

Comparison of urine Gram stain and urine culture to diagnose urinary tract infection in children

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Abstract

Background Urinary tract infection (UTI) are due to pathogen invasion of the urinary tract. The upper or lower tract may be affected, depending on the presence of infection in the kidney, or bladder and urethra. Infection of urinary tract affect up to 10% of children and are the most common bacterial infection in infants and young children worldwide. The prevalence of UTI is 3-5% in girls and 1% in boys. Urine culture is considered to be the gold standard diagnostic test for UTI. However, Gram stains of uncentrifuged urine have been done in rural health centers and laboratories in peripheral areas that lack facilities to evaluate urine specimens. Gram stains of urine may be an effective method for ruling out UTI in rural health center patients, thus saving time and money in impoverished settings.

Objective To compare urine Gram stain and urine culture as diagnostic tests for UTI in children.

Methods This cross-sectional study was held in H. Adam Malik Hospital from May to June 2010. The 54 participants were aged 0 - 14 years, suspected to have UTI and recruited by consecutive sampling. Urine was collected after the external urethral orifice was cleaned. A drop of the urine specimen was Gram stained and examined by a light microscope, while the remainder of the specimen was used for laboratory urine cultures. If Gram negative bacteria were observed by Gram stain, we considered the subject to have UTI.

Results The sensitivity and specificity of urine Gram stain compared to urine culture were 88% and 100%, respectively. The positive predictive value (PPV) and negative predictive value (NPV) were 100% and 90%, respectively.

Conclusion Urine Gram stain may be a good alternative to urine culture for diagnosing UTI in children living in areas with limited health care facilities. [Paediatr Indones. 2013;53:121-4].

Keywords: Gram stain, urine culture, urinary tract infection

Urinary tract infection (UTI) is defined by the presence of bacteria in the kidney or bladder,¹ affecting up to 10% of children. Infection of urinary tract is the most common bacterial infection in infants and young children worldwide.² The precise incidence is unclear, but referral patterns in Northern England suggest incidences of 3.6% in boys and 11.3% in girls.³ A collaboration of seven Indonesian hospitals reported that the incidence of new UTI cases was 0.1 - 1.9% over a 5-year period.⁴ There are 212 cases of UTI in Cipto Mangunkusumo Hospital and almost 70 new UTI cases yearly.⁵ Urinary tract infection presents with a varied range of manifestations, including minor symptoms to serious ones that require hospitalization. In the intermediate and long-term, recurrent episodes of UTI may lead to chronic renal failure and arterial hypertension. To prevent these complications, UTI should be diagnosed and treated early. Clinical and

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experimental data have shown that delayed UTI treatment increases the risk of renal damage.⁶

Standard UTI diagnosis is based on urine cultures. Interpretation of culture depends on the method and timing of urine collection, as well as the clinical setting. The Kass criteria are used for midstream, voided specimens, with a cut off level of 100,000 colony forming unit/mL.¹ A past study has shown that calculations of the number of bacteria from uncentrifuged urine by Gram stain are similar to urine culture results, but urine culture results can only be obtained a few days later.⁷

Microscopic examinations of fresh, uncentrifuged urine may give useful information, enabling the physician to start treatment while awaiting urine culture results. Finding any bacteria in a Gram-stained urine specimen has been shown to have high sensitivity and specificity for predicting a positive urine culture.⁸ This simple, effective method without the use of a laboratory centrifuge and culture medium makes it an ideal practice in laboratories lacking in resources or facilities to deal with these commonly received specimens.⁹

The aim of our study was to compare Gram staining of urine to urine cultures as a diagnostic test for UTI.

Methods

We conducted a cross-sectional study to compare urine Gram stain to urine culture as diagnostic tests for UTI. The study was conducted from May to June 2010 in the outpatient and inpatient clinics at H. Adam Malik Hospital, North Sumatera.

The 54 participants were recruited by consecutive sampling. We included children aged 0 to 14 years, suspected of having UTI, with or without other diseases. We excluded patients who had received corticosteroids for three months or more, had taken antibiotics less than 48 hours prior to the study and those who underwent incorrect urine procedure. We explained all study procedures to participants and their parents/guardians prior to the study. Subjects' parents/guardians provided written informed consents. Subjects' characteristics and physical examination status were recorded. Each subject provided two test tubes of urine for testing.

All urine specimens were collected without using catheters. The specimens were Gram stained and cultured. Urine was collected with a urogard from children who were not toilet-trained (under 2 years of age). Midstream urine was collected from toilet-trained children after cleaning the perineum with soapy water or an antibacterial skin cleansing agent. Specimens were transported to be examined as early as possible. Urine cultures were performed in the hospital laboratory using cystine-lactose-electrolyte-deficient (CLED) / Brocalin agar. Gram stains were performed by a single physician, using fresh uncentrifuged urine. All slides under examined by a light microscope and patients were considered to have UTI if Gram negative bacteria were observed.

This study was approved by the Research Ethics Committee of the University of North Sumatera Medical School, Indonesia, and appropriate follow-up treatment was provided for all children with confirmed UTI diagnosis.

We used *SPSS version 14.0* for statistical analysis of an association between urine Gram stain and culture, with urine culture as the gold standard for UTI diagnosis. We calculated the sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of Gram stain compared to urine culture as a reference.

Results

Subjects' characteristics are shown in **Table 1**. Fifty-four children participated in this study. The majority children were female (29 subjects; 53.7%) and the median age was 4.3 (range 0-14) years. There were 22 children (40.7%) had Gram negative bugs of urine Gram stain and positive urine culture. We called these subjects had positive Gram stain in their urine specimen. In other hand, we also found 3 subjects (5.6%) had Gram positive bugs of urine Gram stain and positive urine culture. We called these subjects had negative Gram stain. Twenty-nine subjects (53.7%) had no bacterial bugs of urine Gram stain and negative urine culture. We calculated that sensitivity and specificity of urine Gram stain compared to urine culture were 88% and 100%, respectively. The PPV and NPV were 100% and 90%, respectively. It is shown in **Table 2**.

Table 1. Subjects' characteristics

Characteristics	n =54
Gender, n (%)	
Boy	25 (46)
Girl	29 (54)
Age, n (%)	
< 1 year old	7 (13)
1-4 year old	26 (48)
4-14 year old	21 (39)
Clinical features, n (%)	
Fever	28 (52)
Abdominal /flank pain	11 (20)
Strong smelling urine	8 (15)
New onset urinary incontinence	7 (13)
Had Gram negative bugs in urine, n (%)	
Yes	22 (40.7)
No	32 (50.9)
Had positive urine culture, n (%)	
Yes	22 (40.7)
No	32 (50.9)

epidermidis were also found upon culturing. In a Minnesota study, most cases of UTI due to gram-negative bacteremia were caused by *E.coli*.¹¹ Similarly, a prospective study reported that the most common cause of UTI in infants and children was *Escherichia coli* (88%), followed by *Klebsiella pneumoniae* (7%) and other bacteria such as *Enterobacter* spp (2%) and *Staphylococcus aureus* (2%).¹²

We used fresh, uncentrifuged urine specimens. A meta-analysis concluded that the combination of presence of any bacteria revealed by Gram stain on an uncentrifuged urine specimen, with urine dipstick analysis for nitrites or leukocyte esterase performed similarly well for detecting UTI in children. Both techniques were found to be superior to microscopic analysis for pyuria.¹³

Table 2. Sensitivity and specificity tests of urine Gram stain compared to urine culture

	Sensitivity	Specificity	PPV	NPV
Gram stain	88 %	100 %	100 %	90 %

* PPV: positive predictive value; NPV: negative predictive value

Table 3. Bacteria isolated from urine cultures

Bacteria	n =22
<i>Enterobacter aerogenes</i>	1
<i>Enterobacter cloacae</i>	2
<i>Enterobacter agglomerans</i>	1
<i>Citrobacter freundii</i>	2
<i>Citrobacter diversus</i>	2
<i>Escherichia coli</i>	8
<i>Klebsiella pneumoniae</i>	2
<i>Klebsiella oxytoca</i>	3
<i>Klebsiella ozaenae</i>	1

Discussion

We suspected more girls than boys to have UTI. Subject's median age was 4.3 (range 0-14) years. Pediatric UTI typically occurs in infants and young children.¹⁰ The most common age for the first occurrence of a symptomatic UTI is during first year of life, particularly in boys, mainly affecting the upper urinary tract. The risk of developing a symptomatic UTI before the age of 14 years is 1 - 2% in boys and 3 - 8% in girls.⁸

The most bacteria found in this study *Escherichia coli*, followed by *Klebsiella* sp, *Citrobacter* sp and *Enterobacter* sp (Table 3). Gram positive bacteria such as *Staphylococcus aureus* and *Staphylococcus*

Midstream urine from toilet-trained children was collected after cleaning the genitalia. A randomized trial reported that urine contamination rates were higher in midstream urine collected from toilet-trained children who did not first clean the perineal/genital area. Cleaning may reduce the need to return for repeat cultures and for receiving unnecessary antibiotic treatment.¹⁴ In addition, a prospective study recommended that the first few drops or milliliters of urine be discarded when collected by catheterization from young children.¹⁵

Statistical analysis revealed that Gram staining sensitivity and specificity were 88% and 100%, respectively. The PPV and NPV were 100% and 90%, respectively. Similarly, a Turkish, cross-sectional study reported that Gram stain had high sensitivity, specificity, NPV and PPV and was recommended as a rapid tool to rule out the diagnosis of UTI in both clinical and laboratory settings.¹⁶ Furthermore, a study in Japan concluded that quantitative unspun urine microscopy with confirmatory oil-immersion is a simple, accurate diagnostic measure to evaluate significant bacteriuria and is useful because of its quickness.¹⁷

Limitations of our study include not evaluating our subjects' circumcision status or their history of constipation. In conclusion, urine Gram stain may be a

good alternative as a diagnostic test for UTI, especially in health centers with limited resources.

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