sample (data not shown). Because of a lack of urine samples with positive (+) and spare (+/−) results, data for ketones are inconclusive.

Pair-wise comparison of reflection percentages between the Peespot urine collection device and native urine revealed no significant differences for pH, blood, leukocytes, glucose, bilirubin and urobilinogen.