ORIGINAL ARTICLE

CONTENTS

Epidemiology of healthcare-associated endometritis after surgical abortion in Ukraine: results a multicenter study

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ABSTRACT

Aim: To determine the current prevalence of healthcare-associated endometritis after surgical abortion and antimicrobial resistance of responsible pathogens in Ukraine.

Materials and Methods: We performed a prospective, multicentre cohort study was based on surveillance data of healthcare-associated endometritis after legal induced surgical abortion. Women who underwent induced surgical abortion at gynecological departments of 16 regional hospitals between 2020 and 2022 are included in the study. Definitions of endometritis were adapted from the CDC/NHSN. Antibiotic susceptibility was done by the disc diffusion test as recommended by EUCAST.

Results: Among 18,328 women who underwent surgical abortion, 5,023 (27.4%) endometritis were observed. Of all post-abortion endometritis cases, 95.3% were detected after hospital discharge. The prevalence of endometritis in different types surgical abortion was: after vacuum aspiration at < 14 weeks, 23.8%, and after dilatation and evacuation at ≥ 14 weeks, 32%. The most responsible pathogens of post-abortion endometritis are *Escherichia coli* (24.1%), *Enterococcus* spp. (14.3%), *Enterobacter* spp. (12,8%), *Pseudomonas aeruginosa* (8.3%), *Proteus mirabilis* (6.6%), *Serratia marcescens* (6.2%), *Staphylococcus aureus* (5.9%), and *Stenotrophomonas maltophilia* (5.7%). A significant proportion these pathogens developed resistance to several antimicrobials, varying widely depending on the bacterial species, antimicrobial group.

Conclusions: Results this study suggest a high prevalence of endometritis after surgical abortion in Ukraine. A significant proportion of women were affected by endometritis caused by bacteria developed resistance to several antimicrobials. Optimizing the antibiotic prophylaxis may reduce the burden of endometritis after surgical abortion, but prevention is the key element.

KEY WORDS: surgical abortion, vacuum aspiration, dilatation and evacuation, endometritis, responsible pathogens, antimicrobial resistance, Ukraine

Wiad Lek. 2024;77(5):894-901. doi: 10.36740/WLek202405103 DOI

INTRODUCTION

An induced abortion is one of the most common gynecological procedures in worldwide. Between 1990-2019, the global unintended pregnancy rate has declined, whereas the proportion of unintended pregnancies ending in abortion has increased. Abortion is sought and needed even in settings where it is restricted—that is, in countries where it is prohibited altogether or is allowed only to save the women's life or to preserve her physical or mental health. Unintended pregnancy rates are highest in countries that restrict abortion access and lowest in countries where abortion is broadly legal. As a result, abortion rates are similar in countries where abortion is restricted and those where the procedure is broadly legal (i.e., where it is available on request or on socioeconomic grounds) [1].

Despite well-developed abortion methods, there are known risks and adverse effects that must be considered. One known complication of induced abortion is infection, which is relatively uncommon in the current era of safe, surgical abortion. Potential complications related to abortions include pain, bleeding, an incom-

plete abortion, or an infection in the upper genital tract that causes endometritis, oophoritis, parametritis, and salpingitis [2, 3]. The reported incidence of post-abortion infections in world varies between studies, likely depending on local differences in diagnostics, the study population, laws and regulations, and the prevalence of sexually transmitted diseases.

According to the literature, infections related to abortions are often caused by an ascending bacterial infection such as chlamydia, gonorrhea, mycoplasma and bacterial vaginosis that proceeds from the lower genitals and moves through the cervix to the uterus [4]. The infection, if untreated, can spread to the fallopian tubes and may lead to infertility [2, 5, 6].

The World Health organization (WHO) recommends antibiotic prophylaxis to prevent infectious complications associated with abortions. However, the WHO points out that there is only evidence for prophylactic antibiotics performing a surgical abortion when the risk of infections is more evident [7]. Additionally, antibiotic prophylaxis for all women undergoing abortion procedures likely results in overuse of antibiotics, which is associated with antibiotic resistance [8]. Antibiotic treatment is given if/when a bacterial infection is identified, which could be before, during, or after the abortion. Prior research indicated that the timing of antibiotic administration relative to the timing of the abortion does not affect the rate of post-abortion infection [9,10]. Surgical abortion is one of the most common gynecological procedures in Ukraine, but there is still little knowledge about the epidemiology and microbiology of post-abortion endometritis.

AIM

The aim this study to determine the current prevalence of healthcare-associated endometritis after surgical abortion in women and antimicrobial resistance of responsible pathogens in Ukraine.

MATERIALS AND METHODS

STUDY DESIGN, SETTING AND POPULATION

We performed a prospective, multicentre cohort study was based on surveillance data of healthcare-associated endometritis after legal induced surgical abortion. Women who underwent induced surgical abortion at gynecological department of 16 regional hospitals between 2020 and 2022 are included in the study. Bacterial screening for chlamydia, gonorrhea, mycoplasma, and bacterial vaginosis was performed prior to the abortions. The eligibility criteria for the study were: being a woman aged 15–49; being a resident of the study site. Exclusion criteria: women after of medical abortion, chlamydial infections, syphilis or other sexually transmitted bacterial infections, patients with diagnosis of bacterial vaginosis, candidiasis and trichomoniasis, participation in a clinical trial using antibiotics or genital microbicides.

DEFINITION

The criteria for healthcare-associated endometritis after surgical abortion were adapted from the Centers for Disease Control and Prevention's (CDC) and National Healthcare Safety Network's (NHSN) case definitions. In this study abortion— Disruption of an embryo or fetus implanted in the uterus. A pregnancy does not begin until after the implantation of the blastocyst, ~7 d after fertilization. Abortions may be spontaneous or induced. Induced abortion—An abortion that is deliberately caused for elective or therapeutic medical reasons. Incomplete abortion—An abortion in which some, but not all, of the products of conception (including placenta and amniotic membranes) remain in the uterus. Surgical methods of abortion (surgical abortion)— Use of transcervical procedures for terminating pregnancy, including vacuum aspiration, and dilatation and evacuation (D&E). Vacuum aspiration (electrical or manual; EVA or MVA) — Vacuum aspiration involves evacuation of the contents of the uterus through a plastic or metal cannula, attached to a vacuum source. Electric vacuum aspiration (EVA) employs an electric vacuum pump. The healthcare provider dilates (widens) the cervix and inserts a tube attached to a vacuum and pump. It uses suction to remove tissue from the uterus. With manual vacuum aspiration (MVA), the vacuum is created using a handheld, hand-activated, plastic 60 ml aspirator (also called a syringe). D&E is used after 12–14 weeks of pregnancy. D&E requires preparation of the cervix using osmotic dilators and/or pharmacological agents, and evacuating the uterus primarily with forceps orceps, using vacuum aspiration to remove to remove any remaining blood or tissue. Gestational age (duration of pregnancy) — The number of days or weeks since the first day of the woman's last normal menstrual period (LMP) in women with regular cycles. For women with irregular cycles or when LMP is unknown, gestational age is the size of the uterus, estimated in weeks, based on clinical examination or ultrasound, that corresponds to a pregnant uterus of the same gestational age dated by LMP [11].

DATA COLLECTION

Abortion complications, categorized as healthcare-associated endometritis were assessed in women who

Table 1. Distribution of 5,023 healthcare-associated endometritis after surgical abortion in Ukrainian hospitals, 2020-2022

Type of procedure	Number of patients	Endometritis		95% CI
		n	%	
Vacuum aspiration at < 14 weeks	10,216	2,431	23,8	23,5-24.1
Dilatation and evacuation at ≥ 14 weeks	8,112	2,592	32	31,5-32.5
Total	18,328	5,023	27,4	27,1-27.7

Table 2. Distribution of pathogens isolated from women with healthcare-associated endometritis after surgical abortion in Ukrainian hospitals, 2020-2022

Microorganisms	Number of isolates (n)	Percentage (%)
Gram-positive cocci	1,906	28.1
Staphylococcus aureus	397	5.9
Coagulase-negative staphylococci	287	4.2
Enterococcus spp.	968	14.3
Streptococcus spp.	254	3.7
Gram-negative bacilli	4,878	71.9
Escherichia coli	1,637	24.1
Enterobacter spp.	868	12.8
Proteus mirabilis	451	6.6
Serratia marcescens	422	6.2
Stenotrophomonas maltophilia	388	5.7
Citrobacter spp.	281	4.1
Pseudomonas aeruginosa	564	8.3
Acinetobacter baumannii	267	3.9
Total	6,784	100.0

came in contact with the gynecological clinic within 30 days after the procedure. Required data collected through checklist containing demographic and clinical information such as patient age, gestational age, gestational history, length of hospital stay, cause of abortion, patient's symptoms, cervical condition, complications of abortion, instruments used in abortion if manipulated, microbiological and radiographic investigations, antibiotics usage, and culture and sensitivity of the clinical isolates, and the person performing the abortion. The discharged women were advised for ongoing follow-up care for a month after surgical abortion in the outpatient department. In this study information regarding the post-abortion period following discharge was obtained from the outpatient records and from records documenting follow-up by referring gynecologists.

MICROBIOLOGICAL METHODS

In this study all samples were obtained from women with clinical symptoms of endometritis. All microbial isolates were identified using standard microbiological techniques. Antibiotic susceptibility testing isolates was performed according to the recommendations of the European Committee on Antimicrobial Susceptibility Testing (EUCAST).

ETHICS

In this study all patients gave written consent before the surgical abortion and the study was approved by the Ethics Committee of Shupyk National Healthcare University of Ukraine. Women were excluded if they did not give written consent for adult women and parental/caregiver informed consent and informed assent for women under the age of 18 and if there were no conditions for the interview to be conducted in privacy.

STATISTICAL ANALYSIS

Statistical analysis was performed using STATA 11.0 (StataCorp, College Station, TX) and SAS 9.2 (SAS Institute, Inc, Cary, NC). The data were described using frequencies and proportions. Descriptive statistics, Student's t test, $\chi 2$, and Fisher's exact test were performed as appropriate. The primary outcome, composite 30-day major postoperative infections, was analyzed as a dichotomous variable (Yes/No). Results our study

are expressed as median (range), mean ± standard deviation for continuous variables, and number and corresponding percentage for qualitative variables. The likelihood ratio test statistic was used to compared to the chi-squared distribution of the model and a p-value calculated. Only variables with a p-value of <0.05 based on likelihood ratio testing were included in the final model; therefore, some variables identified on univariate analysis were not included in the final regression model as they did not significantly impact the analysis.

RESULTS

PREVALENCE OF ENDOMETRITIS

A total of 18,328 first-trimester surgical abortions were performed during the study period (2020-2022). Of the 18,328 women evaluated, 10,216 (55.7%) underwent a vacuum aspiration at < 14 weeks and 8,112 (44.3%) underwent a dilatation and evacuation at ≥ 14 weeks. Endometritis cases were registered in 5,023 (27.4%, 95% CI 27.1-27.7%) of all surgical abortions. Of the total post-abortion endometritis cases, 95.3% were detected after hospital discharge. The prevalence of endometritis in different types surgical abortion was: after vacuum aspiration at < 14 weeks, 23.8% (95% CI 23.5-24.1%), and after dilatation and evacuation at ≥ 14 weeks, 32% (95% CI 31.5-32.5%). The distribution of endometritis after surgical abortion in Ukrainian hospitals is shown in Table 1.

The prevalence of endometritis after surgical abortion varied widely within Ukraine, from <10% in three (18.7%) of 16 regional hospitals to ≥20% in eight (50%), mostly in southern (Kherson, Odesa, Dnipro, Kropyvnytskyi, Zaporizhzhia), eastern (Kharkiv), and central (Kyiv, Zhytomyr) Ukraine. An increase in the incidence of post-abortion endometritis was observed in 9 (56.3%) out of 16 regional hospitals, mostly in southern (Kherson, Odesa, Dnipro, Kropyvnytskyi, Zaporizhzhia), eastern (Kharkiv), and central (Kyiv, Zhytomyr, Vinnitsia) Ukraine.

Preoperatively, in 97.6% patients used ultrasound and 78.4% gave perioperative antibiotics. Of all women who positive for one or several bacteria and therefore received antibiotics, 31.7% developed a post-abortion infection. At most hospitals, most surgical abortion was performed under combined local anesthesia and intravenous sedation (74.8%); only 6.2% indicated deep sedation or general anesthesia were used exclusively. Postoperatively, in 51.3% of patients performed immediate tissue examination and for 36.3% of women offered postabortion contraception on the same day as the abortion. Other assessed outcomes included medication regimens and cervical preparation, with a high degree of consistency among facilities and physicians.

RESPONSIBLE PATHOGENS AND ANTIMICROBIAL RESISTANCE

In total, 6,784 pathogens (Gram-negative and -positive bacteria) were isolated from patients with post-abortion endometritis. The predominant post-abortion endometritis pathogens were: *Escherichia coli* (24.1%), *Enterococcus* spp. (14.3%), *Enterobacter* spp. (12.8%), *Pseudomonas aeruginosa* (8.3%), *Proteus mirabilis* (6.6%), *Serratia marcescens* (6.2%), *Staphylococcus aureus* (5.9%), *Stenotrophomonas maltophilia* (5.7%), followed by coagulase-negative staphylococci (4.2%), *Citrobacter* spp. (4.1%), *Acinetobacter baumannii* (3.9%), and *Streptococcus* spp. (3.7%). Distribution of pathogens isolated from women with healthcare-associated endometritis after surgical abortion are presented in Table 2.

Antimicrobial susceptibility testing data were available for all pathogens causing healthcare-associated endometritis after surgical abortion. The antimicrobial resistance reported by Ukrainian hospitals varied widely, depending on the bacterial species, antimicrobial group and geographical region. In this study methicillin/oxacillin resistance was found in 14.8% of *S. aureus* (MRSA), and vancomycin resistance was found in 10.9% of enterococci. Antimicrobial resistance to third-generation cephalosporins was detected in 32.1% of all *Enterobacterales*, and was most common among *E. coli* (27.4%). Carbapenem resistance was found in 14.9% of *Enterobacterales*. Antimicrobial resistance to carbapenems was detected in 37.4% of all non-fermentative, Gram-negative bacteria, and was most common among *P. aeruginosa* (35.7%), and *A. baumannii* (44.2%).

DISCUSSION

This study, to the best of our knowledge the first largest prospective, controlled study to date, we evaluated the prevalence of endometritis after surgical abortion. Additionally, this was the first study of phenotypic characterization of antibiotic resistance of responsible pathogens isolated from patients with endometritis after surgical abortions. This study expands upon the previous reports and is the first study to publish prevalence healthcare-associated endometritis and antimicrobial resistance of responsible pathogens in Ukraine [3, 12].

Induced abortion is one of the most common surgical procedures in Ukraine. Abortion in Ukraine is legal on request during the first twelve weeks of pregnancy. Between 12 and 28 weeks, abortion is available on a

variety of grounds, including medical, social and personal grounds, and for any reason with the approval of a commission of physicians. As of 2010, the abortion rate was 21.2 abortions per 1000 women aged 15–44. In 2018, the abortion rate increased to 247 abortions per 1000 live births. Throughout 2019 almost 75 000 women had an abortion in Ukraine. According to the Ministry of Healthcare of Ukraine, the number of abortions in 2019 reached 74 606, including 727 abortions experienced by minor individuals.

Infection after surgical abortion is considered a very dangerous complication, not only causing inflammation of the reproductive organs, leading to infertility but also life-threatening. However, recognizing signs of infection after abortion is still difficult, because these signs have many similarities with common symptoms.

It is important to understand the underlying physiology that makes post-abortion endometritis such a dangerous complication of pregnancy. Pregnancy begins with the implantation of the blastocyst into the endometrial lining of the uterus. The placenta develops at the point of implantation, becoming the primary interface with the woman's body and the seat of the fetal-maternal communication system that regulates pregnancy. The embryo/fetus develops inside a membranous sac within the uterine cavity. Endometritis occurs as a result of an infection in the lining of the uterus, known as the endometrium. Such infections may develop due to abnormal bacteria, or bacteria usually found in the vagina. The cervix is the opening to the uterus, and it usually keeps bacteria out of the uterus. However, bacteria can get in when the cervix is open. This may happen for various reasons, such as during childbirth or surgery. The infectious agents that produce endometritis after surgical abortion arise from the polymicrobial environment of the vagina and lower genital tract, reaching the uterine cavity through ascending infection. When bacteria gain access to the endometrium, they can spread rapidly to uterine cavity. Devitalized tissue is often present in the uterine cavity in surgical abortions, allowing bacteria to flourish. The confluence of these physiological and microbiological factors explains why infection of the endometrium can disease in such a post-abortion endometritis.

Once the amniotic membranes have ruptured, the risk of infections increases with increasing duration of rupture of the membranes [13, 14]. Incomplete abortion is a powerful risk factor for death from infection. The death-to-case ratio for women with incomplete abortion is over 50 times higher than that for those who have adequate evacuation of the products of conception; the comparative mortality ratio is approximately 18 times higher. Retained tissue provides a nidus for the development of local infection, which then leads to generalized sepsis [15].

Healthcare-associated endometritis after surgical abortion is one of the most important complications of pregnancy that can occur as a result of manipulation. In the literature there are few data on the incidence of clinically significant pelvic infection after surgical abortion. The most healthcare-associated infections after surgical abortion include endometritis, bacterial vaginitis, oophoritis, parametritis, cervicitis, adnexa utery, salpingitis, chorioamnionitis, and other reproductive tract infections [2, 3]. The reported incidence of post-abortion infections varies between studies, likely depending on local differences in diagnostics, the study population, laws and regulations. In Sweden a frequency of 2.4% for infectious complications from medical abortions and 4.9% from surgical abortions [9]. Another study conducted in Sweden and Norway investigated the infection rate after surgical abortions. They reported infections among 4.8% of the patients [10]. These patients had not received any prophylactic antibiotics. Several studies have shown that pre-abortion treatment for BV [10, 16] is effective in reducing the rate of post-abortion infections.

In procedures that access the endometrial cavity through the cervix, some bacterial contamination is inevitable. The reported infection rate following first trimester surgical abortion ranges widely due to various clinical practices and degrees of ascertainment and diagnostic biases. According to the literature, prevalence of healthcare - associated endometritis is estimated is between 9.7% [17] and 25.9% [3]. In our study, the total endometritis frequency after surgical abortions was 27.4%. Of all endometritis cases, 95.3% were detected after hospital discharge. The prevalence of endometritis in different types surgical abortion was: after vacuum aspiration at < 14 weeks, 23.8%, and after dilatation and evacuation at ≥ 14 weeks, 32%.

Endometritis after surgical abortion results from the ascension of bacteria from the cervix and vagina into the uterus. The uterus does not harbour microorganisms until the amniotic sac ruptures, which thus provides passage for bacteria to ascend into the uterus. Microorganisms tend to harbour in an endometrium that is then devitalized and injured. In any pelvic procedure, if proper asepsis is not maintained or if the woman has an untreated vaginal infection prior to a pelvic intervention such as dilatation, curettage, or endometrial aspiration, then the risk of endometritis is higher.

The most bacteria involved in post-abortion infections are found in the normal vaginal flora, which ascend to cause infections of the uterus and upper genital tract, if favorable conditions for growth are present [18, 19].

Cervical and uterine cultures, cultures of the placenta and of any evacuated products of conception.

According to the literature, the main responsible pathogens of healthcare-associated endometritis are *E. coli, Enterococcus* spp., *S. aureus, P. aeruginosa, Enterobacter* spp. [3, 12, 20]. Our results which is consistent with previous research.

Prompt diagnosis, speedy intervention, and rapid escalation of care are of critical importance. The internationally recognized standard of care is prompt intervention with broad-spectrum antibiotic coverage and removal of the products of conception to prevent infectious complications [21]. The selective use of antibiotics for prophylaxis is one of the key advances in infection control. Clinicians should understand when antibiotic prophylaxis is indicated and when it is not. Indeed, inappropriate use of antibiotics contributes to the development of antibiotic resistant bacteria and can therefore also lead to morbidity. The antimicrobial resistance of responsible pathogens reported by Ukrainian hospitals during study period varied widely, depending on the bacterial species, antimicrobial group and geographical region. Previous studies found a high prevalence of healthcare-associated reproductive tract infection caused by multidrug-resistant organisms in hospitals, varying on geographical region of Ukraine [3, 12, 17, 20, 22, 23]. These data underscore the importance of tracking antimicrobial resistance responsible pathogens of healthcare-associated endometritis.

STRENGTHS AND LIMITATIONS

One of the strengths in this study is the size of the study group. A total of 4945 induced abortions were included, which gave a fairly accurate depiction of the incidence of endometritis after surgical abortion. Another strength in this study is the prospective multicentre observational cohort study, based on endometritis after surgical abortions surveillance data and using CDC/NHSN methodology.

The limitations in this study included that it was performed in regional hospitals only. The prevalence of endometritis after surgical abortions and antimicrobial resistance of responsible pathogens in other hospitals was not investigated. Another limitation is that various individuals were involved in categorizing the endometritis after surgical abortions. This may have resulted in misdiagnosis. The timeline of 30 days regarding the follow-up of the patients proved to have disadvantages. Some patients did not contact the gynecological clinic for their post-abortion infections until after 30 days, which leads to an underestimation in the amount of infections. One limitation is that some patients may be missing in our statistics since they sought medical help somewhere other than at regional hospital. However, there are few private gynecological clinics in Ukraine, so it can be assumed that the majority of the infections are represented in this material.

CONCLUSIONS

When performing a surgical abortion, there is always a risk that bacteria from the lower genitals will be brought up to the uterus, causing endometritis. Results this study suggest a high prevalence of endometritis after surgical abortion in Ukraine. A significant proportion of women were affected by post-abortion endometritis caused by bacteria developed resistance to several antimicrobials, varying widely depending on the bacterial species, antimicrobial group. To reduce antimicrobial resistance of responsible pathogens of endometritis after surgical abortion, it is necessary to develop and implement advanced infection control measures based on surveillance data. Lack of evidence on the effect of routine antibiotic prophylaxis for prevention infections after surgical abortion and antimicrobial resistance calls for further research. Optimizing the antibiotic prophylaxis may reduce the burden of endometritis after surgical abortion, but prevention is the key element.

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We thank the participating hospitals and the infection control community for their diligent efforts in performing the prevalence surveys for endometritis after legal induced abortion in Ukraine. The findings and conclusions in this study are those of the authors.

CONFLICT OF INTEREST

The Authors declare no conflict of interest

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RECEIVED: 21.12.2023
ACCEPTED: 27.04.2024