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## **Catheter-Associated Urinary Tract Infection Following Caesarean Section in Nnewi, Nigeria: A Prospective Comparative Study**

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### **Authors' contributions**

*This work was carried out in collaboration between all authors. Authors OAO and GOU designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Author ACN performed the microbiological analyses, Authors IE, VEO and OLO managed the analyses and the literature searches. All authors read and approved the final manuscript.*

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### **ABSTRACT**

**Background:** Urinary tract catheterization is a major risk factor for urinary tract infections (UTIs). Catheter associated urinary tract infections (CAUTIs) still remain a major reservoir of antibiotic resistant pathogens with attendant increase in morbidity and mortality.

**Objective:** To determine and compare the incidence of catheter associated urinary tract infections following immediate and 24-hour postoperative removal of urethral catheters for caesarean section.

**Design:** The study was a prospective, comparative study.

**Place and Duration of Study:** Labour ward, Theatre and Postnatal wards of Nnamdi Azikiwe University Teaching Hospital (NAUTH), Nnewi between August 2012 to April 2013.

**Methodology:** The study involved 156 women admitted for caesarean section where the urethral catheters were removed 24-hour post operatively (group A) or immediately after

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caesarean section (group B). Urine samples were collected. Outcome measures included pre-operative and 72 hour postoperative urine microscopy, culture and sensitivity, urinary frequency, dysuria, urgency, fever and duration of hospital stay. The patients' data were coded, computed and analyzed using SPSS version 16. A P-value of <0.05 was considered significant.

**Results:** Of the 79 patients in group A, 9 (11.4%) had significant bacteriuria in the 72 hour post operative urine culture while 5 (6.5%) had significant bacteriuria in group B, (OR=1.85: 95% CI 0.59-5.80, P=0.28). The overall incidence of catheter associated urinary tract infection in NAUTH was 14(9.0%). *Escherichia coli* were mostly isolated 4 (44.4%). The lowest level of resistance was seen with Amoxicillin- clavulanic acid (Augmentin).

**Conclusion:** The present study showed that significant bacteriuria in Group A almost double the incidence in Group B, however, the difference was not statistically significant. Further studies should be carried out to compare catheterization with non- catheterization for caesarean section.

**Keywords:** Catheter; urinary tract infection; Nnewi.

## 1. INTRODUCTION

Caesarean section is one of the commonly performed surgical operations in obstetric practice and is certainly one of the oldest operations in surgery and its prevalence is rising each year [1-5]. Though it has become increasingly safer, it is still associated with significant morbidity and mortality [6-7]. Reduction of maternal mortality associated with caesarean section resulted from the use of thromboprophylaxis, improved techniques and wider spectrum of potent antibiotics [8]. Some of the preventable morbidities associated with caesarean section include urinary tract infection and difficulties in voiding.

Urethral catheterization is one of the routine pre-operative procedures for caesarean section<sup>9</sup>. The reason for catheterization is to prevent bladder injury, intra-operative difficulties and post operative urinary retention in the belief that an empty bladder is at less risk of damage than one that is distended [10,11,12,13]. A distended bladder is also expected to interfere with exposure and make surgery more difficult [14]. Surgery near the uterovesical area can cause bruising of the bladder and lower abdominal pain leading to urinary retention and it was thought that catheterization before caesarean section would prevent this complication<sup>10</sup>. The catheter is usually removed immediately after surgery or 12-24 hours or more after surgery to avoid urinary retention [10,11,15,16,17].

Catheter associated urinary tract infections are the most common nosocomial infections in the hospitals worldwide with more than one million episodes annually in United States of America alone [18-20]. Urinary tract infections can be asymptomatic or symptomatic. Asymptomatic bacteriuria is defined as the presence of up to 100,000 colony forming units (CFUs) of a single pathogen per milliliter of two freshly voided midstream, clean catch urine specimens or a single catheterization specimen without symptoms of urinary tract infection [21-22]. Symptomatic urinary tract infection is the presence of significant bacteriuria with symptoms or signs of urinary tract infection [22]. The symptoms/ signs include at least one of the following with no other recognized cause: fever (>38°C), urgency, frequency, dysuria, suprapubic tenderness, or costovertebral angle pain or tenderness. Symptomatic infection may involve the lower urinary tract and cause cystitis, or it may involve the renal calyces, pelvis and parenchyma and cause pyelonephritis [21].

Besides, the risk of acquiring bacteriuria was estimated as 8.1% for each day the catheter remains in situ [23]. Most patients with nosocomial urinary tract infections have had genitourinary manipulation and 80% develop after urethral catheterization [24]. Despite closed sterile drainage system and aseptic insertion of the catheter which significantly reduces the incidence of catheter associated UTI, 1 to 48% of hospitalized patients with indwelling catheter still acquire infection [20].

The significance of catheter associated urinary tract infections following caesarean section is that the infections are usually asymptomatic, but are however, besieged with gamut of complications. The complications of catheterized patients may include fever, acute pyelonephritis, bacteraemia and death; patients are at risks for urinary tract stones, local periurinary infections chronic renal inflammation, chronic pyelonephritis and over years, bladder cancer [20]. The associated morbidity and mortality that follow all these complications that arise from the use of indwelling catheter are major drains on hospital resources [25].

## **2. SUBJECTS AND METHODS**

Ethical clearance was obtained before commencement of the work. Eligible women admitted for caesarean section were counseled and recruited for the study. The women who gave consent were clinically evaluated for symptoms of urinary tract infection, obstructed labour, hypertension and the presence of other exclusion criteria. Daily recruitment was done and the subjects were required to fill the survey instrument (proforma).

Socio demographic data collected included: age, gestational age at the time of recruitment, booking status, type of caesarean section, parity and educational status. A total of 166 consecutive pregnant women were enrolled in this study. They were allocated into one of the two groups (A and B) in a 1:1 ratio, using opaque, closed envelopes that were mixed and chosen at random. All the participants were catheterized aseptically on the operating table using Foley urethral catheter size 16 French gauge before abdominal incision was made. In group A, the catheters were removed 24 hours post operatively while it was removed immediately after the surgery for women in group B. Midstream specimen urine was collected for microscopy, culture and sensitivity before surgery. The urine was cultured for 24 hours and the results were used to exclude women who had urinary tract infection pre operatively. Midstream specimen urine for microscopy, culture and sensitivity was also collected 72 hours postoperatively from the eligible participants.

### **2.1 Outcome Measures**

The primary outcome measure was significant bacteriuria defined as  $\geq 100,000$  bacteria of the same colony per millilitre of urine in a sample of midstream urine collected 72 hours postoperatively for microscopy, culture and sensitivity [26,27]. Other outcome measures included: significant bacteriuria on pre-operative urine microscopy, culture and sensitivity, Urgency (defined as severe irresistible urge to micturate [27]. Urinary frequency (defined as micturition more than 7 times during the day or more than twice during the night) [28], fever (defined as temperature of  $38^{\circ}\text{C}$  or more on 2 occasions within 10 days of the procedure, excluding the first 24 hours) [27] and the duration of hospital stay. The duration of hospital stay was defined as the time between the onset of surgery and discharge of the patient.

## **2.2 Sample Collection and Processing**

The laboratory work of this study was done in the department of Microbiology of Nnamdi Azikiwe University Teaching Hospital Nnewi. The women who consented were taught the proper way of collecting midstream urine sample. They were provided with a two sterile universal bottles. About 10 ml of urine was collected in each sterile bottle and coded to match the code used in the proforma and sent immediately to the laboratory for microscopy, culture and sensitivity by the designated laboratory scientist in the microbiology laboratory of NAUTH, Nnewi.

## **2.3 Urine Microscopy and Culture**

This was done using 10 ml of urine sample which was poured into a test tube and centrifuged for 5 minutes. The supernatant was discarded while a drop of the deposit was placed on a grease free slide and covered with a cover slip. Microscopic examination of the urine sample for the presence of red blood cells, bacteria, pus cells and epithelial cells was done.

The urine was cultured on Chocolate and Mac-Conkey agar and the urine samples that were not cultured within two hours were stored at 4°C. A sterile standard wire loop that delivers 0.002 ml of urine was used to streak a loopful of urine samples evenly on dried plates of Chocolate and Mac-Conkey agar to obtain discrete colonies. The plates were incubated at 37°C overnight. Colony counts yielding bacterial growth of 10<sup>5</sup>/ml or more of pure isolates were considered. Biochemical identification of the organisms was done using Analytic Profile Index (API) 20E. (bioMérieux SA, Mercyl'Etoile, France). Biochemical tests to identify the organisms were carried out and interpreted according to the manufacturer's recommendations. At the end of the laboratory work, the code was broken and the information obtained was analyzed using the computer Software Package for Social Science (SPSS Inc., IL, USA) version 16. Continuous variables were expressed as means and standard deviations. Student's t-test was used to analyze continuous variables while statistical relationships between categorical variables were analyzed using chi square test and p-value <0.05 at 95% confidence interval was considered statistically significant. Tables were used to present the results.

Treatment of the patients with urinary tract infection was by the attending Obstetricians. Referral notes were sent to the managing teams and based on sensitivity results, appropriate antibiotics were initiated for those with significant bacteriuria. They were re-evaluated for clearance of bacteriuria after completion of a 10-day course of appropriate antibiotics. The patients were told to report in the hospital immediately if systemic symptoms of infections develop thereafter. They were seen at the post-natal clinic at six week-postoperative day.

## **3. RESULTS**

Ten women were excluded after it was noted that they had significant bacteriuria on the pre-operative microscopy, culture and sensitivity. The remaining 156 women (79 women in group A where the catheters were removed 24 hours after caesarean section, and 77 women in group B where the catheters were removed immediately after the procedure) were used for the study and further analysis. Women with parity 1-4 constituted more than half of the population in both groups, while it was 44 (55.7%) in group A, it was found to be 41

(53.2%) in group B. Grandmultiparous women had the least population in both groups. This was shown in Table I. The booking status revealed that 52 (65.8%) of women in group A were booked while 43 (55.8%) of women in group B were booked. Women who had secondary education constituted more than half of the patients in both groups, while they were 41 (51.9%) in group A, they were 58 (75.3%) in group B (Table I)

**Table I. Characteristics of subjects**

Variables	Duration of indwelling catheter after caesarean section (%)	
	GROUP A	GROUP B
<b>Age</b>		
16-20	4 (5.1)	7 (9.1)
21-25	24 (30.4)	22 (28.6)
26-30	19(24.1)	25 (32.5)
31-35	22 (27.8)	23 (29.9)
36-40	10 (12.7)	0 (0.0)
<b>Parity</b>		
Nullipara	19 (24.1)	27 (35.1)
Para1-4	44 (55.7)	41 (53.2)
Grandmultipara	16 (20.3)	9 (11.7)
<b>Gestational age</b>		
<37	22 (27.8)	18 (23.4)
≥37	57 (72.2)	59 (76.6)
<b>Booking</b>		
Booked	52(65.8)	43 (55.8)
Unbooked	27 (34.2)	34 (44.2)
<b>Educational status</b>		
Tertiary	3 (16.5)	6 (7.8)
Secondary	41 (51.9)	58 (75.3)
Primary	25 (31.6)	13 (16.9)

Of the 156 women that were finally used for the study, 14 (9.0%) had significant bacteriuria in 72 hour urinary culture giving the incidence of catheter associated urinary tract infection in Nnewi as 9.0%. Of the 79 women whose catheters were removed after 24 hours, 9 (11.4%) had significant bacteriuria, while 5 (6.5%) among 77 women whose catheters were removed immediately after the caesarean section had significant bacteriuria. The difference was not statistically significant (OR=1.85: 95% CI 0.59-5.80, P=0.28). Among the 9 women in group A who had significant bacteriuria, 5 (55.6%) were asymptomatic while among the 5 women who had significant bacteriuria in group B, 3 (60.0%) were also asymptomatic (Table 2).

There was also no significant difference between the 2 groups after removal of catheter in the incidence of dysuria (P=0.56), urgency (P=0.99) and urinary frequency (P=0.32). None of the patient had puerperal pyrexia. The duration of hospital stay was 7.18±0.73 days for women in group A while it was 7.01±0.72 days for women in group B. There was no statistically significant difference in the mean length of hospital stay in the 2 groups, (P value =0.16) (Table 2)

As shown in Table 3, nine women in group A who had significant bacteriuria, *Escherichia Coli* only was obtained in 4(44.4%) women, *Klebsiella* was obtained in 3(33.3%) women and *Enterococcus* was also obtained from 2 (22.2%) patient. Among the five women in group B, *Escherichia coli* was obtained from 3 (60.0%). *Klebsiella* was found in 1 (20.0%) of woman while *Proteus mirabilis* was seen in 1 (20.0%) of woman.

**Table 2. Post operative morbidities for women in the study groups**

VARIABLES	GROUP A (n=79)		GROUP B (n= 77)		P VALUE
	YES	NO	YES	NO	
Dysuria	2 (2.5)	77 (97.5)	1 (1.3)	76 (98.7)	0.575
Frequency	1(1.3)	78(98.7)	0 (0.0)	77 (100.0)	0.322
Urgency	1 (1.3)	78 (98.7)	1 (1.3)	76 (98.7 )	0.985
Significant bacteriuria	9 (11.4)	70 (88.6)	5 (6.5)	72 (93.5)	0.284
Duration of hospital stay	7.18 ± 0.73		7.01 ±0.72		0.158

**Table 3. Microbial isolates from patients**

Isolates	Duration of catheterization post caesarean section (%)	
	Group A	Group B
<i>Escherichia coli</i>	4 (44.4)	3 (60.0)
<i>Klebsiella species</i>	3 (33.3)	1 (20.0)
<i>Proteus Mirabilis</i>	0 (0.0)	1 (20.0)
<i>Enterococcus faecalis</i>	2 (22.2)	0 (0.0)
Total	9(100.0)	5 (100.4)

The antibiotic susceptibility pattern of gram negative organism showed high resistance to commonly used antibiotics such as Ampicillin (66.7% in group A and 80% in group B ) and Gentamycin (55.6% in group A, 60.0% in group B). Moderate level of resistance was seen with Ceftriazone and Nitrofurantoin (33.3%) in group A and (40.0%) in group B in both groups). Lowest level of resistance was seen with Amoxycillin clavulanic acid (Augmentin), 11.1% in group A and 20% in group B.

#### 4. DISCUSSION

The use of indwelling urinary catheter during caesarean section is a common practice done in both elective and emergency delivery. The reasons for the use of indwelling catheter were to improve the exposure of the lower uterine segment at the time of the surgery, to reduce the possibility of traumatizing the bladder during the surgery, to assess the urinary output and to avoid post operative urinary retention [29]. Despite the above benefits, catheter associated urinary tract infections have shown to be the cause of nosocomial infection worldwide [19]. The incidence of the infection rises each day the catheter remains *in the bladder* [30]. For the fact that majority of catheter associated urinary tract infections are asymptomatic [31], and routine screening for asymptomatic bacteriuria is not practised despite overwhelming evidence clearly demonstrating its benefits in preventing symptomatic urinary tract infection and adverse pregnancy outcome [32] that means that early recognition and treatment may not be possible, thus the infection persists and lead to complications which include bacteraemia, acute or chronic pyelonephritis, urinary tract stones, chronic renal inflammation [20].

Of the 79 patients in group A, 9 (11.4%) had significant bacteriuria in the 72 hour urine culture while 5 (6.5%) had significant bacteriuria in group B, (OR=1.85: 95% CI 0.59-5.80, P=0.28). The outcome was not statistically significant. A total of fourteen (14) women had significant bacteriuria therefore; the overall incidence of catheter associated urinary tract

infection from the study was 9.0%. The findings from our study was comparable to 11.2% and 8.1% reported by Onile et al. in Ife [15] but these values were however, lower than 19.1% and 31.4% positive culture reported by Tangtrakul et al. observed in women who underwent immediate postoperative removal of urethral catheter and in women who had indwelling urethral catheter respectively [9].

This study demonstrated a higher incidence of significant bacteriuria after 72 hours of the operation in women whose catheters were removed 24 hours after the operation compared with women whose catheters were removed immediately after caesarean section; however the result was not statistically significant. A larger sample size may demonstrate a statistically significant difference among women who undergo immediate catheter removal after the caesarean section.

Most catheter associated bacteriuria have been noted to be asymptomatic [31]. This was reflected in our study. Of the 9 women in group A who had significant bacteriuria, 5 (55.6%) were asymptomatic and of the 5 women in group B who had significant bacteriuria, 3 (60.0%) were also asymptomatic. This was in support of the findings by Tambyan et al. who noted that of the 235 new cases of catheter associated urinary tract infection; more than 90% were asymptomatic [31]. Asymptomatic nature of most patients' CAUTIs is derived from two physiological factors. First, the presence of catheter in the urethra prevents exposure of the urethral mucosa to large numbers of organisms in the infected urine, implicitly preventing infectious urethritis, which produces dysuria and urgency in infected non catheterized patients. Secondly, a patent urinary catheter ensures that the urinary tract is continuously decompressed preventing urgency and frequency associated with distension of an inflamed bladder as well as vesicoureteral reflux [31].

There were no significant difference between the two groups after removal of the catheter in the incidence of dysuria ( $P=0.58$ ), urinary frequency ( $P= 0.32$ ) and urgency ( $P=0.10$ ). This finding was similar to findings by Onile et al. in Ife [15]. who noted no significant difference between the two groups after removal of the catheter in the incidence of dysuria ( $P=0.19$ ), urinary frequency ( $P=0.47$ ), and urgency ( $P=0.13$ ).

Although women whose catheters were removed immediately after the operation had a shorter stay on admission, however there was no significant difference in the mean length of hospital stay between the two groups ( $7.18\pm 0.73$  days versus  $7.01\pm 0.72$  days,  $P=0.158$ ). This finding was similar to findings of Onile et al. in Ile-Ife [15].

*Escherichia coli* were mostly isolated followed by *Klebsiella* species. This was similar to the findings of Billotte-Domingo et al. where *Escherichia Coli* was found to be the most prevalent organisms associated with the use of indwelling catheter [33]. It was however different from the findings of Taiwo et al. where *Klebsiella* species were found to be the most prevalent pathogens associated with the use of indwelling catheter [34]. Awonuga et al. in Ibadan also noted that *Klebsiella* species were the most prevalent cause of asymptomatic bacteriuria [32]. Most of these pathogens are part of the patients' endogenous flora but some may be acquired by cross contamination from other patients or by exposure to contaminated solutions or non-sterile equipment [35].

The antibiotic susceptibility pattern confirms that most of the urinary isolates in our environment are resistant to the commonly used antibiotics. This finding was similar to the report given by Aboderin et al. at Obafemi Awolowo University Teaching Hospital Ile-Ife

where the isolates were resistant to the drugs traditionally employed to treat urinary tract infection but were relatively sensitive to nitrofurantoin [36].

From the overall antibiotic sensitivity pattern, it was noted that pathogens had the highest sensitivity to Amoxicillin- Clavulanic acid (Augmentin). This corroborated the findings by other workers where Cephalosporins and Amoxicillin-Clavulanic acid had the highest sensitivity [37] but different from Awonuga et al. report in Ibadan where the pathogens had higher sensitivity to Ofloxacin, Gentamycin and Nitrofurantoin but were resistant to Amoxicillin, Amoxicillin- Clavulanic acid and Erythromycin [32].

The major strength of this study involved the use of microbiological identification to confirm urinary tract infection since it has been noted that most catheter associated urinary tract infections are asymptomatic. The limitation of this study was that it was a single centre based study and cannot be generalized; we need a multi centre study for general application. Another limitation included lack of generalizability as a result of the performance of this study in an academic tertiary care, urban hospital; the findings might be different from what is obtainable in our secondary health facilities.

## 5. CONCLUSION

The study showed that overall incidence of catheter associated urinary tract infection was 9.0%. The incidence of catheter associated urinary tract infection in women whose catheters were removed after 24 hours was 11.4% while it was 6.5 % in women whose catheters were removed immediately after the caesarean section. Most catheter associated urinary tract infections were asymptomatic. *Escherichia coli* were the most prevalent organisms associated with catheter associated urinary tract infection in both groups. The lowest level of resistance was seen with Amoxicillin-clavulanic acid. The present study showed that significant bacteriuria in Group A almost double the incidence in Group B, however, the difference was not statistically significant. Further studies should be carried out to compare catheterization with non- catheterization for caesarean section.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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