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ORIGINAL ARTICLE

CATHETER-ASSOCIATED URINARY TRACT INFECTIONS AFTER CAESAREAN SECTION IN UKRAINE: RESULTS A MULTICENTER STUDY (2020-2022)

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Aidyn G. Salmanov[1,2], Volodymyr Artyomenko[3], Olena M. Susidko[4], Svitlana M. Korniyenko[3], Orusia A. Kovalyshyn[5], Oleksandr A. Voloshyn[1,6], Oleg V. Golyanovskiy[1,6]

[1]SHUPYK NATIONAL HEALTHCARE UNIVERSITY OF UKRAINE, KYIV, UKRAINE.
[2]INSTITUTE OF PEDIATRICS, OBSTETRICS AND GYNECOLOGY OF THE NATIONAL ACADEMY OF MEDICAL SCIENCES OF UKRAINE, KYIV, UKRAINE
[3]ODESA NATIONAL MEDICAL UNIVERSITY, ODESA, UKRAINE
[4]DOCTOR NIKOLAEV MEDICAL CENTER, DNIPRO, UKRAINE
[5]LVIV MEDICAL INSTITUTE, LVIV, UKRAINE
[6]KYIV REGIONAL MATERNITY HOSPITAL, KYIV, UKRAINE

ABSTRACT

The aim: To obtain the first national estimates of the current prevalence rate of catheter-associated urinary tract infections (CAUTIs) after caesarean section (CSEC) and antimicrobial resistance of causing pathogens in Ukraine.

Materials and methods: Prospective multicentre surveillance was conducted from January 2020 to December 2022 in 15 women hospitals of Ukraine. Definitions of CAUTIs were adapted from the CDC/NHSN. Antibiotic susceptibility was done by the disc diffusion test as recommended by European Committee on Antimicrobial Susceptibility Testing guidelines.

Results: A total of 15,892 catheterized women undergoing primary CSEC and 13.6% CAUTI were identified. The most common uropathogen was *Escherichia coli, Proteus mirabilis*, and Enterococcus species followed by *Providencia stuartii* and *Pseudomonas aeruginosa.* Many uropathogens isolated from CAUTI cases were found to be multidrug resistant.

Conclusions: This study showed that CAUTIs in catheterized women undergoing primary CSEC in Ukraine is a common occurrence and many cases are caused by pathogens that are resistant to antibiotics. Optimizing the management and empirical antimicrobial therapy may reduce the burden of CAUTIs in catheterized women undergoing primary CSEC, but prevention is the key element.

KEY WORDS: catheter-associated urinary tract infection, cesarean section, antimicrobial resistance, pathogens, Ukraine

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INTRODUCTION

Catheter Associated Urinary Tract Infection (CAUTI) is one of the most common healthcare-associated infections (HAI) accounting for up to 40% of all hospital acquired infections [1]. According to literature, eighty percent of these are associated with the use of urinary catheters [2]. In Ukraine, fourteen percent of HAIs are associated with the use of urinary catheters [3]. Risk of infection is about 5-10% with each day of indwelling catheterization [4, 5] [and 1-3% with each insertion in intermittent catheterization [6]. CAUTIs have a high impact in terms of morbidity, mortality, and costs.

CAUTIs can be associated with Cesarean section (CSEC). CSEC is one of the most common surgical procedures performed in the both developed and developing countries [7]. The rate of CSES has seen a soar in the past few decades, varying from 0.4% to as high as 44.1% across the world [8-11]. Among the European Union Member States, CSEC were most frequent in Cyprus (54.8 %), Romania (44.1%), Bulgaria (43.1%), Poland (39.3%) and Hungary (37.3%) [9]. Similarly, high CSEC rates have been reported in the USA, Australia and China, where 32%, 32.4% and 41% of births are by CSEC, respectively [8, 10, 12]. The reported rates of caesarean section are 3.3% in Africa, 33.7% in Latin America, 27.3% in Asia and 40.5% in China with an average of 15.9% [11, 13]. CSEC in Ukraine accounts for up to 23% of all births [14]. Over the past two decades, along with significant improvements in clinical obstetric care in many countries, the incidence rate of CAUTIs after CSEC remains an important issue.

Current guidelines for management of CAUTIs recommend the use of antibiotics for both treatment postoperative infections. However, the growing antimicrobial resistance is limiting their use in Ukraine. Resistant CAUTI is becoming more and more pressing for medical specialists a worldwide. In the available literature, studies on antimicrobial resistance of causing pathogens of CAUTIs after CSEC are limited. Monitoring of the prevalence of causing pathogens of CAUTIs after CSEC and antimicrobial resistance is necessary to enhance our knowledge of its epidemiology.

Incidence rates of CAUTI after CSEC and antimicrobial resistance of causing pathogens in Ukraine are currently unknown. This creates problems as well for physicians and as infection control professionals in hospitals of Ukraine. The prevalence of and causative agents of most CAUTIs after CSEC among female in-patients have not been studies in Ukraine. This was the basis for this study.

THE AIM

The aim of this study was to obtain the first national estimates of the current prevalence rate of CAUTIs after CSEC and antimicrobial resistance of causing pathogens in Ukraine.

MATERIALS AND METHODS

STUDY DESIGN, SETTINGS AND PARTICIPANTS

This a prospective multicenter cohort study was based on surveillance data for CAUTIs done in 15 women hospitals (located in Odessa, Ivano-Frankivsk, Vinnytsia, Volyn, Rivne, Chernivtsi, Lviv, Poltava, Cherkasy, Zhytomyr, Chernihiv, Dnipropetrovsk, and Kyiv, Ukraine) from 13 Ukrainian regions over 36 months period from 1st January, 2020 to 31st December, 2022. We compiled list of the 18 women medical centers. However, only 15 hospitals agreed to take part in our study. This study included fifty hemodynamically stable women without any therapeutic or surgical complications who underwent bladder catheterization after caesarean section. All participants were comparable in terms of indication for cesarean section, type of caesarean section, anaesthesia and same operating surgeon. All participants were local residents. Exclusion criteria: (a) Associated medical problem (e.g. Pregnancy Induced Hypertension or chronic hypertension, Gestational Diabetes Mellitus or Overt Diabetes Mellitus, Renal Disease etc., (b). Surgical complication or previous Caesarean section, (c) Rupture of membranes > 4 hours, (d) Pre-existing UTI; (e) Patients with CAUTI present on admission and other infections of the urinary tract. All patients received the antibiotic ceftriaxone intravenously for prophylaxis.

DEFINITION

CAUTI was evidenced by urine microscopy and culture and sensitivity done in urine sample. CAUTIs were defined according to the published CDC definition ((1) use of an indwelling foley for more than two consecutive days, (2) catheter in place on day of or day prior to event, (3) two or more symptoms concerning for CAUTI and (4) urine culture with no more than two species of organism of which at least one is a bacterium of ≥105 CFU/mL) [Centers for Disease Control and Prevention (CDC). Urinary Tract Infection (Catheter-Associated Urinary Tract Infection [CAUTI] and Non-Catheter-Associated Urinary Tract Infection [UTI]) and Other Urinary System Infection [USI]) Events, 2019.].

MICROBIOLOGICAL METHODS

Urine of all patients was sampled immediately before and 24 hours, and 48 hours post-surgery (cesarean section) and subjected to routine and microscopy examination and culture and sensitivity. Urine was collected as per the guidelines described earlier for culture and sensitivity with aseptic precautions and was transported immediately to the laboratory in a sterile container. The significant bacteriuria was 105 cfu/ml was taken into consideration while confirmation as CAUTI. The identification and antibiotic sensitivity was done by the disc diffusion test as recommended by European Committee on Antimicrobial Susceptibility Testing (EUCAST) guidelines.

DATA COLLECTION

The data were collected using socio-demographic and clinical data sheets. These were all extracted from the patient's medical records in these units and daily observations of the nurses. The Infection control nurse collected all the details like name of the patient, age, date of catheterization, laboratory reports during her daily rounds. All data were collected using the Urinary Tract Infection (UTI) Checklist. It is scrutinized for the signs and symptoms as per CDC/NHSN criteria for confirmation as CAUTI. Caesarean section procedure was performed by conventional manner in all cases. The time of onset of surgery was designated as zero hour. The duration of surgery was defined as interval between the onset of surgery till completion of skin closure, measured by standard clock. The duration of hospital stay was defined as the time from onset of surgery to the hospital discharge. Discom-

Table I. Distribution of catheter-associated urinary tract infections (CAUTIs) after caesarean section (CSEC) procedures in the participating hospitals

Hospital	No. of CSEC procedures	CAUTIs (n/%)	95% CI
A	1,149	157/13.7	12.3 – 14.7
B	1,242	133/10.7	9.8 – 11.6
C	1,128	127/11.3	10.4 – 12.2
D	1,083	186/17.2	16.1 – 18.4
E	982	112/11.4	10.4 – 12.4
G	1,123	176/15.7	14.6 – 16.8
H	988	93/9.4	8.5 – 10.3
I	1,022	131/12.8	11.8 – 13.9
J	996	117/11.7	10.7 – 12.7
K	1,087	168/15.5	14.4 – 16.6
L	988	122/12.3	11.3 – 13.3
M	979	163/16.6	15.4 – 18.8
N	1,007	159/158	14.7 – 16.9
O	989	186/18.8	17.6 – 20.0
P	1,129	138/12.2	11.2 – 13.2
Total	15,892	2,168/13.,6	13.3 – 13.9

CI, confidence interval

fort at first voiding was defined as burning, urging and difficulty at voiding. The time of first voiding was defined into two ways; First, as the time interval between removal of urinary catheter and first spontaneous voiding. Second, as the time interval from the onset of surgery and first spontaneous voiding. The time of first ambulation was defined as interval between onset of surgery and the time patient first ambulated. Method of voiding was noted in the form of use of bedpan or bathroom. Febrile morbidity due to UTI and postoperative urinary retention was also noted.

ETHICS

Ethical approval was obtained from the ethics committee of the Shupyk National Healthcare University of Ukraine, including the aim of the study and confirmation that all data collected, will be kept confidential and used for scientific research only. Informed consent was obtained from the study participants. Women who did not give informed consent for this study were excluded. The Study complies with the Declaration of Helsinki.

STATISTICAL ANALYSIS

Data entry and statistical analysis were done using EXCEL and SPSS 10.0 statistical software package. Data were presented using descriptive statistics in the form of frequencies and percentages. Results were compared and analysed using unpaired student t-test. In this study all statistical analyses were two-sided and significance was set at $P < 0.05$.

RESULTS

PREVALENCE OF CAUTI

In this study total 15,892 catheterized women undergoing primary CSEC without any medical complication or pre-existing Urinary Tract Infections were included from January 2020 to December 2022. Total numbers of catheterized days were 63,568. Catheterization days ranged from 2 days to 9 days. During the study period applying CDC/NHSN methods of detection, a total of 2,168 CAUTIs were identified from 15,892 CSEC procedures. The prevalence of CAUTIs after CSEC in Ukraine was 13.6% [95% confidence interval (CI) 13.3-13.9].

The CAUTIs cases after CSEC in the participating hospitals varied significantly. This study showed that the situation with CAUTI after CSEC in Ukraine varies greatly by region. Lower CAUTIs percentages were reported by Ukrainian regions in the east and west while higher percentages were reported in the central region, north, and south of Ukraine. In terms of regions, fluctuations of the indicator values were observed – from the smallest in Volyn and Rivne region to the largest in Odessa, Lviv, Poltava region, and in Kyiv. Distribution of a catheterized women with CAUTIs undergoing primary CSEC delivery admitted to the women's hospitals of Ukraine are presented in Table I.

Table II. Characteristics of participants with catheter-associated urinary tract infections (CAUTI) after caesarean section (CSEC) in Ukraine (2020-2022)

Variables	Number of participants (n)	CAUTI		95% CI
		n	%	
Age of patricipants				
≤20	936	95	10.1	9.1 – 11.1
21-25	1,218	161	13.2	12.2 – 14.2
26-30	2,336	316	13.5	12.8 – 14.2
31-35	2,983	362	12.1	11.5 – 12.7
36-40	3,874	570	14.7	14.1 – 13.3
41-45	2,811	381	13.6	12.9 – 14.3
46-50	978	152	15.5	14.3 – 16.7
≥51	756	131	17.3	15.9 – 18.7
Total	15,892	2,168	13.6	13.3 – 13.9

CI, confidence interval

Table III. Distribution of microorganisms (n=2,168) identified in catheter-associated urinary tract infections (CAUTIs) after caesarean section (CSEC) in catheterized women in Ukraine (2020-2022)

Microorganisms	All isolates	Percentages, %
Gram-positive cocci	692	27,3
Staphylococcus aureus	91	13,1
Coagulase-negative staphylococci	162	23,4
Enterococcus species	265	38,3
Streptococcus species	108	15,6
Other Gram-positive cocci	66	9,5
Gram-negative bacilli	1,559	71,9
Enterobacteriales	1,196	76,7
Escherichia coli	421	35,2
Citrobacter species	91	7,6
Enterobacter species	103	8,6
Klebsiella pneumoniae	89	7,4
Proteus mirabilis	274	22,9
Serratia marcescens	59	4,9
Providencia stuartii	159	13,3
Gram-negative non- fermentative bacilli	363	23,3
Acinetobacter species	34	9,4
Pseudomonas aeruginosa	157	19,8
Stenotrophomonas maltophilia	72	3.3%
Fungi	17	0,8
Candida species	17	0,8
Total	2,168	100

The CAUTI rates were 5.8% [95% CI 5.6 – 6.0] after elective cesarean delivery and 7.8% [95% CI 7.6 – 8.0] after urgent CSEC. None of the patients died as a result of CAUTIs after CSEC procedure. The median time the duration of catheterized period for all CAUTIs was four days. The median age of women included in this study was 30 years (range 20–51). Characteristics of a catheterized women with CAUTI undergoing primary CSEC delivery admitted to the women's hospitals of Ukraine are presented in Table II.

ANTIBIOTIC PROPHYLAXIS

In our study 100% of women for whom information was collected were given antimicrobial prophylaxis. In most hospitals (12/15) the first choice of antibiotic

agent was ceftriaxone. A further three hospitals used cefazoline or cefotaxim. Of 15,892 CSEC delivery participants who underwent chart review, 11,872 (74.7%) were prescribed combination ceftriaxone and metronidazole postpartum.

CAUSING PATHOGENS OF CAUTI

In this study a total of 2,971 different bacterial strains were isolated from 2,168 a catheterized women are with CAUTIs undergoing primary CSEC delivery. Causative microorganisms were recorded for all of the CAUTIs. Of all CAUTIs 37% (803/2,168) were reported to be polymicrobial. Gram-negative bacilli make up 71,9% and 31.9% gram-positive cocci from of all isolates. The most commonly identified pathogen were *Escherichia coli* (19.4%), *Proteus mirabilis* (12.6%), and *Enterococcus* species (12.2%). Other pathogens included Coagulase-negative staphylococci (7.5%),

Providencia stuartii (7.3%), *Pseudomonas aeruginosa* (7.2%), *Streptococcus* species (5%), *Enterobacter* species (4.8%), *Staphylococcus aureus* (4.2%), Citrobacter species (4.2%), *Klebsiella pneumoniae* (4.1%), *Stenotrophomonas maltophilia* (3.3%), *Serratia marcescens* (2.7%), *Acinetobacter* species (1.6), and *Candida* species (0.8%). Distribution of microorganisms identified in CAUTIs after CSEC in catheterized women in Ukraine shown in Table III.

ANTIMICROBIAL RESISTANCE

Bacterial uropathogens isolated from patients with CAUTI after CSEC revealed the presence of multidrug resistant pathogens. Imipenem was the single best antibiotic for all pathogens except P. aeruginosa where Amikacin was the drug of choice. The Acinetobacter species also showed very high resistance to all antibiotics except Imipenem. The overall proportion of extended spectrum beta-lactamases (ESBL) production among *Enterobacteriales* was 21.7%. The prevalence of ESBL production among *E. coli* isolates was significantly higher than in *K.pneumoniae* (29.7%, vs 13.8%). Resistance to third-generation cephalosporins was observed in 10.5% K. pneumoniae and *E. coli* 14.7% isolates. Methicillin resistance was observed in 9.1% of *S.aureus* (MRSA) and 7,5% CoNS (MRSE). Vancomycin resistance was observed in 5.7% of isolated enterococci (VRE). In this study carbapenem resistance was identified in 11.8% of *P.aeruginosa* isolates.

DISCUSSION

This study presents the first prospective multicenter cohort study for current prevalence of CAUTIs in catheterized women undergoing primary CSEC and antimicrobial resistance of responsible pathogens in Ukraine. Our study showed that CAUTIs in catheterized women undergoing primary CSEC in Ukraine is a common occurrence. The prevalence of CAUTIs after CSEC in Ukraine was 13.6%. The situation with CAUTI after CSEC in Ukraine varies greatly by region. The most common uropathogens were *E. coli* (19.4%), *P. mirabilis* (12.6%), and *Enterococcus* spp. (12.2%) followed by CoNS (7.5%), *P. stuartii* (7.3%) and *P.aeruginosa* (7.2%) from the cases of CAUTI. Our study showed that CAUTIs after CSEC in women in Ukraine were significantly associated with pathogens resistant to antibiotics. Many uropathogens isolated from CAUTI cases in Ukraine were found to be multidrug resistant. These findings correlate with various other studies [15, 16] where multidrug resistant uropathogens were isolated. Increase in the antibiotic resistance amongst the uropathogens indicates that they are hospital acquired and thus difficult to treat. This will be more dangerous if infection prevention practices are not followed during care of the catheterized patients. Possibly, higher incidence rate of CAUTIs after CSEC in Ukraine were significantly associated with many risk factors and antimicrobial resistance of responsible pathogens.

CSEC is a standard obstetric procedure initially recognized as a life-saving intervention to reduce maternal and fetal mortality. The rate of CSES has seen a soar in the past few decades. Urinary catheter (UC) can keep the bladder empty during CSEC procedure, preventing bladder injury and avoiding postoperative urinary retention [17, 18]. Most UTIs acquired in the hospital are associated with a urinary catheter, which is a tube inserted into the bladder through the urethra to drain urine. Therefore, catheters should only be used for appropriate indications and should be removed as soon as they are no longer needed. According to literature, the conventional time for UC removal is immediately after or within 12–24 h of CSEC [19]. Previous studies have reported that delayed UC removal following CSEC could reduce urinary urgency, decrease the incidence of urinary retention, and avoid recatheterization [17, 20]. However, growing evidence has demonstrated that early UC removal after CSEC can reduce the occurrence of UTI, contribute to early ambulation and reduce the length of hospital stay [21]. Onile et al. suggested that UC should be removed immediately after CSEC to minimize the risk of UTI [22]. However, Pandey et al. suggested that routine use of an indwelling UC during CSEC was unscientific and unnecessary, and use of an indwelling UC should be based on the prenatal physical condition of the pregnant woman [23]. Taken together, these studies indicate that the optimal time for UC removal following CS remains debatable [24].

Due to CAUTIs there is increase in the hospital stay of the patient along with increase in the use of higher antibiotics. Multiple risk factors can affect the occurrence of CAUTI. These include quality of aseptic technique, duration of catheterization, appropriate hand hygiene and care of catheter. They directly reflect on the quality care of the hospital. CAUTIs occur with high incidence if preventive protocols are not maintained. The most common practices shall include hand hygiene, close drainage system, aseptic method for insertion and catheter care along with daily need assessment with evidence-based observations. Our study showed moderate to high resistance in few uropathogens which is a concern for all in Ukraine.

Given of the rapidly developing antimicrobial resistance, the policy of antibiotic use for CAUTIs after CSEC treatment in each region should be determined depending on local data on resistance to antimicrobials. The chances of transmission of these multi drug resistant are high if health care workers do not follow preventive practices meticulously [25]. Optimizing the management and empirical antimicrobial therapy may reduce the burden of UTIs, but prevention is the key element. This investigation provides valuable data as a first study for national surveillance of CAUTIs and potential comparison with data from other countries.

CONCLUSIONS

Our study showed that CAUTIs in catheterized women undergoing primary CSEC in Ukraine is a common occurrence and many cases are caused by pathogens that are resistant to antibiotics. Given of the rapidly developing antimicrobial resistance, the policy of antibiotic use for CAUTIs after CSEC treatment in each region should be determined depending on local data on resistance to antimicrobials. Optimizing the management and empirical antimicrobial therapy may reduce the burden of CAUTIs in catheterized women undergoing primary CSEC, but prevention is the key element.

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ORCID and contributorship:
Aidyn G. Salmanov: 0000-0002-4673-1154 [A,C-F]
Volodymyr Artyomenko: 0000-0003-2490-375X [B- D, F]
Olena M. Susidko: 0000-0002-4840-0033 [B-D, F]
Svitlana M. Korniyenko: 0000-0003-3743-426X [B-D, F]
Orusia A. Kovalyshyn: 0000-0002-9710-0694 [B-D, F]
Oleksandr A. Voloshyn: 0000 0002- 6586- 5449 [B-D, F]
Oleg V. Golyanovskiy: 0000-0002-5524-4411 [B-D, F]

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The Authors declare no conflict of interest

CORRESPONDING AUTHOR

Aidyn G. Salmanov
Shupyk National Healthcare University of Ukraine
9 Dorohozhytska St., 04112 Kyiv, Ukraine
tel: +380667997631
e-mail: mozsago@gmail.com

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A - Work concept and design, **B** – Data collection and analysis, **C** – Responsibility for statistical analysis, **D** – Writing the article, **E** – Critical review, **F** – Final approval of the article