

## Association between the frequency of disposable diaper changing and urinary tract infection in children

Meirina Daulay, Rosmayanti Siregar, Oke Rina Ramayani, Supriatmo,  
Rafita Ramayati, Rusdidjas

### Abstract

**Background** Urinary tract infection (UTI) is the most common cause of fever in children. Less frequent disposable diaper changing is thought to be a cause of UTI in children. While wearing a diaper, the perineal area becomes damp with urine allowing bacteria to migrate from the anus to the external urethral orifice.

**Objective** To assess for an association between the frequency of disposable diaper changing and urinary tract infections in children.

**Methods** This cross-sectional study was conducted in the children's outpatient clinic of Haji Adam Malik Hospital from April to June 2010. Urine culture was performed in children with suspected UTI who wore disposable diapers every day. Subjects' ages ranged from 2 months to 2 years 6 months, with samples matched and collected by consecutive sampling. Diagnosis of UTI was based on urine cultures with bacterial count  $\geq 10^5$ /mL. Eighty children were followed in this study and divided into two groups: positive (n=40) and negative (n=40) urine cultures. Chi square test was used to analyze the association between the frequency of daily disposable diapers changing during a one week period and the urine culture results.

**Results** The frequency of daily disposable diapers changing in 80 subjects was as follows: <4 times (22.5%), 4–5 times (40%), and  $\geq 6$  times (37.5%). The frequency of daily disposable diaper changing in children with positive urine culture was as follows: <4 times (18 out of 40), 4–5 times (22 out of 40), and  $\geq 6$  times (0 out of 40); ( $P < 0.0001$ ). The most common bacterial species found in urine cultures was *Escherichia coli*.

**Conclusion** Lower frequency of daily disposable diaper changing is significantly associated with higher UTI incidence in children. [Paediatr Indones. 2013;53:70-5.].

**Keywords:** urinary tract infection, diaper changing, urine culture

Urinary tract infection (UTI) is the most common cause of fever in children. Infection of the urinary tract are also the most common serious type of bacterial infection that occurs in infancy and childhood in developed countries. The epidemiology of UTI during childhood varies by age, sex, and other factors. The prevalence of UTI among infants was reported to be 2.5% in boys and 0.9% in girls. After infancy, the prevalence in girls rises to 1.2 - 1.9%, while the prevalence in boys falls to 0.03%.<sup>1,2</sup> Fifteen percent of UTI cases have been associated with renal scarring, which may cause long term complications of hypertension and chronic renal failure.<sup>3,4</sup>

Infection in the urinary tract depends on predisposing factors, as well as immune system status. In infants and children, bacteria causing UTI generally come from stool, ascending from the urethra. Urinary tract infection may even be caused by less frequent changing of diapers.<sup>1,3-6</sup> In recent

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From the Department of Child Health, University of North Sumatera Medical School / H. Adam Malik Hospital, Medan, Indonesia

**Reprint requests to:** Meirina Daulay, Department of Child Health, University of North Sumatera Medical School / H. Adam Malik Hospital, Jl. Bunga Lau No.17 Medan, 20136. Tel +62-618-361721, +62-618-365663, Fax. +62-618-361721. E-mail: may\_budi@yahoo.com

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years, there has been widespread use of disposable diapers in communities. Disposable diapers were introduced as a product able to absorb a larger volume of urine, leading to less frequent need to change diapers. We have observed on a daily basis parents not changing their children's diapers even though the diaper was full.

Urine specimen collection may be done in 4 ways: midstream clean void, plastic pediatric urine collector, catheterisation, or suprapubic aspiration. In infants, urine is usually collected by plastic pediatric urine collector attached over the child's perineal area.<sup>6,7</sup> The most common bacterial cause of symptomatic or asymptomatic UTI is *Escherichia coli* (65-90%) even in neonates.<sup>1,8</sup> Nosocomial UTI is also usually caused by *E.coli*.<sup>9</sup>

The aim of this study was to evaluate an association between the frequency of disposable diaper changing and UTI in children.

## Methods

This cross-sectional study was conducted from April to July 2010 in subjects who were outpatients of H. Adam Malik Hospital, North Sumatera Province and ranged in age from 2 months to 2 years and 6 months. Subjects wore diapers everyday, were suspected to have a UTI, and had parents willing to fill questionnaires and provide written informed consent. Children with congenital anomalies of the urinary tract, such as hypospadias or epispadias, and those who had taken antibiotics were excluded.

We collected children's data including date of birth, age and gender. Urine was collected from all subjects with plastic bag pediatric urine collector attached to the perineal area. Before attaching the plastic bag, the perineum was cleaned with water and soap 3 - 4 times, wiped from front to back, and dried with sterile gauze. After urine was collected, it was delivered to the microbiology laboratory in our hospital within 30 minutes for urine culture.

Urine culture was performed with a calibrated inoculating loop (0.001 cc) to place the urine specimen onto sterile agar plate (Mac Conkey or blood agar). Plates were incubated at 37°C for > 24 hours and resulting bacterial growth was Gram stained.

Parents filled questionnaires on the frequency

of disposable diaper changing in the daytime and nighttime every day for 1 week before urine culture was done.

Chi square test was used to analyze the association between the frequency of disposable diaper changing and UTI. A P value of < 0.05 was considered as statistically significant.

## Results

Eighty children who wore disposable diapers everyday underwent urine culture testing. Forty children out of them had positive urine cultures while the other 40 children had negative urine cultures.

Subjects' characteristics are shown in **Table 1**, with more girls than boys using diapers daily. The mean age of children with positive urine culture was 12.93 (SD 8.60) months and the mean age in children with negative urine culture was 10.5 (SD 6.93) months. Subjects from both groups ranged in age in children from 2 months to 2 years 6 months. The most common reason in both groups for mothers to change a diaper was that the diaper was full of urine, with 55% in the positive culture group and 95% in the negative urine culture group. We found *E. coli* to be the most common bacteria causing UTI in our subjects, in 50% of the positive urine culture group. Also, in the positive culture group there were 80% with bacteriuria > 10<sup>5</sup> CFU/mL urine and 20% with bacteriuria ≥ 10<sup>4</sup> CFU/mL with UTI suggestive clinical signs.

In the positive culture group, 18 children (45%) underwent diaper changes less than 4 times daily, and 22 children (55%) were changed 4-5 times daily. In the negative culture group, 10 children (25%) underwent 4 to 5 diaper changes daily, and 30 children (75%) were changed ≥ 6 times daily. We found a significant association between less frequent daily disposable diaper changing and UTI (P=0.0001) (**Table 2**).

An association between the frequency of disposable diaper changing in the afternoon and UTI is shown in **Table 3**. We found that 38 children (95%) with positive urine cultures underwent < 4 diaper changes in daytime. Less frequent diaper changes in daytime were significantly associated with UTI (P=0.0001).

In 39 children with positive urine cultures,

diapers were changed at night < 4 times. Of the 20 children whose diapers were changed at night  $\geq$  4 times, 19 had negative urine cultures. As shown in

**Table 4**, we found a significant association between the lower frequency of disposable diaper changing in the night and incidence of UTI ( $P=0.0001$ ).

**Table 1.** Characteristics of subjects

Characteristics	Urine culture	
	Positive (n = 40)	Negative (n = 40)
Sex, n (%)		
Male	16 (40)	16 (40)
Female	24 (60)	24 (60)
Mean age (SD), months	12.9 (8.60)	10.5 (6.93)
Reason to change diapers , n (%)		
Full of urine	22 (55)	37 (92.5)
Defecation	10 (25)	3 (7.5)
Taking bath	8 (20)	0 (0)
Bacterial species isolated from urine culture, n (%)		
<i>E. coli</i>	20 (50)	
<i>K. pneumonia</i>	8 (20)	
<i>S. epidermidis</i>	5 (12.5)	
<i>K. ozaenae</i>	4 (10)	
<i>P. mirabilis</i>	3 (7.5)	
Bacteriuria		
$\geq$ 100,000 CFU/mL urine	32 (80)	
$\geq$ 10,000 CFU/ mL urine	8 (20)	

CFU = colony forming unit

**Table 2.** Association between the frequency of daily disposable diaper changing and UTI

Frequency of daily disposable diaper changing	Urine culture results		Total n=80	P value
	Positive n=40	Negative n=40		
< 4 times, n (%)	18 (45)	0 (0)	18 (22.5)	0.0001
4 – 5 times, n (%)	22 (55)	10 (25)	32 (40)	
$\geq$ 6 times, n (%)	0 (0)	30 (75)	30 (37.5)	

**Table 3.** Association between frequency of disposable diapers changing in daytime and UTI

Frequency of disposable diapers changing in daytime	Urine culture results		Total n=80	P value
	Positive n=40	Negative n=40		
<4 times, n (%)	38 (95)	2 (5)	40 (50)	0.0001
$\geq$ 4 times, n (%)	2 (5)	38 (95)	40 (50)	

**Table 4.** Association between frequency of disposable diaper changing at nighttime and UTI

Frequency of disposable diaper changing at nighttime	Urine culture results		Total n=80	P value
	Positive n = 40	Negative n = 40		
<4 times, n (%)	39 (97.5)	21 (52.5)	60 (75)	0.0001
$\geq$ 4 times, n (%)	1 (2.5)	19 (47.5)	20 (25)	

## Discussion

In our study, there were more girls than boys who wore diapers everyday. We also found more girls than boys with positive urine cultures. The average age of subjects was < 1 year and positive urine cultures were mostly found in one year-old children.

Urinary tract infection commonly occurs in infants and children.<sup>1</sup> Infection of the urinary tract generally shows more clinical signs in older children than in younger children. The incidence of UTI was reported to be highest in the first year of life for all children, but decreasing after that. Incidence in boys less than 1 year old was 3% and while that of girls less than 1 year old was 7%.<sup>3,6,10</sup>

In order to collect urine specimens from our subjects, we used plastic urine collectors (*Urogard*<sup>®</sup>). The collector is attached to the cleansed perineum, for ease of urine collection in non-toilet trained children

Suprapubic aspiration is considered to be the best method to obtain urine for culture in children, but this procedure is invasive and often fails, thereby requiring multiple attempts. A non-invasive method is the plastic pediatric urine collector bag (*Urogard*<sup>®</sup>), but it is difficult to do, time-consuming, and associated with high rates of bacterial contamination by fecal and perineal flora. The best time for collecting urine is early in the morning.<sup>1,11</sup> Israeli studies found that urine obtained from a disposable diaper can also provide a valid sample for diagnosing UTI, when compared to midstream urine and suprapubic aspiration.<sup>12,13</sup>

This study was conducted to evaluate an association between the frequency of disposable diaper changing and UTI. We found a significant association between frequency of disposable diaper changing and UTI. In subjects with positive urine cultures, we found that 45% underwent <4 disposable diaper changes daily, while none of those in the negative culture group were in this category of diaper-changing frequency. The frequency of daily disposable diapers changing more than 6 times was found in 30 children with negative urine culture (100%). In addition, in children with negative urine cultures, 75% underwent >6 disposable diaper changes daily, while none of those in the positive culture group were in this category of diaper-changing frequency.

We also determined the frequency of disposable diaper changing in the daytimes and nighttimes. In both times of day and durations, we found associations between the lower frequency of disposable diaper changing and UTI. In the 40 subjects with positive urine cultures, disposable diapers were changed <4 times in 38 (95%) subjects in the daytime and 39 (97.5%) subjects in the nighttime.

Pathogenesis of urinary tract infection is complex, depending host conditions and the organisms themselves. Bacteriuria may come from the kidney, pyelum, ureter, bladder or even the urethra. Infection in the urinary tract may also depend on predisposing factors, such as immune status. In infants and children, the bacterial route of access is generally ascending through the urinary tract.<sup>1,6,14</sup>

Infants pass urine at least 3-4 times each day in the first few days of life. By the end of the first week, the baby may pass urine 10-15 times each day.<sup>15</sup> Various types of disposable diapers are readily available in communities and are relatively inexpensive. Disposable diapers were promoted as a product able to absorb a large volume of urine, thus allowing for less frequent diaper changes. A greater risk of UTI may occur due to less frequent diaper-changing. Urine in the diaper causes the perineal area to become damp, easing bacterial migration from the anus to the external orifice. The contraction of the pelvic floor and the sphincter may not allow the floor to relax sufficiently during micturition, leading to residual urine remaining. When this situation is repetitive, it may result in reflux of bacteria from the urethra to the bladder, causing recurrent urinary infections.<sup>1,16,17</sup>

A Japanese study showed an association between disposable diaper changing and UTI in children. They found that an average daily number of diaper changes of < 4.7 times per day increased the risk of UTI.<sup>14</sup> In contrast, an Iranian study found that there was no difference in the number of daily diaper changes and incidence of UTI,<sup>18</sup> but a United Kingdom study found that changing a urine collection pad every 30 minutes almost eliminated heavy mixed growth contamination, and was reliable for diagnosing and excluding UTI in young, hospitalized children who were still in nappies.<sup>11</sup>

In our study, the most common bacteria found in urine cultures was *E.coli* (50%). *E.coli* is a Gram-

negative bacteria with fimbriae that may easily attach to the uroepithelial and nephron tissue, causing inflammation.<sup>19-21</sup> Furthermore, a Jordanian study reported that UTI due to *E.coli* were more common in females.<sup>9</sup>

Limitations of our study were that we did not compare the varieties of disposable diapers used and data was taken only from questionnaires filled by parents. An Iranian study showed that the type of diaper may be a risk factor for UTI in children, as they compared superabsorbent diapers, ordinary diapers and washable cotton diapers. They found that UTI was more common in children who wore superabsorbent diapers, perhaps because they are a more suitable environment for bacterial overgrowth due to incomplete evaporation of urine, thus providing a ready source of infection.<sup>18</sup> Another study showed that “jelly beads” found in synthetic diapers can easily cause UTI in children, because these clear-coloured beads incorporate chemicals that precipitate in wet diapers.<sup>22</sup>

In conclusion, we found that more frequent changing of daily disposable diapers is associated with negative urine cultures. There is a significant association between the lower frequency of disposable diaper changing and higher UTI incidence in children.

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