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ORIGINAL ARTICLE

PATTERN OF CATHETER-ASSOCIATED URINARY TRACT INFECTION FOLLOWING CAESAREAN SECTION AT AN URBAN TERTIARY HOSPITAL IN LAGOS, NIGERIA

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ABSTRACT

Introduction: This study investigated the pattern of Catheter-Associated Urinary Tract Infection (CAUTI) following Caesarean Section (CS) at an urban hospital in Lagos, Nigeria. Specific objectives included assessing the incidence and prevalent microorganisms associated with CAUTI.

Methods: This cross-sectional study was conducted at the Maternal and Child Centre, Ifako-Ijaiye, Lagos State. A hundred pregnant women who had both elective and emergency C-sections and had urethral catheterization for at least 24 hours were recruited. Data on demographic characteristics, C-section details, and urinary symptoms were collected. Catheter urine samples were sent for microbiological analysis for all the participants.

Results: Despite prophylactic antibiotics, the prevalence of CAUTI was 2%. One participant cultured Staphylococcus aureus, while Escherichia coli was cultured in the other. Both participants had emergency C-sections. Two percent of the patients developed CAUTIs.

Conclusion: This study revealed a CAUTI prevalence of 2% post-CS, emphasizing the significance of catheterization duration and aseptic techniques. This was recorded in the emergency C-section participants.

Keywords: Catheter-Associated Urinary Tract Infection (CAUTI), Caesarean Section (C-section), Microorganisms.

INTRODUCTION

Urinary Tract Infection (UTI) can be classified as complicated or uncomplicated.[1] Complicated UTI is said to occur following catheterization or in immunocompromised patients. On the other hand, uncomplicated Urinary Tract Infections (UTIs) can occur in low-risk individuals in the community. Catheter-associated urinary Tract Infection (CAUTI) is a recognized complication of Caesarean Section (C-section, CS) and is therefore classified as a complicated Urinary Tract Infection (UTI). Pregnancy, as well as the proximity between the female urogenital tract, are recognized risk factors for CAUTI.[2,3]

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Although the incidence of CAUTI following Caesarean delivery has been reported to be on the decline, it still contributes significantly to morbidity, prolonged hospitalization, and the financial cost of this popular and often life-saving procedure.[4] The Cochrane database reported an incidence of 3.1% of UTIs following elective C-sections.[5] A Ukraine-based multi-center study reported an incidence of 13.6% following Caesarean Elective deliveries.[6] A comparative study in Sudan reported CAUTI in 29.3% of subjects who had CS and were catheterized before the procedure, while only 4% of those who were not catheterized developed UTIs.[3,7] In Nigeria, Onile *et al*. documented a rate of 11.2% of CAUTI following CS in 2008.[8] More recently, a 26% prevalence rate was reported in Ekiti State by Adeyanju *et al.* in 2023.[9]

Urethral catheterization prevents bladder injury during C-section and is one of the procedures necessary for surgical safety. It is also useful in monitoring post-operative urinary output and preventing delayed voiding, which has the potential to lead to overflow incontinence. Reported infection rates vary, depending on the period of catheterization, from 1-5% after a single brief episode of catheterization and increase by 3% to 7% daily.[3] A study conducted in Southwest Nigeria that randomized CS cases based on the duration of catheterization reported a statistically significant post-catheterization UTI rate of 0% in the 8 hours group compared to 7.3% in the 24-hour group (7.3% versus 0.0%; RR: 0.07; CI: 0.87 to 0.97; p=0.001).[10]

Early removal of urethral catheters (within 6-12 hours) is one key post-operative element of the Enhanced Recovery after Caesarean (ERAC).[11] This programme has been adopted successfully in the UK and the United States of America. The usual practice in most teaching hospitals in Nigeria is to remove a urethral catheter after 24 hours. The impact of this practice on the incidence of CAUTI and asymptomatic bacteriuria has been debated.[4,12] Prophylactic antibiotics in the perioperative period are the usual practice for surgical procedures such as Caesarean delivery.[13] However, the duration, choice of antibiotics, and effect on UTI prevention are debatable.. This consequently has led to a debate about the optimal duration of catheterization and its continued relevance.[12]

Urethral catheterization is often regarded as a harmless procedure, and the rules of asepsis may not be followed in catheterizing patients. Up to 3% of catheter-associated bacteriuric episodes may produce secondary bloodstream infections.[14] It can significantly contribute to the duration of hospitalization, morbidity, financial cost, and patient dissatisfaction. Our study, therefore, aims to highlight the incidence and prevalent microorganisms associated with CAUTI in our patients following Caesarean section.

METHODS

Study Population

Pregnant women scheduled for Caesarean Section at Maternal and Child Hospital, Ifako-Ijaiye, Lagos.

Study Design

This study was a cross-sectional study carried out between June and December 2014.

Study Site

This study was conducted at the Maternal and Child Hospital (MCH), Ifako-Ijaiye, Lagos. MCH Ifako-Ijaiye is a purpose-built, 50-bed maternal and child center in Lagos's Agege area. It is in a densely populated area about 10km from Ikeja, the capital of Lagos State. It, therefore, receives referrals from neighboring public and private hospitals in Lagos state.

Inclusion Criteria

1. All pregnant women scheduled for Caesarean section whose bedside urinalysis was negative for nitrites and proteins.
2. Participants who had indwelling urethral catheters for 24 hours and beyond.

Exclusion Criteria

Subjects who had treatment for Urinary tract infection during pregnancy were excluded, as well as patients with other medical conditions such as diabetes mellitus, retroviral disease, and sickle cell disease. Patients with preeclampsia and eclampsia were also excluded.

Sample size

The sample size was estimated using $n=z^2p((1-p)/d^2)$, where n = sample size, z = standard deviation (1.96), d=0.05 (accepted sample error at 5%), and p was the prevalence rate (3.1%) from a previous study.[5] An attrition rate of 10% was allowed for missing data. This equated to about 50 subjects. We, therefore, recruited 50 subjects who had electives (ELCS) and 50 women who had emergency C-sections (EMCS).

Sampling technique

Convenience sampling technique was used to recruit subjects consecutively as CS was done, based on the inclusion and exclusion criteria.

Data collection

Relevant biodata was obtained using a purpose-designed proforma. Demographic data like age, parity, and marital status were documented. Information on the indication for cesarean section, estimated blood loss, intra-operative complication, birth weight, APGAR score, and duration of catheterization was extracted from the patients' records. Questions on the presence or absence of urinary symptoms, such as frequency, fever, and dysuria, were also extracted.

Participants who met the inclusion criteria were followed up after their catheters were removed for five postoperative days. This follow-up was done in person while they were still on admission and by telephone if they had been discharged home. They were told to report symptoms of UTI such as dysuria, urinary frequency, malaise, fever, or lassitude.

Catheterization and Urine Collection Procedures

It is routine practice in our center to administer prophylactic antibiotics. Therefore, we administered intravenous (IV) Cefuroxime 750mg 8-hourly and IV metronidazole 500mg 8-hourly for 48 hours as prophylactic antibiotics. The first dose was administered in the theatre just before the abdominal incision.

All subjects were catheterized on the operating theatre table before spinal anaesthesia. The patient was placed in the dorsal position with the thighs flexed and feet together. A sterile field was created with sterile drapes. A doctor wearing sterile gloves swabbed the perineum thrice: the right labium, then the left, and the vestibule from the front backward with chlorhexidine solution on cotton swabs. After periurethral cleaning, the left hand was used to part the labia. while the right hand was used to pass in the latex catheter, which had been pre-connected to a closed drainage system into the urethra to ensure strict asepsis. The catheter balloon was then inflated with 5 ml of sterile water to secure it.

The urethral catheter was removed after 24 hours once the patient had commenced ambulation. A catheter urine sample was collected and sent for microscopy, culture, and sensitivity testing in all participants.

Urine collection for culture was done using an aseptic technique to avoid contamination and unnecessary antimicrobial treatment.[17] We collected catheter urine specimens from the port after cleaning with 70% alcohol and allowing 30 seconds for the access port to dry. The urine samples were collected into a sterile, wide-mouthed container which was closed immediately to prevent contamination.

Semi-quantitative urine culture was done with a calibrated loop using a loopful (0.001 mL) of well-mixed un-centrifuged urine inoculated onto the cysteine lactose electrolyte deficient medium (CLED) surface. The culture plates were incubated aerobically at 37°C for 18-24 hours. Culture of a single

bacterial species from the urine sample at a concentration of 10^5cfu/ml associated with microscopy findings of >10 white blood cells (WBCs) per high power field was taken as significant bacteriuria. A diagnosis of UTI was made when there were at least 10^5 colony-forming units of the same organism along with symptoms. Asymptomatic bacteriuria was diagnosed if this criterion was met without symptoms.

Identification of Bacterial Isolates

The bacterial isolates were identified by colonial morphology on the agar plate. Gram staining and biochemical tests, such as citrate utilization, urease test, reaction on triple sugar iron agar, and indole production, were done for Gram-negative bacilli to identify *E. coli*. Catalase and coagulase tests were carried out on Gram-positive cocci to identify *S. aureus*. All tests were done according to the recommendations of the Clinical and Laboratory Standards Institute.[15]

Antimicrobial Susceptibility Testing

Antimicrobial susceptibility testing was done using the modified Kirby-Bauer disc diffusion method. Mueller-Hinton agar plates were incubated for 18-24 hours after being inoculated with test organisms and placed with antibiotic discs.[16] The isolated bacteria were tested against ciprofloxacin (5µg), ofloxacin (5µg), co-amoxiclav (20/10µg), gentamicin (10µg), and nitrofurantoin (300µg). The results were interpreted according to the Clinical and Laboratory Standards Institute parameters.[15]

The subjects were monitored clinically for features of UTI for 5 days after removal of the catheter, which included fever, dysuria, frequency, and urgency. Those symptomatic with positive culture results had their antibiotics changed according to the sensitivity pattern.

A diagnosis of CAUTI was made when there is bacteriuria associated with clinical features of UTI in a catheterized patient within 48 hours or more of removal of the urethral catheter.[17]

Statistical analysis

The data obtained were analyzed using the Statistical Package for Social Sciences, version 22.0. Continuous variables were represented by mean (standard deviation), while categorical variables were summarized as percentages. P-value less than 0.05 (95% CI) was accepted as statistically significant.

Ethical considerations

Ethical clearance was obtained from the Ethics and Research Committee of the Hospital (UREC/10/02/412). Informed consent was obtained from the study subjects after they had been adequately counseled about the study.

RESULTS

A total of 312 Caesarean sections were performed during the study period, out of which 100 women who met the criteria for our study were recruited. The mean age was 33.76 ± 2.56 years for ELCS and 31.42 ± 3.75 years for EMCS (p-value = 0.06). Maternal parameters such as weight, height, parity, birth weight, duration of C/S, duration of hospital stay, and duration of catheter use were captured in Table I.

Table I: Parameters of participants in the study

Parameters	Emergency	Elective
Mean Age (years)	31.42±3.75	33.76±2.56
Mean Height (m)	1.59± 0.05	1.60± 0.05
Mean Weight (kg)	73.98± 18.21	80.96±16.11
Parity (median)	1	2
Mean duration of C/S (minutes)	45±9.25	50 ± 13.83
The mean duration of hospital stay (days)	3.33±0.59	3.47±0.84
Mean duration of Catheter use (hours)	30.84±6.20	29.12±7.53

Most of the participants in the elective arm were booked (98%), while 75.5% of those who had emergency C-sections were booked. The commonest indication was previous CS with post-dated pregnancy for ELCS {16/50(32%)}, while cephalopelvic disproportion constituted the commonest indication in those who had EMCS {23/50 (46%)}.

Two of the 100 patients in this study had positive urine culture results (UTI), giving a prevalence of 2%. Both patients had EMCS. They were both referred to our facility on account of cephalopelvic disproportion at term. The diagnosis of CAUTI was made when they complained of dysuria and urinary frequency 2 and 4 days, respectively, after the catheter was removed.

Of the 2 positive cultures, the organisms cultured were *Staphylococcus aureus* in one subject and *Escherichia coli* in the other. The antibiotic sensitivity pattern for *Staphylococcus aureus* in this study was to fluoroquinolones like ofloxacin, perfloxacin, and ciprofloxacin, with resistance to more commonly used drugs like cefuroxime (cephalosporin) and amoxicillin-clavulanic regimen. *E. coli* was sensitive to ofloxacin and ciprofloxacin, showing resistance to ampiclox and gentamycin

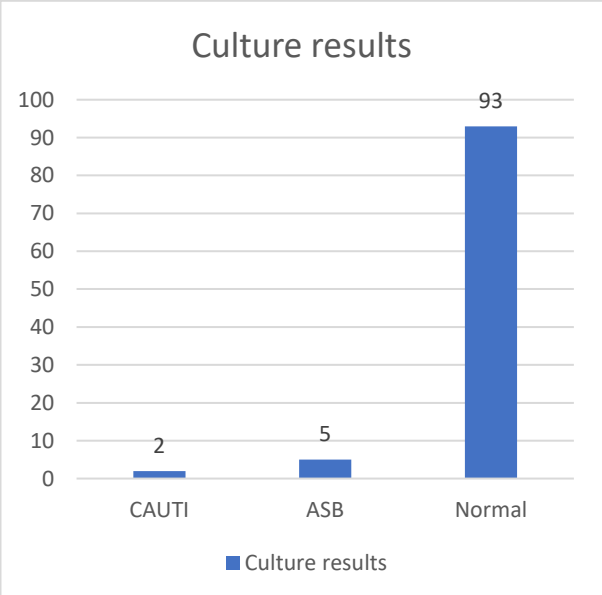

Figure 1: Frequency of participants with CAUTI using urine culture results and symptoms

Figure 1 shows the frequency of participants with CAUTI using urine culture results and symptoms as well as those with asymptomatic bacteriuria (ASB). There was a significant association between CAUTI and Caesarean section types in the studied population (p=0.495, table 2) while there was no statistically significant relationship between duration of catheter use and CAUTI (table 3).

Table 2. Association between CAUTI and Caesarean section types in the studied population

	CAUTI		
Type of CS	**Positive**	**Negative**	**Total**
Emergency CS	2	48	50
Elective CS	0	50	50
Total	2	98	100

p-value = 0.495; 95% C. I. = 0.30 to 83.11

Table 3: Relationship between duration of catheter use and CAUTI

Duration	CAUTI Positive	Negative	Total	X^2
24 hours	1	68	69	
25-48 hours	1	30	31	0.526

Fischer's Exact Test p-value = 0.526

DISCUSSION

The prevalence of CAUTI following Caesarean section in this study is 2%. This is comparable to 1.5% of CAUTI reported by Moulton *et al*. who studied 2,419 women who had catheterization for CS in a multi-center retrospective study.[18] This is, however, lower than the 4% and 11% reported by Nicole and Abdel-Aleem, respectively, as CAUTI rates following Caesarean section in earlier literatures.[3,12] This incidence is also lower

than the 7.3% reported by a recent study in Ile-Ife, which utilized a less stringent exclusion criteria.[10] Most of our participants were young, healthy women whose only risk factors for UTI were female gender and pregnancy. We excluded women with comorbidities that are recognized to increase the risk of UTI, such as diabetes mellitus and sickle cell disease. We recognize that the very stringent exclusion criteria may limit the generalizability of this study. The reported high but variable prevalence in earlier literature is the basis for questioning the continued relevance of the practice of indwelling catheterization as opposed to asking the patient to empty her bladder just before the procedure and encouraging her to void after.[4,12]

Staphylococcus aureus was isolated in one subject, while *E. coli* was isolated in the other participant with CAUTI. *Staphylococcus aureus* is a normal skin flora mainly associated with wound infection.[19] It may also be acquired through cross-contamination with other hospital patients or personnel. It can also spread by exposure to contaminated solutions or non-sterile equipment. Although a Nigerian study reported this organism as the most frequently isolated organism in UTI,[20] this is at variance with findings from other studies that reported *E.coli, Klebsiella, and Candida albicans* as the commonest aetiological agents.[2,6,21,22] More recently, *Staphylococcus aureus* was reported as the prevalent organism in complicated UTIs.[23] This has been linked to the emerging concept of urinary microbiome. There are postulations that because the urinary tract is not sterile, an imbalance in the urinary microbiome may result in the development of urinary symptoms in UTI.[24,25]

Most of our subjects were catheterized for 24 hours. This probably contributed significantly to the low incidence of CAUTI reported in our study. However, we could not establish a significant CAUTI rate in those catheterized for up to 48 hours (p value=0.526). This contrasts with earlier reports of the incidence of UTI increasing with days or duration of catheterization.[28] This may be because of the very low prevalence reported by our study. Larger studies have clearly justified the recommendation for early discontinuation of urethral catheters post-operatively.[26,28]

The caliber of medical personnel who catheterize the patient is also important in evaluating the risk of developing UTI.[20] This was instituted to ensure that the standard protocol of catheterization was observed for patients engaged in this study, as they were all catheterized by doctors in the operating theatre under aseptic conditions. This may be responsible for the low number of those infected in this study. Saint *et al.* supported this claim, highlighting the impact of health providers' training and protocol adherence in reducing CAUTI rates.[27] Also, the Infectious Diseases Society of America's guidelines emphasize the association between aseptic technique during catheterization and reduced CAUTI incidence.[28]

The antibiotic resistance pattern in our study is in tandem with findings in similar studies in the literature, which have documented resistance to commonly used antibiotics such as cefuroxime, gentamycin, and fluoroquinolones.[29,30] Although systemic antibiotics have been found to delay the onset of bacteriuria in catheterized patients, they may be associated with the emergence of resistant pathogens.[31] A larger Randomized control trial is important to evaluate the important issue of antibiotic sensitivity and resistance. Antibiotic stewardship is the recommended intervention for preventing CAUTI rather than prophylactic antibiotics. More recently, vaccines have been developed for UTIs caused by *E.coli.*[31] Further studies are necessary on their effectiveness and acceptability to patients prior to widespread use.

Earlier studies have reported a higher incidence of postpartum infections and morbidities in women who have been in labour compared to elective Caesarean deliveries.[6,18,32]. This forms the basis for excluding emergency C-section cases in most studies on CAUTI following abdominal deliveries. This may, therefore, confound a

finding of increased CAUTI in Emergency cases of C-section relative to elective cases.[6,18] Other cited reasons included incomplete data on pre-existing urinary tract health in emergency cases.[10] This increased risk has been postulated to be due to intrapartum events such as vaginal examinations and pre-existing health status of the parturient. The two cases of CAUTI recorded in our study had emergency Caesarean delivery. This is in tandem with earlier findings in the literature.[18,32] This may be explained by probable poor management of labour before they were referred for abdominal delivery. Perhaps vaginal toileting with chlorhexidine or povidone-iodine reported to prevent SSIs and post-operative pyrexia may be beneficial in reducing the risk of CAUTI as well. [33,34] This may be the subject of future research.

Although asymptomatic bacteriuria (ASB) was not our primary outcome, it was noted in more participants in this study. Therefore, it is important to stress the significance of signs and symptoms in the diagnosis of CAUTI. ASB should be differentiated from CAUTI surveillance as they do not have much clinical significance. CAUTI, on the other hand, contributes significantly to hospital-acquired infections.[17]

Strategies to reduce the incidence of CAUTI are mainly preventive.[6] They include establishing a valid indication for catheterization before passing it to patients, limiting urethral catheterization to less than 24 hours, or the barest minimum time where this is impossible, and ensuring strict asepsis during the procedure. Regular training of healthcare team members on maintaining asepsis during the procedures will also aid in significantly reducing the morbidity associated with urethral catheterization.

CONCLUSION

The study reveals a CAUTI prevalence of 2% following C-section, underscoring the significance of catheterization duration and aseptic techniques. To mitigate CAUTI risks, it is crucial to consider limiting catheterization duration and strictly adhering to asepsis protocols.

RECOMMENDATION

Catheterization for bladder protection during Caesarean delivery should be limited to 24 hours to reduce CAUTI and morbidity in the patients.

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CONFLICT OF INTEREST

The authors report no conflict of interest.

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