# CLINICAL INVESTIGATION ON THE SIGNIFICANCE OF BACTERIURIA IN MOTHER FOR DEVELOPMENT OF URINARY TRACT INFECTION IN NEWBORN

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*ABSTRACT - Newborns at risk for early renal impairment were selected after a screening of 1200 neonates. We investigated intrapartal transmission of uropathogenic bacteria from mother to a predisposed child. The most common pathogens of urinary tract infections (UTI) and significant asymptomatic bacteriuria (SAB) in the perinatal period, the origin (maternal foci) and the route of neonatal infection were documented. Two groups of newborns with their mothers were included. The first had UTI (N=54) and the second had SAB (N=52). Urine and stool cultures of the newborns and their mothers were analyzed. Bacterial transmission from mother was documented in 90.7% of newborns with UTI. The most common agent found in that group was uropathogenic E. coli (59.3%). It originated mostly from maternal urine (53.7%), stool (33.3%) and blood (7.5%). Neonatal infection was acquired by a direct contact with maternal excretions and followed by ascension through urinary tract in 61.1% of cases, by swallowing them in 22.2%, and in 7.5% of children the bacteria were transmitted via blood. Uropathogenic E. coli was found in 48% of the newborns with SAB. Bacterial transmission from mother was documented in 73.1% of newborns. The bacteria originated from maternal urine and stool with equal frequency (42.3%, each). Neonatal infection was acquired by a direct contact with maternal excretions and ascension in 55%, and by swallowing them in 23.1% of cases. Maternal bacteriuria should be adequately cured, thus preventing bacterial transmission into newborn and early renal damage in a prone child.*

**Key words:** bacteriuria in pregnancy, route of urinary tract infection, significant asymptomatic neonatal bacteriuria, origin of infection

## INTRODUCTION

Next to respiratory, urinary tract infections are the most common infections in childhood. They can ensue even perinatally in predisposed children. Symptoms of UTI in that period are not specific and can be overlooked easily. Sometimes only the first attack of infection presents with symptoms, while the others remain asymptomatic or oligosymptomatic (1). If the first infection

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passed unrecognized, even the most serious urinary tract anomalies could be overlooked.

Unrecognized or uncured UTI is the cause of 27% of cases of chronic renal failure in children, while 16% of CRF result from obstructive uropathy (2,3). Perinatal UTI is sometimes difficult to diagnose, therefore it seems reasonable to prevent it by screening pregnant women for UTI, and by its eradication. Thus one also delays the first attack of infection in a predisposed child for a later period when it presents with more symptoms.

## SCOPE

The aim of the study was to document that uncured bacteriuria in the mother can cause UTI or SAB in a predisposed child. The most common causative agents, the origin of the infection, and the route of intrapartal bacterial transmission were investigated.

## PATIENTS AND METHODS

The two groups of newborns were recruited after a screening of 1200 newborns at NICU for UTI and SAB. The selective criteria for both groups were three positive separately taken urine cultures (10,000 and more Gram positive or 100,000 or more Gram negative bacteria per 1 mL of urine). With respect to laboratory findings (at least one of the following: leukocytosis of more than $30x10^9$ white blood cells/L, leucopenia with less than $8x10^9$/L, raised proportion of nonsegmented granulocytes - 5% and more, toxic neutrophilic granulations, raised CRP value - more than 20 g/L) (4,5,6) the newborns were selected into the first group with UTI (54 newborns). If laboratory findings were negative and bacteriuria was still documented in the fourth month of life, the newborn dropped into the second group with SAB (52 newborns). Asymptomatic bacteriuria was found in 212 neonates after birth, but disappeared in 160 of them during the first months of life.

In all newborns urine cultures were taken on the second day of life after morning bath. If the culture was positive, two additional urine cultures were taken. Thus the specificity of the procedure increased, as the data from literature suggest (7). In the newborns with all three positive urine cultures, urinalysis, CBC and CRP were determined. Biochemical analyses were performed using standard biochemical procedures. Stool cultures were analyzed in newborns of the both groups. In mothers of the newborns from both groups urine and stool cultures were taken. These specimens were taken in the first week after delivery. Clean - voided urine specimens were taken from the first morning voiding. Positive blood cultures findings were taken from the records during pregnancy. Urine and stool cultures were analyzed using standard microbiological procedures. The type of *E. coli* was determined by latex agglutination of antibodies for types O, D, E, F and R, and for serotypes.

If the same bacteria were documented in urine and stool of a newborn, and in urine and/or stool of the mother, fecal-oral transmission was considered, i.e. the infection occurred by swallowing maternal excretions. If the same bacteria that was present in maternal urine and/or stool were found in child's urine culture, but not in child's stool or in mother's blood, infection gained by ascension was presumed. The bacteria were transmitted from maternal urine and/or stool into neonatal urethra during birth and spread from there upward.

## RESULTS

### *I. Etiology of UTI and bacteriuria in newborns*

UTI was found in 54 children (4.5% of 1200 newborns that underwent screening), 33 boys (61.1%) and 21 girls (38.9%). About 81.5% of newborns with UTI were born spontaneously. Cesarean section was performed in 18.6% of neonates, and half of them were born after premature velamentous rupture. The second group included 52 children (neonates with persistent asymptomatic bacteriuria for three months). About two thirds were boys.

Logically, all newborns with UTI had a bacterium in urine culture, while that finding was the inclusion criterion. UTI was mostly caused by uro-

Table 1
*Microbiological findings in urine and stool of newborns with UTI and SAB and in their mothers.*

| bacteria | newborn | | | | mother | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | urine | | stool | | urine | | stool | | blood culture |
| | A | B | A | B | A1 | B1 | A1 | B1 | A1 |
| uropathogenic *E. coli* | 32 | 25 | 6 | 6 | 19 | 11 | 11 | 14 | 4 |
| *Klebsiella* | 9 | 13 | 1 | 2 | 4 | 7 | 3 | 5 | |
| *Enterococcus* | 6 | 8 | 3 | 3 | 5 | 2 | 2 | 3 | |
| Nonuropathogenic *E. coli* | 3 | 5 | 1 | 1 | 2 | 2 | 1 | | |
| *Streptococcus* group B | 2 | | | | 2 | | | | |
| *Proteus mirabilis* | 1 | 1 | 1 | | | | 1 | | |
| *Pseudomonas aeruginosa* | 1 | | | | | | | | |
| TOTAL | 54 | 52 | 12 | 12 | 32 | 22 | 18 | 22 | 4 |
| % | | | 22 | 23 | 59 | 42 | 33 | 42 | 7.4 |

A - newborns with UTI
B - newborns with bacteriuria
A1 - mothers of newborns with UTI
B1 - mothers with newborns with bacteriuria

pathogenic *E. coli*. The bacteria were found in urine of 59.3% of newborns. The most common type was 06, 04 and 02. The second most often agent found was Klebsiella (16,7%), then Enterococcus (11,1%), while the other agents are responsible for about 10% of cases.

The same bacterium that was present in urine was also found in stool of 22.2% newborns with UTI. Stool specimens also most frequently contained *E. coli* (50% of the bacteria positive specimens). Bacteria were found in 59.3% of maternal urine specimens and in 33.3% of their stool samples.

*E. coli* (serotypes 06 and 02) was found most frequently in newborns with persistent asymptomatic bacteriuria, too. *Klebsiella* and *Enterococcus* followed as the next most common agents found. The simultaneously positive urine and stool cultures were found in 12 children (23.1%).

*II. Origin of neonatal UTI*

Table 2
*Origin (maternal material with bacteria) of neonatal infection*

| Origin of infection | A1 | | B1 | |
|---|---|---|---|---|
| | N | % | N | % |
| urine | 27 | 50.0 | 16 | 30.8 |
| stool | 16 | 29.6 | 16 | 30.8 |
| blood | 1 | 1.9 | | |
| urine + stool | 2 | 3.7 | 6 | 11.5 |
| blood + urine | 3 | 5.6 | | |
| negative specimens | 5 | 9.3 | 14 | 26.9 |
| TOTAL | 54 | 100.0 | 52,0 | 100.0 |

A1 - mothers of newborns with UTI
B1 - mothers with newborns with bacteriuria

In mother, bacteria were found most frequently only in urine, or only in stool specimens. If bacteria were found in two different materials, this was recorded separately. The origin of neonatal infection could not be proved in 5 cases. Negative finding in maternal specimens signified that bacteria were found neither in urine nor in stool, and that there was not a positive blood culture finding in mother's records.

*III. The route of bacterial transmission*

The same bacteria were found in only blood specimen of the mother in just one case, and in three cases in blood and urine samples of the mother at the same time. We concluded that all four infections resulted from hematogenic transmission. The rationale for this conclusion was based on the fact that the three newborns with simultaneous positive findings in blood and urine were

Table 3
*The most probable route of bacterial transmission into a newborn*

| Route of infection | A | | B | |
|---|---|---|---|---|
| | N | % | N | % |
| ascension | 33 | 61.1 | 26 | 50.0 |
| swallowing mother's urine and/or stool | 12 | 22.2 | 12 | 23.1 |
| haematogenous | 4 | 7.4 | - | |
| not determined | 5 | 9.3 | 14 | 26.9 |
| TOTAL | 54 | 100.0 | 52 | 100 |

A - newborns with UTI
B - newborns with bacteriuria

delivered by Cesarean section and without PVR, so it seemed impossible to gain the infection by any other kind of contact or ascension.

The newborns got infection mostly by a direct contact with mother's excretions in more than half cases. The route of bacterial invasion was not determined in 26.9% newborns with asympthomatic bacteriuria and 9.3% with UTI.

## DISCUSSION

Newborns with UTI and some of those with SAB are at risk for early renal impairment (8). Nephrological examination revealed a significant number of urinary tract anomalies in these children (9). The most common etiologic agents of UTI and SAB in newborns were Gram negative bacteria. In most cases *E. coli* was found, in 85.4% of UTI and in 84.6% of cases of significant asymptomatic bacteriuria. UTI was mostly caused by *E. coli* serotypes 06, 04, 02 and 01, while serotypes 06 and 02 were the most frequent agents found in SAB. In both conditions *Klebsiella* and *Enterococcus* were the next most common pathogens. These data match the previously published and well-known data alleging that Gram negative bacteria were responsible for more than 85% of neonatal UTI (10). The two groups of children did not differ regarding the causative agents. This phenomenon could be ascribed to the fact that the newborns suffering of any of the two conditions (UTI or SAB) had less resistant urinary tract prone to bacterial invasion. Not a single newborn was found to have more strains of bacteria at the same time, not even children with UTA.

Bacteriuria and/or UTI in a mother plays an important role in the development of UTI in the newborn, i.e. in the process of invasion of his urinary system. A close contact with maternal secrets and excretions during delivery, as well as with blood, enables transmission of microorganisms that cause infection in a predisposed child. Probability for the development of infection depends on the quantity of transmitted bacteria and on the inborn defensive strength of a newborn. Cesarean section delivered ten children with UTI or SAB; in only 5 of the cases velamens were intact. These 5 newborns could have

gained the infection exclusively via maternal blood, but in the cases with PVR bacteria could reach the neonatal organism also by swallowing or by ascension.

The mothers of both groups of newborns, with UTI and SAB, often had urine cultures positive for uropathogenic bacteria (in more than half cases of neonatal UTI and in 42.3% cases of newborns with SAB). Maternal blood cultures were least frequently positive material (related with 7.5% of infected children). The newborns with SAB got infection equally often from urine and from stool of their mothers, while in children with UTI bacteria originated from maternal stool twice less frequently than from their urine.

Concerning the route of bacterial invasion, the group with UTI was mostly infected by bacterial ascension (61.1%) after a direct contact with maternal excretions during spontaneous delivery or Cesarean section (with RVP), twice less frequently by swallowing contents of delivery channel, and very seldom via blood. Newborns with SAB acquired uropathogenic bacteria twice more often through a contact with maternal excretions than by swallowing.

The way of transmission remains unexplained in 5 newborns with UTI (9.3%). It is worth noting that the first morning urine specimens and stool were taken from mothers on day 5 after delivery. Negative finding in mother's urine culture could be ascribed to a possible technical omission in urine collection. Women after delivery still have enlarged uterus and nocturia, and it could easily happen that therefore the first morning urine was not concentrated enough. Theoretically, stool could be negative due to laxatives commonly prescribed after delivery, reducing bacterial quantity by frequent subsequent defecations.

The route of infection was not determined in 14 newborns with SAB (29.6%). There was no blood culture positive for bacteria recorded for mothers of that group of children. The bacteria in those newborns could originate from hospital environment.

## CONCLUSION

Microorganisms that cause UTI in newborns are the same as those responsible for UTI in older children. The most common pathogen was uropathogenic *E. coli*, serotypes 06, 04 and 02 in UTI, and 06 and 02 in SAB.

In more than half of the cases bacteria were transmitted from maternal urine, but could also originate from stool. The least frequent way of transmission was hematogenic. In most cases newborns were infected through a direct contact with maternal excretions during a spontaneous labor or by Cesarean section if PVR preceded. Every fifth child with UTI was infected swallowing maternal excretions, and every twentieth via blood. Therefore, it is of extreme importance to treat every bacteriuria and UTI in pregnancy (11,12,13). Considering that in developing countries pregnant women routinely do not undergo screening for bacteriuria, it is recommended to perform at least urinaly-

sis in a pregnant woman complaining of urinary tract disturbances, and to pay attention to subtle symptoms of UTI and bacteriuria in newborns.

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# KLINIČKO ISPITIVANJE ZNAČAJNOSTI BAKTERIURIJE U MAJKE ZA RAZVOJ INFEKCIJE URINARNOG TRAKTA NOVOROĐENČETA

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*SAŽETAK – Nakon pregleda 1200 novorođenčadi odabrana su ona pod rizikom ranog bubrežnog oštećenja. Istraživali smo prijenos uropatogenih bakterija tijekom poroda s majke na predisponirano dijete. Dokumentirani su najčešći uzročnici infekcija urinarnog trakta (UTI) i značajne asimptomatske bakteriurije (SAB) u perinatalnom razdoblju, izvorište (iz majke) i put infekcije novorođenčeta. Uključene su dvije skupine novorođenčadi i njihove majke. Prva je skupina imala UTI (N=54), a druga SAB (N=52). Analizirane su kulture urina i stolice novorođenčadi i majki. U 90,7% novorođenčadi s UTI dokumentiran je prijenos bakterija s majke. Najčešći uzročnik u toj grupi bila je uropatogena E. coli (59,3%). Uglavnom joj je izvorište bilo majčin urin (53,7%), zatim stolica (33,3%) i krv (7,5%). Do infekcije novorođenčeta došlo je direktnim kontaktom s ekskretom majke i ulaskom kroz urinarni trakt u 61,1% slučajeva, gutanjem u 22,2%, a u 7,5% djece bakterije su ušle preko krvi. U 48% novorođenčadi sa SAB nađena je uropatogena E. coli. Prijenos bakterija s majke dokumentiran je u 73,1% novorođenčadi. Bakterije su s jednakom učestalošću imale izvorište u urinu i stolici majke (po 42,3%). U 55% je do infekcije došlo direktnim kontaktom s ekskretom majke i ulaskom kroz urinarni trakt, a gutanjem u 23,1%. Bakteriurija u majke treba se adekvatno liječiti jer se time sprečava prijenos bakterija na novorođenče i rano oštećenje bubrega predisponiranog djeteta.*

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